Interventions for preventing obesity in children (Review)

Summerbell CD, Waters E, Edmunds L, Kelly SAM, Brown T, Campbell KJ

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[Intervention Review]

Interventions for preventing obesity in children

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ABSTRACT

Background

Obesity prevention is an international public health priority. The prevalence of obesity and overweight is increasing in child populations throughout the world, impacting on short and long-term health. Obesity prevention strategies for children can change behaviour but efficacy in terms of preventing obesity remains poorly understood.

Objectives

To assess the effectiveness of interventions designed to prevent obesity in childhood through diet, physical activity and/or lifestyle and social support.

Search strategy

MEDLINE, PsycINFO, EMBASE, CINAHL and CENTRAL were searched from 1990 to February 2005. Non-English language papers were included and experts contacted.

Selection criteria

Randomised controlled trials and controlled clinical trials with minimum duration twelve weeks.

Data collection and analysis

Two reviewers independently extracted data and assessed study quality.

Main results

Twenty-two studies were included; ten long-term (at least 12 months) and twelve short-term (12 weeks to 12 months). Nineteen were school/preschool-based interventions, one was a community-based intervention targeting low-income families, and two were family-based interventions targeting non-obese children of obese or overweight parents.

Six of the ten long-term studies combined dietary education and physical activity interventions; five resulted in no difference in overweight status between groups and one resulted in improvements for girls receiving the intervention, but not boys. Two studies

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focused on physical activity alone. Of these, a multi-media approach appeared to be effective in preventing obesity. Two studies focused on nutrition education alone, but neither were effective in preventing obesity.

Four of the twelve short-term studies focused on interventions to increase physical activity levels, and two of these studies resulted in minor reductions in overweight status in favour of the intervention. The other eight studies combined advice on diet and physical activity, but none had a significant impact.

The studies were heterogeneous in terms of study design, quality, target population, theoretical underpinning, and outcome measures, making it impossible to combine study findings using statistical methods. There was an absence of cost-effectiveness data.

Authors' conclusions

The majority of studies were short-term. Studies that focused on combining dietary and physical activity approaches did not significantly improve BMI, but some studies that focused on dietary or physical activity approaches showed a small but positive impact on BMI status. Nearly all studies included resulted in some improvement in diet or physical activity. Appropriateness of development, design, duration and intensity of interventions to prevent obesity in childhood needs to be reconsidered alongside comprehensive reporting of the intervention scope and process.

PLAIN LANGUAGE SUMMARY

Interventions for preventing obesity in children

The current evidence suggests that many diet and exercise interventions to prevent obesity in children are not effective in preventing weight gain, but can be effective in promoting a healthy diet and increased physical activity levels.

Being very overweight (obese) can cause health, psychological and social problems for children. Children who are obese are more likely to have weight and health problems as adults. Programmes designed to prevent obesity focus on modifying one or more of the factors considered to promote obesity.

This review included 22 studies that tested a variety of intervention programmes, which involved increased physical activity and dietary changes, singly or in combination. Participants were under 18 and living in Asia, South America, Europe or North America. There is not enough evidence from trials to prove that any one particular programme can prevent obesity in children, although comprehensive strategies to address dietary and physical activity change, together with psycho-social support and environmental change may help. There was a trend for newer interventions to involve their respective communities and to include evaluations.

Future research might usefully assess changes made on behalf of entire populations, such as improvements in the types of foods available at schools and in the availability of safe places to run and play, and should assess health effects and costs over several years.

The programmes in this review used different strategies to prevent obesity so direct comparisons were difficult. Also, the duration of the studies ranged from 12 weeks to three years, but most lasted less than a year.

BACKGROUND

Obesity

The prevalence of obesity and overweight is increasing in both adult and childhood populations throughout the world (WHO 1997; Lobstein 2004). Current estimates of the prevalence of overweight and obesity in school-aged children from 34 countries range from those seen in Malta (25% overweight, 8% obese) and the US (25% overweight, 7% obese) to those seen in Lithuania (5% overweight, 1% obese) and Latvia (6% overweight, 1% obese) (Janssen 2005). Data from a large survey of young children (aged 1 month to 4 years) in England show a rise in the prevalence of overweight since 1990, and current estimates are now meeting those of school-aged children (Bundred 2001).

Developing consistent approaches to the clinical assessment of childhood obesity is a priority issue in this field (Barlow 1998) and international standardised cut-points have been proposed (Cole 2000). Current expert opinion supports the use of body mass index (BMI) cutoff points for children and adolescents, but experts are divided as to which centiles should be used for comparison (

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Bellizzi 1999; Reilly 2002). The lack of a consistent measurement of obesity in children makes it difficult to compare studies that have used different measures and weight outcomes. A variety of indicators of adiposity were collected for this review reflecting this inconsistency and also to produce a more comprehensive evaluation of change given that the use of BMI as an outcome measure can be relatively insensitive over time and between children and between different types of interventions (i.e. diet or physical activity).

Overweight and obesity in childhood are known to have significant impact on both physical and psychosocial health. Indeed, many of the cardiovascular consequences that characterise adult-onset obesity are preceded by abnormalities that begin in childhood. Hyperlipidaemia, hypertension and abnormal glucose tolerance occur with increased frequency in obese children and adolescents (Freedman 1999) and children are now presenting with type 2 diabetes (Arslanian 2002). In addition, obesity in childhood is known to be an independent risk factor for adult obesity (Whitaker 1997). Guo and Chumlea report that the risk of developing adult obesity (BMI>28) in children aged >9 years who are obese (defined as BMI above the 95th percentile for weight), is up to 80% at age 35 years (Guo 1999). Furthermore, there is evidence of an association between adolescent obesity and increased risks for health in adult life (Must 1992; Must 1999; Power 1997). For example, Must et al. found that adolescent overweight predicted a broad range of adverse health effects that were independent of adult weight (Must 1992). The relative risks among men were 1.8 (95 percent confidence interval, 1.2 to 2.7; P = 0.004) for mortality from all causes and 2.3 (95 percent confidence interval, 1.4 to 4.1; P = 0.002) for mortality from coronary heart disease. Overweight in adolescence was a more powerful predictor of risk than overweight in adulthood.

Causes of childhood obesity

The increasing prevalence of childhood obesity is a result of an increased energy content of the diet, decreased levels of physical activity, and increasingly sedentary lifestyles (Brownell 1994; Jeffery 1987; Prentice 1995). A vast number of cultural and environmental factors have been identified as contributing to problem. Increases in overweight and obesity have occurred in the context of the rising incidence of asthma, behavioural problems, and mental health concerns, the reductions in injury, an increase in family breakdown, reductions in family size, urban and metropolitan sprawl and greater community dissonance. The impact of these factors is experienced unequally at a population level, with a significant trend in developed countries observed between poorer health and lower socioeconomic status. A range of different trend patterns in developing countries is observed, although this is poorly characterised. This changing environmental context calls for a multifactorial response.

The policy context

The rising prevalence of obesity in children has resulted in a significant policy response from many countries and governments around the globe. A number of evidence reviews have been called for (described below), resulting in a range of recommendations, depending on the scope of the review. The responses and programs have followed through with a combination of government initiatives and industry responses. Government initiatives, in some countries, have funded programs for after school activity, removal of vending machines in schools and strategies to replace sweet drinks with access to water, nutritional labelling on food products, walking school bus systems, modification of school lunch systems, to active transport. Industry responses range from changes in fast food offerings towards increased fruit and vegetables on the menus, and a plethora of commercial fitness industry programs targeted to the apparent needs of children.

Previous reviews

There are a number of extremely useful evidence reviews available which have focussed on outcomes such as healthy eating, physical activity, or levels of overweight and obesity in children. Considering just those that have been published since 2002, a number of reviews have been produced in Canada. One, as part of the Effective Public Health Practice Project (EPHPP), is a review entitled "Effectiveness of physical activity enhancement and obesity prevention programs in children and youth (Healthy Weights Review) which can be viewed at: http://www.hamilton.ca/phcs/ephpp/. In addition, Canada have also published guidance entitled "Addressing Childhood Obesity: The Evidence for Action" which is available at this web site: http://www.caphc.org/partnerships_obesity.html. In addition, the Calgary Health Region are currently completing a systematic review to develop best practice recommendations for the prevention of overweight and obesity in children, with a focus on immigrant families new to industrialized countries. In the US, the Oregon Evidence-based Practice Centre has published a review entitled "Screening and Interventions for overweight children and adolescents" for the United States Preventive Services Task Force which is available at: http://www.ahcpr.gov/clinic/uspstfix.htm.

While not directly concerned with obesity prevention, a number of reviews have considered the effectiveness of interventions to promote healthy eating and physical activity in children (e.g. EPPI Centre, UK; EPHPP, Canada). Two UK agencies have published clinical guidelines for the management of childhood obesity in 2002 (Scottish Intercollegiate Guidelines Network available at http://www.sign.ac.uk; Royal College of Paediatrics, London at http://www.rcpch.ac.uk). The National Health and Medical Research Council of Australia has developed guidelines for the management of overweight and obesity in adults and children, (http://www.health.gov.au/hfs/nhmrc/advice/mgtobsty.htm).

However, it is becoming increasingly clear that decision makers

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need much more information upon which to base policy and program decisions, than has been sought in the past. More recently, economic analyses of the

long term consequences of overweight and obesity in adults have highlighted the significant economic input of doing nothing versus opportunities for health improvements (Avenell 2004) (http://www.hta.nhsweb.nhs.uk).

This review

This review aimed to provide an update of evidence from studies which have employed a study design which sought to compare the effect of interventions to prevent childhood obesity between those who have received the intervention and those who have not. We aimed to update the previous review (Campbell 2002) by examining new research evidence. In addition, we included information (where available) in the review which has been sought by public health and health promotion decision makers, such as the context in which the intervention was conducted, the extent to which the interventions were conducted as intended, whether all participants were exposed or received the intervention, the economic outcomes, the experience of participants and the difference in effectiveness between socioeconomic background. We used the guidance for Systematic Reviews of Health Promotion and Public Health Interventions (Jackson 2004) to help guide this new aspect of the review.

OBJECTIVES

The main objective of the review is to determine the effectiveness of educational, health promotion and/or psychological/family/behavioural therapy/counselling/management interventions which focus on diet, physical activity and/or lifestyle support, and were designed, or had an underlying intention to prevent obesity/further weight gain, in children as assessed by change in Body Mass Index (BMI). Specific objectives include:

- Evaluation of the effect of dietary educational interventions versus control on changes in BMI, prevalence of obesity, rate of weight gain and other outcomes among children under 18 years;
- Evaluation of the effect of physical activity interventions versus control on changes in BMI, prevalence of obesity and rate of weight gain and other outcomes among children under 18 years;
- Evaluation of the effect of dietary educational interventions versus physical activity intervention on changes in BMI, prevalence of obesity and rate of weight gain and other outcomes among children under 18 years;
- Evaluation of combined effects of dietary educational interventions and physical activity interventions versus control on changes in BMI, prevalence of obesity and rate of weight gain and other outcomes among children under 18 years.

Secondary aims are to describe the interventions in order to identify the characteristics of the interventions that are related to both positive and negative outcomes. Specific objectives include:

- Evaluation of demographic characteristics of participants (socio-economic status, gender, age, ethnicity, geographical location, etc.);
- Evaluation of particular process indicators (i.e. those that describe why and how a particular intervention has worked);
- Evaluation of contextual factors contributing to the performance of the intervention;
- Evaluation of the maintenance of short-term changes beyond 12 weeks.

METHODS

Criteria for considering studies for this review

Types of studies

We included data from controlled trials (with or without randomisation), with a minimum duration of twelve weeks. Studies were categorised into long-term (at least one year) and short-term (at least twelve weeks). The length of study refers to the intervention itself or to a combination of the intervention with a follow-up phase.

Studies in which individuals were randomised were accepted and studies in which groups of individuals were randomised were accepted. For those with group randomisation only studies with 6 or more groups were accepted.

Changes to the protocol

The protocol for this review included studies of minimum one year. Duration referred to the intervention itself or to a combination of the intervention with a follow-up phase. However, in light of the very small numbers of studies (n=3) that met this criterion for the first version of this review (published in 2001) we changed the criteria to include shorter term studies with minimum duration three months. The reviewers are aware of susceptibility of post hoc questions to bias (Alderson 2005a). We reviewed our protocol in light of the Cochrane Guidelines for Health Promotion and Public Health Reviews (Jackson 2004) and changed the inclusion criteria of this study to exclude studies published before 1990.

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Types of participants

We included studies of children less than 18 years at the commencement of the study, including studies where children were part of a family group receiving the intervention if data could be extracted separately for the children. Studies with interventions that included children who were already obese at baseline were included to reflect a public health approach that recognises the prevalence of a range of weight within the general population of children. We excluded studies of interventions designed to prevent obesity in pregnant women and studies designed for children with a critical illness or severe co-morbidities.

Types of interventions

Strategies

We included educational, health promotion, psychological/family/behavioural therapy/counselling/management strategies.

Interventions included

We included studies of interventions that involved diet and nutrition, exercise and physical activity, lifestyle and social support were included.

Setting

Interventions within the community, school or clinic-based were included.

Types of comparison

We included studies which compared diet and/or physical activity interventions to a non-intervention control group that received usual care or another active intervention (i.e. head-to-head comparisons).

Intervention personnel

There was no restriction on who delivered the interventions for example researchers, primary care physicians (general practioners), nutrition/diet professionals, teachers, physical activity professionals, health promotion agencies, health departments, specialist doctors or others.

Indicators of theory and process

Data on indicators of intervention process and evaluation, health promotion theory underpinning intervention design, modes of strategies and attrition rates from these trials were collected. We compared where possible, whether the effect of the intervention varied according to these factors. However, as the total number of studies was few, this information was included in descriptive analyses.

Interventions excluded

We excluded studies of interventions designed specifically for the treatment of childhood obesity and studies designed to treat eating disorders such as anorexia and bulimia nervosa.

Types of outcome measures

To be included, studies have to report one or more of the following primary outcomes, presenting a baseline and a post-intervention measurement. This data could be used to evaluate change from baseline if not reported within the study.

Primary outcomes included:

- weight and height;
- percent fat content;
- body mass index;
- ponderal index;
- skin-fold thickness;

Secondary outcomes included:

- activity levels;
- dietary intake (using validated measures such as diaries etc);
- change in knowledge;
- environment change (such as food provision service);
- stakeholders views of the intervention and other evaluation findings;
- measures of self-esteem, health status and wellbeing, quality of life;
- harm associated with the process or outcomes of the intervention;
- cost effectiveness/costs of the intervention.

Search methods for identification of studies

Compared with the search strategy used for previous versions of this review, we extended the search strategy, and the databases searched, for this update to include those that may provide corroborative evidence in keeping with the Health Promotion and Public Health Interventions Systematic Review Handbook (Jackson 2004). Databases were searched from 1990 to February 2005. Studies were not excluded on the basis of language.

Databases searched

The following databases were searched from 1990 to February 2005: MEDLINE (strategy below), EMBASE (Table 1), the Cochrane Central register of controlled trials (CENTRAL) (Issue 1 2005 of The Cochrane Library) (Table 2), PsycINFO (Table 3) and CINAHL (Table 4). We used the search strategy listed below for MEDLINE and adapted it for use in other databases.

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Table 1. Search strategy for EMBASE

Dates 1990 to 2005
1. exp OBESITY/
2. exp Weight Gain/
3. exp Weight Loss/
4. obes$.af.
5. (weight gain or weight loss).af.
6. (overweight or over weight or overeat$ or over eat$).af.
7. weight change$.af.
8. ((bmi or body mass index) adj2 (gain or loss or change)).af.
9. or/1-8
10. exp Behavior Therapy/
11. exp Social Support/
12. exp Family Therapy/
13. exp Psychotherapy, Group/
14. ((psychological or behavio?r$) adj (therapy or modif$ or strateg$ or intervention$)).af.
15. (group therapy or family therapy or cognitive therapy).af.
16. ((lifestyle or life style) adj (chang$ or intervention$)).af.
17. counsel?ing.af.
18. social support.af.
19. (peer adj2 support).af.
20. (children adj3 parent$ adj therapy).af.
21. or/10-20
22. exp OBESITY/dh [Diet Therapy]
23. exp Diet, Fat-Restricted/
24. exp Diet, Reducing/
25. exp Diet Therapy/
26. exp FASTING/
27. (diets or diet or dieting).af.
28. (diet$ adj (modif$ or therapy or intervention$ or strateg$)).af.
29. (low calorie or calorie control$ or healthy eating).af.
30. (fasting or modified fast$).af.
31. exp Dietary Fats/
32. (fruit or vegetable$).af.
33. (high fat$ or low fat$ or fatty food$).af.
34. formula diet$.af.
35. or/22-34
36. exp EXERCISE/
37. exp Exercise Therapy/
38. exercis$.af.
39. (aerobics or physical therapy or physical activity or physical inactivity).af.
40. (fitness adj (class$ or regime$ or program$)).af.
41. (aerobics or physical therapy or physical training or physical education).af.
42. dance therapy.af.
43. sedentary behavio?r.af.
44. or/36-43
45. exp Complementary Therapies/
46. (alternative medicine or complementary therap$ or complementary medicine).af.
47. (hypnotism or hypnosis or hypnotherapy).af.

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Table 1. Search strategy for EMBASE (*Continued*)

48. (acupuncture or homeopathy or homoeopathy).af.
49. (chinese medicine or indian medicine or herbal medicine or ayurvedic).af.
50. or/45-49
51. ((diet or dieting or slim$) adj (club$ or organi?ation)).af.
52. (weightwatcher$ or weight watcher$).af.
53. (correspondence adj (course$ or program$)).af.
54. (fat camp$ or diet$ camp$).af.
55. or/51-54
56. exp Health Promotion/
57. exp Health Education/
58. (health promotion or health education).af.
59. (media intervention$ or community intervention$).af.
60. health promoting school$.af.
61. ((school or community)adj2 program$).af.
62. ((school or community)adj2 intervention$).af.
63. (family intervention$ or parent$ intervention).af.
64. (parent$ adj2 (behavio?r or involve$ or control$ or attitude$ or educat$)).af.
65. or/56-64
66. exp Health Policy/
67. exp Nutrition Policy/
68. (health polic$ or school polic$ or food polic$ or nutrition polic$).af.
69. or/66-68
70. exp OBESITY/pc [Prevention & Control]
71. exp Primary Prevention/
72. (primary prevention or secondary prevention).af.
73. (preventive measure$ or preventative measure$).af.
74. (preventive care or preventative care).af.
75. (obesity adj2 (prevent$ or treat$)).af.
76. or/70-75
77. exp Clinical Trial/
78. exp Randomized Controlled Trial/
79. exp Randomization/
80. exp Double-Blind procedure/
81. exp Single-Blind procedure/
82. exp Crossover procedure/
83. clinical trial.tw.
84. ((singl$ or doubl$ or treble$ or tripl$) and (mask$ or blind$)).tw.
85. latin square.tw.
86. exp PLACEBO/
87. placebo$.tw.
88. random$.tw.
89. Comparative Study/
90. exp Evaluation/
91. clinical trial.tw.
92. clinical trial.pt.
93. latin square.tw.
94. (before adj2 after adj3 (stud$ or trial$ or design$)).tw.
95. ((singl$ or doubl$ or trebl$ or tripl$) adj5 (blind$ or mask)).tw.
96. placebo$.tw.

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Table 1. Search strategy for EMBASE (*Continued*)

97. random$.tw.
98. (matched communities or matched schools or matched populations).tw.
99. control$.tw.
100. (comparison group$ or control group$).tw.
101. matched pairs.tw.
102. (outcome study or outcome studies).tw.
103. (quasiexperimental or quasi experimental or pseudo experimental).tw.
104. (nonrandomi?ed or non randomi?ed or pseudo randomi?sed or quasi randomi?ed).tw.
105. prospectiv$.tw.
106. volunteer$.tw.
107. or/77-107
108. 21 or 35 or 44 or 50 or 55 or 65 or 69 or 76
109. 9 and 108 and 107
110. Animals/
111. exp CHILD/
112. exp ADOLESCENT/
113. exp CHILD, PRESCHOOL/or CHILD/
114. exp INFANT/
115. (child$ or adolescen$ or infant$).af.
116. (teenage$ or young people or young person or young adult$).af.
117. (schoolchildren or school children).af.
118. (pediatr$ or paediatr$).af.
119. (boys or girls or youth or youths).af.
120. or/111-119
121. 109 not 110
122. 121 and 120
123. limit 122 to yr=1990-2005

Table 2. Search strategy for CENTRAL (on The Cochrane Library)

Issue 1 2005

1. exp OBESITY/
2. exp Weight Gain/
3. exp Weight Loss/
4. obes$.af.
5. (weight gain or weight loss).af.
6. (overweight or over weight or overeat$ or over eat$).af.
7. weight change$.af.
8. ((bmi or body mass index) adj2 (gain or loss or change)).af.
9. or/1-8
10. exp Behavior Therapy/
11. exp Social Support/
12. exp Family Therapy/
13. exp Psychotherapy, Group/
14. ((psychological or behavio?r$) adj (therapy or modif$ or strateg$ or intervention$)).af.
15. (group therapy or family therapy or cognitive therapy).af.
16. ((lifestyle or life style) adj (chang$ or intervention$)).af.

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Table 2. Search strategy for CENTRAL (on The Cochrane Library) (*Continued*)

17. counsel?ing.af.
18. social support.af.
19. (peer adj2 support).af.
20. (children adj3 parent$ adj therapy).af.
21. or/10-20
22. exp OBESITY/dh [Diet Therapy]
23. exp Diet, Fat-Restricted/
24. exp Diet, Reducing/
25. exp Diet Therapy/
26. exp FASTING/
27. (diets or diet or dieting).af.
28. (diet$ adj (modif$ or therapy or intervention$ or strateg$)).af.
29. (low calorie or calorie control$ or healthy eating).af.
30. (fasting or modified fast$).af.
31. exp Dietary Fats/
32. (fruit or vegetable$).af.
33. (high fat$ or low fat$ or fatty food$).af.
34. formula diet$.af.
35. or/22-34
36. exp EXERCISE/
37. exp Exercise Therapy/
38. exercis$.af.
39. (aerobics or physical therapy or physical activity or physical inactivity).af.
40. (fitness adj (class$ or regime$ or program$)).af.
41. (aerobics or physical therapy or physical training or physical education).af.
42. dance therapy.af.
43. sedentary behavio?r.af.
44. or/36-43
45. exp Complementary Therapies/
46. (alternative medicine or complementary therap$ or complementary medicine).af.
47. (hypnotism or hypnosis or hypnotherapy).af.
48. (acupuncture or homeopathy or homoeopathy).af.
49. (chinese medicine or indian medicine or herbal medicine or ayurvedic).af.
50. or/45-49
51. ((diet or dieting or slim$) adj (club$ or organi?ation)).af.
52. (weightwatcher$ or weight watcher$).af.
53. (correspondence adj (course$ or program$)).af.
54. (fat camp$ or diet$ camp$).af.
55. or/51-54
56. exp Health Promotion/
57. exp Health Education/
58. (health promotion or health education).af.
59. (media intervention$ or community intervention$).af.
60. health promoting school$.af.
61. ((school or community)adj2 program$).af.
62. ((school or community)adj2 intervention$).af.
63. (family intervention$ or parent$ intervention).af.
64. (parent$ adj2 (behavio?r or involve$ or control$ or attitude$ or educat$)).af.
65. or/56-64

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Table 2. Search strategy for CENTRAL (on The Cochrane Library) (*Continued*)

66. exp Health Policy/
67. exp Nutrition Policy/
68. (health polic$ or school polic$ or food polic$ or nutrition polic$).af.
69. or/66-68
70. exp OBESITY/pc [Prevention & Control]
71. exp Primary Prevention/
72. (primary prevention or secondary prevention).af.
73. (preventive measure$ or preventative measure$).af.
74. (preventive care or preventative care).af.
75. (obesity adj2 (prevent$ or treat$)).af.
76. or/70-75
77. randomized controlled trial.pt.
78. controlled clinical trial.pt.
79. exp Controlled Clinical Trials/
80. exp Random Allocation/
81. exp Double-Blind Method/
82. exp Single-Blind Method/
83. exp Placebos/
84. *Research Design/
85. exp Intervention studies/
86. exp Evaluation studies/
87. exp Comparative Study/
88. exp Follow-Up Studies/
89. exp Prospective Studies/
90. exp Cross-over Studies/
91. clinical trial.tw.
92. clinical trial.pt.
93. latin square.tw.
94. (time adj series).tw.
95. (before adj2 after adj3 (stud$ or trial$ or design$)).tw.
96. ((singl$ or doubl$ or trebl$ or tripl$) adj5 (blind$ or mask)).tw.
97. placebo$.tw.
98. random$.tw.
99. (matched communities or matched schools or matched populations).tw.
100. control$.tw.
101. (comparison group$ or control group$).tw.
102. matched pairs.tw.
103. (outcome study or outcome studies).tw.
104. (quasiexperimental or quasi experimental or pseudo experimental).tw.
105. (nonrandomi?ed or non randomi?ed or pseudo randomi?sed or quasi randomi?ed).tw.
106. prospectiv$.tw.
107. volunteer$.tw.
108. or/77-107
109. 21 or 35 or 44 or 50 or 55 or 65 or 69 or 76
110. 9 and 109 and 108
111. Animals/
112. exp CHILD/
113. exp CHILD, PRESCHOOL/or CHILD/
114. exp INFANT/

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Table 2. Search strategy for CENTRAL (on The Cochrane Library) (*Continued*)

115. (child$ or adolescen$ or infant$).af.
116. (teenage$ or young people or young person or young adult$).af.
117. (schoolchildren or school children).af.
118. (pediatr$ or paediatr$).af.
119. (boys or girls or youth or youths).af.
120. or/112-119
121. 110 not 111
122. 121 and 120

Table 3. Search strategy for PsycINFO

Date 1990 to 2005
1. exp OBESITY/
2. exp Weight Gain/
3. exp Weight Loss/
4. obes$.af.
5. (weight gain or weight loss).af.
6. (overweight or over weight or overeat$ or over eat$).af.
7. weight change$.af.
8. ((bmi or body mass index) adj2 (gain or loss or change)).af.
9. or/1-8
10. exp Behavior Therapy/
11. exp Social Support/
12. exp Family Therapy/
13. exp Psychotherapy, Group/
14. ((psychological or behavio?r$) adj (therapy or modif$ or strateg$ or intervention$)).af.
15. (group therapy or family therapy or cognitive therapy).af.
16. ((lifestyle or life style) adj (chang$ or intervention$)).af.
17. counsel?ing.af.
18. social support.af.
19. (peer adj2 support).af.
20. (children adj3 parent$ adj therapy).af.
21. or/10-20
22. exp OBESITY/dh [Diet Therapy]
23. exp Diet, Fat-Restricted/
24. exp Diet, Reducing/
25. exp Diet Therapy/
26. exp FASTING/
27. (diets or diet or dieting).af.
28. (diet$ adj (modif$ or therapy or intervention$ or strateg$)).af.
29. (low calorie or calorie control$ or healthy eating).af.
30. (fasting or modified fast$).af.
31. exp Dietary Fats/
32. (fruit or vegetable$).af.
33. (high fat$ or low fat$ or fatty food$).af.
34. formula diet$.af.
35. or/22-34

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Table 3. Search strategy for PsycINFO (*Continued*)

36. exp EXERCISE/
37. exp Exercise Therapy/
38. exercis$.af.
39. (aerobics or physical therapy or physical activity or physical inactivity).af.
40. (fitness adj (class$ or regime$ or program$)).af.
41. (aerobics or physical therapy or physical training or physical education).af.
42. dance therapy.af.
43. sedentary behavio?r.af.
44. or/36-43
45. exp Complementary Therapies/
46. (alternative medicine or complementary therap$ or complementary medicine).af.
47. (hypnotism or hypnosis or hypnotherapy).af.
48. (acupuncture or homeopathy or homoeopathy).af.
49. (chinese medicine or indian medicine or herbal medicine or ayurvedic).af.
50. or/45-49
51. ((diet or dieting or slim$) adj (club$ or organi?ation)).af.
52. (weightwatcher$ or weight watcher$).af.
53. (correspondence adj (course$ or program$)).af.
54. (fat camp$ or diet$ camp$).af.
55. or/51-54
56. exp Health Promotion/
57. exp Health Education/
58. (health promotion or health education).af.
59. (media intervention$ or community intervention$).af.
60. health promoting school$.af.
61. ((school or community)adj2 program$).af.
62. ((school or community)adj2 intervention$).af.
63. (family intervention$ or parent$ intervention).af.
64. (parent$ adj2 (behavio?r or involve$ or control$ or attitude$ or educat$)).af.
65. or/56-64
66. exp Health Policy/
67. exp Nutrition Policy/
68. (health polic$ or school polic$ or food polic$ or nutrition polic$).af.
69. or/66-68
70. exp OBESITY/pc [Prevention & Control]
71. exp Primary Prevention/
72. (primary prevention or secondary prevention).af.
73. (preventive measure$ or preventative measure$).af.
74. (preventive care or preventative care).af.
75. (obesity adj2 (prevent$ or treat$)).af.
76. or/70-75
77. 21 or 35 or 44 or 50 or 55 or 65 or 69 or 76
78. Animals/
79. (child$ or adolescen$ or infant$).af.
80. (teenage$ or young people or young person or young adult$).af.
81. (schoolchildren or school children).af.
82. (pediatr$ or paediatr$).af.
83. (boys or girls or youth or youths).af.
84. or/79-82

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Table 3. Search strategy for PsycINFO (*Continued*)

85. 9 and 77 and 84
86. 85 not 78

Table 4. Search strategy for CINAHL

Date 1990 to 2005
1. exp OBESITY/
2. exp Weight Gain/
3. exp Weight Loss/
4. obes$.af.
5. (weight gain or weight loss).af.
6. (overweight or over weight or overeat$ or over eat$).af.
7. weight change$.af.
8. ((bmi or body mass index) adj2 (gain or loss or change)).af.
9. or/1-8
10. exp Behavior Therapy/
11. exp Social Support/
12. exp Family Therapy/
13. exp Psychotherapy, Group/
14. ((psychological or behavio?r$) adj (therapy or modif$ or strateg$ or intervention$)).af.
15. (group therapy or family therapy or cognitive therapy).af.
16. ((lifestyle or life style) adj (chang$ or intervention$)).af.
17. counsel?ing.af.
18. social support.af.
19. (peer adj2 support).af.
20. (children adj3 parent$ adj therapy).af.
21. or/10-20
22. exp OBESITY/dh [Diet Therapy]
23. exp Diet, Fat-Restricted/
24. exp Diet, Reducing/
25. exp Diet Therapy/
26. exp FASTING/
27. (diets or diet or dieting).af.
28. (diet$ adj (modif$ or therapy or intervention$ or strateg$)).af.
29. (low calorie or calorie control$ or healthy eating).af.
30. (fasting or modified fast$).af.
31. exp Dietary Fats/
32. (fruit or vegetable$).af.
33. (high fat$ or low fat$ or fatty food$).af.
34. formula diet$.af.
35. or/22-34
36. exp EXERCISE/
37. exp Exercise Therapy/
38. exercis$.af.
39. (aerobics or physical therapy or physical activity or physical inactivity).af.
40. (fitness adj (class$ or regime$ or program$)).af.
41. (aerobics or physical therapy or physical training or physical education).af.

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Table 4. Search strategy for CINAHL (*Continued*)

42. dance therapy.af.
43. sedentary behavio?r.af.
44. or/36-43
45. exp Complementary Therapies/
46. (alternative medicine or complementary therap$ or complementary medicine).af.
47. (hypnotism or hypnosis or hypnotherapy).af.
48. (acupuncture or homeopathy or homoeopathy).af.
49. (chinese medicine or indian medicine or herbal medicine or ayurvedic).af.
50. or/45-49
51. ((diet or dieting or slim$) adj (club$ or organi?ation)).af.
52. (weightwatcher$ or weight watcher$).af.
53. (correspondence adj (course$ or program$)).af.
54. (fat camp$ or diet$ camp$).af.
55. or/51-54
56. exp Health Promotion/
57. exp Health Education/
58. (health promotion or health education).af.
59. (media intervention$ or community intervention$).af.
60. health promoting school$.af.
61. ((school or community)adj2 program$).af.
62. ((school or community)adj2 intervention$).af.
63. (family intervention$ or parent$ intervention).af.
64. (parent$ adj2 (behavio?r or involve$ or control$ or attitude$ or educat$)).af.
65. or/56-64
66. exp Health Policy/
67. exp Nutrition Policy/
68. (health polic$ or school polic$ or food polic$ or nutrition polic$).af.
69. or/66-68
70. exp OBESITY/pc [Prevention & Control]
71. exp Primary Prevention/
72. (primary prevention or secondary prevention).af.
73. (preventive measure$ or preventative measure$).af.
74. (preventive care or preventative care).af.
75. (obesity adj2 (prevent$ or treat$)).af.
76. or/70-75
77. exp study design/
78. exp evaluation research/
79. exp comparative studies/
80. exp Random Assignment/
81. exp Random sample/
82. exp Placebos/
83. exp Prospective Studies/
84. clinical trial.tw.
85. clinical trial.pt.
86. (clin$ adj25 (trial$ or stud$)).mp. [mp=title, cinahl subject headings, abstract, instrumentation]
87. latin square.tw.
88. (time adj series).tw.
89. (before adj2 after adj3 (stud$ or trial$ or design$)).tw.
90. ((singl$ or doubl$ or trebl$ or tripl$) adj5 (blind$ or mask)).tw.

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Table 4. Search strategy for CINAHL (*Continued*)

91. placebo$.tw.
92. random$.tw.
93. (matched communities or matched schools or matched populations).tw.
94. control$.tw.
95. (comparison group$ or control group$).tw.
96. matched pairs.tw.
97. (outcome study or outcome studies).tw.
98. (quasiexperimental or quasi experimental or pseudo experimental).tw.
99. (nonrandomi?ed or non randomi?ed or pseudo randomi?sed or quasi randomi?ed).tw.
100. prospectiv$.tw.
101. volunteer$.tw.
102. or/77-101
103. 21 or 35 or 44 or 50 or 55 or 65 or 69 or 76
104. Animals/
105. exp CHILD/
106. exp ADOLESCENT/
107. exp CHILD, PRESCHOOL/or CHILD/
108. exp INFANT/
109. (child$ or adolescen$ or infant$).af.
110. (teenage$ or young people or young person or young adult$).af.
111. (schoolchildren or school children).af.
112. (pediatr$ or paediatr$).af.
113. (boys or girls or youth or youths).af.
114. or/105-113
115. 9 and 103
116. 115 and 102 and 114
117. 116 not 104

MEDLINE (through Ovid)

Searched 12 February 2005/16 February 2005

1. exp OBESITY/
2. exp Weight Gain/
3. exp Weight Loss/
4. obes$.af.
5. (weight gain or weight loss).af.
6. (overweight or over weight or overeat$ or over eat$).af.
7. weight change$.af.
8. ((bmi or body mass index) adj2 (gain or loss or change)).af.
9. or/1-8
10. exp Behavior Therapy/
11. exp Social Support/
12. exp Family Therapy/
13. exp Psychotherapy, Group/
14. ((psychological or behavio?r$) adj (therapy or modif$ or strateg$ or intervention$)).af.
15. (group therapy or family therapy or cognitive therapy).af.
16. ((lifestyle or life style) adj (chang$ or intervention$)).af.
17. counsel?ing.af.
18. social support.af.
19. (peer adj2 support).af.
20. (children adj3 parent$ adj therapy).af.
21. or/10-20

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22. exp OBESITY/dh [Diet Therapy]

23. exp Diet, Fat-Restricted/

24. exp Diet, Reducing/

25. exp Diet Therapy/

26. exp FASTING/

27. (diets or diet or dieting).af.

28. (diet$ adj (modif$ or therapy or intervention$ or strateg$)).af.

29. (low calorie or calorie control$ or healthy eating).af.

30. (fasting or modified fast$).af.

31. exp Dietary Fats/

32. (fruit or vegetable$).af.

33. (high fat$ or low fat$ or fatty food$).af.

34. formula diet$.af.

35. or/22-34

36. exp EXERCISE/

37. exp Exercise Therapy/

38. exercis$.af.

39. (aerobics or physical therapy or physical activity or physical inactivity).af.

40. (fitness adj (class$ or regime$ or program$)).af.

41. (aerobics or physical therapy or physical training or physical education).af.

42. dance therapy.af.

43. sedentary behavio?r.af.

44. or/36-43

45. exp Complementary Therapies/

46. (alternative medicine or complementary therap$ or complementary medicine).af.

47. (hypnotism or hypnosis or hypnotherapy).af.

48. (acupuncture or homeopathy or homoeopathy).af.

49. (chinese medicine or indian medicine or herbal medicine or ayurvedic).af.

50. or/45-49

51. ((diet or dieting or slim$) adj (club$ or organi?ation)).af.

52. (weightwatcher$ or weight watcher$).af.

53. (correspondence adj (course$ or program$)).af.

54. (fat camp$ or diet$ camp$).af.

55. or/51-54

56. exp Health Promotion/

57. exp Health Education/

58. (health promotion or health education).af.

59. (media intervention$ or community intervention$).af.

60. health promoting school$.af.

61. ((school or community) adj2 program$).af.

62. ((school or community) adj2 intervention$).af.

63. (family intervention$ or parent$ intervention).af.

64. (parent$ adj2 (behavio?r or involve$ or control$ or attitude$ or educat$)).af.

65. or/56-64

66. exp Health Policy/

67. exp Nutrition Policy/

68. (health polic$ or school polic$ or food polic$ or nutrition polic$).af.

69. or/66-68

70. exp OBESITY/pc [Prevention & Control]

71. exp Primary Prevention/

72. (primary prevention or secondary prevention).af.

73. (preventive measure$ or preventative measure$).af.

74. (preventive care or preventative care).af.

75. (obesity adj2 (prevent$ or treat$)).af.

76. or/70-75

77. randomized controlled trial.pt.

78. controlled clinical trial.pt.

79. exp Controlled Clinical Trials/

80. exp Random Allocation/

81. exp Double-Blind Method/

82. exp Single-Blind Method/

83. exp Placebos/

84. *Research Design/

85. exp Intervention studies/

86. exp Evaluation studies/

87. exp Comparative Study/

88. exp Follow-Up Studies/

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89. exp Prospective Studies/

90. exp Cross-over Studies/

91. clinical trial.tw.

92. clinical trial.pt.

93. latin square.tw.

94. (time adj series).tw.

95. (before adj2 after adj3 (stud$ or trial$ or design$)).tw.

96. ((singl$ or doubl$ or trebl$ or tripl$) adj5 (blind$ or mask)).tw.

97. placebo$.tw.

98. random$.tw.

99. (matched communities or matched schools or matched populations).tw.

100. control$.tw.

101. (comparison group$ or control group$).tw.

102. matched pairs.tw.

103. (outcome study or outcome studies).tw.

104. (quasiexperimental or quasi experimental or pseudo experimental).tw.

105. (nonrandomi?ed or non randomi?ed or pseudo randomi?sed or quasi randomi?ed).tw.

106. prospectiv$.tw.

107. volunteer$.tw.

108. or/77-107

109. 21 or 35 or 44 or 50 or 55 or 65 or 69 or 76

110. 9 and 109 and 108

111. Animals/

112. exp CHILD/

113. exp ADOLESCENT/

114. exp CHILD, PRESCHOOL/or CHILD/

115. exp INFANT/

116. (child$ or adolescen$ or infant$).af.

117. (teenage$ or young people or young person or young adult$).af.

118. (schoolchildren or school children).af.

119. (pediatr$ or paediatr$).af.

120. (boys or girls or youth or youths).af.

121. or/112-120

122. 110 not 111

123. 122 and 121

124. limit 123 to yr=1990-2005

Websites searched

Additionally, a number of websites were searched for corroborative evidence:

- BiblioMap;
- The Evidence for Policy and Practice Information and Co-ordinating Centre (EPPI Centre) database of health promotion research, http://eppi.ioe.ac.uk;
- The Health Technology Database through the University of York NHS Centre for Reviews and Dissemination, http://www.york.ac.uk/inst/crd;
- The Health Evidence Bulletins, Wales, http://hebw.uwcm.ac.uk/;
- The Effective Public Health Practice Project, http://www.city.hamilton.on.ca/sphs/EPHPP/ephppSumRev.htm;
- HealthPromis, the public health database for England through the Health Development Agency, http://www.hda-online.org.uk/;
- The Health Development Agency's website that describes the study design terms http://www.hda.nhs.uk/evidence/indexing˙results.html;
- Evidence Network research and reviews through the Medical Research Council Social and Public Health Sciences Unit, http://www.msoc-mrc.gla.ac.uk;
- The Community Guide - Guide to Community Preventive Services - Systematic reviews and evidence-based recommendations, http://www.thecommunityguide.org/home˙f.html;
- The Food Standards Agency, http://www.food.gov.uk;
- The Department of Health, http://www.dh.gov.uk;

Copies of the full search strategies are available on request from the first author.

Contacting experts

Experts in the field of obesity prevention were contacted with a view to seeking additional references.

Reference lists checked

The reference lists of systematic reviews (identified from searches detailed above) that included information on interventions for

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the prevention of childhood obesity published since 2000 were scanned.

Management of hits

We prepared a QUOROM statement to describe how we processed the references identified through our searching (Figure 1).

The hits identified from the searches of the electronic database [Medline 3,608, CINAHL 2,390, PsycINFO 1,534, EMBASE 6,405] CENTRAL (828)] were combined (n=13,937) and de-duplicated (11,848). These list hits were then de-duplicated against the hits identified for the previous version of this review. This reduced list of hits were then screened on titles and abstracts (SK). The search of CENTRAL was carried out separately giving 828 hits. These 828 hits were not combined with the other hits, and were printed out and scrutinised separately.

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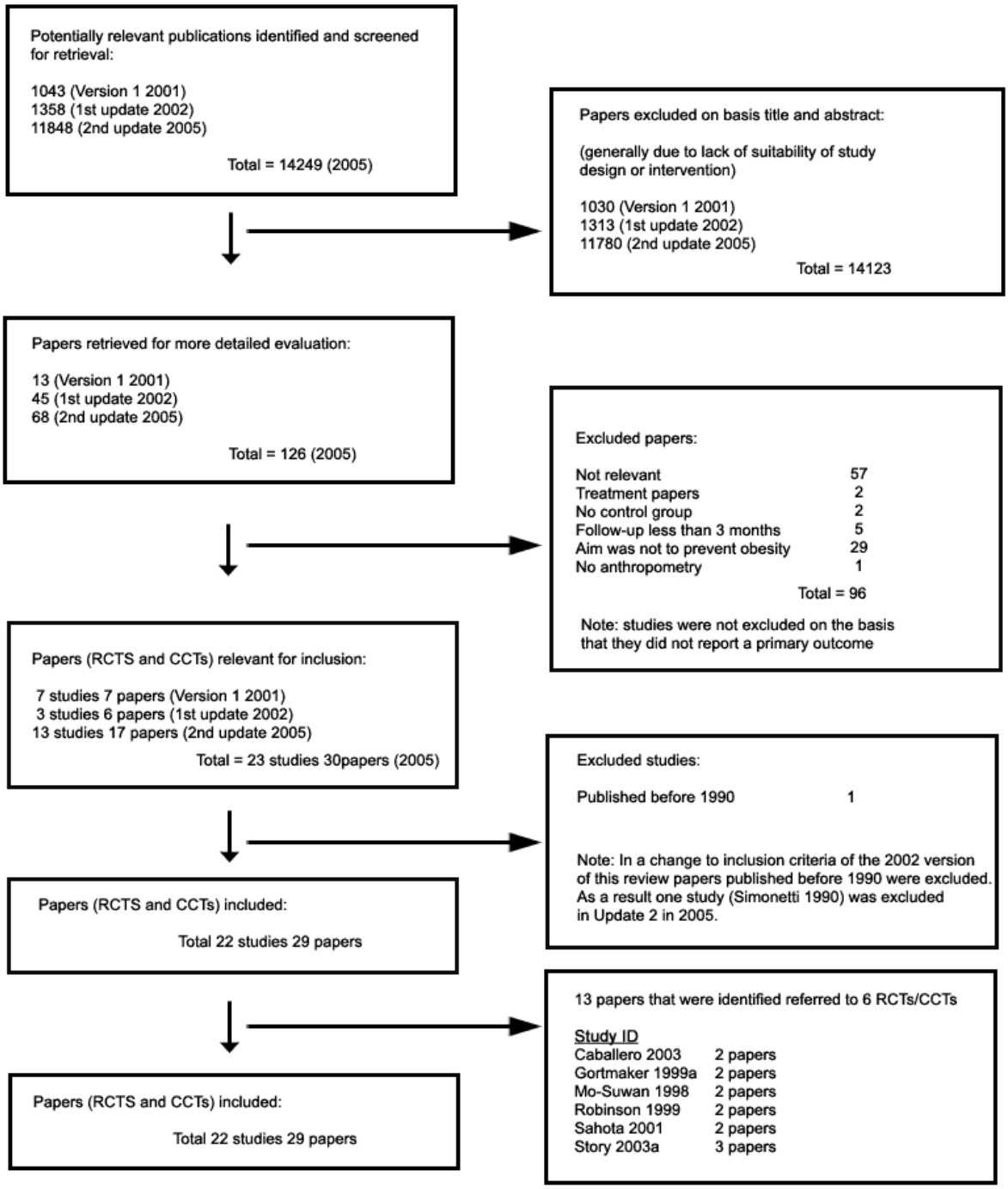
Figure 1. Quorom statement flow diagram - Interventions for preventing obesity in children



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Articles were rejected on initial screen if the reviewer could determine from the title and abstract that the article did not meet the inclusion criteria for this review.

Full-text copies of forty papers were assessed independently against the inclusion criteria by three reviewers (CS, SK and LE). Twelve new studies have been included in this version. They are the four pilots for the Girls health Enrichment Multi-site Studies GEMS (Baranowski 2003; Beech 2003; Robinson 2003; Story 2003a) as well as eight others (Caballero 2003; Dennison 2004; Harvey-Berino 2003; James 2004; Kain 2004; NeumarkSztainer 2003; Pangrazi 2003; Warren 2003). The excluded studies included a treatment study (He 2004) and those relating to a variety of studies preventing cardio-vascular disease: STRIP (Lagstrom 1997; Niinikoski 1997; Rask-Nissila 2000; Talvia 2004), CHIC (Harrell 1999; McMurray 2002), Healthy Start (Bollela 1999a; Bollela 1999b; D'Agostino 1999; Spark 1998; Williams 1998), and 16 individual prevention studies (Arbeit 1992; Burke 1998; Chomitz 2003; Dixon 2000; Harrell 1998; Hopper 1996; Horodynski 2004; Howard 1996; Koblinsky 1992; Lionis 1991; McGarvey 2004; Simon 2004; Stephens 1998; Stewart 1995; Tamir 1990; Vandongen 1995).

Data collection and analysis

Selection of studies

We included studies published during or after 1990. Included and excluded studies published from 1990 onwards that were identified for the previous versions of this review were carried forward to this review. Articles were rejected on initial screen when the reviewer determined from the title and abstract that the article was not a report of a randomised or controlled trial; or the trial did not address an intervention which aims to improve food intake, physical activity and/or prevent obesity; or the trial was exclusively in individuals greater than 18 years old, pregnant women/young adults or the critically ill; or the trial was of less than 12 weeks duration; the intervention was multi-factorial or was concerned with the treatment of eating disorders such as anorexia nervosa and bulimia nervosa.

When a title or abstract could not be rejected with certainty, the full text of the article was obtained for further evaluation. The inclusion of studies was assessed independently by two authors and differences between their assessment were resolved by discussion and, when necessary, in consultation with a third author.

Data extraction and management, and assessment of methodological quality of included studies

A data extraction form based on the Effective Public Health Practice Project Quality Assessment Tool for quantitative studies (Thomas 2003) was specifically designed for this review and was pre-tested using a sub-sample of studies.

Measures of treatment effect and process

All reported outcomes were taken directly from studies. No re-calculations were performed. Unless otherwise stated all data are presented in the format mean and standard deviation (SD) with 95% confidence intervals (CI). Results with P> 0.05 are reported as not significant (ns). Similarly, P values are not given if they were unreported in the original study.

Process factors were also sought, such as methods of involvement of relevant stakeholders during the process of planning and implementation of the intervention; descriptions of formative research, pilot studies and on-going evaluation; modification of the program, programme reach, completeness of the implementation of the intervention, maintenance of the programme after the intervention ceased.

Theoretical model

Where possible, the underlying theory of the intervention and contextual factors was noted, including historical factors, and the policy environment.

Data synthesis

Each study was summarised and described according to variables such as characteristics of participants, characteristics of interventions, follow up and outcomes measured. Methodological quality of studies were compared including methods of identifying intervention and control groups, selecting participants to measure outcomes in, comparing between groups at baseline, the statistical analyses used, and rates of attrition. Summaries of groups were undertaken where this was both possible and conceptually sound. For systematic reviews to be relevant to policy and practice it is increasingly useful for potential users of the review to be involved in key stages of the review process (Oliver 1997). This involvement can ensure that the review will address the key questions that policy-makers and practitioners consider important, consider all relevant outcomes; and present its findings and recommendations in an accessible way (Oliver 2004). We did not formally involve any new policy makers and review users in this update of the review as many of the authors of this review are currently in these positions, involved in advising on policy, and in disseminating evidence from reviews to users. However, in conducting the next update we shall ensure that we formally involve key stakeholders.

RESULTS

Description of studies

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

Ten studies met the inclusion criteria for long-term (duration 1year or more) studies (Caballero 2003; Donnelly 1996; Epstein 2001; Gortmaker 1999a; James 2004; Mo-Suwan 1998; Mueller 2001; Sahota 2001; Sallis 1993; Warren 2003). The choice of a 12-

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month follow-up period was supported by behaviour change literature which suggests that behavioural change is, in most instances, unlikely to be sustained (Prochaska 1997). Therefore, measurements of behavioural change close to the intervention are unlikely to reflect the longer term impacts of the intervention, and as such must be considered with caution.

Twelve studies met the inclusion criteria for short-term (minimum duration 3 months maximum up to but not including 1 year) (Baranowski 2003; Beech 2003; Dennison 2004; Flores 1995; Harvey-Berino 2003; Kain 2004; NeumarkSztainer 2003; Pangrazi 2003; Robinson 1999; Robinson 2003; Stolley 1997; Story 2003a). We remain mindful of the potential weaknesses (and bias) of short-term behaviour change data.

The opportunity to perform pre-specified subgroup analysis to examine heterogeneity of results was limited due to interventions being targeted at different age, gender, socioeconomic status, and ethnic/cultural groups.

Due to the range of interventions included in this review, descriptive details were integrated into the results section and can be seen in the Table of Included Studies. Details of outcomes reported in long-term studies are reported in Table 5 and for short-term studies in Table 6.

Table 5. Results of Long-Term Studies

Study ID	Primary Outcomes	Secondary Outcomes
Caballero 2003	Primary Outcomes: 1. Fatness assessed by repeat measures of height and weight (and calculated BMI), at baseline and after 3 years (end of intervention): OUTCOME: No differences between intervention and control 2. Triceps and subscapular Skinfolds. OUTCOME: No differences between intervention and control 3. Bioelectrical impedance. OUTCOME: No differences between intervention and control.	Secondary Outcomes: 1. Lunch Program: OUTCOME: Intervention school's lunches had significantly less energy from fat (4%), P = 0.005. 24 hour dietary records showed significant reduction in energy P = 0.003 and total fat P = 0.001. 2. Physical Activity OUTCOME: Tri Trac R3D accelerometer showed no significant differences, but trends were in the desired direction. 24 hour recalls were significantly higher in I P = 0.001. 3. Knowledge, attitudes and beliefs: OUTCOME: significant improvements were found in I, especially in the 3rd grade (8-9 years), but Self efficacy to be physically active was higher in I schools but choosing healthy foods was not. 4. Family programme OUTCOME: families attending events was 58%.
Donnelly 1996	Primary Outcomes: 1. Fatness assessed by repeat measures of height and weight (and calculated BMI), at baseline and after 2 years (end of intervention): OUTCOME: No differences between intervention and	Secondary Outcomes: 1. Lunch Program: OUTCOME: Intervention school's lunches had significantly less energy (9%), fat (25%), sodium (21%) and more fibre (17%). However, 24 hour dietary records

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Table 5. Results of Long-Term Studies (*Continued*)

	control 2. Improved physical fitness: OUTCOME: No differences between intervention and control.	showed differences between intervention and control only for sodium intake. 2. Nutrition Knowledge: OUTCOME: Intervention students had significantly fewer mistakes on standardised nutrition test than did controls.
Epstein 2001	1. Fatness assessed by percentage of overweight (established by comparing the BMI of the subject with the relevant 50th BMI percentile based on the gender and age of the subject) at baseline and at one year (end of intervention). OUTCOME: Children showed no significant differences in percentage of overweight with either intervention (increase fruit and vegetable or decrease high fat/high sugar). 2. Dietary intake: OUTCOME: High fat/high sugar intake significantly decreased across all children independent of group. Children also showed trends toward greater increases in fruit and vegetable intake for the Increase Fruit and Vegetable group through the one year study.	None reported
Gortmaker 1999a	1. Fatness assessed by repeat measures of height, weight, (and calculated BMI), and triceps skinfold thickness, at baseline and after 18 months (end of intervention): OUTCOME: Obesity was reduced among intervention girls but not boys.	1. Television viewing time: OUTCOME: Both girls and boys in the intervention group spent less time viewing television. 2. Dietary intake: OUTCOME: Intervention girls reported eating more fruit and vegetables and reduced their increase in dietary energy over the two years of the intervention. Behavioural variables as explanations for intervention effect: Regression indicated that only change in television viewing mediated the intervention effect.
James 2004	Primary Outcomes: 1. Fatness assessed by repeat measures of height and weight (and calculated BMI), at baseline and after 1 year (end of intervention): OUTCOME: No differences between intervention and control.	Secondary Outcomes: 1. Carbonated drink consumption: OUTCOME: Children in intervention classes reported fewer carbonated drinks (0.6 glasses fewer compared with an increase in controls of 0.2 (95% CI: 0.1 to 1.3). 2. Water consumption: OUTCOME: No differences between intervention and control.
Mo-Suwan 1998	1. Fatness assessed by weight, height (Body Mass Index, WHCU weight (kg)/height cubed), and triceps skinfold thickness at baseline, twice during intervention and at 29.6 weeks (end of intervention).	None reported

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Table 5. Results of Long-Term Studies (*Continued*)

	OUTCOME: No statistically significant change between intervention and control at 29.6 weeks (end of intervention). Follow up data on (overall prevalence of obesity, using 95th percentile National Center for Health Statistics triceps-skinfold thickness cut-offs in the control group) Data from 6 months after intervention is unpublished: Prevalence of obesity Baseline Intervention 12.9 Control 12.2 Post intervention (29.6 wks) Intervention 8.8 Control 9.4 Six months later Intervention 10.2 Control 10.8 Data for Follow up 29.6 wks+6 months. School I Baseline Intervention 16.2 Control 12.5 Post intervention (29.6 wks) Intervention 8.1 Control 8.3 Six months later Intervention 13.5 Control 8.3. School II Baseline Intervention 11.8 Control 12.1 Post intervention (29.6 wks) Intervention 9.2 Control 9.9 Six months later Intervention Intervention 9.1 Control 12.1. It is not known (information not available)if the changes at 29.6 weeks plus 6 months are statistically significant . But small changes are unlikely to be clinically significant.	
Mueller 2001	1. Fatness assessed by repeat measures of height and weight. OUTCOME: No significant difference between I and C from BMI data available at baseline and 1 year. The median of the BMI was 15.2 (intervention school) and 15.4 for children in control schools. At one-year follow-up the corresponding data were 16.1 and 16.3 respectively. 2. TSF (triceps skinfold). OUTCOME: Significant difference in favour of the intervention group at one-year follow-up.	1. Nutrition knowledge OUTCOME: significant increase from 48% to 60% of the children. 2. Daily physical activities OUTCOME: significant increase from 58 to 65% of the children. 3. Daily fruit and vegetable consumption OUTCOME: significant increase from 40 to 60% of the children. 4. Daily intake of low fat food OUTCOME: significant increase in frequency of daily intake of low fat food from 20 to 50%.

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Table 5. Results of Long-Term Studies (*Continued*)

		5. Decrease in TV watching OUTCOME: significant decrease from 1.9 to 1.6 h/day.
Sahota 2001	1. Fatness assessed by repeat measures of height and weight (and calculated BMI) at baseline and after 1 year (end of intervention):OUTCOME: No differences between I and C.2. Dietary intake:OUTCOME: Intervention children had statistically significant higher vegetable intakes at the end of the study (1 year).3. Physical activity:OUTCOME: Sedentary behaviour increased by one third in the overweight children in the intervention group compared with the control children.4. Psychological measures:OUTCOME: small increase in global self-worth for obese children in the intervention schools.	1. Nutrition knowledge:OUTCOME: Focus groups indicated higher levels of self-reported behaviour change, understanding and knowledge.
Sallis 1993	1. Fatness assessed by weight, height, BMI, calf and triceps skinfold at baseline and 6, 12, 18 months. OUTCOME: Little difference in BMI for boys and girls between specialist and teacher led intervention conditions (statistical significance not addressed)at 6, 12 and 18 months. Small differences in BMI for boys and girls between specialist-led, teacher-led conditions and usual physical education control. (statistical significance not addressed)at 6, 12 and 18 months.	None reported
Warren 2003	1. Fatness assessed by repeat measures of height and weight. OUTCOME: No significant changes in the rates of overweight and obesity were seen as a result of the 3 different interventions.	1. Nutrition knowledge: OUTCOME: all conditions improved their knowledge, I vs C not reported. No gender differences. 2. Diet: OUTCOME: significant increase in vegetable consumption (P<0.05) and fruit (P<0.01). However, 24h recall showed no significant differences between the groups or genders at base line or at follow-up. 3. Physical activity: OUTCOME: No intervention effect was found in either the children's or parents questionnaires.

Table 6. Results of Short-Term Studies

Study ID	Primary Outcomes	Secondary Outcomes
Baranowski 2003	1. Fatness assessed by repeat measures of height and weight (and calculated BMI) at baseline and end of pilot: OUTCOME: No differences between intervention	1. Participation in summer camp OUTCOME: I: 91.5% and C: 80.5% 2. Monitoring website usage (log-on rates). OUTCOME: Intervention: child mean 48%, par-

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Table 6. Results of Short-Term Studies (*Continued*)

	and control. 2. Waist circumference: OUTCOME: No differences between intervention and control. 3. Dual X-Ray Absorptiometry (DEXA) for % Body fat OUTCOME: Not reported. 4. Physical activity: CSA accelerometer, OUTCOME: No differences between I and C. 5. a modification of the Self-Administered Physical Activity Checklist (SAPAC), OUTCOME: No differences between intervention and control. 6. GEMS Activity Questionnaire (GAQ) computerised OUTCOME: No differences between intervention and control. 7. Dietary intake measured by two 24 hour recalls using Nutrition Data System computer programme (NDS-R). OUTCOME: No differences between intervention and control.	ent mean 47%; Control: child mean 25%, parent mean 16%.
Beech 2003	1. Fatness assessed by repeat measures of height and weight (and calculated BMI) at baseline and end of pilot: OUTCOME: No differences between intervention and control. 2. Waist circumference: OUTCOME: No differences between intervention and control. 3. Dual X-Ray Absorptiometry (DEXA) for % Body fat OUTCOME: Not reported. 4. Physical activity: accelerometer CSA, OUTCOME: No differences between intervention and control. 5. a modification of the Self-Administered Physical Activity Checklist (SAPAC), OUTCOME: Not reported. 6. GEMS Activity Questionnaire(GAQ) computerised OUTCOME: No differences between intervention and control. 7. Dietary intake measured by two 24 hour recalls	1. Psychological variables: Body silhouettes McKnight Risk Factor Survey, and Stunkard et al. 1983. OUTCOME: No differences between intervention and control 2. Over concern with weight or shape: OUTCOME: Intervention significantly better than control. 3. Parental food preparation practices OUTCOME: Intervention significantly better than control. 4. Self-Perception Profile for Children OUTCOME: No differences between intervention and control 5. Healthy Growth Study for physical activity expectations, and a self-efficacy measure. OUTCOME: No differences between intervention and control.

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Table 6. Results of Short-Term Studies (*Continued*)

	using Nutrition Data System computer programme (NDS-R). OUTCOME: Intervention parent group significantly lower for sweetened drinks compared with intervention child group and controls.	
Dennison 2004	1. Fatness assessed by repeat measures of height and weight (and calculated BMI) at baseline and after 1 year (end of intervention): OUTCOME: No differences between intervention and control. 2. Skinfolds: OUTCOME: No differences between intervention and control. 3. Waist circumference: OUTCOME: No differences between intervention and control. 4. Television Viewing: OUTCOME: television viewing was significantly reduced in intervention group on weekdays and Sundays. The percentage of children watching >2h per day was also significantly decreased in intervention group.	1. Computer games playing: OUTCOME: No differences between intervention and control. 2. Dietary assessment: OUTCOME: No significant changes or differences between intervention and control groups in the frequency of snacking whilst watching TV or the number of days family ate dinner together or watched TV during dinner (actual data not reported).
Flores 1995	1. Fatness assessed by height, weight (and Body Mass Index) at baseline and 12 weeks (end of intervention): OUTCOME: Statistically significant reductions in BMI between intervention and control girls. 2. Physical Fitness: OUTCOME: Statistically significant reductions in heart rate but not in timed mile run, between intervention and control girls. 3. Attitudes to Physical activity OUTCOME: No statistically significant differences between intervention and control girls. No statistically significant change between intervention and control boys on any outcome measures.	None reported
Kain 2004	1. Fatness assessed by repeat measures of height and weight (and calculated BMI) at baseline and after 1 year (end of intervention): OUTCOME: No differences between intervention and control. 2. Skinfolds: OUTCOME: No differences between intervention and control. 3. Waist circumference: OUTCOME: decreased significantly in interven-	1. Dietary assessment: food frequency questionnaire of 16 key items: OUTCOME: Not reported. 2. Attitudes and behaviours (14 questions about physical activity and some about fruit and vegetable consumption): OUTCOME: Not reported.

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Table 6. Results of Short-Term Studies (*Continued*)

	tion group by a mean of 0.9cm and increased in controls by same amount. 2. Physical Fitness: OUTCOME: Shuttle run test and lower back flexibility both improved for boys and girls in the intervention group compared with controls.	
Harvey-Berino 2003	1. Maternal fatness assessed by repeat measures of height and weight (and calculated BMI) at baseline and end of pilot: OUTCOME: No differences between intervention and control. 2. % WHP scores > 85th and 95th percentile: OUTCOME: No differences between intervention and control. 3. % WHZ scores > 85th and 95th percentile:	1. Diet 3 day food records: OUTCOME: No differences between intervention and control. 2. Physical activity: CSA accelerometer, OUTCOME: No differences between intervention and control. 3. Psychological variables: Outcomes Expectations Self-efficacy Intentions Child Feeding Questionnaire OUTCOME: No differences between intervention and control.
Neumark-Sztainer 2003	The primary outcomes were the feasibility i.e. sustainability and satisfaction of the intervention as assessed by a various satisfaction, behaviour change, personal change and socio-environmental support variables. All did not achieve significance except: 1. Change in Physical Activity Stage: OUTCOME: Intervention significantly greater than controls.	1. BMI OUTCOME: No differences between intervention and control.
Pangrazi 2003	1. Fatness assessed by repeat measures of height and weight (and calculated BMI) at baseline and end of pilot: OUTCOME: No differences between intervention and control. 2. Physical activity: accelerometer CSA, OUTCOME: All students: PLAY & PE, and PLAY only groups were significantly more active than C. Girls: PLAY & PE, and PE only groups were significantly more active than controls.	None reported.
Robinson 1999	1. Fatness assessed by weight and height (and Body Mass Index), waist circumference and triceps skinfolds at baseline and six months (end of intervention): OUTCOME: Interventions had statistically significant reductions in Body Mass Index and all other measures of body fat.	1. Media use: OUTCOME: Statistically significant reductions in intervention group's reported television viewing time when compared to controls. 2. Parental report of child and family behaviours: OUTCOME: Statistically significant reductions in intervention group's reported number of meals eaten

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Table 6. Results of Short-Term Studies (*Continued*)

		in front of television when compared to controls. 3. Physical Activity: OUTCOME: No difference between intervention and control. 4. Dietary Behaviours: OUTCOME: No differences between intervention and control. 5. Cardio-respiratory fitness: OUTCOME: No differences between intervention and control.
Robinson 2003	1. Fatness assessed by repeat measures of height and weight (and calculated BMI) at baseline and end of pilot: OUTCOME: No differences between intervention and control. 2. Waist circumference: OUTCOME: No differences between intervention and control. 3. Dual X-Ray Absorptiometry (DEXA) for % Body fat OUTCOME: Not done 4. Physical activity: accelerometer CSA, OUTCOME: No differences between intervention and control. 5. a modification of the Self-Administered Physical Activity Checklist (SAPAC): OUTCOME: No differences between intervention and control. 6. GEMS Activity Questionnaire(GAQ) computerised OUTCOME: Not reported 7. Dietary intake measured by two 24 hour recalls using Nutrition Data System computer programme (NDS-R). OUTCOME: No differences between intervention and control.	1. TV usage: TV, videotape and video games: OUTCOME: No differences between intervention and control. 2. Total household TV usage: OUTCOME: Intervention significantly less than control. 3. Ate breakfast with TV on: OUTCOME: No differences between intervention and control. 4. Ate dinner with TV on: OUTCOME: Intervention significantly less than control. 5. Over concern with weight or shape: OUTCOME: Intervention significantly better than control.
Stolley 1997	1. Fatness assessed by weight and height at baseline and at 12 weeks (end of the intervention): OUTCOME: No statistically significant change between intervention and control.	1. Dietary Intake: OUTCOME: Significant reductions found in intervention mothers' daily saturated fat intakes and percentage of energy from fat when compared to controls. Also intervention girls had statistically significant reductions for percentage energy from fat when compared to controls.

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Table 6. Results of Short-Term Studies (*Continued*)

Story 2003a	1. Fatness assessed by repeat measures of height and weight (and calculated BMI) at baseline and end of pilot: OUTCOME: No differences between intervention and control. 2. Waist circumference: OUTCOME: No differences between intervention and control. 3. Dual X-Ray Absorptiometry (DEXA) for % Body fat OUTCOME: Not done. 4. Physical activity: CSA accelerometer, OUTCOME: No differences between intervention and control. 5. a modification of the Self-Administered Physical Activity Checklist (SAPAC), OUTCOME: Not reported. 6. GEMS Activity Questionnaire(GAQ) computerised OUTCOME: No differences between intervention and control. 7. Dietary intake measured by two 24 hour recalls using Nutrition Data System computer programme (NDS-R). OUTCOME: No differences between intervention and control.	Psychological variables: 1. Over concern with weight or shape: OUTCOME: Intervention significantly better than control. 2. Diet: Healthy choice Behavioral Intentions: OUTCOME: Intervention significantly better than control. 3. Self-Efficacy for Healthy Eating OUTCOME: No differences between intervention and control. 4. Diet knowledge: OUTCOME: Intervention significantly better than control. 5. Physical Activity Outcomes Expectations, and a self-efficacy measure. OUTCOME: No differences between intervention and control (except physical activity preference). 6. Parental reported diet OUTCOME: Significant differences with intervention better than control: % energy from fat and low fat food practices. 7. Parental reported physical activity: OUTCOME: No differences between intervention and control.

Risk of bias in included studies

All 22 studies had some methodological weaknesses and none of the included studies fulfilled all the necessary quality criteria (Alderson 2005b).

Most studies reported follow-up data of more than 80% of the baseline sample, one (Sallis 1993) reported 74%. Three long-term studies (Caballero 2003; Sahota 2001; Warren 2003) and seven short-term studies (Baranowski 2003; Beech 2003; Kain 2004; NeumarkSztainer 2003; Robinson 1999; Robinson 2003; Story 2003a) reported undertaking process evaluations, that is, attempted to measure whether the study was adhered to and conducted as it was intended. Their findings are presented with results. Most studies considered the important issue of generalisability from study outcomes. Some were designed to be delivered by existing staff contributing to potential sustainability. However cost effectiveness was not discussed.

While measures of height and weight, if conducted by the same, trained operator are reasonably reliable, the inclusion of clinical methods such as Dual X-Ray Absorptiometry (DEXA) for percentage body fat improves reliability. Measures of variables such as diet and physical activity are considered to be, at best, relatively weak estimates of actual behaviour. For example, in these studies, dietary data were usually collected by recall of the past 24 hours' food intake or by food frequency checklists. In ideal situations, dietary data should be collected over at least three days, including one weekend day to provide best estimates of actual intake (Jenner 1989; Crawford 1994). Furthermore, while food frequency questionnaires are considered to be valuable in the clarification of major dietary patterns (Hu 1999), they are considered to be methodologically inappropriate for measurement of usual intake in individuals (Jenner 1989; Crawford 1994; Stein 1992; Iannotti

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1994). A further problem with dietary records is the tendency for respondents to under-report energy intake, with under-reporting of energy intake observed to be greater in the obese and overweight (Little 1999; Macdiarmid 1998). The measurement of physical activity is similarly problematic (Sallis 2000). The use of more objective measures used in more recent studies (notwithstanding validity issues of their own), will address some of the issues with physical activity measurement. These objective measures include pedometers which count paces (e.g. YAMAX) and accelerometers which respond to changes in direction of movement either unidirectionally (e.g. CSA) or tri-axially (e.g. Tritrac R3D).

As noted above, the reliability of some of the reported measures for secondary outcomes, such as diet and physical activity, remains a significant weakness of these studies.

Due to the range of interventions included in this review, methodological details were integrated into the results section and can be seen in the Table of Included Studies.

Effects of interventions

Of note, many of the studies included in this review have unit of allocation errors, since allocation was often by institution (e.g. school) but assessment was by individual child. The results of these studies which are reported in the text below (and in the tables) with 95% CIs and P values are likely to be misleadingly optimistic. We documented any information we had about how the studies processed unit of analysis errors in the Table of included studies.

Details of outcomes reported in long-term studies are reported in Table 5 and for short-term studies in Table 6.

Long-term studies

Dietary education vs. control

Two long-term studies evaluated dietary education versus control (Epstein 2001; James 2004).

An RCT by Epstein et al (Epstein 2001), conducted in the US, where 26 children (and their families) were randomised into two conditions (increasing fruit and vegetables or decreasing fat and sugar) with 13 children in each. Children were aged 6 to 11 years with at least one obese parent. Children in the intervention group (fruit and vegetables) were mean 7.2% (SD 6.0%) overweight (6 boys; 7 girls) and the comparison group were mean 6.5% (SD 8.0%) overweight (3 boys, 10 girls). The intervention, in the form of a comprehensive behavioural weight control programme, was delivered to the parents, which evaluated the effect of an increased fruit and vegetable intake dietary intervention against a comparison group which decreased intake of high fat/high sugar foods. The study had methodological limitations such as the randomisation concealment and blinded assessment were not described. This study also has a comparison group receiving a different intervention rather than no treatment. The changes in percentage of overweight in the children after 12 months were mean -1.10% (SD 5.29%) in the increased fruit and vegetable group and mean -2.40% (SD 5.3%) in the decreased fat and sugar group. These differences in percentage of overweight were not statistically significant. Similarly changes in dietary intake for each group were not significant. No theory base or evaluation was discussed, although Epstein et al (Epstein 2001) have many years of experience in treating childhood obesity.

In a good quality RCT by James et al (James 2004) conducted in the UK, 644 children were randomised by class (N = 29: 14 control and 15 intervention) in six schools. Children were aged 7-11 years (mean age 8.7 years) and had a mean BMI (SD) of 17.6 (0.7) in the control classes and 17.4 (0.6) in the intervention classes. At baseline, the prevalence of obesity [Obesity was defined by BMI >95th centile of the 1990 UK reference growth charts] was: boys: controls (n = 155) 10% (7.0) and intervention (n = 169) 11% (6.9); girls: controls (n = 164) 12% (7.5) and intervention (n = 156) 10% (6.6). The intervention evaluated the effect of reducing carbonated drink consumption in children. Each intervention class received three, one-hour sessions (one per term) delivered by trained personnel with the assistance of teachers, who were then asked to reiterate the messages in lessons. The sessions promoted drinking water or diluted fruit juice, tasting fruit (to establish natural sweetness), included a music competition, a "Ditch the Fizz" song, encouragement to create a song with healthy message, a quiz and children were encouraged to access the project website. The control programme was not described, but presumably this was the usual school curriculum. Some methodological issues were addressed, for example potential unit of analysis errors were statistically accounted for and power calculations were discussed. However no theoretical framework or evaluation was discussed. On assessment at 12 months, change in BMI Z score was not significantly different between intervention and control classes mean Z score 0.7 (SD 0.2) verses mean Z score 0.8 (SD 0.3) respectively. The prevalence of obesity at follow-up was: boys: controls 12% (9.0) and intervention 11% (7.1); girls: controls 13% (9.0) and intervention 9% (6.5). There was a reduction in the self-reported soft drink consumption over three days in the intervention group of 0.6 glasses (250 ml per glass) compared with an increase of 0.2 glasses in the control group (mean difference 0.7 glasses; 95% CI 0.1 to 1.3).

Physical activity intervention versus control

Two long-term studies evaluated physical activity interventions versus control (Mo-Suwan 1998; Sallis 1993).

The RCT conducted in Thailand (Mo-Suwan 1998) was classified as a short-term study in the original version of this review but additional follow-up data are now available beyond 12 months so it is now included as a long-term study. Thai kindergarten children (n = 292) were randomised by class (n = 10) into the exercise group or control (5 classes in each). At baseline the children mean age 4.5 (SD 0.4) years, with the intervention group (82 boys and 65 girls) having a mean BMI (SD) of 16.25 (2.4) and the control group (88 boys and 57 girls) having a mean BMI (SD) of 16.36 (2.2). Mean triceps skinfolds (mm) were 9.9 (SD 3.7) for boys and 10.3 (SD 3.9) for girls. Specialists (authors) delivered a specific

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regimen of exercise (15 minutes of walking plus 20 minutes of aerobic exercise) three times a week for 29.6 weeks in addition to the usual school physical education provision, which the controls received. Outcome measures were BMI, triceps skinfolds measured at six months and additionally weight/height^3 (WHCU) measured at 12 months. The methodology addressed some issues such as randomisation concealment and unit of analyses errors. While Mo-Suwan notes no theoretical underpinning, this study appeared to be informed by an environmental change model. At the initial evaluation at 29.6 weeks Mo-Suwan found a reduction of the prevalence of obesity in the intervention pre-school children that nearly reached statistical significance (P = 0.057). The study showed that intervention girls had a lower likelihood of having an increased BMI slope than control girls (odds ratio 0.32; 95%CI 0.18 to 0.56), while the opposite was true for boys (odds ratio 1.08; 95% CI 0.62 to 1.89). Data at 6 months post-intervention have now been collected. Overall prevalence of obesity, using 95th percentile National Center for Health Statistics triceps-skinfold thickness cut-offs in the control group decreased from 12.2% at baseline to 9.4% after the intervention at 29.6 weeks and was 10.8% at 29.6 weeks plus 6 months. In the exercise intervention group, the prevalence of obesity was 12.9% at baseline, 8.8% at 29.6 weeks and 10.2% six months later. It is not known (information not available) if the changes at 29.6 weeks plus 6 months are statistically significant, but such small differences between groups are unlikely to be clinically significant.

Another RCT conducted in the US by Sallis et al (Sallis 1993) included 549 children (302 boys). Their six schools, stratified by percentage of ethnic minorities and size, were randomised into either the interventions (specialist led: 2 schools; teacher led: 2 schools) or control condition (2 schools). A seventh school was included as an additional control to accommodate children leaving the study. Children had a mean age of 9.25 years (SD 0.50). Their anthropometric data were presented graphically, but all children have the same baseline start points for BMI and triceps and calf skinfolds. The intervention SPARK (Sports, Play and Active Recreation for Kids) was a physical education program with a self-management component, designed to provide high levels of physical activity for children in three 30 minute sessions per week. In one condition, the program was delivered by physical education specialists and in the other condition the program was delivered by trained teachers. The usual school physical education curriculum was evaluated as a control. Adiposity was measured by triceps and calf skinfolds and BMI at six monthly intervals over 18 months. Many of the methodological issues were unclear and no theoretical framework was reported. Although no figures were given in the paper, results were represented graphically and the figures used in this review have been extracted from graphs provided in the primary study. Results for boys showed that the control group (n = 101) had significantly lower BMIs at 6 and 12 months (P<0.05), but not at 18 months. However their skinfolds results showed that boys in the specialist led group (n = 77) had thinner skinfolds at 6 and 12 months, but not at 18 months. Girls results showed the control group (n = 97) to have lower BMIs at each time point and this reached significance at 18 months (P<0.01). The teacher led group (n = 76) showed the thinnest skinfolds at each time point, but not significantly so. These findings may reflect how each gender responds to different physical activity interventions.

Dietary versus physical activity interventions

No studies found.

Combined effects of dietary interventions and physical activity interventions

Six studies met a priori inclusion criteria (Caballero 2003; Donnelly 1996; Gortmaker 1999a; Mueller 2001; Sahota 2001; Warren 2003).

In a good quality RCT, Pathways (Caballero 2003) conducted in the US, 1704 children took part in 41 schools randomized into the intervention or control condition. The children were American Indian in grades 3 to 5 (8-11 years), mean age 7.6 years (SD 0.6). At baseline mean BMI was 19.0 in the intervention group and 19.1 in the control, and mean triceps skinfolds (mm) were 13.3 and 13.3 respectively (no SDs given). Pathways was a school-based, multi-component, multi-centre intervention for reducing percentage body fat delivered by existing school staff. The intervention had four components: 1) change in dietary intake, 2) increase in physical activity, 3) a classroom curriculum focused on healthy eating and lifestyle, and 4) a family-involvement program. The classroom curriculum included two 45 minute lessons each week for 12 weeks in grades 3 and 4; and 8 weeks in grade 5. US Department of Agriculture and Pathways Behavioural guidelines were followed to amend the food service provision to reduce energy from fat in school meals. The activity components were physical education in schools (30 minutes, 3 to 5 times per week of moderate to vigorous activity), an American Indian games module, and exercise breaks in classroom time (2-10 minutes each). The family involvement included action packs to take home with food ideas and family events at school such as cooking demonstrations and physical activities. Details of the control condition were not reported so presumably they received the usual curriculum. Outcomes were measured at baseline and three years and included BMI, triceps and subscapular skinfolds, percentage body fat, together with dietary and physical activity behaviours and knowledge. Although randomisation concealment was not reported, other methodological issues were, such as unit of analysis errors. Pathways was also underpinned by Social Cognitive Theory. At the end of the three year intervention, no significant differences were found for BMI, skinfolds or percentage body fat. Motion sensor (assessing physical activity) findings were also not significantly different between the intervention and control groups, but there was a trend in the desired direction. School lunch observations showed a reduction in calories from fat (mean calories from fat: intervention: 28.2; control: 32.4; 95% CI -7.1 to -1.3) and self-report measures showed significant outcomes in favour of the intervention group (24h dietary recall and physical activity questionnaire). Knowledge was improved in the

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intervention schools for all three years. Pathways was fully evaluated. Representatives from the American Indian community were involved at all stages in the development and delivery with indigenous learning models such as story telling was integrated into the intervention along with principles of American Indian culture and practices. In the process evaluation, the classroom curriculum was delivered successfully (94%) and the food service guidelines implemented (78%), with most schools achieving the minimum physical education sessions per week. Parents who attended the family events responded positively. The intervention was designed to be delivered by existing staff, which suggests that sustainability of interventions was a consideration.

One long-term study was a non-randomised trial with concurrent control group (CCT) (Donnelly 1996). This was conducted in the US, with 338, predominantly Caucasian children in grades 3 to 5 (8-11 years), with 102 in the intervention school and 236 in the control school. At baseline mean BMI (SD) were: controls: 18.5 (3.4) and intervention group: 18.3 (3.9). The intervention aimed to reduce energy, fat and sodium of school meals and formal meetings were held with kitchen staff five times per year creating the potential for sustainability. This was also supported by nutrition education modules. The physical activity programme was designed with school staff and included 30 to 40 minutes of activities, three times per week and emphasis was placed on lifestyle aerobic activities rather than competitive games. 'Controls received the usual food supply and school curriculum. Outcomes included BMI, blood chemistry and pressure, fitness measures, self-report lifestyle behaviours and contents of school meals at baseline and at two years. Methodologically this was a weak study which had very poor rates of follow-up over the two-year period of the study. Potential of contamination between groups and a theoretical framework were not discussed. At follow-up Donnelly et al found that while there were some positive changes in targeted behaviours, overall on follow-up at the end of the two years, the intervention was found to have had no impact on obesity. Blood pressure results were not significant, but serum concentration of high density lipoprotein (HDL) cholesterol was in favour of the intervention (presented graphically P<0.05). The intervention resulted in statistically significant and positive changes in food provided at intervention schools (decreases in total energy and fat, and increases in carbohydrate and fibre (P<0.05)), and related, statistically significant differences in food provision, between intervention and control schools. In addition, this intervention resulted in small, but statistically significant increases in the amount of activity undertaken in class. Unfortunately, there appeared to be compensation outside school for these changes in diet and physical activity. Therefore, over 24 hours there appeared to be no statistically significant differences in dietary intakes between intervention and control groups, and the intervention group were actually less physically active outside of the class than were the control group.

In a high quality RCT called Planet Health (Gortmaker 1999a), which included 1295 ethnically diverse children in 10, US schools which were randomised into control schools (n = 5) or intervention schools (n = 5). The children (52% boys) were in grades 6 to 8 (ages 11 to 12) and had a mean age of 11.7 years. Their baseline measures for mean BMI (SD) were: controls 20.7 (4.0) and intervention group 20.6 (4.5), and for mean triceps skinfolds (mm) (SD) were: controls 15.9 (6.9) and intervention group 16.0 (7.2). This program was a behavioural choice intervention and concentrated on the promotion of physical activity, modification of dietary intake and reduction of sedentary behaviours (with a strong emphasis on reducing television viewing). Teachers in intervention schools received training workshops, lesson and physical education materials (with resources for students), wellness sessions and fitness funds. Teaching units were developed with teacher input and focus groups to ensure that they were student-centred. Controls presumably received the usual curriculum, but this is not reported. The primary outcomes were BMI and triceps skinfolds assessed at baseline and at 18 months. Secondary outcomes related to behavioural change. Most methodological issues were addressed such as allocation concealment and unit of analysis errors. Planet Health was also strongly underpinned by behavioural choice and Social Cognitive Theory. Evaluation at follow-up showed that the percentage of obese girls in the intervention schools was reduced compared with controls, controlling for baseline obesity (adjusted odds ratio 0.47; 95% CI 0.24 to 0.93; P = 0.03). Among boys obesity declined among both control and intervention students however, after controlling for co-variates, there was no significant difference in outcome (adjusted odds ratio 0.85: 95% C; 0.52 to 1.39; P = 0.48). In addition, there was greater remission of obesity among intervention girls versus control girls (remission % 2.16; 95% CI 1.07 to 4.35; P = 0.04). Gortmaker reports that the intervention reduced television hours among both girls (-0.58 hours; 95% CI -0.85 to -0.31; P = 0.001) and boys (-0.4 hours; 95% CI -0.56 to -0.24; P<0.001). In addition, the authors report an increased fruit and vegetable consumption in girls (0.32 serves/day; 95% CI 0.14 to 0.5; P = 0.003), resulting in a smaller daily increment in total energy intake among girls (-575 kJ; 95% CI -1155 to 0; P = 0.05). Gortmaker concluded that reductions in television viewing predicted obesity change and mediated the intervention effect (in girls but not boys). Among girls, each hour of reduction in television viewing predicted reduced obesity prevalence (0.85; 95% CI 0.75 to 0.97; P = 0.02). Of additional interest was the finding that measures of extreme dieting behaviour remained unchanged (and low) throughout the intervention and were not different between intervention and control schools.

The RCT set in Germany, Mueller et al (Mueller 2001) is on - going and the one year follow-up data are included here. Background data were collected from 1640 children, but the initial intervention was conducted with 414 children, with six schools randomised into the control group or intervention (Kiel Obesity Prevention Study, KOPS). Children were aged 5-7 years and recruited from a general population where 20.7% of this age group was categorized as overweight and obese. The median BMI (no

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SDs) of children at baseline was 15.4 in the control schools and 15.2 in the intervention schools, and triceps skinfolds (mm) data for 297 children were: median (no SDs) 10.7 and 10.9 respectively. Mean percentage overweight was 27.7 in the control school and 24.1 in the intervention schools. The intervention incorporated nutrition education and 'active breaks' into the school curriculum. Key messages were to eat fruit and vegetables each day; to reduce high fat foods; to keep active at least 1 hour a day; and to decrease TV viewing to less than 1 hour a day. The course was conducted by a skilled nutritionist together with a teacher. In addition, a family-based intervention plus a structured sports program was offered to families with overweight or obese children or with obese parents (n = 25). The controls received usual schooling during this time period but will cross-over every alternate year. Outcome measures include BMI, triceps skinfolds at one year, with dietary and physical activity behaviours at three months and one year. There were some methodological weaknesses such as a lack of clarity for allocation concealment, protection against contamination and not addressing unit of analysis errors. Additionally no theoretical framework was discussed. At three months knowledge and self-reported behaviours had significantly improved in the intervention schools. At one year, there was no difference in mean change in BMI between the children in the two groups, corresponding data were mean change in BMI From baseline 16.3 (controls) and Mean change in BMI from baseline 16.1 (intervention schools). Contrary to BMI, the one year changes in fat mass (as reflected by triceps skinfold thickness (TSF) or sum of four skinfolds) did reach statistical significance in favour of the intervention group: controls 13.0 mm and intervention schools 11.3 mm. [Overweight was defined by TSF >90th centile of a child reference population from Germany]. The percentage overweight did not change in schools. The intervention also had a positive effect on the overweight children, where fat mass was attenuated compared with control children.

In a good quality RCT set in England, APPLES (Sahota 2001) included 634 children in 10 schools randomised to the intervention (n = 5) or control (n = 5). Children were ethnically diverse and aged 7-11 years (mean age 8.4 years, SD 0.6). At baseline mean BMI Z score was 0.12 (SD 1.0) in the intervention schools and 0.04 (SD 1.2) in the controls, 6% categorised as obese and 11% respectively [Obesity was defined by BMI >95th centile of the 1990 UK reference growth charts]. APPLES, the Active Programme Promoting Lifestyle in Schools, was one year, multidisciplinary and designed to influence diet and physical activity behaviours. The whole school was targeted including parents, teachers and catering staff and was based on action plans developed by each school on the basis of their perceived needs. The intervention included teacher training and resources, modification of school meals, with support for physical education, tuck shops and playground activities. Controls received the usual curriculum. Outcomes focused on BMI, diet and physical activity behaviours and psychological measures at baseline and at one year. Methodological issues such as allocation concealment and potential unit of analysis errors were addressed and the intervention was underpinned by the Health-Promoting Schools philosophy. At one year, there was no difference in change in BMI between the children in the two groups, nor was there any difference in dieting behaviour. However, children in the intervention group reported higher consumption of vegetables (weighted mean difference 0.3 portions/day, 95% CI 0.2 to 0.4). Sedentary behaviour was higher in overweight children in the intervention group compared with overweight controls (0.3, 95% CI 0.0 to 0.7). Global self worth score was higher in obese children in the intervention group compared with obese controls (0.0, 95% CI 0.3 to 0.6), which is important for the inclusion of obese children in a school-based intervention. There were no differences in other psychological measures (dietary restraint, body shape preference, self-perception). Process evaluation showed that the APPLES intervention was successful in producing changes at the school level, in terms of changing the ethos of the schools and the attitudes of the children. Also, 89% of the actions points were implemented in the ten schools and changes were made to the food provision. Both parents and teachers were supportive of the dietary education and promotion of physical activity. Parental questionnaires (64% returned) detailed suggestions for improvements such as promotion of healthier break time snacks with enforcement by school, material on healthy eating for children and fun physical activity ideas. Of the twenty teachers invited, 19 attended and were satisfied with the training, resources and materials offered. Children had higher scores for knowledge, attitudes and were positive about the intervention in focus groups.

The third RCT set in England, Be Smart (Warren 2003) randomised 218 children from three schools into four conditions (a nutrition group, a physical activity group, a combined nutrition and physical activity group and a control). Children (51% boys) were aged 5-7 years, mean age (SD) 6.1 (0.6) years. There were no significant differences in mean BMI (SD) at baseline; all groups 15.9 (2.1); or percentage of children categorised as obese [Obesity was defined by BMI >98th centile of the International Obesity Task Force reference charts]; all groups 4%. The intervention ran for 20 weeks over four school terms (approx. 14 months) and took place in lunchtime clubs where an interactive and age-appropriate nutrition and/or physical activity curriculum was delivered by the research team, with both involving parents. Intervention elements included raising the value of desired behaviours with reinforcement of messages, healthy food tastings, non-competitive activities, and the development of related skills. The control group received an education programme covering the non-nutritional aspects of food and human biology. Outcomes at baseline and post intervention, assessed BMI, dietary and physical activity behaviours and nutritional knowledge. Methodologically this was a weak study with many issues not reported, however the intervention was based on Social Learning Theory. At final stage no significant changes in the rates of overweight and obesity were seen as a result of the three different approaches, with subject numbers

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too small for statistical analyses. Significant changes in self-report knowledge and dietary intake were found in the desired direction within the four conditions, with some evidence that physical activity had improved in the intervention groups. Parental food frequency questionnaires showed little change as they reported low fat and medium to high fibre intakes initially. This study may have been subject to ceiling effects as the study population was relatively well-educated as 39% of parents had obtained either a degree or a post-graduate qualification. The process evaluation included a log of lesson evaluations, parental phone calls and letters, together with a quiz about the main messages as an impact evaluation. Parents and teachers also completed a satisfaction survey. Briefly, children enjoyed the practical tasks, quizzes and tastings, 83% of parents thought their child had benefited from the programme and all teachers thought that components should be integrated into the Personal Social Health and Citizenship Education curriculum. However, the need for trained personnel was likely to impede the intervention's potential sustainability.

Short-term studies

Dietary intervention vs. control

No studies found.

Physical activity intervention versus control

Four studies evaluated physical activity changes (Flores 1995; NeumarkSztainer 2003; Pangrazi 2003; Robinson 1999).

In a 12 week RCT set in the US Flores (Flores 1995) included 110 children randomised by class into a control group and a Dance for Health group. Adolescents, 54% of whom were girls, were aged 10-13 years (mean age 12.6 years), with an ethnic mix of 44% African American and 43% Hispanic. At baseline BMI (SD) was 22.9 (6.1) in the intervention group and 22.2 (4.4) in the controls. The intervention comprised a supporting health education programme twice a week and a 50 minute dance oriented physical activity curriculum where students received 150 minutes of dance per week (over three sessions). This replaced the regular physical activity sessions which was received by the control group. It is unclear who delivered the program of dance. Follow-up measures (BMI, Timed mile run, resting heart rate and attitudes towards physical activity were taken at 12 weeks. Methodologically this study appeared weak with many issues not reported and no theoretical basis was discussed. However Flores reports significant reductions in BMI between intervention and control girls (BMI change -0.8 and 0.3 respectively). Girls also showed changes in fitness (Heart rate change -10.9 beats/min and -0.2 beats/min respectively). Boys showed similar trends but they did not reach significance. Compliance with the intervention was achieved by allowing participants to select the music.

In a RCT set in the US and conducted over 24 weeks, New Moves (NeumarkSztainer 2003) included 201, racially mixed girls from six schools, with schools randomised into the intervention (n = 3) or as controls (n = 3). The girls were physically inactive and in grades 9-12 (14-18 years; mean age in intervention was 14.9 (SD 0.9) years and controls were 15.8 (SD 1.1) years). The intervention was targeted at those unlikely to attend after school clubs and who had a BMI at or above 75th percentile. At baseline BMI (SD) was 27.6 (6.5) in the intervention group and 25.9 (5.8) in the controls. The intervention addressed personal and behavioural factors in addition to physical activity four times per week, nutrition and social support session every other week for total of 16 weeks. The aim was to increase enjoyment and self-efficacy, aided by community guest instructors once a week who led different activities such as kick-boxing, self-defence and water aerobics, community field trips with free passes to return and community links encouraged. Girls were advised to avoid dieting and increase fruit and vegetables and decrease fats and sugar intake, healthy food choices and taste-testing sessions. A maintenance component for 8 weeks included healthy informal lunch meetings and topic discussion. Postcards were mailed home every 2-3 weeks during first 16 weeks to enhance parental support. Controls presumably received the usual curriculum as this is not reported. Outcomes measured at baseline and eight months included BMI and a variety of psycho-social variables as the main aim of this study was to assess the feasibility and acceptability of New Moves. Methodologically this study appeared weak with many issues not reported, however the intervention was based on Social Cognitive Theory. At follow-up, BMI was not significantly different between the intervention and control schools. Positive changes in behaviours and personal factors were reported by those in intervention schools, most did not reach statistical significance. The only significant variable was a progression in physical activity stage based on the Stages of Change Model (P=0.004). This study also had a comprehensive developmental stage involving focus groups with stakeholders and included process evaluations. The process evaluation showed that parents expressed strong enthusiasm for programme, and all thought it should be continued. They reported their daughters eating more healthily, doing more physical activity and were more accepting of their bodies. Parents made other suggestions such as being most willing to read relevant literature and buy healthier snacks, but were least willing to attend classes with daughters. The girls liked the food tastings, nutrition sessions, guest instructors, and the array of physical activity options. They thought the girls only aspect was very important component for the intervention's success. In the three intervention schools, the Principals found ways of sustaining New Moves, and offered girls guest instructors. They have and have now integrated nutrition and social support in to physical education classes.

In an RCT set in the US and conducted over 12 weeks, Pangrazi (Pangrazi 2003) included 606 children randomised by school (n = 35) into four conditions. Children were 4th grade (9-10 years; mean age 9.8 (SD 0.6)), with 315 girls and 291 boys. Baseline data were not presented. The intervention called PLAY (Promoting Lifestyle Activity for Youth), had four conditions: PLAY and physical education (PE), PLAY only, physical education only, and control (no physical education or PLAY). Physical activity was

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measured using the YAMAX pedometer at the beginning and end of the intervention for four days on each occasion, with supporting survey logs to identify activities and missing data. The PLAY intervention comprised three stages: Step 1: promote play behaviour (first week) teachers and students participated, more walking, less standing, sitting, children were informed about the importance of physical activity and identified appropriate adult role models. Step 2: teacher directed activities (3 weeks) games and activities which were enjoyable and could be played outside school. Step 3: encourage self-directed activity (8 weeks) with students aiming to achieve 30 minutes of activity per day independently of teacher outside school. Control and physical education schools, children received log sheets similar to the PLAY ones but were asked to record their after school activities (active and sedentary). Outcomes (BMI and number of steps) were measured at baseline and at 12 weeks. This study appeared to have methodological limitations as many issues were not reported. However the intervention only used relatively objective outcomes and has been adopted in Arizona elementary schools, with 24,000 children having received the intervention. This intervention was likely to have been refined experientially, but was not theory based. Protection against contamination was assumed by including children who would have received the programme before. At follow-up, BMI was not significantly different between the intervention and control schools. However girls were significantly more active in the PLAY and physical education and physical education only conditions, but PLAY only was not significantly higher than control girls. Boys showed no significant differences in steps across treatment groups as the control boys were already more active than average 10-year-old boys in the area (data from previous study).

In a good quality RCT conducted over six months in the US by Robinson (Robinson 1999), 198 children were randomised by school (n = 2) into the intervention or control conditions. Children were in grades 3 and 4 (8-10 years; mean age 8.9), with girls comprising 44.6% of the intervention groups and 48.5% of the controls. Mean baseline measures for BMI (SD) were: intervention group 18.4 (3.7) and controls 18.1 (3.8), and mean triceps skinfolds (TSF) (mm) (SD) were: intervention group 14.6 (6.1) and controls 14.0 (5.4). The intervention aimed to reduce television, videotape and video game use consisted of incorporating 18 lessons of 30 to 50 minutes into the standard curriculum. The intervention included self-monitoring and self-reporting of television, videotape and video game use to motivate children to want to reduce the time they spent in these activities. This was followed by encouragement to turn the television off and then adopt a 7 hour per week budget. The programme used for the control was not reported and so was presumably usual curriculum. Outcomes were measured at baseline and at six months. These included a variety of anthropometric, physical activity and dietary variables. Methodological issues such as allocation concealment and potential unit of analysis errors were addressed and the intervention was underpinned by Social Cognitive Theory. At follow-up, after adjustment by mixed-model analysis of co-variance for the baseline values, age, and sex, the intervention group (both boys and girls) had statistically significant relative decreases in all measures of body fatness. The change in BMI of the intervention group from baseline to follow-up was 18.38 to 18.67 and change in BMI of control group was 18.10 to 18.81, the mean difference adjusted for baseline values age and sex was -0.45 (95% CI -0.73 to -0.17; P = 0.002); change in triceps skinfold thickness of the intervention group was 14.55 mm to 15.47 mm and change in triceps skinfold thickness for the control was 14.0 mm to 16.5 mm the mean difference adjusted for baseline values of age and sex of -1.47 (95% CI -2.41 to -0.54; P = 0.002). The change in waist circumference of the intervention group was 60.5 cm to 63.6 cm and for the control group was 59.5 cm to 64.7 cm the mean difference adjusted for baseline values age and sex was -2.30 (95% CI -3.72 to -1.33; P<0.001). Finally waist to hip ratio of the intervention group from baseline to follow-up was 0.83 to 0.83 and that for the control group was 0.82 to 0.84 with a mean difference adjusted for baseline values age and sex was -0.02 (95% CI -0.03 to -0.01; P<0.001).

In addition, relative to controls, intervention group changes were accompanied by statistically significant decreases in children's reported television viewing (P<0.001) and number of meals eaten in front of the television (P<0.02). There were no statistically significant differences between groups for changes in high-fat food intake, moderate-to-vigorous physical activity, and cardio-respiratory fitness. Given that there was no assessment beyond six months post-intervention, it is not possible to extrapolate the findings of this study to longer-term outcomes. However, Robinson is currently conducting a 12-school randomised controlled trial that includes follow-up assessments 1 year and 18 months after baseline (refer to Characteristics of Ongoing Studies).

Dietary versus physical activity interventions

No studies found.

Combined effects of dietary education interventions and physical activity interventions

The four Girls health Enrichment Multi-site Study (GEMS) pilots (Baranowski 2003; Beech 2003; Robinson 2003; Story 2003a) and four others (Dennison 2004; Harvey-Berino 2003; Kain 2004; Stolley 1997) met these criteria.

The Girls health Enrichment Multi-site Study (GEMS) includes four high quality, pilot RCTs all targeting African-American preadolescent girls aged (8-10 years) and their families (Story 2003b). All were culturally relevant, conducted in the US over 12 weeks and intended to test the acceptability and feasibility of GEMS. Pilots focused on changing eating and physical activity behaviours and enhancing self-esteem with a difference emphasis in each pilot. The control groups in each study were offered a less comprehensive intervention (self-esteem enhancement and cultural awareness programme) as a no-treatment comparison was likely to hamper recruitment and cause ill will in the respective communities. GEMS staff and community personnel (dance or lay health tutors)

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were trained specifically to deliver the programmes. All followed the GEMS methodology (Rochon 2003) and included allocation concealment and protection of contamination for example. Each had a comprehensive developmental stage involving focus groups with stakeholders and was underpinned by Social Cognitive Theory. All four had common data collection methods (BMI, DEXA for % body fat, dietary questionnaire and CSA accelerometry for physical activity with questionnaire) at baseline and at 12 weeks. Authors of the pilots acknowledged that the small numbers were not powerful enough to compare changes in BMI and no significant differences were reported, although all reported positive trends in anthropometry in the intervention groups. Trends in the desired direction were also found for behavioural changes in all the pilots, some of which were significant.

The first by Baranowski (Baranowski 2003) randomised 38 girls (intervention: n = 19; controls: n = 16) from middle incomes families. There was a significant difference in BMI at baseline: BMI (SD) intervention 21.1 (4.4) versus control 26.3 (7.9) which may have influenced findings. This pilot focused on healthy eating, drinking water and improving physical activity where girls attended a day summer camp (1 intervention and 1 control) for 4 weeks and then offered an 8 week internet intervention. Participation in the camps was high but there was a notable decline in the internet phase in both groups.

The second by Beech (Beech 2003) randomised 60 children in to a child group (n = 21), a parent group (n = 21) and a control (n = 18). Girls were from low-income homes. Their BMI at baseline were: BMI (SD) child intervention 25.5 (7.4), parent intervention 23.0 (5.6), control 22.6 (5.6). This pilot was set in community centres and examined the psychological aspects of dietary and physical activity behaviours in addition to the actual behaviours. The girls group and the parent group received weekly parallel sessions lasting 90 minutes on aspects of improving nutrition and physical activity. At follow-up girls in both intervention conditions were consuming fewer sweetened drinks. In this pilot public announcements were used to raise awareness of the study which resulted in the disappointment of controls. The evaluation identified a preference for mothers and daughters to be together and parents also found the concept of weight gain prevention difficult despite many explanations of GEMS.

The third by Robinson (Robinson 2003) randomised 61 girls (intervention: n = 28; controls: n = 33) from low incomes families. At baseline BMI was: BMI (SD) intervention 21.0 (5.4) versus control 21.6 (5.3). This intervention was set in three community centres and focused on school day dance classes and reducing television viewing. At follow-up there was less television viewing in the intervention group. Robinson et al concentrated on holistic health with importance of dance in African-American culture rather than obesity prevention, and African-American phlebotomists took blood samples in children's homes to increase acceptability and participation which helped to address attitudes of suspicion in the community with regard to medical research. Participation was high apart from one set of classes as there were no after school buses available.

The last pilot by Story (Story 2003a) randomised 54 girls (intervention: n = 26; controls: n = 28) from low incomes families. At baseline BMI was: BMI (SD) intervention 21.9 (5.9) versus control 19.5 (3.3). This intervention offered after school clubs set in school that included a range of activities, healthy eating and self-esteem enhancement. Several significant improvements in dietary practices and psychosocial variables were observed. The Story study found that providing transportation and motivational phone calls were well received, but the opportunity to take part in health hikes was not.

In the RCT conducted in the US by Dennison (Dennison 2004), 176 children were randomised by day care centre (n = 18) into the 12 week intervention or control. Data were presented for 77 children, mostly Caucasian, 2.6 to 5.5 year-olds (mean age 4.0 years) from middle income families. Their baseline measures for BMI (SD) were: intervention group 15.9 (0.3) and controls 15.9 (0.2). The intervention aimed to reduce TV viewing by encouraging them to read. This is part of a programme that addresses diet and activity change in preschoolers, but only the reduction of TV findings were presented in this paper. Children received seven, one hour sessions supported by appropriate reading materials, with packs sent home to parents. Controls received materials and activities about health and safety. This study appeared to have methodological limitations as many issues were not reported. At the end of the intervention, BMI was unchanged, but behaviours such as the number of children watching more than two hours of television per day was significantly lower in the intervention group, as was total number of hours watched.

In the RCT pilot conducted in the US by Harvey-Berino (Harvey-Berino 2003), 40 children were randomised into the 16 week intervention or control. Children were between the ages of 9 months and 3 years (mean age: 21 months, no SDs reported), 54% of whom were boys, with children able to walk, and mothers had a BMI >25. At baseline children's weight-for-height (or length) Z score (WHZ) (SD) was 0.79 (1.2) in the intervention group and 0.67 (1.6) in the controls. The percentage of children categorized as obese [Obesity was defined by WHZ >95th centile of the National (US) Center for Health Statistics growth charts] was 3% in the intervention group and 5% in the controls. The home visiting intervention, delivered by a specially trained, indigenous peer educator, focused on parenting skills that would develop appropriate dietary and activity behaviours to prevent obesity. It was designed specially for Native Americans and covered eleven parenting topics. Controls received the usual parenting programme. Outcomes were measured at baseline and 16 weeks, and included BMI, dietary and physical activity (measured by Tritrac R3D accelerometer) for both mothers and children. This study appeared to have methodological limitations as some issues were not reported and no theoretical framework was discussed. However, this intervention was integrated into the enhanced parenting interven-

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tion based on the Active Parenting curriculum, a previously evaluated Alderain parenting education programme, which was already established in the respective Native American communities. At the end of the intervention maternal BMI and prevalence of obesity were not significantly different, trends in WHZ =95 (weight-for-height (or length) Z score) were in the desired direction. No differences were observed for the accelerometery, but energy intake was decreasing in the intervention group and increasing in the controls for mothers and children.

The Chilean intervention (Kain 2004) aimed to compare improved nutrition education and physical activity in elementary school children. The dietary component focussed on healthier food kiosks and health snack contests, together with increases in physical activity provision: 90 minutes of additional physical activity weekly children in grades 3 to 8 for 6 months (mainly basketball, volleyball and soccer), and active recess where children were encouraged to dance to music or play ping-pong, basketball or volleyball, daily for 5 minutes, during the last 3 months of the intervention. The Canadian Active Living Challenge was translated into Spanish which provided a practical behavioural resources and activities. This was adapted and used weekly by physical education teachers with children in grades 1 to 8. Additional activities were promoted by individual physical education teachers which tended to differ between schools. On assessment at the end of the intervention, BMI was not significantly different between intervention and controls: BMI 19.5 (SD 3.7) versus 18.9 (SD 3.3); BMI at 6-month follow-up: 19.5 (SD 3.5) versus 19.2 (SD 3.1). Boys were found to have improved their shuttle run tests and lower back flexibility scores compared with their initial scores and between the intervention and control schools (both P<0.001). Waist circumferences and BMI Z-scores improved within the intervention boys and (both P<0.001), but neither was significantly different between the two conditions and no equivalent findings were present for triceps skinfolds. Girls showed no significant differences in anthropometry, but like the boys showed improvements in the same fitness tests (both P<0.0001) within the intervention and a difference between the intervention and control conditions (P = 0.001). Kain et al collected data from parents about perceptions of possible changes in their children, and teachers were asked for details of time spent delivering the intervention, their opinions of the programme and the support of the nutritionist. Monitoring the intervention, they found the healthier kiosks were not effective due to a lack of regulation and schools needed revenue to support them. Parental attendances at sessions in Santiago were half that of the two other locations, but no explanation was offered. A detailed report of the evaluation will be published in a separate paper (Kain 2004).

In a RCT conducted for 12 weeks in the US, Stolley (Stolley 1997) randomised 62 mother and daughter pairs into intervention and control groups. Girls were aged 7-12 years (mean age 9.9 (SD 1.3) years) and from low-income, inner-city African American backgrounds. Daughters baseline measures for BMI (SD) were: intervention group 18.4 (4.0) and controls 20.1 (6.4), with 7.9% overweight and 16.3% overweight in each group respectively [overweight was defined by BMI >85th percentile of the US Standard Height-Weight Tables]. The intervention focussed on culturally appropriate modifications of diet and activity and was based on the Know Your Body Program. The intervention was influenced by method of presentation being as important as intervention content; had a strong emphasis on experiential learning and was delivered by dietitians or doctoral clinical psychologists. Pilot findings showed that parental participation was imperative, as was having a gang neutral site within walking distance of participants, and building menus from locally available foods. Outcomes (anthropometry and behavioural variables) were assessed at baseline and at follow-up. This study appeared to have methodological limitations as many issues were not reported. However the potential of contamination between study groups was discussed and the intervention was underpinned by Social Learning Theory and detailed knowledge of the target group. On assessment at 12 weeks, results showed significant differences between the treatment and control mothers, but the only comparable results for daughters presented were mean percentage of daily calories from fat: intervention baseline 39.1 (SD 5.1) to 35.2 (SD 7.0) at follow-up; and controls baseline 41.9 (SD 4.6) to 40.6 (SD 4.6) at follow-up, which reached significance. Saturated fat and dietary cholesterol were not significantly different. Longitudinal data has been collected in this study, however, it has not been analysed and remains unreported.

DISCUSSION

This updated review provides useful data on published studies themselves, and expands the spectrum of information provided by the systematic review process that should make it more useful for public health decision makers.

Between 2000 and 2004 there has been a very small increase in the number of long-term studies (three new studies) whilst the number of short-term studies have quadrupled from three to twelve. There are now 10 studies with a duration or follow up of greater than one year, and 12 studies where participants have been followed for 3 to 12 months, that meet the inclusion criteria of this review.

The results of these studies indicate that the interventions employed to date have, largely, not impacted on weight status of children to any significant degree. Even the most recently published study of a comprehensive multi centre multifactorial behaviour change intervention that was conducted over 3 years has been unable to demonstrate a change in weight status of children, despite showing a significant improvement in knowledge and behaviour (Caballero 2003).

A simple conclusion might be to infer that the length of time over which interventions are being conducted is too short to modify

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weight status. However, it is likely that the conclusion needs to be expanded to include recognition of the complexity of the problem and its determinants, the sophistication of the intervention content, and the research methods required, in order to produce sound and sustainable outcome changes.

It is worth noting that the results reported from the studies identified in this review should be viewed with caution for at least two reasons. First, the impact of the intervention was assessed by comparing it with what happened in the control group. Given that children in the control groups were all aware of the study aims, and were assessed for height, weight, and dietary intake and/or physical activity levels, this assessment could itself have had an impact on the children's diet and physical activity patterns in the same direction as the intervention. Thus, any comparison of the impact of an intervention with such controls is likely to underestimate the effect. Second, the unit of allocation error discussed above, and commonly seen in the studies included in this review, is likely to overestimate the results.

There are some additional aspects of the methods used in the studies included in this review which may help put the findings of this review into context. First, the studies, overall, have largely been underpowered and/or poorly designed, given the complexity of the intervention and the outcomes sought. Second, the majority of the intervention approach content has been short-term in impact and downstream or midstream (i.e.. impact on behaviour change, school meal services) rather than addressing some of the environmental influences (physical and social) that impact on the sustainability of the intervention (cultural norms, organizational system changes, long-term commitment). The findings from the studies have not described whether the environmental changes made during the interventions are maintained subsequently.

Third, those that employed a theoretical framework that considered structural and environmental change produced results that were maintained at the environment level but weren't able to demonstrate sustainable changes in behaviour, whereas those that employed a theoretical framework that aimed to impact on individual behaviour change without making an impact at the environment or systems level, resulted in changes at the individual behaviour level without environmental changes. Perhaps outcomes will only be achieved through a multifactorial theoretical approach that considers the impact of system, environment and organizational issues, as well as the need to consider and address individual and group behaviour change.

Finally, from epidemiological and population level data internationally, we observe differences in prevalence of overweight and obesity by socioeconomic background. Social determinants are clearly a strong contributor to over and under weight. Intervention studies are beginning to address this issue with the development of studies such as GEMS as well as others (Caballero 2003; Harvey-Berino 2003; Stolley 1997). However, some studies appear to have sought to conduct their intervention with well educated population groups and families, limiting both the generalisability of the findings and potentially widening the inequalities experienced. The absence of well designed evaluations of upstream factors such as food availability, financial options for healthier food and activity options, safer play spaces, school-community partnerships etc, limits our capacity to consider their relative contribution as an effective intervention option.

Thus, the most useful information emerging from the process of undertaking this systematic review have been the trends in research and intervention design. The more recent studies are conducting trials with more attention to participant involvement, pilot preparatory studies and more comprehensive evaluations. Significantly, these background and contextual details are also now being published. It appears that the most promising interventions are now underway and yet to report findings.

From a public health and decision making perspective, the lack of economic data throughout the study findings is extremely disappointing. Similarly, the lack of information on the context in which these interventions were conducted, hampers our ability to examine the putative impact of policy, media and societal impact on the success or otherwise of interventions, carefully designed and implemented, or otherwise.

It is not unreasonable to suggest that the obesogenic environment in many countries, in which driving physiological goals to be sedentary and well fed are overwhelmingly supported by an increasingly complex socio-political environment, is likely to reduce the effectiveness of interventions aimed at individuals (Glanz 1998; Swinburn 1999). A further conceptual challenge is posed by our limited understanding of the interface between individual's behaviours and the environment. Evidence of interventions that aim to change the environment to enable individuals to more easily eat a healthy diet and be more physically active are lacking.

The mismatch between the prevalence and significance of the condition and the knowledge base from which to inform preventive activity continues to be remarkable.

AUTHORS' CONCLUSIONS

Implications for practice

This review highlights a paradoxical situation. At a time in which we see obesity prevention nominated as a public health priority, we have only a limited number of studies from which to examine findings.

The strongest recommendation is that all interventions are accompanied by a carefully considered evaluation design that enables sufficiently powered analysis of what is working, or not, and for whom.

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The review can recommend that a focus on short-term, behaviour change is unlikely to be sustainable or effective in impacting on weight status of children and thus not an effective strategy in the absence of corresponding interventions which would impact on the sustainability of the interventions and a conducive and supporting environment. Practitioners need to consider the issues impacting on sustainability and environmental change whilst simultaneously addressing behaviour change. The interventions identified in this review rarely considered the impact of parents' and family's increasingly complex working and living arrangements, yet the potential for change at the family level in the absence of addressing supportive strategies is likely to be diminished.

We recommend that stakeholders (families, school environments, and others) be included in the decision making regarding the potential strategies to be implemented, and that a sustained strategy to bring about supportive environments and behaviour change in physical activity, sedentariness and healthier food choices is likely to make more of a positive impact than the interventions identified in this review.

Implications for research

Current efforts at obesity prevention need to continue to build the evidence base to determine the most cost effective and health promoting strategies to achieve the goal of healthy weight for all children. In undertaking new studies, particular attention should be given to the following aspects of design:

- Using qualitative methods to ask questions that will inform the design of interventions;
- Addressing social determinants of overweight and obesity;
- Reporting the developmental and design stages of interventions;
- Sufficient power-adequate numbers;
- Follow-up of participants;
- Reliability of outcome measurements (reporting of BMI);
- Consider reporting broader adiposity measures (such as waist circumference), not just height and weight;
- Where interventions focus on increasing exercise levels, consider measuring additional outcomes such as fitness and muscle mass;
- Greater length and intensity of interventions;
- Process indicators-indication of whether the study was adhered to and conducted as it was intended;
- Cost effectiveness;
- Appropriate and adequate statistical analysis;
- Evaluations including views of stakeholders;
- Sustainability;
- Generalisability;
- Use the CONSORT statement for reporting study findings;

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* *Indicates the major publication for the study*

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CHARACTERISTICS OF STUDIES

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

Baranowski 2003

Methods	RCT Randomisation concealment: Reported. Follow-up: Twelve weeks. Blinded assessment: Not reported Differences in baseline characteristics: Reported. Reliable outcomes: Yes for anthropometry and accelerometry. Protection against contamination: Not reported, but set in two camps. Unit of allocation: Child Unit of analysis: Child.
Participants	N (controls baseline) =16 N (controls follow-up)=14 N (interventions baseline) =19 N (interventions follow-up)=17 Recruitment: all consenting 8 year old, African American girls =50th percentile for age and gender BMI, with a parent willing to be involved. Set in Texas, US. Proportion of eligibles participating: Not stated, but children needed access to internet Mean Age: Intervention: 8.3 (SD 0.3); Controls: 8.4 (SD 0.3) years. Sex: girls only.
Interventions	Set in summer camps and homes, the intervention was delivered by trained personnel in camp and researchers via a website. The intervention was designed to prevent obesity and aimed to increase fruit, vegetable and water consumption, and enhance physical activity. Intervention continued via a website with weekly visits. The pilot also evaluated the feasibility of a larger trial. Controls received usual camp activities and asked to visit control website once a month.
Outcomes	Body Mass Index Waist circumference Physical maturation Dual X-Ray Absorptiometry (DEXA) for % Body fat Physical activity: CSA accelerometer, a modification of the Self-Administered Physical Activity Checklist (SAPAC), GEMS Activity Questionnaire (GAQ) computerised Dietary intake measured by two 24 hour recalls using Nutrition Data System computer programme (NDS-R). Monitoring website usage.
Notes	

Risk of bias

Item	Authors' judgement	Description

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Baranowski 2003 (*Continued*)

Allocation concealment?	Unclear	B - Unclear

Beech 2003

Methods	RCT Randomisation concealment: Not described. Follow-up: Twelve weeks. Blinded assessment: Not reported Differences in baseline characteristics: Reported. Reliable outcomes: Yes for anthropometry and accelerometry. Protection against contamination: Not reported. Unit of allocation: Child Unit of analysis: Child.
Participants	N (controls baseline) =18 N (controls follow up) =18 N (child intervention baseline) =21 N (child intervention follow-up)=21 N (parent intervention baseline) =21 N (parent intervention follow-up)=21 Recruitment: all consenting 8 to10 year old, African American girls =25th percentile for age and gender BMI, with a parent willing to be involved. Set in Tennessee, US. Proportion of eligibles participating: Not stated Mean Age: Intervention (Child): 8.7 (SD 0.8) years; Intervention (Parent): 9.1 (SD 0.7) years; Controls: 8.9 (SD 0.8) years. Sex: girls only.
Interventions	Set in community centre and delivered by a trained researcher and a community lay health educator. The intervention aimed to prevent obesity and had three arms: girls, parents and a comparison group. The aim was to improve physical activity and improve diet, and to examine the psychological aspects of both. The pilot also evaluated the feasibility of a larger trial. Controls received 3 meetings (90 minutes each) designed to enhance self-esteem, with additional arts and crafts activities.
Outcomes	Body Mass Index Waist circumference Physical maturation Dual X-Ray Absorptiometry (DEXA) for % Body fat Blood samples for insulin Physical activity: accelerometer CSA, a modification of the Self-Administered Physical Activity Checklist (SAPAC), GEMS Activity Questionnaire (GAQ) computerized. Dietary intake measured by two 24 hour recalls using Nutrition Data System computer programme (NDS-R). Psychological variables: Body silhouettes McKnight Risk Factor Survey, and Stunkard et al. 1983. Parental food preparation practices

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Beech 2003 (*Continued*)

	Self-Perception Profile for Children Healthy Growth Study for physical activity expectations, and a self-efficacy measure.
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Caballero 2003

Methods	RCT (cluster randomized trial) Randomisation concealment: Not described. Follow-up: Three years. Blinded assessment: Adequately addressed Differences in baseline characteristics: Reported. Reliable outcomes: Yes for anthropometry and accelerometry. Protection against contamination: Adequately addressed. Unit of allocation: School Unit of analysis: Child. Unit of analysis errors addressed.
Participants	N (controls baseline) = 835 N (controls follow-up)=682 N (interventions baseline) =879 N (interventions follow-up)=727 N of schools: 41 Recruitment: all consenting American Indian students in grades 3 to 5 (8 to 11years) from schools in Arizona, New Mexico, South Dakota, US. Proportion of eligibles participating: Not stated, but schools had to provide: >15 3rd graders; 90% American Indian; retention of 3-5 grades over 70% in past 3 years; school meals prepared on site; facilities for PA programme; approval of study by school, community and tribal authorities. Mean Age: 7.6 (SD 0.6) years Sex: both sexes included but no figures given.
Interventions	School-based multi-component trial utilising school curriculum and existing staff resources trained by licensed SPARK (Sports, Play and active Recreation for Kids, see Sallis et al. 1993) instructors and Pathways personnel who also acted as mentors. The intervention aimed to attenuate obesity and reduce percentage body fat. Four components included improved physical activity, food service, class-room curriculum and family involvement programme. Control programme not reported, presumably usual curriculum.
Outcomes	Body Mass Index Triceps and subscapular Skinfolds.

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Caballero 2003 (*Continued*)

	Bioelectrical impedance. Physical activity: TriTrac R3D accelerometer, and checklist standardised from pilot work was used as a 24 recall questionnaire. Knowledge attitudes and beliefs: self report questionnaires developed in pilot. Dietary intake measured by modified 24 hour recall Observations of school meals. Analysis of school menus for energy, protein, carbohydrate, fat, sodium and fibre using the Nutrition Data System computer programme.
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Dennison 2004

Methods	RCT (cluster randomised trial) Schools stratified by mean child age Randomisation concealment: Reported. Follow-up: Twelve weeks. Blinded assessment: Not done. Differences in baseline characteristics: Not reported. Reliable outcomes: anthropometric measures yes. Protection against contamination: Reported Unit of allocation: Nursery Unit of analysis: Unclear.
Participants	N (controls baseline) =83 N (controls follow up) =73 (8 centres) N (interventions baseline) =93 N (interventions follow-up)=90 (8 centres) Setting: School Geographic Region: New York State, US Proportion of eligibles participating: Not stated Mean Age: 4.0 years Sex: both sexes included but no figures given
Interventions	Preschool and day care centre based intervention delivered by one early childhood teacher and a music teacher. This was part of larger 'Brocodile the Crocodile' health promotion programme which lasted for 39 weeks for 1 hour each week including 32 sessions on healthy eating. Seven educational sessions assessed intervention to encourage reduction of TV viewing for both parents and children. Controls received materials and activities about health and safety.

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Dennison 2004 (*Continued*)

Outcomes	Body Mass Index Triceps Skinfolds. Parental estimates of child's sedentary activity in previous week in hours, and to estimate number of hours usually spent in these activities for each weekend day and each week day. Alternate activities as a result of reduced TV viewing were not stated/measured.
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Donnelly 1996

Methods	CCT. Randomisation concealment: Not done. Follow-up: Over two years. Blinded assessment: Not done. Differences in baseline characteristics: Reported. Reliable outcomes: Most measures adapted from existing measures for this age group. Dietary measure is reportedly weak as is self-report measure of physical activity outside school. Protection against contamination: Not clear Unit of allocation: School Unit of analysis: Child. Not known if unit of analysis errors addressed.
Participants	N (controls baseline) =236 N (controls follow up) =100 N (interventions baseline) =102 N (interventions follow-up)=100 Also had a subset of students for detailed analysis: Controls =64, Intervention =44 Recruitment: all consenting students in grades 3-5 (8 to 11 years) from two school districts in Nebraska, US. Proportion of eligibles participating: Not stated Mean Age: School grade only reported age not reported. Mean Grade was 4.8 (SD=1.1) Sex: both sexes included but no figures given.
Interventions	School-based interdisciplinary trial utilising school curriculum and existing staff resources which aimed to attenuate obesity and improve physical and metabolic fitness. Components included a nutrition intervention (changes to food supply and nutrition education in curriculum)and physical activity intervention. Controls received usual schooling.

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Donnelly 1996 (*Continued*)

Outcomes	Body Mass Index 1 mile walk/run to assess fitness nutrition knowledge test Self-reports of physical activity outside of school SOFIT (fitness protocol) used to assess activity in PE lessons Peak aerobic capacity measured by treadmill testing. Blood chemistry included lipids, insulin/glucose, iron and ferritin. Blood Pressure Dietary intake measured by modified 24 hour recall Analysis of school menus for energy, protein, carbohydrate, fat, sodium and fibre.
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	D - Not used

Epstein 2001

Methods	RCT. Randomisation concealment: Not described. Follow-up: One year. Blinded assessment: Not clear. Differences in baseline characteristics: Reported. Reliable outcomes: Yes for height and weight. Protection against contamination: Not clear. Unit of allocation: Child Unit of analysis: Child.
Participants	For percentage of overweight (height and weight measured but not reported) N (controls baseline) = 13 (low fat/sugar) N (controls follow-up)=13 N (interventions baseline) =13 (fruit and veg) N (interventions follow-up)=13 Two interventions, 13 children in each intervention group. 30 started but only 26 children provided baseline data Geographic region: New York State, US. Proportion of eligibles participating: Not stated Mean Age: 8.8 (1.8) (low fat/sugar) 8.6 (1.9) (fruit/veg) Sex: both sexes included boys/girls 6/7 (low fat/sugar) 3/10 (fruit/veg)

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Epstein 2001 (*Continued*)

Interventions	Families with obese parents and non-obese children were randomized to groups in which parents were provided a comprehensive behavioural weight-control program and were encouraged to increase fruit and vegetable intake. Comparison groups were encouraged to decrease intake of high fat/high sugar foods.
Outcomes	Percentage of overweight Servings per day of fruits and vegetables Servings per day of high fat/high sugar foods.
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Flores 1995

Methods	RCT(cluster randomised trial) Randomisation concealment: Not done. Follow-up: Twelve weeks Blinded assessment: Not done. Differences in baseline characteristics: Reported. Reliable outcomes: Yes. Protection against contamination: Not clear. Unit of allocation: Class Unit of analysis: Child. Not known if unit of analysis errors addressed.
Participants	N (intervention baseline) =43 N (control baseline) =38 N (intervention follow-up)=26 girls, number of boys not reported N (control follow-up)=23 girls, number of boys not reported Setting: School Geographic Region: California, US. No data regarding: proportion of eligible population enrolled, number, nor characteristics of dropouts, eligibility for inclusion, sex Age: 10-13 years Sex: both sexes included; 54% girls.
Interventions	School-based, activity-focussed intervention that substituted aerobic dance session for usual practice in existing physical activity sessions. A health education component was also added. Controls received usual school curriculum.

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Flores 1995 (*Continued*)

Outcomes	Body Mass Index Timed mile run Resting heart rate Attitudes towards physical activity
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	D - Not used

Gortmaker 1999a

Methods	RCT (cluster randomised trial). Randomisation concealment: Done. Follow-up: Over two school years (18 months). Blinded Assessment: Not done. Differences in baseline characteristics: Reported. Reliable outcomes: Self report outcome measures were developed or modified from existing measures. If not designed for youth sample the measures were validated for use in this sample. Protection against contamination: Not clear. Unit of allocation: School Unit of analysis: Child. Unit of analysis errors addressed.
Participants	N (intervention follow-up)=641 N (control follow-up)=654 Outcome data collected for: 82% of baseline N enrolled: (81% Intervention and 82% Controls) 65% of eligible population =1560. N participants: 1295 N of schools: 10 Setting: School Geographic Region: Massachusetts, US. Age: mean age 11.7 years Sex: 48% girls.
Interventions	School-based interdisciplinary intervention utilising the school curriculum and existing school teachers to promote 4 major subjects and physical education. Sessions focused on decreasing television viewing, decreasing consumption of high-fat foods, increasing fruit and vegetable consumption and increasing moderate and vigorous physical activity. Control programme not reported, presumably usual school curriculum.

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Gortmaker 1999a (*Continued*)

Outcomes	Body Mass Index Triceps Skinfold. Food and activity survey 11-item TV and video Measure Youth Activity Questionnaire used to measure moderate and vigorous physical activity Food Frequency Questionnaire used to measure aspects of dietary intake including % energy from fat and saturated fat, fruit and vegetable intake and total energy intake.
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	A - Adequate

Harvey-Berino 2003

Methods	RCT Randomisation concealment: Not described. Follow-up: Sixteen weeks. Blinded assessment: Adequately addressed Differences in baseline characteristics: Reported. Reliable outcomes: Yes for anthropometry and accelerometry. Protection against contamination: Not reported. Unit of allocation: Child Unit of analysis: Child.
Participants	N (controls baseline) =20 N (controls follow up) =17 N (intervention baseline) =20 N (intervention follow-up)=20 Recruitment: Child between the ages of 9 months and 3 years, child was walking, mother BMI >25, mother agreed to keep all appointments. Set in Northern New York State, US, Quebec and Ontario, Canada. Proportion of eligibles participating: Not stated Mean Age: 21 months (no SD reported). Sex: both sexes included; 54% boys.
Interventions	Home visiting programme delivered by an indigenous peer educator who was extensively trained. The intervention was an adaptation of the Active Parenting Curriculum where 11 parenting topics were covered in 16 weeks. The focus for the treatment group was exclusively on how to improve parenting skills to develop appropriate eating and exercise behaviours to prevent obesity. Controls received the usual parenting support programme.

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Harvey-Berino 2003 (*Continued*)

Outcomes	Maternal Body Mass Index N classified >85th and 95th weight for height z (WHZ) centile scores. Diet: 3 day food records analysed for total calorie and fat intake using Nutritionist IV computer programme. Physical activity: Tritrac R3D accelerometer (mother and child) Psychological variables: Outcomes Expectations Self-efficacy Intentions Child Feeding Questionnaire.
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

James 2004

Methods	RCT (cluster randomised trial) Randomisation concealment: Described. Follow-up: One year. Blinded assessment: Not reported Differences in baseline characteristics: Reported. Reliable outcomes: Yes for height and weight. Protection against contamination: Not reported. Unit of allocation: Class Unit of analysis: Class. Unit of analysis errors addressed.
Participants	N (intervention baseline and follow-up)325 (15 classes) N (control baseline and follow-up)=319 (14 classes) No of classes: 29 Outcome data collected for: 100% of sample. % of eligible population enrolled: Not stated Setting: School Geographic Region: Southern UK Age: 8.7 years (range 7 to 10.9 years) Sex: both sexes included; Controls: 51% girls; Intervention: 48% girls.
Interventions	School-based educational intervention aiming to prevent obesity by reducing consumption of carbonated drinks, delivered by the author and supported by existing staff. Three sessions, one per term, promoted drinking water and a reduction of carbonated drinks.

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James 2004 (*Continued*)

	Control programme not reported, presumably usual school curriculum.
Outcomes	Body Mass Index Carbonated drink consumption and water consumption using a drinks diary.
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Kain 2004

Methods	CCT (cluster case controlled trial) Randomisation concealment: Not done. Follow-up: Six months Blinded assessment: Not done. Differences in baseline characteristics: Reported. Reliable outcomes: Yes Protection against contamination: Not clear. Unit of allocation: School Unit of analysis: Unclear.
Participants	N (Intervention and control at baseline) =2375 N (intervention follow-up)=2141; N (control follow-up)=945. N of schools: 5 (Authorities assigned schools to intervention on basis of need and so boys had higher BMIs in intervention schools at baseline). Outcome data collected for: 100% of sample. % of eligible population enrolled: Not stated. Setting: School Geographic Region: Chile. Age: 10.6 (SD 2.6) Sex: both sexes included; Controls: 52% boys; Intervention: 53.5% boys.
Interventions	School-based multi-component intervention aimed to change adiposity and physical activity levels, delivered by a nutritionist and a Physical Education (PE) teacher. Nutrition education was available for children and parents supported by healthier food kiosks. Sessions included 90 minutes additional physical activity weekly for 3rd to 8th grade for 6 months and 15minutes of activity in recess per day, for last 3 months. Control programme not reported, presumably usual school curriculum.
Outcomes	Body Mass Index Triceps Skinfolds Waist Circumference

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	Fitness: Shuttle run test (20m Leger and Lambert test) Sit and reach for lower back flexibility.
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Mo-Suwan 1998

Methods	RCT (cluster randomised trial). Randomisation concealment: Done. Follow-up: Over one year. Blinded assessment: Not clear. Differences in baseline characteristics: Reported. Reliable outcomes: All measures validated in children over 6 years of age. Protection against contamination: Not clear. Unit of allocation: Class Unit of analysis: Child. Unit of analysis errors addressed.
Participants	Follow-up at 6 months:- N (intervention baseline) =158 N (intervention follow-up)=147 N (control baseline) =152 N (control follow up) =145 N of classes: 10 Outcome data collected for: 94% of baseline N followed up 75% of eligible population enrolled =310 Geographic setting: Thailand. Age: 4.5 (SD 0.4) years Sex: both sexes included; Controls: 61% boys; Intervention: 56% boys.
Interventions	Kindergarten-based physical activity program conducted by specially trained staff and including a 15 minute walk and a twenty minute aerobic dance session 3-times a week. Study objective was to evaluate the effect of a school-based aerobic exercise program on the obesity indexes of preschool children. Control programme not reported, presumably usual school curriculum.
Outcomes	Body Mass Index Triceps Skinfold (TSF) WHCU (ratio of wt in kg divided by ht cubed in meters) Computation of BMI, WHCU and TSF slopes.

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Mo-Suwan 1998 (*Continued*)

Notes		
Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	B - Unclear

Mueller 2001

Methods	RCT (cluster randomised trial). Randomisation concealment: Not clear. Follow-up: One year (still ongoing - further follow-up to be done at 4 and 8 years). Blinded assessment: Not clear. Differences in baseline characteristics: Reported Reliable outcomes: Yes for weight, height, triceps skinfolds (TSF) (but method of measurement not reported). Protection against contamination: Not done. (Every alternating year schools change and control schools become intervention schools and intervention schools become control schools). Unit of allocation: School Unit of analysis: Child. Not known if unit of analysis errors addressed.
Participants	For weight, height and TSF N (controls baseline) =161 N (controls follow up) =161 N (interventions baseline) =136 N (interventions follow-up)=136 N of schools: 6 Recruitment: all consenting school pupils aged 5-7 years. General recruitment took place as part of health examinations by the school physicians. Geographical setting: Kiel, Germany. Proportion of eligibles participating: 30.2 % Mean Age: Not reported (children aged 5-7 years) Sex: both sexes included but not reported for the 297 (136+161) children followed up for weight, height and skin fold thickness.
Interventions	School-based intervention which included an 8 hour course of nutrition education including 'active' breaks was given by a skilled nutritionist and a trained teacher. The course included the following messages: 'eat fruit and vegetables each day', 'reduce intake of high fat foods', keep active at least 1 hour each day', 'decrease TV consumption to less than 1 hour per day'. (In addition a family-based intervention plus a structured sports programme were offered to families with overweight or obese children and to families with normal weight children but obese parents). The controls received usual schooling during this time period but will cross-over every alternate year.

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Mueller 2001 (*Continued*)

Outcomes	Body Mass Index Triceps skinfold thickness % fat mass of overweight children Nutrition knowledge Daily physical activities Daily fruit and vegetable consumption Daily intake of low fat food
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

NeumarkSztainer 2003

Methods	RCT (cluster randomised trial). Randomisation concealment: Not reported. Follow-up: Eight months. Blinded assessment: Poorly addressed. Differences in baseline characteristics: Reported Reliable outcomes: Yes for weight, height, TSF (but method of measurement not reported). Protection against contamination: Not done. Unit of allocation: School Unit of analysis: Child. Not known if unit of analysis errors addressed.
Participants	N (intervention baseline) =89 N (intervention follow-up)=89 (3 high schools) N (control baseline) =112 N (control follow up) =112 (3 high schools) Outcome data collected for all those enrolled i.e. 100% follow-up % of eligible population enrolled = 86.8% of intervention school, 83.6% of control school. Geographical setting; Minnesota, US. Mean Age: Intervention: 14.9 (SD0.9) years: Controls: 15.8 (SD1.1). Sex: girls only.
Interventions	High-school based girls only, intervention with priority given to girls with BMI at or above 75th percentile and who did less than 30 minutes per day 3 times per week physical activity (eating disorders excluded). Delivery was by school staff and research team, with local guest instructors. Intervention addressed socio-environmental, personal and behavioural factors, with physical activity four times per week, nutrition and social support session every other week for total of 16 weeks with an 8 week maintenance component of lunch time meetings.

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NeumarkSztainer 2003 (*Continued*)

	Control programme not reported, presumably usual school curriculum.
Outcomes	Body Mass Index Physical activity Stages of change (based on the Stages of Change Model) Participation in physical activity based on Godin and Sheppard. Dietary intake adapted from Youth and Adolescent Food Frequency Questionnaire Binge eating adapted from the Minnesota Adolescent Health Survey. Personal Factors Harter's Self Perception Profile for Children Media internailsaiton Self-efficacy to be active Socio-environmental support.
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Pangrazi 2003

Methods	RCT (cluster randomised trial) Randomisation concealment: Not described. Follow-up: Twelve weeks. Blinded assessment: Not reported Differences in baseline characteristics: Not reported. Reliable outcomes: Yes for anthropometry and accelerometry. Protection against contamination: Adequately addressed. Unit of allocation: School Unit of analysis: Group. Not known if unit of analysis errors addressed.
Participants	N at baseline 606 N of controls and treatment group not reported Recruitment: all consenting 4th grade children in 35 schools in Arizona, New Mexico, US. Proportion of eligibles participating: Not stated, but restricted to 4th graders (9 to10 years) as they would not know about PLAY. Mean Age: 9.8 (SD 0.6) years Sex: both sexes included Controls: 57% girls; Intervention: 50.5% girls.
Interventions	School based intervention aimed at increased physical activity with a secondary intention of preventing obesity and delivered by school staff who were specially trained. There were three conditions and a control: 1) PLAY (9 schools); 2) PLAY and PE (10 schools); 3) PE only (10 schools). The intervention has three elements: to promote play behaviour, followed by teacher directed activities and then self-directed activity was encouraged. This was achieved by incorporating 15 minutes of daily activity in the school day and

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Pangrazi 2003 (*Continued*)

	encouraging 30 minutes of out of school play by the end of the intervention. Controls attended schools (N = 6) with no PE provision.
Outcomes	Body Mass Index Physical activity: CSA accelerometer.
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Robinson 1999

Methods	RCT (Cluster randomised trial). Randomisation concealment: Done. Follow-up: Over six months. Blinded assessment: Done. Differences in baseline characteristics: Reported. Reliable outcomes: All measures validated for this age group. Protection against contamination: Not clear. Unit of allocation: School Unit of analysis: Child.
Participants	N (intervention baseline) =92 N (intervention follow-up)=92 N (control baseline) =100 N (control follow up) =100 Number stated in paper 198, data presented for 192 i.e. 97% at follow-up. Percent of eligible population enrolled = 86.8% of intervention school, 83.6% of control school. Mean Age: 8.9 years Sex: both sexes included Controls: 48.5% girls; Intervention: 44.6% girls.
Interventions	School-based intervention utilising existing teaching staff, that aimed to assess the effects of reducing television , videotape and video game use on changes in adiposity, physical activity and dietary intake. The intervention consisted of incorporating 18 lessons of 30 to 50 minutes into the standard curriculum. Early lessons included self-monitoring and self-reporting of television, videotape and video game use to motivate children to want to reduce the time they spent in these activities. Followed by a television turnoff and then encouragement to follow a 7 hour per week budget. Control programme not reported, presumably usual school curriculum.
Outcomes	Body Mass Index Triceps skinfold Waist and hip circumference

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Robinson 1999 (*Continued*)

	2-day self report of TV , video viewing or playing video games. Parental estimates of child's sedentary activity (as above) on weekend day. Child/parental estimates of time spent in other sedentary activity. Child and parent completed 24-hour activity checklist (yesterday). Child completed 1-day food frequency recalls (yesterday). Child and parent report of food eaten with television on or snacking while watching television/video or playing video games. Maximal, multistage, 20-m, shuttle run test (20-MST) used to asses cardio-respiratory fitness.
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	A - Adequate

Robinson 2003

Methods	RCT Randomisation concealment: Not described. Follow-up: Twelve weeks. Blinded assessment: Adequately addressed Differences in baseline characteristics: Reported. Reliable outcomes: Yes for anthropometry and accelerometry. Protection against contamination: Not reported. Unit of allocation: Child Unit of analysis: Child. Unit of analysis errors - unclear if these were addressed.
Participants	N (controls- baseline) = 33 N (controls- follow up) = 33 N (interventions- baseline) = 28 N (interventions-follow-up)= 28 Recruitment: all consenting 8-10 year old, African American girls =50th percentile for age and gender. BMI, with a parent having a BMI =25, willing to be involved. Set in Oakland and Palo Alto, California, US. Proportion of eligibles participating: Not stated, but criteria kept broad. Intended to recruit 50 and 61 were enrolled Mean Age: Intervention: 9.5 (SD 0.8) years; Controls: 9.5 (SD 0.9) Sex: girls only.
Interventions	After school dance classes set in community centers designed to improve physical activity, reduce sedentary behaviours and enhance diet. The intervention called START (sisters taking action to reduce television) was delivered by trained university based dance instructors and a female African American intervention specialist. The programme consisted daily dance classes during school weeks and reducing television was covered in five home based lessons. Four community lectures were also provided.

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Robinson 2003 (*Continued*)

	Controls received newsletters and health education lectures.
Outcomes	Body Mass Index Waist circumference Physical maturation Dual X-Ray Absorptiometry (DEXA) for % Body fat Physical activity: CSA accelerometer, a modification of the Self-Administered Physical Activity Checklist (SAPAC), GEMS Activity Questionnaire(GAQ) computerised Dietary intake measured by two 24 hour recalls using Nutrition Data System computer programme (NDS-R).
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Sahota 2001

Methods	RCT (cluster randomised trial). Randomisation concealment: Done. Follow-up: One year. Blinded assessment: Not done. Differences in baseline characteristics: Reported. Reliable outcomes: Yes for height and weight. Protection against contamination: Not done. (schools which were controls one year received the intervention the following year). Unit of allocation: School Unit of analysis: Child. Unit of analysis errors addressed.
Participants	For weight and height:- N (controls baseline) =312 N (controls follow up) =303 N (intervention baseline) =301 N (intervention follow-up)=292 N of schools: 10 Recruitment: Not clear Geographical setting: Northern UK. Proportion of eligibles participating: For weight and height: control 97% intervention 96% Mean Age: Control: 8.42 (0.63) years Intervention: 8.36 (0.63) years Sex: both sexes included

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Sahota 2001 (*Continued*)

	Control: 59% boys Intervention: 51% boys.
Interventions	School-based intervention - Active Programme Promoting Lifestyle in Schools (APPLES). The programme was designed to influence diet and physical activity and not simply knowledge. Targeted at the whole school community including parents, teachers and catering staff. The programme consisted of teacher training, modifications of school meals and the development and implementation of school action plans designed to promote healthy eating and physical activity. Control schools received usual curriculum.
Outcomes	Body Mass Index Dietary intake - 24 hour recall and 3 day food diaries Physical activity - frequency of physical activity and sedentary behaviour was measured by questionnaire. Psychological measures - three validated measures including a Self-Perception Profile for Children, a questionnaire to distinguish global self-worth from competence and a measure of dietary restraint.
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Yes	A - Adequate

Sallis 1993

Methods	RCT Random allocation: Schools stratified by % of ethnic minority students and size. Blinded assessment: Children: Unclear Providers: Teachers and specialist staff Differences in baseline characteristics: Reported. Reliable outcomes: Yes for anthropometry. Length of intervention and follow up:18 month follow up Protection against contamination: Unclear Unit of allocation: School Unit of analysis: Child. Not known if unit of analysis errors addressed.
Participants	N (controls and intervention not reported separately) = 740 N (follow-up)= 549 (data presented for these.) From graphs: Controls = 198; teacher intervention = 200 and specialist intervention = 98. N of schools: 6 (one school added to control group, 7 schools in total) Setting: School Geographic Region: California, US. Age range (mean) 9.25 years Sex: both sexes included; 55.5% boys.
Interventions	School-based intervention. Followed the (Sports, Play and Active Recreation for Kids) SPARK intervention, incorporating physical education and self-management into the school curriculum. Two intervention schools, led by either 1) certified physical education specialists or 2) classroom teachers evaluated against

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Sallis 1993 (*Continued*)

	a control. Controls received usual PE curriculum.
Outcomes	Weight Status: BMI presented at fall 1990, spring 1991, fall 1991 and spring 1992.
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Stolley 1997

Methods	RCT Randomisation concealment: Not described. Follow-up: 12 weeks. Blinded assessment: Not clear. Differences in baseline characteristics: Reported. Reliable outcomes: Validation of dietary measure only in adults (but used here in children). No reliability data for this measure. Protection against contamination: Not possible. Unit of allocation: Child Unit of analysis: Child.
Participants	N (intervention baseline) = 32mothers and 32 daughters N (control baseline) = 30 mothers and 33 daughters N (intervention follow-up)= 20 mothers and 23 daughters have dietary data reported however, stated that in all 51 mothers (78%) and 54 daughters (83%) had data collected. Unable to separate intervention from control figures with data provided. Geographical setting: Chicago, US. Age: 7 to 12 years, mean age Intervention 9.9 (SD I.3); Controls 10.0 (SD 1.5) years Sex: girls only.
Interventions	Set up within a community based tutoring program this intervention examined the effectiveness of a culturally specific obesity prevention program for low-income, inner-city African American, preadolescent girls and their mothers. Program focused on adopting a low-fat, low-calorie diet and increased activity. Controls were offered a general health programme.
Outcomes	Mother and daughters: Body weight and height % overweight Daily caloric intake, total fat gram intake, % calories from fat, sat fat, dietary cholesterol assessed by Quick Check for Fat (QCF) and analysed with Quick Check Diet (QCD). Parental completion of a self-report measure of parental support and role modelling around food.

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Stolley 1997 (*Continued*)

Notes		
Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	B - Unclear

Story 2003a

Methods	RCT Randomisation concealment: Not described. Follow-up: Twelve weeks. Blinded assessment: Not reported. Differences in baseline characteristics: Reported. Reliable outcomes: Yes for anthropometry and accelerometry. Protection against contamination: Not reported. Unit of allocation: Child Unit of analysis: Child.
Participants	N (controls baseline) = 27 N (controls follow up) = 27 N (intervention baseline) = 26 N (intervention follow-up)= 26 Proportion of eligibles participating: Not stated, but criteria kept broad. Intended to recruit 50 and 61 were enrolled Geographical setting: Minnesota, US. Mean Age: Intervention 9.4 (SD 0.9); Controls 9.1 (SD 0.8) years Sex: girls only.
Interventions	After school classes set in schools designed to improve skill building and practice in support of health behaviour messages in the programme. These included drinking water, eating more fruit, vegetables and low fat foods, increasing physical activity reducing TV watching and enhancing self-esteem. The intervention was delivered by African American GEMS staff. Family contact and activities supported the intervention. Controls received a 12 week programme unrelated to nutrition and physical activity (enhancing self-esteem and cultural enrichment).
Outcomes	Body Mass Index Waist circumference Physical maturation Dual X-Ray Absorptiometry (DEXA) for % Body fat Physical activity: CSA accelerometer, a modification of the Self-Administered Physical Activity Checklist (SAPAC), GEMS Activity Questionnaire(GAQ) computerised Dietary intake measured by two 24 hour recalls using Nutrition Data System computer programme (NDS-R).

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Story 2003a (*Continued*)

	Psychological variables: Body silhouettes McKnight Risk Factor Survey, and Stunkard et al. 1983. Healthy choice Behavioral Intentions (diet) Self-Efficacy for Healthy Eating Physical Activity Outcomes Expectations, and a self-efficacy measure.
Notes	

Risk of bias

Item	Authors' judgement	Description
Allocation concealment?	Unclear	B - Unclear

Warren 2003

Methods	RCT Randomisation concealment: Not described. Follow-up: Fourteen moths. Blinded assessment: Poorly addressed. Differences in baseline characteristics: Reported. Reliable outcomes: Height and weight and dietary measures validated for this age group. Protection against contamination: Not reported. Unit of allocation: Child Unit of analysis: Child.
Participants	N (controls and interventions - baseline) = 218 N (controls follow up) = 54 N (3 interventions follow-up)= 164 Recruitment: all consenting 5-7 year-olds from 3 primary schools. Set in central UK. Proportion of eligibles participating: Not stated Mean Age: all groups 6.1 (SD 0.6) years; Sex: both sexes; 51% boys.
Interventions	School and family-based interventions focussing on nutrition, physical activity, or both, upon the prevalence of overweight/obesity. The setting was lunchtime clubs where an interactive and age-appropriate nutrition and/or physical activity curriculum was delivered by the project team. Controls received an education programme covering the non-nutritional aspects of food and human biology.
Outcomes	Body Mass Index Skinfolds measured at five sites (biceps, triceps, subscapular, supra-iliac, calf). Nutrition knowledge: validated questionnaire . Physical activity: children and parents completed basic questions about habitual activity (not validated). Diet: parents reported on behalf of children a 24h recall and a food frequency questionnaire.

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Warren 2003 (*Continued*)

Notes		
Risk of bias		
Item	**Authors' judgement**	**Description**
Allocation concealment?	Unclear	B - Unclear

Mo-Suwan has supplied follow-up data for 6 months after intervention via email (20/12/01)
Glossary
BMI, Body Mass Index
CSA accelerometer, COmputer Sciences Applicvations accelerometer
GEMS, Acronym for Girlsl health Enrichment Multi site Studies.
TSF, Triceps Skinfold
WHCU weight/height cubed.

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

Arbeit 1992	1)YES 2)YES 3)YES 4)NO: Aim of the trial was to prevent cardiovascualr disease
Bollela 1999a	1)YES 2)YES 3)YES 4)NO: Aim of the trial was to improve nutritional intake
Bollela 1999b	1)YES 2)YES 3)YES 4)NO: Aim of the trial was to improve nutritional intake
Borys 2000	1)NO: not an RCT or CCT 2)YES 3)YES 4)YES
Burke 1998	1)YES 2)YES 3)YES 4)NO: Aim was to improve physical activity
Cairella 1998	1)NOT CLEAR 2)NOT CLEAR 3)NOT CLEAR 4)YES
Chomitz 2003	1)YES 2)YES 3)YES 4)YES However paper does not contain any anthropometric data.
Cullen 1996	1) NOT CLEAR 2) YES 3) YES 4) NO: Aim of the trial was to prevent children's behaviour disorders
D'Agostino 1999	1)YES 2)YES 3)YES 4)NO: Aim of the trial was to improve nutritional intake

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(*Continued*)

Dixon 2000	1)YES 2)YES 3)YES 4)NO: Aim of the trial was to improve nutritional intake
Flodmark 1993	1)YES 2)YES 3)YES 4)NO: Aim was to treat obese children
Gortmaker 1999b	1)NO: not RCT or CCT 2)YES 3)YES 4)NO: Aim was not to prevent childhood obesity
Harrell 1998	1)YES 2)YES 3)NO: Intervention less than 12 weeks duration 4)NO: Aim of trial was not to prevent childhood obesity
Harrell 1999	1)YES 2)YES 3)NO: Intervention less than 12 weeks duration 4)NO: Aim of trial was not to prevent childhood obesity
He 2004	1)YES 2)YES 3)YES 4)NO: Aim of the trial was to treat obese children
Hopper 1996	1)YES 2)YES 3)YES 4)NO: Aim of the trial was to prevent cardiovascualr disease
Horodynski 2004	1)YES 2)YES 3)YES 4)NO: Aim of the trial was to improve nutritional intake
Howard 1996	1)YES 2)YES 3)YES 4)NO: Aim of the trial was to prevent cardiovascualr disease
Koblinsky 1992	1)YES 2)YES 3)YES

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(*Continued*)

	4)NO: Aim of the trial was to improve nutritional intake
Lagstrom 1997	1)YES 2)YES 3)YES 4)NO: Aim of the trial was to improve nutritional intake
Lionis 1991	1)YES 2)YES 3)YES 4)NO: Aim of the trial was not to prevent childhood obesity
Luepker 1996	1)YES 2)YES 3)YES 4)NO: Aim of the trial was to prevent cardiovascualr disease
Manios 1998	1)YES 2)YES 3)YES 4)NO: Aim of the trial was to improve physical activity
Manios 1999	1)NO 2)YES 3)YES 4)NO: Aim of the trial was to improve nutritional intake
McGarvey 2004	1)YES 2)YES 3)NO: Intervention was 8 weeks 4)YES
McMurray 2002	1)YES 2)YES 3)NO: Intervention less than 12 weeks duration 4)YES
Niinikoski 1997	1)YES 2)YES 3)YES 4)NO: Aim was to improve nutritional intake
Obarzanek 1997	1)YES 2)YES 3)YES 4)NO: Aim of the trial was to improve nutritional intake

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(*Continued*)

Oehrig 2001	1)YES 2)YES 3)YES 4)NO: Aim of trial was not to prevent childhood obesity
Rask-Nissila 2000	1)YES 2)YES 3)YES 4)NO: Aim of trial was not to prevent childhood obesity
Sadowsky 1999	1)NOT CLEAR 2)YES 3)NO: Intervention duration was 8 weeks 4)YES
Simon 2004	1)YES 2)YES 3)YES 4)NO: Aim of the trial was to improve physical activity
Simonetti 1986	1)YES 2)YES 3)YES 4)YES This trial was conducted before 1990 and so had been excluded from this review
Spark 1998	1)YES 2)YES 3)YES 4)NO: Aim of the trial was to improve nutritional intake
Stephens 1998	1)YES 2)YES 3)YES 4)NO: Aim of the trial was to improve physical activity
Stewart 1995	1)YES 2)YES 3)YES 4)NO: Aim was to improve nutritional intake
Talvia 2004	1)YES 2)YES 3)YES 4)NO: Aim of trial was to improve nutritional intake
Tamir 1990	1)YES 2)YES 3)YES

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(*Continued*)

	4)NO: Aim of the trial was to prevent cardiovascualr disease
Tershakovec 1998	1)YES 2)YES 3)YES 4)NO: Aim of trial was not to prevent childhood obesity
Trudeau 2000	1)NOT CLEAR 2)YES 3)YES 4)NO: Aim of trial was not to prevent childhood obesity
Vandongen 1995	1)YES 2)YES 3)YES 4)NO: Aim of the trial was to prevent cardiovascualr disease
Williams 1998	1)YES 2)YES 3)YES 4)NO: Aim of the trial was to prevent cardiovascualr disease

Criteria for study inclusion:-
1) Is it an RCT or CCT?
2) Is it an RCT or CCT in children?
3) Is the intervention plus follow-up 1 year or more? if not 12 weeks or more?
4) Is the aim of the trial to PREVENT childhood obesity?

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

Fitzgibbon 2002

Trial name or title	Hip Hop
Methods	
Participants	3-5 year old African-American and Latino minority children in 24 Head Start sites.
Interventions	Preschool based study which aims to reduce dietary fat and increase fibre, increase physical activity and be inclusive of families. The theoretical base is combination of social learning theory and transtheoretical model of stages of change. It is not clear who delivers the intervention.
Outcomes	The three week pilot addressed feasibility and acceptability in the deprived communities.
Starting date	Autumn 1999 for Black Head Start units (12) and autumn 2000 for Latino Head Start units (12). The main trial is ongoing for 5 years.
Contact information	Dr Marian Fitzgibbon, Eating Disorders Research Program, 710 N. Lake Shore Dr. Suite 1200 Chicago IL 60611 Fax: (312) 908 5070 Mlf056@northwestern.edu
Notes	

Mueller

Trial name or title	Kiel Obesity Prevention Study
Methods	
Participants	
Interventions	
Outcomes	
Starting date	
Contact information	Prof. Dr. med. Manfred James Mueller Institut fur Humanernahrung und Lebensmittelkunde Agrar- und Ernahrungswissenschaftliche Fakulat Christian-Albrechts-Universitat zu Kiel Dusternbrooker Weg 17

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Mueller (*Continued*)

	D-24105 Kiel Germany email mmueller@nutrfoodsc.uni-kiel.de
Notes	

NHLBI 2001

Trial name or title	Decreasing weight gain in African-American pre-adolescent girls
Methods	
Participants	
Interventions	
Outcomes	
Starting date	
Contact information	http://www.nhlbi.nih.gov/resources/docs/plandisp.htm
Notes	

Reilly 2002

Trial name or title	RCT of a nursery and home-based intervention for obesity prevention and cardiovascular risk factor reduction
Methods	
Participants	
Interventions	
Outcomes	BMI SDS two indices of fat distribution blood pressure estimated fat mass motor skills physical activity level
Starting date	To commence April 2002. To be completed December 2004
Contact information	Dr John Reilly Senior lecturer University of Glasgow Department of Human Nutrition (email jjr2y@clinmed.gla.ac.uk)

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Reilly 2002 (*Continued*)

Notes	Funded by British Heart Foundation, UK

Robinson

Trial name or title	Reducing children's television viewing to prevent obesity - long term follow-up.
Methods	
Participants	3rd graders in 12 public elementary schools in two ethnically and socioeconomically-diverse school districts in the San Francisco Bay Area (N approx. 850 at baseline).
Interventions	Rx: The SMART classroom curriculum delivered by the regular classroom teachers and accompanied by parent newsletters. Ctrl: A tobacco prevention classroom curriculum delivered by the regular classroom teachers and accompanied by parent newsletters
Outcomes	Primary outcome is BMI. Secondary outcomes include television, videotape and video game use, physical activity and dietary intake variables.
Starting date	Commenced on 4/1/99, and concludes on 3/31/2002
Contact information	Assistant Professor Thomas N. Robinson, MD, MPH Assistant Professor of Pediatrics and Medicine Stanford Center for Research in Disease Prevention Stanford University School of Medicine 1000 Welch Road Palo Alto, CA 94304-1825 email: Tom.Robinson@Stanford.edu
Notes	Funded by a grant from the National Heart, Lung, and Blood Institute, National Institutes of Health

Stolley 2003

Trial name or title	
Methods	
Participants	
Interventions	
Outcomes	

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Stolley 2003 (*Continued*)

Starting date	
Contact information	
Notes	

TAAG 2001

Trial name or title	Trial of activity for adolescent girls (TAAG)
Methods	
Participants	
Interventions	
Outcomes	
Starting date	Study dates 2001-2007
Contact information	http://www.nhlbi.nih.gov/resources/docs/plandisp.htm
Notes	

Waters

Trial name or title	Fun 'n' healthy in Moreland
Methods	
Participants	Primary School Children in 24 Schools in Moreland, an inner city suburb of Melbourne, Australia
Interventions	Intervention is a facilitated approach to supporting school to implement an evidence based approach with interventions based on priorities within the school, ensuring focus on diet, physical activity and child health and wellbeing.
Outcomes	BMI, child health and wellbeing,
Starting date	2004-2008
Contact information	http://www.mchs.org.au/
Notes	Victorian Government Departments of Sport and Recreation and Human Services

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Yin 2005

Trial name or title	FitKid Project
Methods	
Participants	Elementary school children in 18 schools in Georgia, US.
Interventions	After school physical activity programme including: academic enrichment, healthy snacks, physical activity in a mastery-oriented environment.
Outcomes	Adiposity and fitness measures
Starting date	3 years
Contact information	Exercise Scientist and co-principal investigator: Dr Zenong Yin Medical College of Georgia, Email: zenong.yin@utsa.edu
Notes	

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DATA AND ANALYSES

This review has no analyses.

WHAT'S NEW

Last assessed as up-to-date: 27 March 2005.

10 November 2008	Amended	Converted to new review format.

HISTORY

Protocol first published: Issue 4, 1999

Review first published: Issue 1, 2001

CONTRIBUTIONS OF AUTHORS

CS: Secured funding, co-ordinated this review, helped in writing text, reviewed papers for inclusion/exclusion, extracted data from included papers, contributed to previous versions of this review.

EW: Secured funding, helped in writing text, contributed to previous versions of this review.

LE: Helped in writing text, reviewed papers for inclusion/exclusion, extracted data from included papers.

SK: Developed and ran searches, helped in writing text, reviewed papers for inclusion/exclusion, extracted data from included papers, contributed to previous versions of this review.

TB: Helped in writing text, reviewed papers for inclusion/exclusion, extracted data from included/excluded papers.

KC: Helped in writing text, contributed to previous versions of this review.

DECLARATIONS OF INTEREST

There are no conflicts of interest to report.

SOURCES OF SUPPORT

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Internal sources

- School of Health and Social Care, University of Teesside, UK.
- School of Health Social Sciences, Deakin University, Australia.

External sources

- Department of Health, UK.
- World Health Organisation, Switzerland.

NOTES

Future updates of this review

Data on prevalence of obesity is helpful to policymakers, and may be more sensitive than changes in Body Mass Index (BMI), especially if the fatter children make more effort to follow the advice to improve their diets or exercise more compared with the leaner children. For the next update of this review, changes in BMI and prevalence measures (where available) will be explicitly included.

INDEX TERMS

Medical Subject Headings (MeSH)

Adolescent; Controlled Clinical Trials as Topic; Diet; Exercise; Obesity [diet therapy; *prevention & control]; Treatment Outcome

MeSH check words

Child; Humans

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