

## Obesity Prevention

# Interventions that involve parents to improve children's weight-related nutrition intake and activity patterns – what nutrition and activity targets and behaviour change techniques are associated with intervention effectiveness?

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### Summary

Parent involvement is an important component of obesity prevention interventions. However, the best way to support parents remains unclear. This review identifies interventions targeting parents to improve children's weight status, dietary and/or activity patterns, examines whether intervention content and behaviour change techniques employed are associated with effectiveness. Seventeen studies, in English, 1998–2008, were included. Studies were evaluated by two reviewers for study quality, nutrition/activity content and behaviour change techniques using a validated quality assessment tool and behaviour change technique taxonomy. Study findings favoured intervention effectiveness in 11 of 17 studies. Interventions that were considered effective had similar features: better study quality, parents responsible for participation and implementation, greater parental involvement and inclusion of prompt barrier identification, restructure the home environment, prompt self-monitoring, prompt specific goal setting behaviour change techniques. Energy intake/density and food choices were more likely to be targeted in effective interventions. The number of lifestyle behaviours targeted did not appear to be associated with effectiveness. Intervention effectiveness was favoured when behaviour change techniques spanned the spectrum of behaviour change process. The review provides guidance for researchers to make informed decisions on how best to utilize resources in interventions to support and engage parents, and highlights a need for improvement in intervention content reporting practices.

**Keywords:** Behaviour change, child, obesity prevention, parent involvement.

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### Introduction

Globally, 5–30% of children (1) and 10–70% of adults (2) are overweight or obese. Preventing excess weight gain in childhood is critical to reducing the prevalence of overweight and obesity and associated health consequences (1).

Previous child obesity prevention reviews have focused on the relationship between intervention effectiveness and intervention components (e.g. the presence or absence of nutrition, activity, behaviour modification or family involvement) (3,4), intervention settings (e.g. school, home) (5), intervention duration (3) or target population (5,6).

Campbell and Hesketh concluded in their 2007 review of nine studies targeting young children (0 to 5 years) that 'families can be supported to make effective changes which seem likely to influence the propensity for fatness in their children' (5). However, how best to engage and support parents in obesity prevention interventions across each stage of childhood remains unclear.

As role models and providers of food and opportunities to be active, parents shape children's weight-related food and activity behaviours in powerful ways (7). To date child obesity prevention efforts have tended to focus on schools, which while a promising public health intervention setting, has had limited success, particularly long-term (3). Reaching the range of settings in which children spend their time – including their homes through their parents – is likely to enhance the long-term impact and sustainability of obesity prevention efforts (3,5). While there is some evidence that parent involvement and family-targeted interventions are effective (3,5,8), the best way to engage and support parents in such interventions remains unclear.

The 2007 Cochrane review of interventions to prevent obesity in children concluded that 'the interventions employed to date have, largely, not impacted on weight status of children to any significant degree' (3). Innovative and effective obesity prevention will require sophisticated interventions and evaluation methodology, reflecting the multiple and integrated food and activity behaviours that influence energy balance, and the wider environments in which these behaviours occur (3). The 2007 Cochrane review highlights 'decision makers need much more information upon which to base policy and programme decisions, than has been [reported] in the past' (3).

While reviews support multi-component interventions for child obesity prevention – encompassing nutrition, activity, behaviour modification and family involvement – little attention has been given to the specific strategies or techniques used to change weight-related food and activity behaviours in children. There is little literature critiquing the specific nutrition or activity targets or behaviour change techniques used in obesity prevention interventions. The question of whether the lifestyle target or behaviour change content moderates the effectiveness of child obesity prevention interventions remains largely untouched (9). A lack of consistent language and systematic categorization of lifestyle behaviour targets and behaviour change techniques has limited the ability to make firm conclusions (9). Abraham and Michie sought to address this limitation by developing and validating a comprehensive taxonomy of behaviour change techniques (9). Such taxonomies provide a consistent language and novel way of describing interventions that will enable intervention content-based rather than study design-based comparison and critique.

Therefore, of interest to this review are the intervention targets and behaviour change techniques that are relevant

to engaging and supporting parents and modifying the home setting as a means of preventing excess weight gain and/or improving children's nutrition and activity behaviours. The objective of this review is to determine whether the food and activity behaviours targeted and behaviour change techniques employed in family-targeted interventions are associated with intervention effectiveness.

## Methods

### Criteria for considering studies for review

#### *Inclusion criteria*

*Types of studies.* Prospective studies of any duration, evaluating the effectiveness of a researcher-introduced intervention run in parallel with a control or comparison group, with outcomes measured at baseline and (at a minimum) post intervention.

*Types of participants.* Intervention participation involved at least one parent or caregiver, either with or without their child/ren. At least one intervention outcome assessed in children aged 1–18 years.

*Type of intervention.* Interventions including a nutrition or activity component AND a behaviour change component which intend to increase physical activity, decrease sedentary activity, change nutrition intake or weight status in children AND involving parents or caregivers as a key participant. Parental involvement was defined using the criteria: able to identify parental exposure to intervention; identify active parental participation (i.e. beyond receipt of a newsletter or pamphlet), and/or the intervention behaviour occurs in the home AND parental or home outcomes are assessed. Studies where the intervention targeted families alone and where families were targeted within a comprehensive intervention were considered. The studies where families were targeted alone are considered here.

*Types of outcome measures.* Studies with at least one objectively measured primary outcome or, a subjective outcome assessed using a validated tool. Primary outcomes were assessed at the child level, and included weight status, or lifestyle behaviours (nutrition and activity level), or metabolic health markers. Secondary outcomes were determinants of children's lifestyle behaviours, focusing on parental characteristics such as parent or child knowledge; parent and child interactions such as feeding practices; environmental measures such as food availability; and predictors of behaviour change such as self efficacy.

#### *Exclusion criteria*

To focus on recent interventions, studies were limited to those published in English between 1998 and 2008. Studies

not applicable to the general population (i.e. pregnancy, lactation, weaning/preterm infants, athletes, weight loss diets, eating disorders, behavioural/learning difficulties, disabilities, cystic fibrosis, diabetes and asthma) were excluded.

### Search methods for identification of studies

A three-step search strategy covering both published and unpublished literature was used. A list of search terms and keywords were developed from relevant reviews (4) and refined based on the review aim, lifestyle behaviours of interest (10) and behaviour change technique framework (9). An information specialist refined this list, with search terms developed and combined under the following headings:

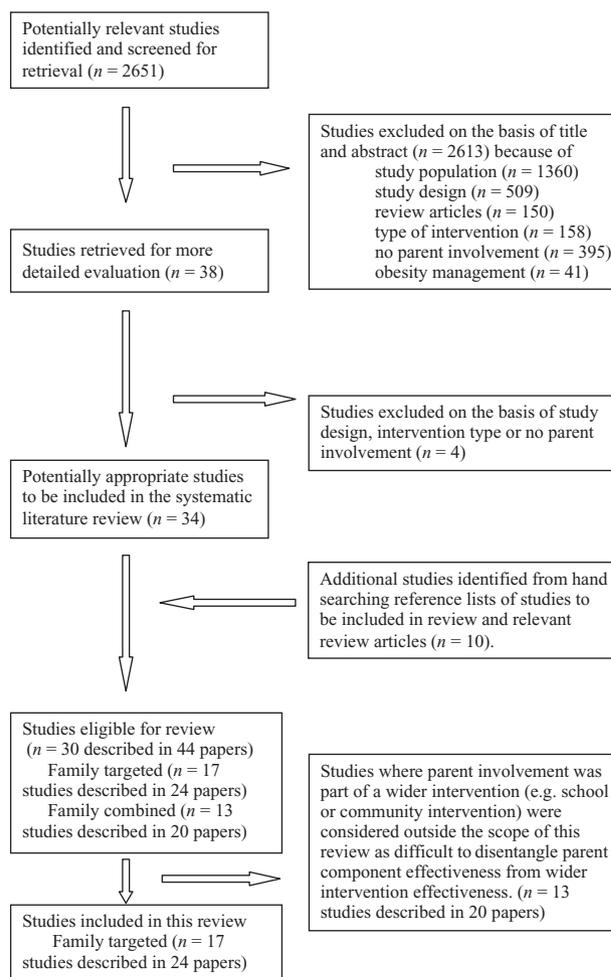
1. child (1–18 years), e.g. child, adolescent;
2. caregiver or home, e.g. parent, caregiver or guardian, family;
3. nutrition-related, activity-related, weight-related, e.g. fruit or vegetable, obesity, activity;
4. behaviour change theory, e.g. behaviour change, behaviour modification;
5. study design, e.g. randomized controlled trial, clinical controlled trial, intervention or evaluation study;
6. limits applied – 1998–2008, human, English.

Following piloting and title/abstract text word analysis in PubMed, the main search was undertaken in September 2008 in: PubMed (MESH and keyword); Web of Science; Cochrane databases; PsycINFO; dissertation abstracts (no further searching of grey literature). Search term lists were comprehensive, inclusive and adapted for the individual databases searched (available from authors). Finally, reference lists of identified reviews and articles were searched for additional studies.

Title screening and abstract keyword searching assessed search results against the exclusion criteria. The first author assessed abstracts (and full text where necessary) against review criteria using a standard review criteria form. Fig. 1 summarizes review article selection. Seventeen studies evaluated interventions targeting parents or home environment alone (*family targeted alone*) and are reviewed here. Thirteen studies evaluated interventions where parent involvement was part of a wider intervention (e.g. school or community intervention) and are reviewed separately.

### Data extraction and synthesis

Two reviewers independently extracted all data from included studies including measures of methodological



**Figure 1** 2002 Quorum statement flow diagram. Interventions involving parents or caregivers to facilitate improvements in children's nutrition, activity or weight status.

quality and intervention content coding (see Tables 1 and 2 for details of information extracted).

Two reviewers independently scored the methodology quality of all studies using the Effective Public Health Practice Project quality assessment tool (11). In an assessment of 213 quality assessment tools, this tool was identified as useful for systematic reviews that evaluate randomized and non-randomized intervention studies (12). Eight quality components were scored (weak/moderate/strong): selection bias, study design and allocation bias, confounders, blinding, data collection methods, withdrawals and dropouts, intervention integrity and analysis. An overall quality rating was assigned; 'strong' where four of six key quality assessment criteria were rated as strong, with no weak ratings; 'moderate' if less than four criteria were rated strong and one criterion was rated weak; and 'weak' where two or more criteria were rated weak. Reviewer differences were resolved by discussion and consensus.

**Table 1** Study setting and design, intervention description and summary of results for family targeted interventions to improve children's weight-related nutrition intake or activity patterns

Study and quality rating	Participants and data points	Intervention description	Intervention focus and key results
Epstein 2001 (25) USA University CCT Moderate quality rating	Families with obese parent and non-obese children (primary school/mixed gender)  N = baseline/follow-up Treatment 1: 13/13 (100%) Treatment 2: 13/13 (100%)  Baseline and 12 months (follow-up)	<u>Delivery:</u> Individual and group. Weekly for 8 weeks, followed by 4 bi-weekly and 2 monthly meetings.  <u>Intervention:</u> Comprehensive behavioural weight loss program for parents plus environmental changes and activities for children.  <u>Target behaviour:</u> Decrease intake of fat and sugar (Treatment 1), increase intake of fruit and vegetables (Treatment 2).  <u>Behaviour change component</u> Agent of change:† Parent (high intensity) and child. Social cognitive theory 13 behaviour techniques reported spanning 5 out of 5 behaviour change process steps.*	<u>Weight status:</u> Percentage overweight: NS  <u>Nutrition</u> Fruit and vegetables (serves): Treatment 1 +0.72 ± 1.11, Treatment 2 -0.55 ± 1.31; F(1,24) = 7.20; P = 0.025).  Fat and sugar foods (serves): Time effect (P < 0.001) Treatment 1 -4.5 ± 7.97, Treatment 2 -8.5 ± 7.6; Group effect NS.
Haire-Joshu 2008 (20) USA Community (Parents as Teacher sites, includes home visits) RCT Moderate quality rating	Families attending 16 sites (preschool aged children/mixed gender)  N = baseline/follow-up Intervention: 759/642 (605 for analysis) (80%) Control: 899/745 (701 for analysis) (78%)  Baseline and end of intervention (average 7 months, range 6–11 months)	<u>Delivery:</u> Group, home visits and newsletter. At least 5 home visits, on site group activities and newsletters offered on an annual basis.  <u>Intervention:</u> Control group received standard Parents As Teachers parenting and child development program. Intervention group received an additional 4 home visits, 1 tailored newsletter and storybooks. Intervention components offered over 1 year (average 7 months).  <u>Target behaviour:</u> Encourage positive fruit and vegetable environment and positive parent-child communication and environment.  <u>Behaviour change component</u> Agent of change: Parent only (low intensity). Social ecological model/behavioural learning theory 9 behaviour techniques reported spanning 4 out of 5 behaviour change process steps.	<u>Nutrition</u> Fruit and vegetables (serves): NS (However, in normal weight children only. Intervention group +0.23 vs. control -0.11; P = 0.02)
De Boudeaudhuij 2002 (15) Belgium School (home component) Quasi experimental Moderate quality rating	Families – parent and child (high school/mixed gender)  N = baseline/ follow-up Intervention: combined parent and child 55/44 (80%) Control: child only 71/50 (70%), parent only 47/40 (85%)  Baseline, 6 weeks (end of intervention), 10 weeks (follow-up)	<u>Delivery:</u> Individually tailored letter, letter provided feedback on intake, attitudes, self-efficacy, food substitution advice and managing high-risk situations.  <u>Intervention:</u> Nutrition messages to the family to reduce fat intake (treatment 1), provided nutrition messages to the individual (parent or child) to reduce fat intake (treatment 2).  <u>Target behaviour:</u> Reduce fat intake  <u>Behaviour change component</u> Agent of change: Parent alone or child alone or family alone (all low intensity). Health education model 6 behaviour techniques reported spanning 4 out of 5 behaviour change process steps.	<u>Nutrition</u> Fat intake: NS

Table 1 Continued

Study and quality rating	Participants and data points	Intervention description	Intervention focus and key results
De Boudeaudhuij 2000 (16) Belgium Community (home component) CCT Weak quality rating	Families – two parents and two children (high school/gender not reported) <u>N = baseline/follow-up</u> Intervention: families 20/18 (90%) Control: families 20/17 (85%) Baseline, 6 weeks (end of intervention)	<u>Delivery</u> : Individually tailored letter, provided nutrition message and education. <u>Intervention</u> : Treatment 1 – messages to the family to reduce fat intake. Letter provided feedback on intake, attitudes, self-efficacy, food substitution advice and managing high risk situations. Treatment 2 – general nutrition education provided in a letter. Importance of a healthy diet, information on fat reduction, health risks, general guidelines and ways to reduce fat. <u>Target behaviour</u> : Reduce fat intake <u>Behaviour change component</u> Agent of change: Parent (low intensity) and child. Health education model 6 behaviour techniques reported spanning 4 out of 5 behaviour change process steps.	<u>Nutrition</u> Fat intake: time effect: Decreased intake in all family members $F(1,17) = 5.8, P < 0.05$
McGarvey 2004 (26) USA Community Women Infants Children (WIC) sites Prospective cohort Weak quality rating	Parents of children attending chosen sites (preschool/mixed gender) <u>N = baseline/follow-up</u> Intervention: families 185/121 (65%) Control: families 151/65 (43%) Baseline and 12 months (end of intervention)	<u>Delivery</u> Group and individual, every 2 months, individual session every 6 months <u>Intervention</u> : Usual care – existing WIC program provided by health departments, with group session. Intervention – formed part of existing WIC program, 6 key nutrition and physical activity messages were presented to parents in written format and promoted in sessions and reinforced by staff and the community. <u>Target behaviour</u> : 6 key and activity messages <u>Behaviour change</u> Agent of change: Parent (low intensity). Social ecological model/behavioural learning theory 10 behaviour techniques reported spanning 4 out of 5 behaviour change process steps.	<u>Nutrition</u> Fruit and vegetables: NS Offering water: increased $0.64(0.19, 1.09)$ vs. $0.16(-0.16, 0.49)$ $F(1,145) = 8, P = 0.009$ <u>Activity</u> Engaging in active play: $0.47(0.14, 0.8)$ vs. $-0.22(-0.7, 0.26)$ $F(1,161) = 7.03, P = 0.01$
Wilfley 2007 (29) USA University RCT Strong quality	Families – at least one parent overweight and children 20–100% overweight (primary school/mixed gender) <u>N = baseline/follow-up</u> Control 49/37 (76%) Intervention 1 (BSM): 51/42 (82%) Intervention 2 (SFM): 50/43 (86%) Baseline, 5 months (end of weight loss – out of review scope), 9 months (post maintenance intervention) and 2 years	<u>Delivery</u> : Group and families. Following a 5 month standard weight loss program, the control group received no intervention. <u>Intervention</u> : Following weight loss program received a 4 month weight maintenance intervention (16 weekly sessions). Two maintenance strategies were compared – behavioural skills (BSM) and social facilitation (SFM). BSM taught strategies to assist weight loss maintenance and SFM focused on creating a supportive social environment. <u>Target behaviour</u> : Weight maintenance <u>Behaviour change component</u> Agent of change: Parent (high intensity) and child (compared with child and parent). Social cognitive theory 8 behaviour techniques reported spanning 3 out of 5 behaviour change process steps.	<u>Weight status</u> BMI z-score: Interventions vs. Control $-0.08 (-0.16 \text{ to } -0.01, P = 0.007)$ ; Effect size = $-0.40$ 2 year follow-up: NS.

Table 1 Continued

Study and quality rating	Participants and data points	Intervention description	Intervention focus and key results
Anand 2007 (17) Canada Community (home visits only) RCT Moderate quality rating	Stable household of aboriginal families in Canada – at least one parent and one child living in the same house (all persons in the house aged 5–70 years/mixed gender) N = baseline/follow-up Control: 28/23 households (82%) Intervention: 29/28 households (96%) Baseline and 6 months (end of intervention)	<u>Delivery:</u> Family households <u>Intervention:</u> Aboriginal health counsellors made regular home visits to help families set dietary and physical activity goals. Other program goals were the provision of filtered water, a physical activity program for children and educational events about healthy lifestyles. <u>Target behaviour:</u> Nutrition (food group) and activity behaviours <u>Behaviour change component</u> Agent of change: Parents (low intensity) and children. Social cognitive theory 4 behaviour techniques reported spanning 3 out of 5 behaviour change process steps.	<u>Nutrition</u> Decrease in fats/oils/sweets (serves): Intervention group –4.9 vs. –3.0; $P = 0.006$ Increase in water consumption +0.3 vs. –0.1; $P = 0.04$ Decrease in soft drink/juice –0.3 vs. –0.1; $P = 0.02$ <u>Activity</u> Physical activity: NS Screen time: NS
Paineau 2008 (21) France Community (home component) RCT Moderate quality rating	Volunteer families – one parent and at least one child (primary school/mixed gender) N = baseline/follow-up Control 418/393 families Intervention A: 297/280 families (94%) Intervention B: 298/274 families (92%) Baseline, 10 months (end of intervention)	<u>Delivery:</u> Families received information about nutrition. <u>Intervention:</u> Internet monitoring, general information but no individual advice. Intervention groups received monthly telephone counselling to change food habits and meet dietary targets, internet monitoring and newsletter for eight months. <u>Target behaviour:</u> Reduce fat and increase complex carbohydrates (group A); reduce both fat and sugar and increase complex carbohydrate intake (group B). <u>Behaviour change component</u> Agent of change: Child and parent (high intensity). Nil behaviour model identified 6 behaviour techniques reported spanning 3 out of 5 behaviour change process steps.	<u>Nutrition</u> Intervention effects: Decreased % energy fat A: –3.3(–4.0 to –2.6); $P < 0.01$ B: –2.3 (–3.0 to –1.5); $P < 0.01$ Complex carbohydrates % energy: A: 3.3 (2.6 to 4.0); $P < 0.01$ B: 2.4 (1.6 to 3.1); $P < 0.01$
Harvey-Berino 2003 (18) USA Community (home visits only) CCT Moderate quality rating	Volunteer native American families – overweight mother and child (toddler/mixed gender) N = baseline/follow-up Control: 20/20 (100%) Intervention: 23/20 (87%) Baseline and 16 weeks (end of intervention)	<u>Delivery:</u> Mother received weekly parent support sessions (PS), based on Active Parenting curriculum based on psychological and behavioural goals. <u>Intervention:</u> Families received an obesity prevention program plus parenting support aimed at reducing obesity (OPPS). <u>Target behaviour:</u> Development of appropriate eating and exercise behaviours. <u>Behaviour change component</u> Agent of change: Parents alone (high intensity). Social ecological model 12 behaviour techniques reported spanning 5 out of 5 behaviour change process steps.	<u>Weight status</u> Weight/height z-score: PS increase $0.31 \pm 1.1$ , OPPS $-0.27 \pm 1.1$ ; $P = 0.06$ <u>Nutrition</u> Energy intake: PS $6.8 \pm 55.4$ , OPPS $-39.2 \pm 89.4$ ; $P = 0.06$

Table 1 Continued

Study and quality rating	Participants and data points	Intervention description	Intervention focus and key results
Wardle 2003 (19) UK Community (home visits only) CCT Moderate quality rating	Families who had previously participated in a study (preschool/mixed gender) <u>N = baseline/follow-up</u> Control: 45/44 Intervention – Exposure: 50/48 (34 compliant with intervention) (68–96%) Intervention – Information: 48/48 (100%) Baseline and 2 weeks (end of intervention)	<u>Delivery</u> : Parent, information based education using leaflets about fruit and vegetable recommendations. <u>Intervention</u> : Self-administered daily for 2 weeks, Repeated exposure to children of a target vegetable to increase acceptance and liking. Parents received information about the exposure techniques. <u>Target behaviour</u> : Fruit and vegetable intake and liking <u>Behaviour change component</u> Agent of change: Parent alone (low intensity). Social ecological model 6 behaviour techniques reported spanning 4 out of 5 behaviour change process steps.	<u>Nutrition</u> Vegetable intake Intervention group (g) 4.1(1.4) to 9.0(1.7); $t(33) = 4.36$ ; $P < 0.001$ Control group 5.7(2.1) to 7.3(1.8); $t(47) = 1.02$ ; $P = 0.06$ <u>Determinants</u> Liking of target vegetable increased in exposure $t(33) = 6.64$ ; $P < 0.001$ , and control group $t(43) = 4.19$ , $P < 0.001$
Horodyski 2005 (22) USA Community (home visits) Quasi experimental Moderate quality rating	Low income families enrolled in Early Head Start program (toddlers/mixed gender) <u>N = baseline/follow-up</u> Control: 73/53 (73%) Intervention: 62/43 (69%) Baseline, 4 weeks (after group intervention), 6 months (after individual reinforcement sessions)	<u>Delivery</u> : Group and families, Early Head Start program – 4 group sessions and 18 weekly home visits over 6 months. <u>Intervention</u> : Nutrition Education Aimed at Toddlers focused on improving meal time interactions by training adults to be responsive to toddlers' verbal/non-verbal cues. <u>Target behaviour</u> : Parental role modelling, introducing new foods, parenting skills <u>Behaviour change component</u> Agent of change: Parent alone (high intensity). Social ecological model 9 behaviour techniques reported spanning 4 out of 5 behaviour change process steps.	<u>Determinants</u> Trend decrease in TV viewing during meals Intervention vs. control –19% vs. +2%; $P = 0.077$
Ransdell 2003 (13,30) USA Community (home component) RCT Weak quality rating	Mother daughter pairs with irregular or inactive physical activity habits (high school/females only) <u>N = baseline/follow-up</u> Control (home based): 10/10 (100%) Intervention (community based): 7/7 (100%) Baseline and 12 weeks (end of intervention)	<u>Delivery</u> : Individual and group, 3 sessions per week for 12 weeks. <u>Intervention</u> : Interventions aimed at increasing physical activity and health-related fitness. <u>Target behaviour</u> : Home-based fitness exercise encouraged via education material (treatment 1); group-based exercise sessions 3 times per week, recreational type exercise (treatment 2). <u>Behaviour change component</u> Agent of change: Parent (high intensity) and child. Behavioural learning theory 9 behaviour techniques reported spanning 5 out of 5 behaviour change process steps.	<u>Physical activity/fitness</u> Treatment 2 greater increase in muscular endurance (sit ups) than Treatment 1: Change of 32.1 vs. 13.15; $P = 0.03$

Table 1 Continued

Study and quality rating	Participants and data points	Intervention description	Intervention focus and key results
Salminen 2005a,b (23,31) Finland Clinical (home visits) Concurrent cohort Weak quality rating	All children in families of high risk adults on hospital register (primary and high school/mixed gender) <u>N = baseline/ follow-up</u> Control: 768 children (high risk 245, low risk 523)/623 (high risk 200, low risk 423) (81%) Intervention: 515/432 children (84%)  Baseline and 2 years (end of intervention)	<u>Delivery:</u> Family and group, 2 sessions at school and 3 sessions at home over 2 years. <u>Intervention:</u> Family-oriented health education program (nutrition, exercise, smoking), shared decision-making approach delivered by a nurse. Nutrition and exercise goals set for family.  <u>Target behaviour:</u> Healthy behaviours – nutrition, exercise and smoking.  <u>Behaviour change component</u> Agent of change: Children and parents (low intensity). Health education 7 behaviour techniques reported spanning 4 out of 5 behaviour change process steps.	<u>Determinants</u> Favourable changes in the use of fat and salt and exercise in the intervention group relative to the control groups.
Niinikoski 2007 (27,32–34) Finland Clinical CCT Moderate quality rating	Children recruited into STRIP at 5 months and randomised at 7 months and followed up until age 14 years. (mixed gender) <u>N = baseline/follow-up</u> Control: 552/278 (50%) note this is at 14 years Intervention: 540/254 (47%)  Baseline and then majority of outcomes measured annually over study period (end of intervention)	<u>Delivery:</u> Families seen by study team every 1–3 months until child aged 2 years, and then twice per year thereafter. <u>Intervention:</u> Targeted CHD risk factors, introduce a low saturated fat, low cholesterol diet to their infants. Parents alone (high intensity) (treatment 1), and with counselling aimed at controlling CHD risk factors (treatment 2). <u>Target behaviour:</u> CHD risk factors, nutrition (fat and saturated fat) <u>Behaviour change component</u> Agent of change: Parent (high intensity) and child. Child development theory 6 behaviour techniques reported spanning 4 out of 5 behaviour change process steps.	<u>Blood lipids</u> Lower total cholesterol (3.91–4.23 vs. 4.11–4.30; $P < 0.001$ ) in intervention than control children during 14 years <u>Nutrition</u> Total fat intake (31 vs. 31–32%; $P < 0.001$ ) Saturated fat intake (12 vs. 13%; $P < 0.001$ ) intakes lower in intervention group compared to control during 14 years
Saakslahti 2004 (28) Finland Clinical CCT Weak quality rating	Families from the STRIP cohort followed up for 3 years (preschool/ mixed gender) <u>N = baseline/ follow-up</u> Control: 112/85 (76%) Intervention: 116/86 (74%)  Baseline, 1 year, 2 years, 3 years (end of intervention).	<u>Delivery:</u> Families, one intensive session with parents and children each year, plus educational material sent out twice per year. <u>Intervention:</u> Physical activity was introduced to families during their routine STRIP visit, aimed at increasing parent's knowledge about physical activity in the attempt to change children's behaviour. <u>Target behaviour:</u> Physical activity <u>Behaviour change component</u> Agent of change: Parent (high intensity) and child. Child development theory 6 behaviour techniques reported spanning 4 out of 5 behaviour change process steps.	<u>Physical activity</u> Children in the intervention spent more time playing outdoors ( $F(1,527) = 4.21$ ; $P = 0.041$ ) and less time playing indoors ( $F(1,527) = 3.88$ ; $P = 0.049$ ).

Table 1 Continued

Study and quality rating	Participants and data points	Intervention description	Intervention focus and key results
Tershakovec 1998a,b (24,35) USA Clinical CCT Strong quality rating	Hypercholesterolemic children between 85–130% overweight (primary school/ mixed gender) <u>N = baseline/ follow-up</u> Control: At risk control: 87/78 (90%) Not at risk control: 81/78 (96%) Intervention: PCAT: 86/73 (85%) Counselling: 88/66 (75%) Baseline, 3 (end of intervention), 6, 12 months (follow-up)	<u>Delivery:</u> Families, self paced over 10 weeks <u>Intervention:</u> Two control groups (1) at risk control; (2) not at risk control, no contact or educational material provided. Intervention groups received the Parent Child Auto Tutorial (PCAT): Home-based education program using material for parents and children about 'heart smart' nutrition recommendations. Education focus was on how to make dietary changes in the home, positive food experiences and role modelling of 'heart smart' food consumption. <u>Target behaviour:</u> 'Heart smart' nutrition – fat intake  <u>Behaviour change component</u> Agent of change: Child and parent (low intensity). Behavioural learning theory 7 behaviour techniques reported spanning 3 out of 5 behaviour change process steps.	<u>Nutrition</u> Intervention effect: Both intervention groups decreased their fat intake significantly more than the high-risk control group ( $P < 0.05$ ).
Beech USA 2003 (14,36) Community University RCT Moderate quality rating	African-American girls at risk of obesity (primary school/females only) <u>N = baseline/follow-up</u> Control: 18/18 (100%) Intervention: Child target: 21/21 (100%) Parent target: 21/21 (100%) Baseline and 12 weeks (end of intervention)	<u>Delivery:</u> Group, control group monthly for 12 weeks (3 meetings) plus information mail outs bi-monthly, intervention group weekly sessions for 12 weeks. <u>Intervention:</u> Focused on enhancing children's self-esteem in general. Increasing knowledge and behaviour change skills to promote healthy eating and increase physical activity (treatment 1); sessions teaching parents eating and activity skills to encourage healthy eating and physical activity in their children (treatment 2). <u>Target behaviour:</u> Healthy eating and increased activity.  <u>Behaviour change component</u> Agent of change: Parent alone (high intensity) versus child alone. Behavioural learning theory 5 behaviour techniques reported spanning 4 out of 5 behaviour change process steps.	<u>Nutrition</u> Intervention effect: Decreased serves of sweetened drinks consumed, combined adjusted mean difference intervention vs. control 1.57(0.40) serves $P = 0.03$ .

\*refer to Table 3 for details of behaviour change techniques and five step behaviour change process framework.

†Agent of change defined as the primary target/s for exposure to and participation in the study intervention. Parental participation categorised as low or high based on level of parental engagement using the frequency of contact and/or between session activities parents were asked to undertake. CCT, clinical controlled trial; RCT, randomized controlled trial.

The nutrition and activity intervention content were coded using definitions developed for this review based on World Health Organization recommendations and existing literature (10). Behaviour change techniques were coded using standardized definitions outlined in the taxonomy by Abraham and Michie (Table 3) (9). The taxonomy defines 26 behaviour change techniques with standard definitions provided in a five-page coding manual. Two reviewers independently coded all interventions following the coding manual guidelines (i.e. coded only text describing the

intervention itself, coded for most comprehensive intervention described, technique checklist utilized with frequent reference to technique definition). For quality assurance, the behaviour change techniques were also independently coded by two reviewers with a psychology background. Coding differences were infrequent and were resolved by discussion and consensus using the technique definitions and coding guidelines.

Because of heterogeneity in outcomes and outcome assessment methodology, meta-analysis was not under-

**Table 2** Results summary of evaluations of family targeted interventions to improve children's weight-related nutrition intake or activity patterns

Study	Weight status/lipids	Nutrition intake/activity patterns	Determinants of nutrition/activity behaviour	Intervention effective*	
				End-I	FU
Epstein 2001 (25)	Percent overweight	X	Fruit and vegetables (serves) High fat/high sugar foods (serves)	✓	Yes
Haire-Joshu 2008 (20)	-	Fruit and vegetables (serves)	Parental food habits Child feeding practices Parental knowledge Parental modelling Child feeding practices Fruit and vegetable availability	✓ ✓ X ✓ ✓ ✓	-
De Boudeaudhuij 2002 (15)	-	Total fat intake (% of energy)	Social support and intention Attitudes, self-efficacy, awareness, family perception and friends perceptions	✓ X	No
De Boudeaudhuij 2000 (16)	-	Fat intake (% of energy total, saturated, mono-unsaturated, poly-unsaturated)	Child attitudes, self-efficacy, intention	✓	Yes
McGarvey 2004 (26)	-	-	Family perception and friends perceptions Social support and awareness Offering water, engaging in active play Offering fruit and vegetables, mealtime behaviour, role modelling with family activity, television viewing while eating, efficacy, outcome expectancy, risk perception and readiness to change	✓ X ✓ X	-
Wilfley 2007 (29)	BMI z-scores % overweight	✓ ✓	Self efficacy, friend support and participation Perceived barriers, positive alternatives, weight concerns and problem coping	✓ X	No
Anand 2007 (17)	Body fat, weight, waist circumference Blood pressure	X X	Knowledge Attitudes	✓ X	-
		X X X X	Food group intake (serves); fats and oils, water, soft drink Food group intake (serves); bread/cereals, fruit and vegetables, meat/poultry, dairy Energy and macronutrient intake Activity level and screen time		

Table 2 Continued

Study	Weight status/lipids	Nutrition intake/activity patterns	Determinants of nutrition/activity behaviour	Intervention effective*	
				End-I	FU
Paineau 2008 (21)	BMI z-score, fat mass and circumferences	Energy intake Macronutrient intakes Sedentary/physical activity	✓ Food-related quality of life (no harm)	✓	-
Harvey-Berino 2003 (18)	Weight/height z score	Energy intake Fat intake	✓ Food practices	✓	-
Wardle 2003 (19)	-	Intake of target vegetable	✓ Liking and ranking of vegetables	✓	-
Horodynski 2005 (22)	-	-	Child-parent meal time behaviour (direct observation), feeding children knowledge and feeding self-efficacy Television on during meal time	X	No
Ransdell 2003 (13,30)	Body composition Height/weight Blood pressure	Strength and endurance Aerobic capacity, flexibility	✓ Participation in aerobic, muscular and flexibility activities	✓	-
Salminen 2005a,b (23,30)	-	Fat intake, salt intake and high fibre choices	✓ Fat type, high fibre choices	✓	-
Niinikoski 2007 (27,32-34)	BMI Lipid profile	Exercise frequency and intensity Fat and saturated intake	X	-	Yes
Saakslanti 2004 (28)	-	Time spent outdoors and indoors	✓	-	No
Tereshakovec 1998a,b (24,35)	Weight z score	Fat intake (% of energy) and energy intake	✓ Knowledge	✓	No
Beech USA 2003 (14,36)	BMI % body fat Waist circumference	Sweetened drinks (serves) Fruit and vegetables and water (serves) Energy and fat intake Activity – time and intensity	✓ Low and high fat food practices X Body weight concerns X	✓	-

\*End-I, end intervention; X No statistically significant change; ✓ Significant change (see Table 1 for details); FU, follow-up.

**Table 3** Behaviour change technique taxonomy and frequency of techniques use

Processes underpinning behaviour change process	Behaviour change techniques as defined by Abraham and Michie taxonomy	All studies (n = 17)	Effective studies (n = 11)	Ineffective studies (n = 6)
Identify and motivate readiness to change	Provide general information on behaviour-health link	10	5	5
	Provide information consequences	1	0	1
	Provide information about others approval	0	0	0
	Provide general encouragement	6	4	2
	Motivational interviewing	0	0	0
Facilitate motivation to change	Prompt intention formation	8	5	3
	<i>Prompt specific goal setting</i>	4	4	0
	<i>Prompt self-monitoring of behaviour</i>	6	5	1
	Agree behavioural contract	0	0	0
Provide relevant information and advice/behaviour change strategies	Provide instruction	15	10	5
	<b>Anticipatory guidance*</b>	4	2	2
	<b>Tailored or personalised delivery*</b>	3	1	2
	<i>Environmental restructuring*</i>	6	5	1
	<b>Feeding practices*</b>	5	2	3
	<b>Parenting Skills: generic*</b>	2	1	1
	<b>Parenting Skills: specific to lifestyle behaviours*</b>	2	2	0
	Time management (including planning)	1	1	0
	Provide contingent rewards	2	2	0
	Teach to use prompts/cues	1	1	0
Build self-efficacy (and independence)	Set graded tasks	2	2	0
	Model/demonstrate the behaviour	3	2	1
	<i>Provide performance feedback</i>	6	4	2
	Prompt practice	3	2	1
	Provide opportunities for social comparison	6	3	3
	Plan social support/social change	3	2	1
	Prompt identification as role model/position advocate	7	4	3
Prompt self-talk	2	2	0	
Prevent and manage relapse	Prompt barrier identification	8	6	2
	Prompt review of behavioural goals	3	2	1
	Use of follow-up prompts	1	1	0
	Relapse prevention	1	1	0
	Stress management	0	0	0

\*Validity/reliability for these behaviour change techniques is limited. Techniques in bold are additional techniques developed for this review. Techniques in italics are more common in effective interventions.

taken. Results are presented in narrative form. A study was classified as supporting 'intervention effectiveness' where there was (i) a significant change in an objective measure of adiposity (e.g. body mass index z score or percent overweight) or health risk factor (e.g. cholesterol); OR (ii) at least one significant change in a measure of dietary intake or activity level AND a significant change in at least one determinants of nutrition/activity behaviour. The frequency of 'intervention effectiveness' by study characteristics and intervention content was assessed.

## Results

### Study description and quality assessment

Table 1 summarizes the 17 family-targeted only studies reviewed. Most studies involved preschool or primary-school aged children (14 studies) (Table 1). Two interven-

tions targeted girls only (13,14). The intervention setting included the home directly in 11 studies, either alone (15–19) or in conjunction with a community or education setting (13,20–22) or a clinical or research setting (23,24). Fourteen studies targeted parents only or identified parents as the primary agent of change (Table 1). Twelve studies evaluated interventions up to 6 months duration (7–12 weeks duration), with only five evaluating interventions 12 months or longer (23,25–28). Individual counselling, group sessions, and written materials only were the top three modes of intervention delivery. Outcome evaluation focused on short-term effects (end of intervention) with only eight studies conducting follow-up post intervention (Table 1). Two studies were rated as strong (24,29), five weak (13,16,23,26,28) and 10 studies were rated moderate quality (Table 1). The quality criteria on which studies performed most poorly were those relating to selection bias, confounders and dropouts.

## Study intervention content summary

### *Intervention focus*

Table 1 summarizes the lifestyle behaviours targeted in each intervention. Nutrition behaviours were targeted by 12 studies. General healthy eating and food choices were the most frequently targeted nutrition behaviours (e.g. fruit and vegetables or soft drink intake), followed by energy or nutrient intake (e.g. fat or kilojoule intake), menu planning/food procurement (e.g. low-fat meal practices) and child-feeding behaviours (e.g. offering of water). Six studies targeted activity, changing physical/sedentary activity levels or behaviours equally common. Weight status was a reported intervention target in three studies; and one reported blood lipids as a primary outcome.

### *Behavioural change techniques*

All but one study (21) reported the behaviour change model underpinning the intervention (Table 1). Behavioural learning theory and ecological models (family environment) most frequently underpinned the study intervention (10 and 5 studies, respectively). Seven studies were underpinned by multiple theories. Table 3 lists the behavioural change techniques used to code intervention descriptions. The average number of behaviour change techniques reported was eight (range 3–13). The majority of studies reported using the following techniques: provide instruction (15 studies), provide general information (10), prompt intention formation (8) and prompt barrier identification (8). Identify role model, general encouragement, prompt self-monitoring, provide performance feedback and provide opportunities for social comparison or environmental restructuring were also commonly used techniques (described in at least a third of study interventions).

Behaviour change techniques are most effective when used in combination and facilitate movement through a behaviour change process (37). The behaviour change techniques defined by the Abraham and Michie taxonomy were categorized into five processes of behaviour change: identify and motivate readiness to change, facilitate motivation to change, provide relevant information and advice/ facilitate behaviour change, build self efficacy and independence and help prevent and manage relapse. Only three of the 17 studies employed behaviour change techniques across all behaviour change processes (13,18,25). An additional eight studies employed behaviour change techniques in four of five behaviour change processes, missing motivation to change (15,16,22,23) or prevent and manage relapse (19,20,26). The remaining six studies had significant limitations in their use of behaviour change techniques across the behaviour change process. Supporting maintenance of behaviour change was the least utilized behaviour change process.

## Intervention effectiveness

Study outcomes favoured 'intervention effectiveness', as defined earlier, in 11 of the 17 studies reviewed (Table 2. Detailed results for all outcomes are available from authors).

### Weight status and health risk factors

Eight interventions included a measure of weight status (14,17,18,21,24,25,27,29). For the six interventions with an obesity prevention focus (14,17,18,21,25,29), three reported significant results (Table 2). One study targeted coronary risk factors and reported significant decreases in the cholesterol levels of children in the intervention (26).

### Nutrition and activity

Ten studies reported dietary changes in terms of fat intake (14–18,21,23–25,27), two with significant results (Table 2). Four studies intended to reduce energy intake to prevent excess weight gain (14,17,18,21), all with significant results. Among the interventions that reported food outcomes, consumption of fruit and vegetables was most common (14,17,19,20,25), followed by sweetened beverages (14,17), high-fat foods (17,25) and water consumption (14,17). Two studies reported significant increases in fruit and vegetable consumption, one using behavioural strategies (25), and the other using an exposure technique to increase children's liking and intake of one chosen vegetable (19). Two studies reported change in intake in terms of high-fat foods; one found a trend towards significance (17) and the other non-significant (25). Six studies included a measure of physical activity (13,14,17,21,23,28) but only one reported a significant change in the activity levels in children (28). Television viewing time was included as an outcome in four studies (14,17,18,26) with no significant results reported.

### Determinants of lifestyle behaviours

Fourteen of the 17 family interventions included one or more determinants of lifestyle behaviours as study outcomes. These included parent characteristics such as knowledge; parent and child interactions such as feeding practices; environmental measures such as food availability; and predictors of behaviour such as self efficacy. Study results for these outcomes are summarized in Table 2.

### Study characteristics, intervention content and intervention effectiveness

For the 11 studies where results favoured intervention effectiveness, all but two were rated as either strong or

moderate study quality. A median of eight behaviour change techniques were reported in the intervention description (range 4–13). Six studies included behaviour change techniques that covered the spectrum of behaviour change processes (or all steps apart from maintenance/relapse prevention). Seven engaged parents as the primary agent of change and had a higher degree of intensity or engagement with parents as part of the intervention. Of the six studies where results did not support intervention effectiveness, there were no studies rated as strong study quality and there were three rated as moderate quality. A median of seven behaviour change techniques were reported per intervention (range 3–10). One did not include behaviour change techniques in several behaviour change process categories. Three engaged parents as the primary agent of change but only one had a high degree of engagement with parents during the intervention. The following behaviour change techniques appeared more frequently in ‘effective interventions’: prompt barrier identification, restructure the home environment, prompt self-monitoring, prompt specific goal setting, set graded tasks, provide contingent rewards and prompt self-talk (Table 3). The number of lifestyle behaviours targeted in the interventions did not appear to be associated with intervention effectiveness. Targeting either a single or a group of lifestyle behaviours appeared effective in certain circumstances. However, in ‘effective interventions’, energy intake/density and food choices (positive or negative) were more likely to be targeted.

## Discussion

Although child obesity prevention research highlights the importance of the home setting (5), parents are a difficult group to engage and support (38). This review evaluated the recent literature where interventions target parents as a means of preventing excess weight gain and improving children’s nutrition and activity behaviours. The focus was the intervention content and whether the food and activity behaviours targeted and behaviour change techniques employed were associated with effectiveness. The 17 studies reviewed were heterogeneous in study population, nature of the comparison group, intervention content and, in particular, the outcomes and assessment methodology used. While the heterogeneity limited the ability to perform meta-analysis, it was possible and useful to make comparisons using a consistent vocabulary describing the quality of the study methodology (11), and the specific nature of the intervention content, using a validated behaviour change taxonomy (9).

Studies where there was support for intervention effectiveness tended to be of better quality. Interventions considered effective also tended to have a cluster of features, including: parents responsible for intervention participa-

tion and implementation (rather than the child), a higher degree of meaningful parental involvement (i.e. ranging from a 2 week parent-led vegetable taste protocol to 8–13 group sessions or home visits over about 6 months), targeting energy intake/density or food choices, use of (slightly) more behaviour change techniques and use of particular techniques (environmental restructuring, specific goal setting, monitoring and barrier identification). Intervention effectiveness was also favoured where use of behaviour change techniques spanned a behaviour change process (37).

All but one of the studies reviewed reported that the intervention was underpinned by behaviour change theory, most commonly behavioural or ecological (environmental) models of behaviour change. The shift towards use of behaviour change theory within a child development framework (i.e. understanding how children’s lifestyle behaviours develop via parent–child interactions and the child’s environment) is promising (37). While a number of reviews now also support behaviour theory based intervention development (5,7,39), the findings of this review highlight the need to consider how theory is operationalized as intervention behavioural techniques. This step of translating theory into practice is likely to impact on the intervention effectiveness potential.

This review systematically described the behaviour change techniques reported in child obesity prevention interventions using a standardized and validated taxonomy. The number of behaviour change techniques identified in this review (median of eight) was similar to those identified in systematic reviews of healthy eating (average 6, range 1–13) and physical activity (average 8, range 1–14) interventions in free living adults (9). For the first time, reported behaviour change techniques were mapped against processes considered best practice for facilitating lifestyle behaviour change. In doing so, gaps in the application of behaviour change theory into practice are highlighted. In particular, attention is needed to ensure behaviour change techniques that support prevention and management of relapse are included in future interventions. This is likely to enhance both the initial effectiveness and long-term sustainability of behavioural lifestyle interventions.

Kamath and colleagues recently undertook a meta-analysis of 29 randomized controlled trials of behavioural interventions to prevent childhood obesity. This review differed from the present review as the studies included interventions that did not target parents or targeted parents in combination with settings such as schools (7). Kamath and colleagues found that intervention effectiveness was associated with use of multiple cognitive components (e.g. goal setting, problem solving/relapse prevention) and inclusion of reinforcement in interventions to increase physical activity, decrease sedentary activity or promote healthy

eating. Intervention effectiveness was not associated with inclusion of informational, environmental or social support components. The present review also supports inclusion of intervention content that extends beyond information, such as use of cognitive and behavioural strategies (e.g. specific goal setting, prompt barrier identification, prompt self-monitoring). However, in the group of studies reviewed here, environmental restructuring was more commonly used in effective interventions. The differences between the present review and Kamath and colleagues may reflect the different group of studies reviewed, and the approach taken in categorizing intervention content. It may also highlight the difference in intervention approaches needed in targeting families, and specifically parents, compared with school-based or child-focused interventions.

In considering which lifestyle behaviours should be the target of family-focused child obesity interventions, this review suggests that intervention effectiveness was not influenced by the number of nutrition and activity behaviours. This is encouraging as interventions may choose to focus on a few targeted behaviours or a range of complex and inter-related behaviours with equal opportunity for effectiveness.

Variation was observed in the specific food and activity behaviours targeted by interventions. While most interventions achieved a change in the intended behaviour, more research is needed on the ability of different behaviour targets to have a discrete and cumulative or synergistic impact on energy balance. For example, the promotion of fruit and vegetable intake is a common target in child obesity prevention interventions. However, if the nutrition behaviour of increased fruit and vegetable intake is not coupled with a reduction in overall food, or specifically energy intake, then an 'effective' intervention could increase fruit and vegetable intake without any impact on weight status or rate of weight gain.

The strength of this review is in the systematic use of a taxonomy to describe studies in terms of intervention content. While this has been undertaken in adults (39) and recently in children (7), the taxonomy used here is comprehensive and validated (9). Other strengths include the broad search focus (i.e. interventions targeting obesity prevention and translatable healthy lifestyle promotion interventions were included for review), focus on recent literature and interventions that incorporate 'best practice' cornerstone, combining nutrition and/or activity with behaviour modification and family involvement led by parents. Finally, a comprehensive but stringent evaluation of intervention effectiveness was undertaken. Intervention effectiveness was considered across all study outcomes assessed (e.g. health, lifestyle behaviours and determinants of lifestyle behaviours). However, the quality of outcome measurement and results across outcome categories were also considered, to avoid an intervention being deemed effective on the basis of a single outcome.

This review is not without limitations. The review does draw on evidence from a range of studies which vary in methodological quality, intervention and follow-up duration. In terms of follow-up direction, there was a tendency in included studies to focus on end of intervention effects only. As a result of the limitations in available resources, intervention content was only categorized based on the description provided in published articles. While it is likely that this means that intervention content reported here may underestimate the true intervention content, this in itself is an important lesson for researchers. In line with improvements in the reporting of the design and methodology of intervention studies, there is a need to improve the reporting of intervention content, to inform both researchers and practice. The development and use of taxonomies such as that utilized in this review would aid synthesis of research findings in a way which is relevant to practice. Another consideration is the definition of intervention effectiveness, while it tried to capture overall effectiveness, studies without an objective measure or studies that only measured one aspect of children's behaviour did not meet the criteria for effectiveness. While beyond the scope of the present review, the specific intervention content best suited to interventions with younger vs. older children would be worth exploring in future reviews and as more family-targeted studies become available.

## Conclusion

The current review makes a useful contribution to the existing body of reviews on child obesity prevention and treatment. It critically analysed the content of family-based obesity prevention interventions involving parents. It provides a comprehensive understanding of the intervention features associated with effective behaviour change in children. Table 4 provides a summary of key points for researchers and practitioners, designing and implementing behaviour change interventions involving parents. The results remind us of the importance of engaging and supporting parents as part of a multi-level approach to promoting healthy weight and lifestyle behaviours in children. Detailed synthesis of this broad literature will support policy makers and developers of interventions in making informed decisions on how to best utilize resources and prioritize intervention content. To maximize intervention effectiveness, the behaviour change techniques used should be carefully considered to ensure they are linked to behaviour change theory, are associated with effective interventions (e.g. specific goal setting, monitoring, performance feedback and environmental restructuring) and span best practice behaviour change processes. This should improve child obesity prevention intervention effectiveness, and perhaps the development of effective but lower intensity interventions better suited to delivery in public health settings.

**Table 4** Key points for researchers and practitioners designing and evaluating behaviour change interventions involving parents in an obesity prevention setting

Key points for intervention evaluation	Key points for intervention design
Improve reporting of study quality and design including selection bias, confounders and where possible drop out rates.	Include strategies that span the spectrum of the behaviour change process.
Improve reporting of intervention content to include underlying theory, target of the intervention, behaviour change components including techniques and strategies used.	Behaviour change techniques to consider include specific goal setting, prompt self-monitoring and self-talk, encourage barrier identification, restructure the home environment, set graded task and provide contingent rewards.
Recommend using taxonomy for consistent vocabulary to aid in study comparisons.	Targeting one or multiple behaviours to change can be effective.

### Conflicts of Interest Statement

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### References

- Lobstein T, Baur L, Uauy R. Obesity in children and young people: a crisis in public health. *Obes Rev* 2004; 5(Suppl. 1): 4–85.
- James PT, Leach R, Kalamara E, Shayeghi M. The worldwide obesity epidemic. *Obes Res* 2001; 9(Suppl. 4): 228S–233S.
- Summerbell CD, Waters E, Edmunds LD, Kelly S, Brown T, Campbell KJ. Interventions for preventing obesity in children. *Cochrane Database Syst Rev* 2005; 3: CD001871.
- Kamath CC, Vickers KS, Ehrlich A, McGovern L, Johnson J, Singhal V, Paulo R, Hettinger A, Erwin PJ, Montori VM. Clinical review: behavioral interventions to prevent childhood obesity: a systematic review and metaanalyses of randomized trials. *J Clin Endocrinol Metab* 2008; 93: 4606–4615.
- Campbell KJ, Hesketh KD. Strategies which aim to positively impact on weight, physical activity, diet and sedentary behaviours in children from zero to five years. A systematic review of the literature. [Review]. *Obes Rev* 2007; 8: 327–338.
- Doak CM, Visscher TLS, Renders CM, Seidell JC. The prevention of overweight and obesity in children and adolescents: a review of interventions and programmes. [Review]. *Obes Rev* 2006; 7: 111–136.
- Ventura AK, Birch LL. Does parenting affect children's eating and weight status? *Int J Behav Nutr Phys Act* 2008; 5: 15.
- Oude Luttikhuis H, Baur L, Jansen H, Shrewsbury VA, O'Malley C, Stolk RP, Summerbell CD. Interventions for treating obesity in children. *Cochrane Database Syst Rev* 2009; 1: CD001872.
- Abraham C, Michie S. A taxonomy of behavior change techniques used in interventions. *Health Psychol* 2008; 27: 379–387.
- WHO/FAO Expert Consultation. Diet, nutrition and the prevention of chronic disease. Contract No.: 916, 2003.
- Thomas B, Ciliska D, Dobbins M, Micucci S. A process for systematically reviewing the literature: providing the research evidence for public health nursing interventions. *Worldviews Evid Based Nurs* 2004; 1: 176–184.
- Deeks JJ, Dinnes J, D'Amico R, Sowden AJ, Sakarovitch C, Song F, Petticrew M, Atman DG. Evaluating non-randomised intervention studies. *Health Technol Assess* 2003; 7: 27.
- Ransdell LB, Taylor A, Oakland D, Schmidt J, Moyer-Mileur L, Shultz B. Daughters and mothers exercising together: effects of home- and community-based programs. *Med Sci Sports Exerc* 2003; 35: 286–296.
- Beech BM, Klesges RC, Kumanyika SK, Murray DM, Klesges L, McClanahan B, Slawson D, Nunnally C, Rochon J, McLain-Allen B, Pree-Cary J. Child- and parent-targeted interventions: the Memphis GEMS pilot study. *Ethn Dis* 2003; 13(Suppl. 1): S40–S53.
- De Bourdeaudhuij I, Brug J, Vandelanotte C, Van Oost P. Differences in impact between a family- versus an individual-based tailored intervention to reduce fat intake. *Health Educ Res* 2002; 17: 435–449.
- De Bourdeaudhuij I, Brug J. Tailoring dietary feedback to reduce fat intake: an intervention at the family level. *Health Educ Res* 2000; 15: 449–462.
- Anand SS, Atkinson S, Davis AD, Blimkie C, Ahmed R, Brouwers M, Jacobs R, Morrison K, Xie CC, De Koning L, Hill A, Gerstein H, Sowden J, Yusuf S. A family-based intervention to promote healthy lifestyles in an aboriginal community in Canada. *Can J Public Health* 2007; 95: 447–452.
- Harvey-Berino J, Rourke J. Obesity prevention in preschool Native-American children: a pilot study using home visiting. *Obes Res* 2003; 11: 606–611.
- Wardle J, Cooke LJ, Gibson EL, Sapochnik M, Sheiham A, Lawson M. Increasing children's acceptance of vegetables: a randomized trial of parent-led exposure. *Appetite* 2003; 40: 155–162.
- Haire-Joshu D, Elliott MB, Caito NM, Hessler K, Nanney MS, Hale N, Boehmer TK, Kreuter M, Brownson RC. High 5 for Kids: the impact of a home visiting program on fruit and vegetable intake of parents and their preschool children. *Prev Med* 2008; 47: 77–82.
- Paineau DL, Beauflis F, Boulier A, Cassuto DA, Chwalow J, Combris P, Couet C, Jouret B, Lafay L, Laville M, Mahe S, Ricour C, Romon M, Simon C, Tauber M, Valensi P, Chapalain V, Zourabichvili O, Bornet F. Family dietary coaching to improve nutritional intakes and body weight control. *Arch Pediatr Adolesc Med* 2008; 162: 34–43.
- Horodyski MA, Stommel M. Nutrition education aimed at toddlers: an intervention study. *Pediatric Nursing* 2005; 31: 367–372.
- Salminen M, Vahlberg T, Ojanlatva A, Kivela SL. Effects of a controlled family-based health education/counseling intervention. *Am J Health Behav* 2005; 29: 395–406.
- Tershakovec AM, Jawad AF, Stallings VA, Zemel BS, McKenzie JM, Stolley PD, Shannon BM. Growth of hypercholesterolemic children completing physician-initiated low-fat dietary intervention. *J Pediatr* 1998; 133: 28–34.

25. Epstein LH, Gordy CC, Raynor HA, Beddome M, Kilanowski CK, Paluch R. Increasing fruit and vegetable intake and decreasing fat and sugar intake in families at risk for childhood obesity. *Obes Res* 2001; **9**: 171–178.
26. McGarvey E, Keller A, Forrester M, Williams E, Seward D, Suttle DE. Feasibility and benefits of a parent-focused preschool child obesity intervention. *Am J Public Health* 2004; **94**: 1490–1495.
27. Niinikoski H, Lagström H, Jokinen E, Siltala M, Rönnemaa T, Viikari J, Raitakari OT, Jula A, Marniemi J, Näntö-Salonen K, Simell O. Impact of repeated dietary counseling between infancy and 14 years of age on dietary intakes and serum lipids and lipoproteins: the STRIP study. *Circulation* 2007; **116**: 1032–1040.
28. Saakslahti A, Numminen P, Salo P, Tuominen J, Helenius H, Valimäki I. Effects of a three-year intervention on children's physical activity from age 4–7. *Pediatr Exerc Sci* 2004; **16**: 167–180.
29. Wilfley DE, Stein RI, Saelens BE, Mockus DS, Matt GE, Hayden-Wade HA, Welch RR, Schechtman KB, Thompson PA, Epstein LH. Efficacy of maintenance treatment approaches for childhood overweight – a randomized controlled trial. *JAMA* 2007; **298**: 1661–1673.
30. Ransdell LB, Detling NJ, Taylor A, Reel J, Shultz B. Effects of home- and university-based programs on physical self-perception in mothers and daughters. *Women and Health* 2004; **39**: 63–81.
31. Salminen M, Vahlberg T, Kivelä S-L. Effects of family-oriented risk-based prevention on serum cholesterol and blood pressure values of children and adolescents. *Scand J Prim Health Care* 2005; **23**: 34–41.
32. Lagstrom H, Seppanen R, Jokinen E, Ronnema T, Salminen M, Tuominen J, Viikari J, Simell O. Nutrient intakes and cholesterol values of the parents in a prospective randomized child-targeted coronary heart disease risk factor intervention trial – the STRIP project. *Eur J Clin Nutr* 1999; **53**: 654–661.
33. Talvia S, Lagstrom H, Rasanen M, Salminen M, Rasanen L, Salo P, Viikari J, Ronnema T, Jolinen E, Vahlberg T, Simell O. A randomized intervention since infancy to reduce intake of saturated fat – calorie (energy) and nutrient intakes up to the age of 10 years in the Special Turku Coronary Risk Factor Intervention Project. *Arch Pediatr Adolesc Med* 2004; **158**: 41–47.
34. Talvia S, Rasanen L, Lagstrom H, Pakkala K, Viikari J, Ronnema T, Arffman M, Simell O. Longitudinal trends in consumption of vegetables and fruit in Finnish children in an atherosclerosis prevention study (STRIP). *Eur J Clin Nutr* 2006; **60**: 172–180.
35. Tershakovec AM, Shannon BM, Achterberg CL, McKenzie JM, Martel JK, Smiciklas-Wright H, Pammer SE, Cortner JA. One-year follow-up of nutrition education for hypercholesterolemic children. *Am J Public Health* 1998; **88**: 258–261.
36. Rochon J, Klesges RC, Story M, Robinson TN, Baranowski T, Obarzanek E, Mitchell M. Common design elements of the Girls health Enrichment Multi-site Studies (GEMS). *Ethn Dis* 2003; **13**(Suppl. 1): S6–14.
37. Baranowski T, Cullen K, Nicklas T, Thompson D, Baranowski J. Are current health behavioral change models helpful in guiding prevention of weight gain efforts? *Obes Res* 2003; **11**: 23S–43S.
38. Perry CL, Luepker RV, Murray DM, Kurth C, Mullis R, Crockett S, Jacobs DR Jr. Parent involvement with children's health promotion: the Minnesota Home Team. *Am J Public Health* 1988; **78**: 1156–1160.
39. Hardeman W, Griffin S, Johnston M, Kinmonth AL, Wareham NJ. Interventions to prevent weight gain: a systematic review of psychological models and behaviour change methods. *Int J Obes Relat Metab Disord* 2000; **24**: 131–143.