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Effectiveness of universal parental support interventions addressing children's dietary habits, physical activity and bodyweight: a systematic review

Manzur Kader[a], Elinor Sundblom[a,b], Liselotte Schäfer Elinder[a,b]

[a]Department of Public Health Sciences, Karolinska Institutet, Tomtebodavägen 18A, 171 77 Stockholm, Sweden

[b]Centre for Epidemiology and Community Medicine, Stockholm County Council, Box 1497, 171 29 Solna, Sweden

Corresponding author:

Liselotte Schäfer Elinder, Department of Public Health Sciences , Karolinska Institutet, Tomtebodavägen 18A, 171 77 Stockholm, Sweden

E-mail addresses:

manzur.kader@med.lu.se

elinor.sundblom@sll.se

liselotte.schafer-elinder@ki.se

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Introduction

The Global burden of disease study provides convincing evidence for the fundamental importance of diet and physical activity (PA) for health and disease, particularly in the aetiology of cardiovascular diseases, cancers, obesity and type-2 diabetes (Lim et al., 2013; Wang et al., 2012). Therefore, promotion of health-related behaviours from young age is recommended by the WHO (2004), the European Commission (2007) and national authorities. Parents have a high degree of responsibility and control over young children's dietary and PA habits in the home environment (Anzman et al., 2010; Hendrie et al., 2013). Parents' skills and family functioning (Kitzman-Ulrich et al., 2010), parental styles and feeding practices (Gerards et al., 2011; Sleddens et al., 2011; Xu et al., 2013) and parents' own behaviour, acting as role models, are some of the most important determinants of children's health-related behaviours (Birch and Ventura, 2009; Lindsay et al., 2006). Factors perceived by parents as making a healthy diet and adequate PA difficult to achieve, are child resistance, low availability of healthy food, a busy lifestyle, the influence of food advertising, weather conditions and keeping children occupied (Slater et al., 2010). Therefore it is important to develop effective interventions, addressing these determinants and barriers. However, the transition from childhood to adolescence is marked by greater autonomy and decision-making power of children (Golan and Crow, 2004), and therefore it can be hypothesized that the influence of parents and of parental support programmes will decrease as children grow older. Another aspect to consider is socioeconomic position (SEP). It is a general finding that in developed countries, individuals with lower SEP face much higher obesity rates than those with higher education and income, which is true for both adults (Magnusson et al., 2014; McLaren, 2007) and children (de Onis et al., 2010).

A number of systematic reviews have looked at interventions aiming to prevent obesity in children (Waters et al., 2011), interventions that involved parents to improve children's weight-related behaviours (Golley et al., 2011), diet (Hingle et al., 2010), PA (O'Connor et al., 2009), and interventions aiming to reduce socioeconomic inequalities in obesity among children (Hillier-Brown et al., 2014; Laws et al., 2014). However, none of these reviews focused on universal (population-based) interventions targeting parents as the *main* component. Therefore, in this review we summarise recent knowledge regarding the effectiveness of universal interventions targeting parents as the main component or in combined interventions but with the parental component evaluated separately. We also looked

at the use of theory, which is generally recommended in intervention development to understand causal mechanisms (Michie et al., 2009).

The aim of the current review was twofold: 1) To identify and review the effectiveness of universal parental support interventions designed to promote healthy dietary habits, PA or prevent overweight and obesity among children aged 2-18 years, according to type of intervention and age; and 2) to review the effectiveness of parental support interventions in relation to family SEP.

Method

The review process was carried out according to the guidelines provided by the Swedish Council on Health Technology Assessment (Swedish Council on Health Technology Assessment, 2013).

Study selection criteria

The review included interventions studies published from January 1990 to November 2013, in peer-reviewed English-language journals.

Types of studies. Prospective studies of any intervention duration, which evaluated the effectiveness of a controlled intervention (randomised or non-randomised), with outcomes measured at baseline and post intervention in both groups, with or without follow-up.

Types of participants. The study included at least one parent or caregiver of a child 2-18 years, either with or without their child.

Type of intervention. Any type of intervention where the main component was parental involvement and with relevant outcomes. If the intervention was combined e.g. in a school-based intervention, the parental component should be clearly described and evaluated on its own.

Type of outcome measure. Studies with at least one of the following outcomes at child level:

- Dietary habits. Studies examined the child's intake of various food items, such as fruit, vegetables, fish and energy dense food (e.g. sweetened beverages), macronutrients (e.g. fat) and macro-minerals (e.g. calcium).
- Physical activity. Studies measured physical activity objectively or subjectively.

- Sedentary behavior. The total time for sedentary behaviour was measured such as television viewing, playing video games or using the Internet, not only hours of any specific sedentary behaviour such as television viewing.
- Weight status. Studies measured height and weight and calculated BMI z-score or BMI percentile, percent body fat or prevalence of overweight and obesity.

Exclusion criteria

Observational studies (e.g. cross-sectional association or correlation study), reviews, meta-analysis, editorials, unpublished reports, conference papers, dissertations, qualitative studies and study protocols were excluded, studies targeting risk groups selectively, e.g. being physically inactive or overweight, pilot studies with number of participants lower than 50, studies with outcomes of intake of vitamins and trace minerals only, studies not applicable to the general population (i.e. weaning/preterm infants, athletes, weight loss diets, eating disorders, behavioural/learning difficulties, disabilities, diabetes and asthma).

Other criteria

A study was classified as effective where there was a statistically significant change ($p<0.05$) in one or several of the specific outcomes defined above in the intervention group relative to the control group. The definition of the study sample as having low SEP or belonging to a minority group was based on the original authors' definition.

Search strategies and study identification

Six electronic databases were searched (Medline, PsycINFO, Web of Science, CINAHL, ERIC, Cochrane CENTRAL). Specific search strategies for the different databases included combinations of the following key words: 'parental support', 'prevention', 'intervention', 'children', 'adolescents', 'teenagers', 'diet', 'food habits ', 'physical activity', 'exercise' and 'overweight', 'obesity'. Citations and abstracts of all retrieved studies were downloaded to Endnote X7 citation management software (Thomson Reuters, PA, USA). The searches yielded 12243 hits once duplicates were removed. The titles were then assessed for relevance against the inclusion criteria by one of the authors (MK), which resulted in 11491 articles being excluded. The remaining articles were first assessed on their abstracts (534 excluded) and then read in full text (196 excluded) (Figure 1). Additional studies were retrieved from manually searching the reference lists of previous reviews in this area. The searches through

electronic databases were run by librarians at Karolinska Institutet. Full search histories and reasons for exclusion of studies are available on request from the corresponding author.

Data extraction and quality assessment

All remaining articles were read independently by two of the authors and data was extracted according to pre-defined inclusion and exclusion criteria with any discrepancies resolved by discussion. Data extracted for each article was: Study characteristics, study design, participants, sample size at baseline and post intervention, intervention type and content, theoretical framework , main results, and study quality. Because of large variability in intervention format, study design, study quality, outcomes, and outcome assessment methodology, a meta-analysis was not undertaken. Study quality was scored according to minimal requirements used by the Swedish Council on Health Technology Assessment (Swedish Council on Health Technology Assessment, 2010) by four quality assessment criteria addressing selection and attrition bias, fidelity to intervention and outcome assessment methodology. The following questions were answered with a "Yes" or "No": 1. Was randomization adequately described? 2. Was the attrition rate less than 20 % after six months? 3. Was intervention fidelity measured and reported adequately? 4. Were the measurement tools of outcomes validated? Study quality could therefore vary between outcomes in the same study depending on the instruments used. An overall quality rating was assigned: "strong" where all four quality assessment criteria were rated as yes; "moderate" if three criteria were rated as yes; and "weak" when two or one criteria were rated yes. Quasi-experimental studies could not receive higher rating than moderate. Reviewer differences in rating the quality components (six out of 35 studies) were resolved by discussion and consensus. The analysis included all studies irrespective of quality, but we also tested to exclude studies of weak quality in order to see if this changed the results.

Results

Thirty five intervention studies were included in this systematic review including 27 unique interventions. Summary of study characteristics are shown in Table 1, showing the type of parental involvement, study design, primary study outcomes, primary setting, outcome measurement, parental SEP, and age group targeted.

Table 2 shows a summary of study effectiveness according to primary outcomes. Based on the description of the intervention by the authors, we identified four main types of parental involvement: Individual counselling face-to-face, group education or training (G), information sent home (I), and individual telephone counselling (TC). Some studies combined two types and the main type is shown in bold.

Diet

Twenty five studies of parental support interventions aimed to promote healthy dietary habits.

Ten studies used face-to-face counselling to engage parents (Anand et al., 2007; Baranowski et al., 1990; Haire-Joshu et al., 2008; Hendrie and Golley, 2011; McGowan et al., 2013; Niinikoski et al., 2007; Rasanen et al., 2004; Talvia et al., 2004; Talvia et al., 2006; Wardle et al., 2003). All of them except Haire-Joshu et al. (Haire-Joshu et al., 2008) reported achieving statistically significant changes in dietary habits. Some variations in results were found among subgroups, for example one study found significant improvement in fruit and vegetable intake in boys but not in girls (Talvia et al., 2006). Only two of the ten studies (Hendrie and Golley, 2011; McGowan et al., 2013) were found to be strong according to the quality assessment score; five studies scored moderate (Baranowski et al., 1990; Haire-Joshu et al., 2008; Niinikoski et al., 2007; Talvia et al., 2004; Talvia et al., 2006) and three studies scored weak (Anand et al., 2007; Rasanen et al., 2004; Wardle et al., 2003).

Six studies involved parents through group education or training (Beech et al., 2003; Chen et al., 2010; Fitzgibbon et al., 2013; Hu et al., 2010; Ievers-Landis et al., 2005; Yin et al., 2012). In three studies the authors found significant changes in all the desired diet outcomes (Beech et al., 2003; Chen et al., 2010; Hu et al., 2010). One study found mixed results with significant effects in promoting fruit, vegetables and low-fat milk consumption, but not in meat consumption (Yin et al., 2012). None of the studies scored strong; four studies scored moderate (Chen et al., 2010; Fitzgibbon et al., 2013; Hu et al., 2010; Yin et al., 2012) and two studies scored weak (Beech et al., 2003; Ievers-Landis et al., 2005).

Seven studies involved parents by using newsletters (Fitzgibbon et al., 2013; Haerens et al., 2006b), handouts (Sweitzer et al., 2010), nutrition messages (De Bourdeaudhuij et al., 2002; Vandongen et al., 1995) sent through mail, email, or information packets (Hopper et al., 1992; Luepker et al., 1996) sent home. Two studies found significant changes in the desired diet outcomes (Sweitzer et al., 2010; Vandongen et al., 1995). Vandongen et al. reported

significant effects on decreasing total fat, saturated fat and increasing polyunsaturated fat intake in girls, and decreasing sugar intake in boys (Vandongen et al., 1995). However, results were significant in both the home nutrition group and in the school plus home nutrition groups compared to the control group, which means that there was no effect of the parental component in itself. One study reported achieving an increase in servings of vegetables and whole grains in sack lunches for preschool children, but not in fruits (Sweitzer et al., 2010). Two of the six studies scored moderate quality (Fitzgibbon et al., 2013; Sweitzer et al., 2010) and five studies scored weak (De Bourdeaudhuij et al., 2002; Haerens et al., 2006b; Hopper et al., 1992; Luepker et al., 1996; Vandongen et al., 1995).

In three studies parents received telephone-delivered counselling (Fletcher et al., 2013; Paineau et al., 2008; Wyse et al., 2012). All the studies found significant changes in dietary habits. Fletcher et al. reported a significant decrease in non-core food score at two months follow up, but not at 6 months follow up (Fletcher et al., 2013). One of the studies scored strong (Wyse et al., 2012); two studies scored moderate (Fletcher et al., 2013; Paineau et al., 2008).

In summary, it appears that individual counselling face-to-face or by telephone is the most effective way followed by group counselling to involve parents in improving children's diet. Sending home newsletters or health information packs appears to be the least effective. Excluding studies of weak quality did not change this result.

Physical activity and sedentary behaviour

We found 15 studies that assessed whether parental involvement could lead to an increase in child's PA or a reduction in sedentary behaviour.

Three studies (Anand et al., 2007; Birken et al., 2012; Sääkslahti et al., 2004) used face-to-face counselling. Only one study using long-term intensive counselling reported significant results in the desired outcomes by increasing outdoor play time and decreasing indoor play time in children (Sääkslahti et al., 2004). One study scored moderate (Sääkslahti et al., 2004) and two scored weak (Anand et al., 2007; Birken et al., 2012).

Six studies engaged parents by means of group education or training (Beech et al., 2003; Chen et al., 2010; Fitzgibbon et al., 2013; Ievers-Landis et al., 2005; O'Dwyer et al., 2012; Yin et al., 2012). Three of these found significant effects in increasing children's physical activity, decreasing sedentary behaviours or screen time (Chen et al., 2010; O'Dwyer et al., 2012; Yin

et al., 2012). However, none of the studies scored strong; three studies scored moderate (Chen et al., 2010; Fitzgibbon et al., 2013; Yin et al., 2012) and three studies scored weak (Beech et al., 2003; Ievers-Landis et al., 2005; O'Dwyer et al., 2012).

In five studies, newsletters in combination with internet-based information (Haerens et al., 2007; Haerens et al., 2006b) or nutrition and PA information packets were sent home to parents (Essery et al., 2008; Hopper et al., 1992; Luepker et al., 1996). None of these were effective and all scored weak.

In one study parents received telephone-delivered counselling and it was reported to increase the time spent in outdoor activities and to decrease TV watching time. This study scored weak (Centis et al., 2012).

In summary there is limited evidence for the effectiveness of parental interventions to increase PA in children, mainly because most studies scored moderate to weak regarding PA.

Child weight status

Parental interventions that included weight status of children as the outcome were found in 16 studies. Among them five focused on obesity prevention (Barkin et al., 2012; Centis et al., 2012; Haerens et al., 2006b; Hakanen et al., 2006; Slusser et al., 2012). However, none of them included a power calculation and only two of the five studies (Haerens et al., 2006b; Hakanen et al., 2006) had more than 250 participants and were therefore potentially powered to detect changes in BMI. In the remaining studies, children's weight status was measured as a secondary outcome (Beech et al., 2003; Birken et al., 2012; Chen et al., 2010; Fitzgibbon et al., 2013; Hendrie and Golley, 2011; Hu et al., 2010; Luepker et al., 1996; Niinikoski et al., 2007; Paineau et al., 2008; Vandongen et al., 1995; Yin et al., 2012). Four studies used face-to-face counselling to involve parents (Birken et al., 2012; Hakanen et al., 2006; Hendrie and Golley, 2011; Niinikoski et al., 2007). Only one study reported a decrease in the prevalence of overweight in girls after counselling twice a year for several years, but no significant change in boys (Hakanen et al., 2006). However, at a later follow-up of the same intervention at age 14, no differences were any longer found in BMI between the intervention and control group (Niinikoski et al., 2007). Of these, one study scored strong (Hendrie and Golley, 2011) and three studies scored moderate (Birken et al., 2012; Hakanen et al., 2006; Niinikoski et al., 2007).

Seven studies involved parents by organizing group education or training (Barkin et al., 2012; Beech et al., 2003; Chen et al., 2010; Fitzgibbon et al., 2013; Hu et al., 2010; Slusser et al., 2012; Yin et al., 2012). Four of them reported significant improvement of children's weight-related outcomes (Barkin et al., 2012; Chen et al., 2010; Slusser et al., 2012; Yin et al., 2012). Five studies scored moderate (Barkin et al., 2012; Chen et al., 2010; Fitzgibbon et al., 2013; Hu et al., 2010; Yin et al., 2012) and two studies scored weak (Beech et al., 2003; Slusser et al., 2012).

Involving parents through information using newsletters, CD-ROMs and newsletters for parents in combination with a school-based intervention was studied by Haerens et al. (Haerens et al., 2006b). These authors reported no overall effect of the parental component, but a gender-by condition interaction was found in girls (Haerens et al., 2006b). In two studies home nutrition message/newsletters (Fitzgibbon et al., 2013; Vandongen et al., 1995) and in one study nutrition information packets (Luepker et al., 1996) were sent home, but both were ineffective. Of the four studies, two studies scored moderate (Fitzgibbon et al., 2013; Haerens et al., 2006b) and two studies scored weak (Luepker et al., 1996; Vandongen et al., 1995).

In two studies parents received telephone counselling (Centis et al., 2012; Paineau et al., 2008), where one study reported a decrease BMI z-score (Centis et al., 2012). One study scored moderate (Paineau et al., 2008) and one study scored weak (Centis et al., 2012).

Concluding the studies on weight outcome it seems that effectiveness could be higher in girls than in boys. Furthermore group education seems more effective than individualized counselling, although long-term individual counselling appears to be effective at younger ages. Excluding studies of weak quality did not change the result.

Age-group

Of all 15 studies conducted among preschool children (aged 2-5 years), nine studies found significant results in all desired outcomes (Barkin et al., 2012; Essery et al., 2008; Fletcher et al., 2013; McGowan et al., 2013; O'Dwyer et al., 2012; Slusser et al., 2012; Sääkslahti et al., 2004; Wardle et al., 2003; Wyse et al., 2012), three studies had mixed results (Hu et al., 2010; Sweitzer et al., 2010; Yin et al., 2012) and three studies did not find any significant changes in outcomes (Birken et al., 2012; Fitzgibbon et al., 2013; Haire-Joshu et al., 2008). Among the 11 studies conducted with school aged (6–11 years) children, four studies found significant

results in all desired outcomes (Baranowski et al., 1990; Centis et al., 2012; Chen et al., 2010; Talvia et al., 2004), seven studies had mixed results (Beech et al., 2003; Hendrie and Golley, 2011; Ievers-Landis et al., 2005; Paineau et al., 2008; Rasanen et al., 2004; Vandongen et al., 1995), and one study did not find any significant effect of parental involvement (Luepker et al., 1996). Of five studies conducted among adolescents (aged 12–18 years), only one study showed significant results in all desired outcomes, but only in combination with the school component (Haerens et al., 2007). One study had significant results only among girls (Haerens et al., 2006b), and three studies did not find any significant results (De Bourdeaudhuij et al., 2002; Haerens et al., 2006a; Hopper et al., 1992). Summarising these findings, it appears that parental support interventions targeting parents of preschool-aged children are more effective than those targeting parents of older children.

Socioeconomic position

Five studies were conducted among groups with a low SEP or minority groups (Barkin et al., 2012; Fitzgibbon et al., 2013; O'Dwyer et al., 2012; Slusser et al., 2012; Yin et al., 2012) and one study analysed if there were any moderating effects of SEP in a sample of parents with mixed SEP (Talvia et al., 2004). The latter study using long-term counselling was effective overall, but found no moderating effects of education, income or unemployment status with regard to fat intake during their long-term study between the ages of 4 to 10. The other five studies were conducted among parents with preschool children and involved between 6 to 12 group educational sessions. Four of these studies, of which two were weak and two moderate quality, were reported to be effective in improving diet, PA and/or having a desirable effect on weight status (Barkin et al., 2012;; O'Dwyer et al., 2012; Slusser et al., 2012; Yin et al., 2012). Both Slusser (Slusser et al., 2012) and Fitzgibbon (Fitzgibbon et al., 2013) reported high drop-out rates. In summary, intensive parental support given in group educational settings give promising results, but attrition seems to be a problem to consider.

Use of theory

The theories used in the included studies are given in Table 2. Eleven of the 35 included studies did not refer to a theory of behaviour change, yet seven of these reported to be effective with regard to at least one outcome. Of the studies using theories 17 out of 24 studies reported effectiveness of the parental component with at least one outcome.

Discussion

This systematic review aimed to identify and review universal parental support interventions to promote healthy dietary habits, PA or prevention of overweight and obesity among children aged 2-18 years, and also to identify effective interventions in groups with low SEP. The 35 studies differed by the way of involving parents, study design, implementation, outcomes, and study quality.

Overall, it appears that studies aiming to improve diet were more successful than those aiming to increase physical activity. Effectiveness also seemed to vary with the type of intervention. Long-term individual biannual counselling, as performed in the Finnish STRIP studies, was the most effective intervention for obtaining the desired outcomes both for diet, PA and BMI, and effects were also partly sustained long-term. Regarding parental interventions of shorter duration, individual counselling face-to-face or via telephone appeared to be the most effective type of intervention for changing children's diet. Regarding physical activity, we found limited evidence for the effectiveness of parental interventions of either type to increase PA in children, but most studies had moderate to low quality. For weight-related outcomes, group education or training seemed more promising than individual counselling, and most studies were of moderate quality.

The reason why individual counselling seems to work better with diet than physical activity is not known and this observation has to our knowledge not previously been described. The finding that intervention effectiveness was higher in younger compared to older children is compatible with the general observation that children's autonomy and decision-making power increases (Golan and Crow, 2004), implying that parent's influence decreases with child age. Another finding of our review was that effectiveness regarding weight status was better in girls compared to boys, as also reported previously (Haynos and O'Donohue, 2012). There is good evidence that group education works for low SEP groups, but there is a lack of studies testing an individual approach in this target group. Two recent reviews have addressed the issue of how to tackle socioeconomic inequalities in obesity amongst children. Hillier-Brown et al. concluded that universal interventions have the potential to slow the widening of the obesity gap (Hillier-Brown et al., 2014). Laws et al. concluded that interventions among disadvantaged families are more effective when they have a strong component of parental

engagement, use behaviour change techniques, focus on building skills and not just knowledge acquisition, provide rewards and links to social networking opportunities and community resources (Laws et al., 2014).

Finally, like others (Michie et al., 2009) we found no difference in effectiveness whether theory was used or not, although we did not formally test this. However, it is also important that a clear link is made between defined intervention components and theoretical mechanisms of change, which is missing in many intervention studies today (Golley et al., 2011; Michie et al., 2009). One way to improve this is by using well-developed manuals explaining the programme theory (Fraser MW et al., 2009). The theory should also be tested within the study. This is rarely done, but is an important part of program development.

Like our review, Golley et al. (Golley et al., 2011) also noted that parental support interventions targeting diet were more likely to be effective than those targeting PA and further that intervention effectiveness was favoured when the behaviour change techniques used spanned the spectrum of behaviour change process. Several of the interventions included in this review using counselling had some common elements like giving information or advice, role-modelling, self-monitoring, barrier identification, goal-setting and feed-back. Future intervention studies should provide more details regarding specific behaviour change techniques used during counselling, e.g. by using the taxonomy developed by Michie et al. (Michie et al., 2011) in order to be able to analyse and identify essential elements. It should be noted that only half of the intervention studies included a power calculation, which means that lack of statistical significance in the different outcomes does not necessarily mean a lack of effect. Instead, the number of participants could have been too low for the differences to reach statistical significance.

Our findings adds to the body of knowledge regarding the ineffectiveness of indirect approaches such as sending information material home to parents (Hingle et al., 2010).This is not surprising considering that “lack of knowledge” is not mentioned by parents as barriers for healthy eating or PA (Slater et al., 2010). Our review also showed that when school-based interventions were combined with information sent home to parents it was seldom possible to prove an additional effect of information. Similarly, another review comparing school-based interventions with and without a parental component came to the conclusion that more intense

parental involvement tended to be more effective than less intense (Van Lippevelde et al., 2012).

As regards the question if the gender of the parent played a role for intervention outcome but there was no data available in the included studies to explore this. About half of the studies reported the number of participating mothers and fathers at baseline and in general the proportion of fathers was low. In recent years there has been more focus on the role of fathers in parental interventions e.g. the Healthy Dads Healthy Kids programme (Morgan et al., 2014) and a possible moderating effect of parent gender is an area for further research.

Except for the Finish STRIP-studies (Hakanen et al., 2006; Niinikoski et al., 2007; Rasanen et al., 2004; Sääkslahti et al., 2004; Talvia et al., 2004; Talvia et al., 2006), there were few studies reporting follow-up measurements of more than 6 months (Fitzgibbon et al., 2013; Luepker et al., 1996; Haerens et al., 2006a; Haerens et al., 2006b) Therefore, we do not know if there were any long-term effects beyond 6 months in the other studies. Based on this evidence, we conclude that long-term parental counselling is the only practice that has so far proven effective in the long-term to improve dietary habits and physical activity. Group-based interventions are promising, especially for groups with low SEP, but low participation and attrition are a problem, as also shown previously (Yancey et al., 2006). Previous studies have shown that parents with low income experience logistical barriers to participation in parenting interventions such as unstable schedules, lack of transportation, lack of childcare (Spoth et al., 2000) and some interpersonal barriers such as mistrust of providers, prior negative experiences, and fears of stigmatization (Keller and McDade, 2000) than higher income parents. Therefore it is important to consider such barriers when planning interventions in this target group. The study by Fitzgibbon et al. with Latino parents (Fitzgibbon et al., 2013) was not effective, probably due to low adherence to the programme, as also experienced by Slusser et al. (Slusser et al., 2012) targeting low-income Latino mothers. Fitzgibbon et al. also noted that parents wrongly perceived their child to be normal weight even though it was in fact overweight or obese. Dietary and physical activity patterns are influenced by cultural norms. Cultural opinions about body shape and acceptable weight gain may explain the increase in overweight and obesity in certain populations (Nicolaou et al., 2009; Young-Hyman et al., 2000) and the lack of effectiveness regarding prevention of overweight and obesity. Thus, the challenge with low-income and minority groups seems to be parental participation and knowledge. Future studies should test individual approaches in

disadvantaged groups, and studies with mixed socioeconomic groups should examine differential effects with regard to SEP, which however requires stratification and an adequate sample size. In addition, interventions should involve fathers to a higher extent.

Strengths and limitations

This review is among the first to review studies evaluating effectiveness of different types of parental involvement, as the main component, in universal interventions targeting children's diet, PA, and bodyweight. The initial search was very broad and we used a systematic and rigorous review process to identify the relevant literature, as standardized by the Swedish Council on Health Technology Assessment (Swedish Council on Health Technology Assessment, 2013).

It is a limitation that only one author did the initial search and the assessment of study eligibility, and that our review only includes published articles in English. It is therefore possible that we could have missed relevant articles. Also, publication bias cannot be excluded. When assessing study quality we only accounted for selection and attrition bias, not performance and reporting bias as described in the Cochrane Handbook (Higgins and Green, 2011). However, we did address fidelity to intervention and quality of outcome assessment methodology.

Conclusion

This review, based on 35 studies of universal parental support interventions, has revealed some new findings, which may be of use in the further development of such programmes. In general, it appears that individual long-term counselling is the intervention of choice when it comes to diet, and that diet is more effectively changed through parental counselling than is physical activity. Group-based activities seem equally effective for diet, PA and obesity prevention. Further, our review confirms that parental support interventions work better the younger the children are. Involving parents through sending home information is not effective. With regard to groups with low SEP, group-based approaches of relatively high intensity appear to be effective, but low participation and high attrition remains a challenge. More studies should test an individual counselling approach in disadvantaged groups in order to see if this will improve participation and lead to lower attrition. A major limitation of most studies is that study power is not reported and that followed-up times are too short. Efforts should be made in the future to improve reporting of intervention content, include a power

calculation for the main outcome, use of high quality outcome assessment methodology, and a follow-up period of at least 6 months.

Conflict of interest

None.

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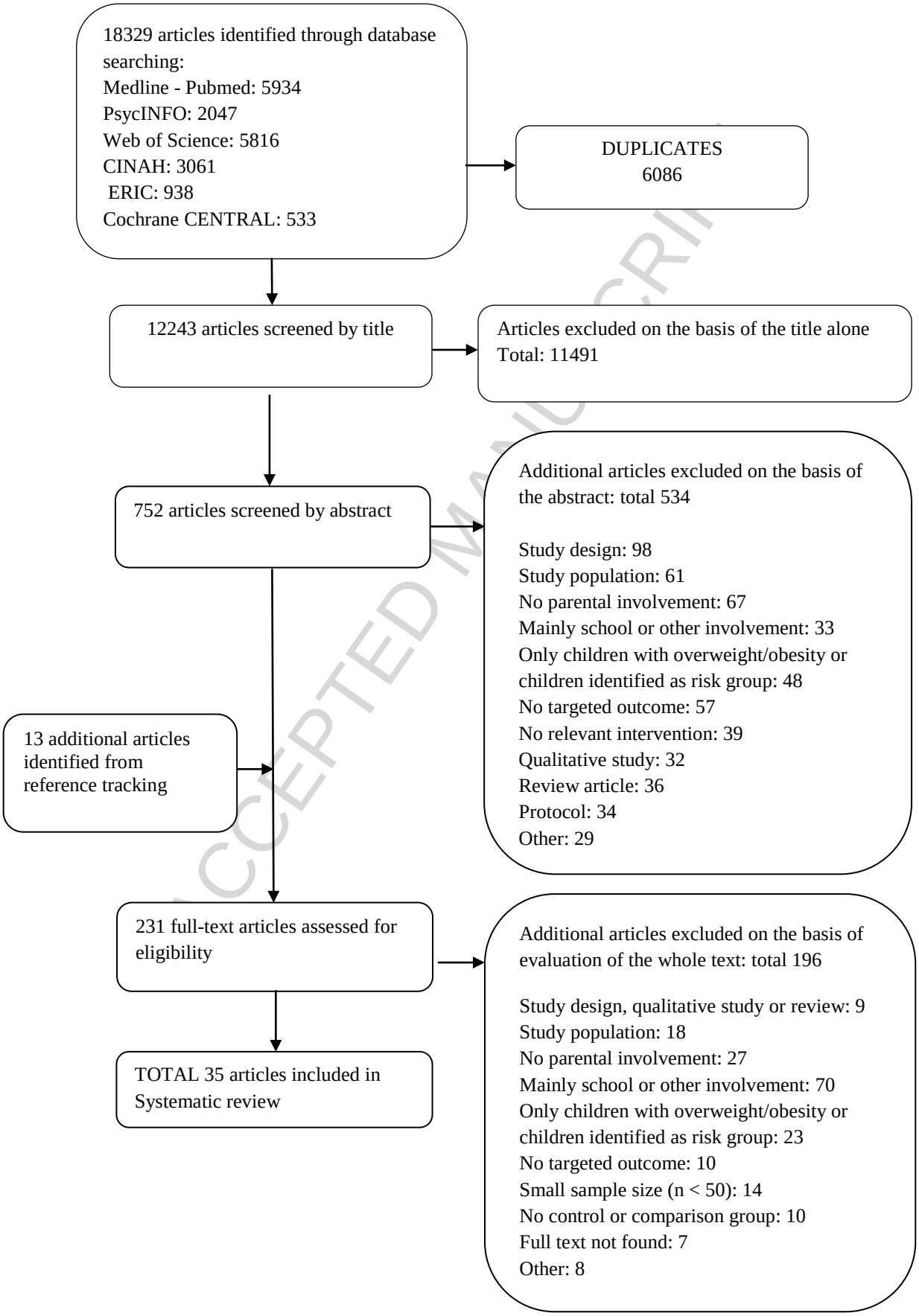

Figure 1. Flow chart of literature search by database

Table 1: Summary of study characteristics

Main type of parental involvement*
Face-to-face counseling (FC) (13 studies): Anand et al., 2007; Baranowski et al., 1990; Birken et al., 2012; Haire-Joshu et al., 2008; Hakanen et al., 2006; Hendrie and Golley, 2011; McGowan et al., 2013; Niinikoski et al., 2007; Rasanen et al., 2004; Sääkslahti et al., 2004; Talvia et al., 2004; Talvia et al., 2006; Wardle et al., 2003
Group education or training (G) (9 studies): Barkin et al., 2012; Beech et al., 2003; Chen et al., 2010; Fitzgibbon et al., 2013; Hu et al., 2010; Ievers-Landis et al., 2005; O'Dwyer et al., 2012; Slusser et al., 2012; Yin et al., 2012
Information sent home (I) (9 studies): De Bourdeaudhuij et al., 2002; Essery et al., 2008; Haerens et al., 2007; Haerens et al., 2006a; Haerens et al., 2006b; Hopper et al., 1992; Luepker et al., 1996; Sweitzer et al., 2010; Vandongen et al., 1995
Telephone counselling (TC) (4 studies): Centis et al., 2012; Fletcher et al., 2013; Paineau et al., 2008; Wyse et al., 2012

Study design
Randomized controlled trial (RTC) (21 studies): Anand et al., 2007; Baranowski et al., 1990; Barkin et al., 2012; Beech et al., 2003; Birken et al., 2012; Centis et al., 2012; Chen et al., 2010; Essery et al., 2008; Hakanen et al., 2006; Hopper et al., 1992; Hu et al., 2010; Ievers-Landis et al., 2005; Niinikoski et al., 2007; Paineau et al., 2008; Rasanen et al., 2004; Slusser et al., 2012; Sääkslahti et al., 2004; Talvia et al., 2004; Talvia et al., 2006; Vandongen et al., 1995; Wardle et al., 2003
Cluster RCT (11 studies): Fitzgibbon et al., 2013; Fletcher et al., 2013; Haerens et al., 2007; Haerens et al., 2006a; Haerens et al., 2006b; Haire-Joshu et al., 2008; Hendrie and Golley, 2011; Luepker et al., 1996; McGowan et al., 2013; O'Dwyer et al., 2012; Wyse et al., 2012
Quasi-experimental study (3 studies): De Bourdeaudhuij et al., 2002; Sweitzer et al., 2010; Yin et al., 2012

Primary study outcomes
Diet (15studies): Baranowski et al., 1990; De Bourdeaudhuij et al., 2002; Fletcher et al., 2013; Haire-Joshu et al., 2008; Hendrie and Golley, 2011; Hu et al., 2010; McGowan et al., 2013; Niinikoski et al., 2007; Paineau et al., 2008; Rasanen et al., 2004; Sweitzer et al., 2010; Talvia et al., 2004; Talvia et al., 2006; Wardle et al., 2003; Wyse et al., 2012
Diet and physical activity (PA) (10 studies): Anand et al., 2007; Beech et al., 2003; Chen et al., 2010; Fitzgibbon et al., 2013; Haerens et al., 2006a; Hopper et al., 1992; Ievers-Landis et al., 2005; Luepker et al., 1996; Vandongen et al., 1995; Yin et al., 2012
PA and decreased sedentary lifestyle (5 studies): Birken et al., 2012; Essery et al., 2008; Haerens et al., 2007; O'Dwyer et al., 2012; Sääkslahti et al., 2004
Overweight/obesity (5 studies): Barkin et al., 2012; Centis et al., 2012; Haerens et al., 2006b; Hakanen et al., 2006; Slusser et al., 2012

Primary setting
Home (9 studies): Anand et al., 2007; Centis et al., 2012; Essery et al., 2008; Fletcher et al., 2013; Haire-Joshu et al., 2008; McGowan et al., 2013; Paineau et al., 2008; Wardle et al., 2003; Wyse et al., 2012
School/preschool (9 studies): De Bourdeaudhuij et al., 2002; Fitzgibbon et al., 2013; Haerens et al., 2007; Haerens et al., 2006b; Hopper et al., 1992; Hu et al., 2010; Luepker et al., 1996; Sweitzer et al., 2010; Vandongen et al., 1995
Clinics/health care center (10 studies): Birken et al., 2012; Hakanen et al., 2006; Hendrie and Golley, 2011; Niinikoski et al., 2007; Rasanen et al., 2004; Slusser et al., 2012; Sweitzer et al., 2010; Sääkslahti et al., 2004; Talvia et al., 2004; Talvia et al., 2006
Community/ other (7 studies): Baranowski et al., 1990; Barkin et al., 2012; Beech et al., 2003; Chen et al., 2010; Ievers-Landis et al., 2005; O'Dwyer et al., 2012; Yin et al., 2012

Outcome measurement
Food frequency questionnaire/food recall/Record/Diary (22 studies): Anand et al., 2007; Baranowski et al., 1990; Beech et al., 2003; Chen et al., 2010; De Bourdeaudhuij et al., 2002; Essery et al., 2008; Fitzgibbon et al., 2013; Fletcher et al., 2013; Haerens et al., 2006a; Haire-Joshu et al., 2008; Hendrie and Golley, 2011; Hopper et al., 1992; Hu et al.,

2010; Luepker et al., 1996; McGowan et al., 2013; Niinikoski et al., 2007; Paineau et al., 2008; Rasanen et al., 2004; Talvia et al., 2004; Talvia et al., 2006; Vandongen et al., 1995; Wyse et al., 2012
Food observation (3 studies): Sweitzer et al., 2010; Wardle et al., 2003; Yin et al., 2012
Accelerometer/caltrac/pedometer (7 studies): Beech et al., 2003; Chen et al., 2010; Fitzgibbon et al., 2013; Haerens et al., 2007; Haerens et al., 2006a; O'Dwyer et al., 2012; Yin et al., 2012
PA recall/questionnaire/diary (9 studies): Anand et al., 2007; Beech et al., 2003; Essery et al., 2008; Haerens et al., 2007; Haerens et al., 2006a; Ievers-Landis et al., 2005; Luepker et al., 1996; Paineau et al., 2008; Sääkslahti et al., 2004
Screen time/ sedentary time (5 studies): Anand et al., 2007; Birken et al., 2012; Essery et al., 2008; Fitzgibbon et al., 2013; O'Dwyer et al., 2012
BMI/ BMI Z-score (14 studies): Anand et al., 2007; Barkin et al., 2012; Beech et al., 2003; Centis et al., 2012; Chen et al., 2010; Fitzgibbon et al., 2013; Haerens et al., 2006b; Hakanen et al., 2006; Hendrie and Golley, 2011; Hu et al., 2010; Paineau et al., 2008; Slusser et al., 2012; Vandongen et al., 1995; Yin et al., 2012
Minority or low SEP groups (6 studies): Barkin et al., 2012; Fitzgibbon et al., 2013; O'Dwyer et al., 2012; Slusser et al., 2012; Talvia et al., 2004; Yin et al., 2012

Age groups targeted
2-5 years (15 studies): Barkin et al., 2012; Birken et al., 2012; Essery et al., 2008; Fitzgibbon et al., 2013; Fletcher et al., 2013; Haire-Joshu et al., 2008; Hu et al., 2010; McGowan et al., 2013; O'Dwyer et al., 2012; Slusser et al., 2012; Sweitzer et al., 2010; Sääkslahti et al., 2004; Wardle et al., 2003; Wyse et al., 2012; Yin et al., 2012
6-11 years (10 studies): Baranowski et al., 1990; Beech et al., 2003; Centis et al., 2012; Chen et al., 2010; Hendrie and Golley, 2011; Ievers-Landis et al., 2005; Luepker et al., 1996; Paineau et al., 2008; Rasanen et al., 2004; Vandongen et al., 1995
12-18 years (5 studies): De Bourdeaudhuij et al., 2002; Haerens et al., 2007; Haerens et al., 2006a; Haerens et al., 2006b; Hopper et al., 1992
Mixed age groups (5 studies): Anand et al., 2007; Hakanen et al., 2006; Niinikoski et al., 2007; Talvia et al., 2004; Talvia et al., 2006

*Some studies used more than one type of involvement but here the grouping is done according to the main typ

Table 2: Main outcomes, study design, setting, participants, intervention content and summary of results of included studies.

Country, study design, setting, and type of intervention*	Participants and data points	Intervention content	Main results	Quality grading per outcome (1-4)
DIET England, Cluster RCT, Counselling in home (FC) (McGowan et al., 2013)	Parents of children aged 2−6 y from 6 Children's Centers N= baseline/follow-up Intervention: 58/51 parents Control: 68/55 parents Baseline and 8 weeks (end of intervention)	Intervention: Home visits (4x60 min) focusing on healthy feeding habits during an 8-week period. A booklet provided the concept of parental habit formation. Control: Offered information to improve healthy eating. Theory: Habit theory	Fruit intake increased by 0.5 servings/day ($P < 0.001$), vegetable intake by 0.8 servings/day ($P < 0.001$), healthy snacking by 1.0 occasion/day ($P < 0.01$), water by 0.6 occasions/day ($P < 0.001$) Unhealthy snack intake decreased by 0.4 occasions/day ($P < 0.01$), and sweet drinks consumption by 0.6 occasions/day ($P < 0.001$). Control: NS	Diet: 4
Australia, Cluster RCT 'Healthy habits trial' Telephone counselling (TC) (Fletcher et al., 2013)	Parents of children aged 3−5 y from 30 preschools N= baseline/follow-up Intervention: 208/174 parents Control: 186/169 parents Baseline, 2 months and 6 months (follow up)	Intervention: Telephone contacts (4x30 min) during 4 weeks to improve diet focusing on parent role-modelling, availability, and supportive food routines. Print materials were mailed home. Control: Mailed generic print materials on basic nutrition information and recommendations for a healthy diet for adults and children. Theory: Socio-ecological theory and the family-based theoretical framework	Mean non-core food (NCF) scores significantly lower at 2-month follow-up ($z = -2.89$, $P < 0.01$), compared to control group, but the effect was not maintained at 6 months.	Diet: 3
Australia, Cluster RCT 'Healthy habits trial' Telephone counselling (TC) (Wyse et al., 2012)	Parents of children aged 3−5 y from 30 preschools N= baseline/follow-up Intervention: 208/174 parents Control: 186/169 parents Baseline, 2 months and 6 months (follow up)	Intervention: Telephone contacts (4x30 min) during 4 weeks to improve diet focusing on parent role-modelling, availability, and supportive food routines. Print materials were mailed home. Control: Mailed generic print materials with basic nutrition information and recommendations for a healthy diet for adults and children. Theory: Socio-ecological theory and the family-based theoretical framework	Mean fruit and vegetable intake scores increased by 1.6 at 2 months ($P < 0.001$) and by 1.1 at 6 months ($P = 0.021$), compared to control group, but no longer in sensitivity analysis.	Diet: 4
Australia, Cluster RCT Counselling in clinic and information (**FC**+I) (Hendrie and Golley, 2011)	Families of children aged 4−13 y N= baseline/follow-up Intervention: 76/76 children Control: 69/61 parents Baseline, 12 weeks (end of	Intervention: Individualized parental nutrition education (3x30 min sessions over 12 weeks) about the importance of consuming reduced-fat dairy products and written shopping guide to take home. Control: Individualized advice (3 sessions)	Total fat intake was 3.4 percentage points lower ($P < 0.003$) and saturated fat intake 2.8 percentage points lower ($P < 0.0001$) at week 12, compared to control group. The differences remained significant at week 24 (total fat: −4.8 % points; saturated fat: −3.3 % points). No significant group differences in total energy intake or	Diet: 4 BW: 4

	intervention) and 24 weeks (follow-up)	about reducing children's screen time; including written material concerning screen time. Theory: Social learning theory	adiposity measures.	
USA, Quasi-experimental 'Lunch Is In The Bag' Child care center Information (I) (Sweitzer et al., 2010)	Families of children aged 3−5 y from six child-care centres N= baseline/follow-up Intervention: 81/81children Comparison: 55/51 children Baseline and 6 weeks (end of intervention)	Intervention: Parent handouts (Five weekly hand outs with nutrition information, menu and recipe suggestions, goal-setting activities, and social references); also classroom activities (for children), education stations (for parent and children), and teacher training. Comparison: None Theory: Theory of planned behaviour and social cognitive theory	Increase in mean number of servings of vegetables, from 0.41 to 0.65 ($P < 0.001$) and servings of whole grains, from 0.54 to 1.06 ($P < 0.001$) in sack lunches. Servings of fruit: NS No significant changes in comparison group.	Diet: 3
China, RCT Group education in kindergarten and information (**G**+I) (Hu et al., 2010)	Children aged 4−6 y from seven kindergartens N= baseline/follow-up Intervention: 1237/ 1042 Control: 831/713 Baseline, 6 months (mid-term) and 1 year (end of intervention)	Intervention: Eight lectures on basic nutrition information guided by National Dietary Guidelines for China (NDGC), skills for food arranging and cooking, and benefits of PA. Additionally, an illustrated book (to children), pamphlets and two series of promotional pictures to each parent. Control: Received a book of general picture stories. Theory: No	By using repeated measures of two levels of response and two groups: less unhealthy diet-related behaviours e. g. unhealthy snacks ($P < 0.0001$), western-style high-energy foods ($P < 0.05$), eating candy before meal ($P < 0.0001$) and improved breakfast eating ($P < 0.05$), compared to control group. No significant change in height, weight, height-for-age Z-score or weight-for-age Z-score	Diet: 3 BW:3
France, RCT Telephone counselling (TC) (Paineau et al., 2008)	One parent and at least one child aged 7−9 y N= baseline/follow-up Intervention A: 297/280 Intervention B: 298/274 Control: 418/393 families Baseline and 8 months (end of intervention)	Intervention: Monthly telephone counselling (8x30 min) and internet-based monitoring regarding: Group A: Reducing dietary fats and increasing complex carbohydrates. Group B: Reducing dietary fat, sugar and increasing complex carbohydrates. In addition (group A and B) monthly newsletters, a series of events (e.g. conferences, museum visits), and 3 nutrition education lessons. Control: General information about nutrition, but no dietary advice. Theory: No	Decreased intake of fat (E %) : Group A: −3.3 (−4.0 to −2.6); $P < 0.01$ Group B: −2.3 (−3.0 to −1.5); $P < 0.01$ Control: − 0.6 (− 1.2 to − 0.1); NS Increased intake of complex carbohydrates (E%): Group A: 3.3 (2.6 to 4.0); $P < 0.01$ Group B: 2.4 (1.6 to 3.1); $P < 0.01$ Group C: 1.2 (0.6 to 1.7); NS Sugar intake: NS BMI z score: NS	Diet: 3 BW:3
USA, RCT 'High 5 for kids' Counselling in home and information (**FC**+I) (Haire-Joshu et al., 2008)	Parents and children aged 2−5 y from the 'Parents as Teachers' (PAT) program sites N= baseline/follow-up Intervention: 759/605	Intervention: The standard PAT program plus the H5- KIDS protocol e. g. a tailored newsletter, home visits (4x60 min) and materials for the parent and child, aiming to improve feeding practices and the food environment in the home.	No increase in fruit and vegetable servings in intervention compared to control group but servings increased in normal weight (mean change = 0.35, $P = 0.02$) but not in overweight children (mean change = −0.10, $P = 0.48$), relative to controls.	Diet: 3

	Control: 899/701 Baseline and end of intervention (average 7 months (range 6−11 months)	Control: The standard PAT program with five home visits, activities and newsletters. Theory: Social cognitive theory and an ecological framework		
Finland, RCT 'STRIP study' Counselling in clinic (FC) (Niinikoski et al., 2007)	Children were randomised at 7 months and followed until age 14 N= baseline/follow-up Intervention: 540/254 Control: 522/278 Baseline, 13 months, 4, 7, 10, 11, 12, 13 and 14 years (end of intervention)	Intervention: Individualized counselling at 1–3 months intervals until child aged 2 years, biannually until 7 and thereafter once a year. Counselling aimed to reduce intake of fat, saturated fat and cholesterol and to encourage intake of vegetables, fruits, berries, and whole grain products. Control: Families were seen biannually until the child was 7 and thereafter once a year. No detailed counselling advice was given and dietary issues were discussed only briefly. Theory: Constructivist theory of learning	Intervention group had lower fat and saturated fat (as E%) intake (both $P < 0.001$) compared to control children throughout the 14 years. No difference in BMI between intervention and control group.	Diet: 3
Finland, RCT 'STRIP study' Counselling in clinic (FC) (Talvia et al., 2006)	Children followed from 7 months until 11 years N= baseline/follow-up Intervention: 540/228 Control: 522/253 Baseline, 13 months, 2, 3, 4, 5, 6, 7, 8, 9 and 10 years (end of intervention)	Intervention: Individualized counselling at 1–3 months intervals until child aged 2 years, biannually until 7 and thereafter once a year. Counselling aimed to reduce intake of fat, saturated fat and cholesterol and to encourage intake of vegetables, fruits, berries, and whole grain products. Control: Families were seen biannually until the child was 7 and thereafter once a year. No detailed counselling advice was given and dietary issues were discussed only briefly. Theory: Constructivist theory of learning	Higher vegetable consumption in intervention group compared to control (mean difference 2.4 g/day; CI 1.2–3.5; $P < 0.001$). Increased vegetable consumption only in boys (mean difference 3.2 g/day; CI 1.5–4.9; $P < 0.001$). Fruit consumption among boys increased as a result of the intervention (mean difference 10.1 g/day; CI 5.3–14.9; $P < 0.001$).	Diet: 3
Finland, RTC 'STRIP study' Counselling in clinic (FC) (Talvia et al., 2004)	Children followed from age 4 to 10 y N= baseline/follow-up Intervention: 540/289 Control: 522/268 Baseline, 4, 7 and 10 years (end of intervention)	Intervention: Individualized counselling at 1–3 months intervals until child aged 2 years, biannually until 7 years of age and thereafter once a year. Counselling aimed to reduce intake of fat, saturated fat and cholesterol and to encourage intake of vegetables, fruits, berries, and whole grain products. Control: Families were seen biannually until the child was 7 years old and thereafter once a year. No detailed counselling advice was given and dietary issues were discussed only briefly. Theory: Constructivist theory of learning	Children in the intervention group received 2−3 E% less saturated fats and 0.5−1.0 E% more polyunsaturated fats (for both $P < 0.001$), compared to controls. Intervention children had more favourable unsaturated/saturated fatty acid ratio ($P < 0.001$), compared to controls.	Diet: 3
Finland, RTC 'STRIP study'	Children studied at age 7.5-9 years	Intervention: Individualized counselling at 1–3 months intervals until child aged 2 years,	At age 7 the intervention children consumed as much total fat, monounsaturated and polyunsaturated fatty acids and sodium but	Diet: 2

Counselling in clinic (FC) (Rasanen et al., 2004)	N= baseline/follow-up Intervention: 47/47 Control: 51/51 Baseline, 7 years and 9 years (end of intervention)	biannually until 7 years of age. Thereafter, nutrition counselling was given both to the children and parents once a year. Counselling aimed to reduce intake of fat, saturated fat and cholesterol and to encourage intake of vegetables, fruits, berries, and whole grain products. Control: Families were seen biannually until the child was 7 years old and thereafter once a year. No detailed counselling advice was given and dietary issues were discussed only briefly. Theory: Constructivist theory of learning	less energy (6460 vs 7008 kJ, P < 0.05) and saturated fatty acids (11.5 vs 13.3 E%, P < 0.01) than the control children. At age 9 intakes of total energy, total fat and monounsaturated fatty acids did not differ between the groups, but the intervention children consumed less saturated fatty acids and more polyunsaturated fatty acids than the control children (11.1 vs 13.4 E%, P < 0.001; 5.7 vs 5.1 E%, P<0.05).	
England, RCT Counselling in home (FC) (Wardle et al., 2003)	Parents of children aged 2−6 y from a larger study of predictors of fruit and vegetable intake. N= baseline/follow-up Taste exposure: 50/34 Information: 48/48 Control: 45/44 Baseline and 14 days (end of intervention)	Intervention: Taste exposure. Parents were asked to offer their child a taste of a target vegetable daily for 14 consecutive days. Nutrition information: Parents were informed about the '5 a day' recommendations and given a leaflet with advice for increasing children's fruit and vegetable intake. Control: No intervention. Theory: No	Significant increase (from 47% pre-intervention to 77% post-intervention) in target vegetable intake in the taste exposure group (t(33)=4.36; P < 0.00) compared to information and control group.	Diet: 3
Belgium, Quasi-experimental School Information (I) (De Bourdeaudhuij et al., 2002)	Children aged 15-18 y from two secondary schools. N= baseline/follow-up Children with one parent: 110 Children alone: 71 Individual parent condition: 47 180 participants were available as postsample Baseline, 6 weeks (feedback letters) and 10 weeks (end of intervention)	All participants received a pre-intervention screening questionnaire to obtain information on the psychosocial determinants of fat intake. Based on the screening questionnaire, participants were mailed nutrition education letters tailored to individual fat intake levels, motivation to reduce fat intake, perceived support and self-efficacy toward fat reduction. Theory: Operant and Social learning theories, and Theory of planned behaviour.	No differences in post-intervention fat intake in either individual or family conditions.	Diet: 2
USA, RCT Counselling and group education in community facility (**FC**+G) (Baranowski et al., 1990)	Children aged 8−12 y of black-American families N= baseline/follow-up Intervention: 50/ 45 mothers Control: 46/43 mothers Baseline and 14 weeks (end of intervention)	Intervention: One educational session and two fitness sessions per week during14 weeks. Each session included family behavioural counselling (10−20 min) group education, aerobic activity (30 min dance) and healthy snacks (low fat, low sodium products) Control: No contact during the 14 week program. Theory: Social learning, social support and	Increase in number of times of intakes by intervention group, compared to control: High total fat foods (56.1 vs 58.2 for boys and 39.6 vs 55.5 for girls) (P < 0.05), High saturated fat foods (35.1vs 51.6 for boys and 21.2 vs 29.6 for girls (P < 0.05), High polyunsaturated fat foods (14.5 vs 17.6 for boys and 13 vs 18.8 for girls) (P < 0.01),	Diet: 3

		adult education theories		
DIET & PA USA, Cluster RTC School Group education and information (**G**+I) (Fitzgibbon et al., 2013)	Parents and children aged 3-5 y from four Head Start preschools in Chicago N= baseline/follow-up Intervention: 72/61 children Control: 74/67 parents Baseline, 14 weeks (end of intervention), 1 year follow-up	Intervention: Educational sessions and physical activity for children (3 times per week 40 min). The parent component included nutrition education and physical activity (6x90 min) and weekly newsletters (low adherence among parents). Control: Weekly sessions for children (20 min each week) that taught general health concepts. Parents received weekly newsletters. Theory: Social cognitive theory, Health belief model, self-determination theory	No significant difference between groups regarding dietary intake, PA or screen time. BMI z-score decreased in both groups, but no significant difference between groups post-intervention and at 1-year follow up.	Diet: 3 PA: 3 BW:3
USA, Quasi-experimental ´Miranos´ Group education (G) in centers (Yin et al., 2012)	Mexican-American children aged 3−5 y from four Head Start centers. N= baseline/follow-up Center-based intervention (C): 118 Center- and home-based Intervention (C+HBI): 66 Comparison : 69 Of the 384 children tested at pretest, 88% were retested at posttest Baseline and 18 weeks (end of intervention)	C: Training of staff to deliver gross motor program during daily outdoor play (30−45 min). Supplemental classroom activities with nine activity modules and story books, food-tasting activities to improve health literacy. C+HBI: As center-based + 7 parents trained (10 hours) as peer educators and prior to delivering an educational series on obesity prevention, nutrition, and PA to other parents/guardians. Parents also received a healthy snack for their children. Com: Received intervention materials and implementation training upon completion of the study. Theory: No	Higher fruit and vegetable consumption (0.19 serving; $p < 0.05$) and low-fat milk (0.06 serving; $p < 0.006$) in C+HBI group compared to Com -group. Higher intake of grain products (0.15 serving; $p < 0.05$) in C-group compared to Com-group No significant change in meat consumption. Both C and C+HBI groups had significantly higher active play levels ($P < 0.05$) at post-test. Higher gains of gross motor skills in C-group ($P < 0.01$) and C+HBI-group ($P < 0.001$). Less gain in weight z-score for age and gender for the C+HBI-group (adjusted mean difference between Com and C and HBI: –0.06, $P < 0.04$), no significant changes for C-group compared to Com-group.	Diet: 3 PA: 3 BW:3
USA, RTC Community Group education (G) (Chen et al., 2010)	Chinese-American children aged 8–10 y and their families. N= baseline/follow-up Intervention: 35/33 children Control: 32/ 24 children Baseline (T_0), 8 weeks (T_1) (end of intervention), follow up 6 months (T_2) and 8 months (T_3)	Intervention: Promotional program on healthy weight management and healthy lifestyles (diet quality, food preparation and improved PA), in small group (8−10 parents) workshops (2x2 hour), during 8 weeks. Children participated in small group session (45 min) on PA (15 min) and on food choices and TV viewing (30 min), once a week for 8 weeks. Control: Promotion on healthy weight management and healthy lifestyles, after completing the final follow-up assessment. Theory: Social cognitive theory	. Significant increase in vegetable and fruit intakes and PA and decrease in BMI in the intervention group between T_0 and T_1, T_0 and T_2 and T_0 and T_3 ($P < 0.05$) No significant differences for control group.	Diet: 3 PA: 3 BW:3
Canada, RCT Counselling in home (FC)	Parent and one child living in the same house (all persons aged 5−70 y) N= baseline/follow-up	Intervention: Regular home visits by health counsellors to set dietary and PA goals. Additionally, provision of filtered water, a PA program for children and educational events	Decrease in fats/oils/sweets (servings) at household level: Intervention group −4.9 vs. −3.0 in control group; $P = 0.006$. Decrease in soft drink/juice: Intervention group −0.3 vs. −0.1 in control group; $P = 0.02$	Diet: 2 PA: 2

(Anand et al., 2007)	Intervention: 29/ 28 families Control: 28/23 families Baseline and 6 months (end of intervention)	about healthy lifestyles. Control: Usual care. Theory: No	Physical activity and screen time: NS	
Belgium, Cluster RCT School Information (I) (Haerens et al., 2006a)	Children aged 11−15 y within 15 schools with technical and vocational education N= baseline/follow-up Intervention with parents (I+P): 1226 Intervention without parents (I): 1006 Control: 759 2287 children were available as 2-year post-sample Baseline, 1 year (mid-term) and 2 years (end of intervention)	Intervention: Opportunities for physical activity, extra sport materials, fitness test and computer-tailored advice on PA and nutrition, school fruit programme, written materials. Parents in I+P group (five schools), attended an interactive meeting on healthy food, PA, and the relationship of overweight and health; newsletters, school paper (3 time/y), a free CD-ROM on healthy food and PA to complete at home. Control: No information Theory: Theory of planned behaviour and trans theoretical model	Parental involvement (I+P) did not increase overall intervention effects on PA above intervention without parents (I) (increase in both genders) and fat intake (decrease in girls).	Diet: 2 PA: 2
USA, RTC Group education in community (G) (Ievers-Landis et al., 2005)	Girls aged 8–11 y and their mothers recruited from the Girl Scouts Council N= baseline/follow-up Girls only (I): 73 Girls+mothers (I+M): 94 Control (C): 80 Out of 395 eligible girls, 108 did not complete the 1-y follow-up assessment and 40 girls dropped out. Baseline and 3 months (end of intervention)	Intervention: Six educational sessions (6x30 min) over a 6−20 weeks period for the I group; 9−22 weeks period for the I+M group; and 6−33 weeks period for the C group. For the C group rope jumping for 4x15 min. Each session focused on improvement of dietary calcium (Ca) intake and weight-bearing PA (I group), and in addition coaching and facilitation (for I+M group). Control: A healthy lifestyles educational curriculum Theory: Theory of social cognition	No significant increases in Ca intake for I or I+M group, compared to the control group when adjusting for baseline values. Weight-bearing PA: NS	Diet: 2 PA: 2
USA, RCT 'Memphis GEMS pilot study' Group education in community (G) (Beech et al., 2003)	African-American girls aged 8−10 y with their parents/caregivers. N= baseline/follow-up Child-targeted: 21/21 Parent-targeted: 21/21 Control: 18/18 Baseline and 12 weeks (end of intervention)	Intervention: Weekly group sessions (12 x 90 min) on knowledge and behaviour change skills, healthy diet and PA with either girls or parents/caregivers for 12 weeks. Control: Three monthly sessions (9 x 90-min) designed to increase and prevent a decline in self-esteem, for 12 weeks. Theory: Social cognitive theory	In girls in parent-targeted group, a significant decrease in servings of sweetened beverages by 47% (P = 0.0087), relative to the control group. No significant difference in girls' PA, BMI and percent body fat in the parent-targeted group, relative to the control group.	Diet: 2 PA: 2
USA, Cluster RCT 'CATCH'	5106 children in third grade. N= baseline/follow-up	Intervention: School-based: School food service modification, enhanced physical	School+home intervention no more effective than school-only intervention for relevant outcomes (except in dietary knowledge).	

School Information (I) (Luepker et al., 1996)	Intervention: School-based intervention 28 schools School+home intervention 28 schools Control: 40 schools Baseline, 3 years (end of intervention)	education, classroom health curricula. School+home-based: As above plus 19 activity packets with nutrition and PA information complementing the classroom curricula requiring adult participation, family fun nights. Control: Usual health curricula, physical education and food service. Theory: No	Decrease in daily energy intake from fat among children in intervention schools compared to control schools after the intervention (from 32.7% to 30.3% vs from 32.7% to 30.3%, P < 0.01). Total PA did not differ between groups, but vigorous PA was significantly higher in the intervention group (58.6 min/day vs 46.5 min/day, P < 0.003). No difference in BMI between groups.	Diet: 2 PA: 2 BW: 2
Australia, RCT School Information (I) (Vandongen et al., 1995)	Children aged 10−12 y from 30 schools, 5 intervention groups N= baseline/follow-up Dietary intake: 1047/921 (869 children for follow-up) Baseline, and 9 months (end of intervention)	Group 1: Fitness (FIT); group 2: Fitness + school nutrition (FIT+SN); group 3: School nutrition (SN); group 4: School nutrition + home nutrition (SN+HN); group 5: Home nutrition (HN); group 6: Control (C). School-nutrition group: Children received lessons (10x60 min) aimed to improve knowledge, attitudes and eating habits. Training of teachers. Home-nutrition group: Five nutrition message using comics containing nutrition educational materials for children and parents separately. Parents were encouraged to become involved in children's nutrition education. Fitness group: Children received classroom sessions (6x30 min) aimed to increase PA in children Control: No intervention Theory: No	Boys and girls were analysed separately, only groups involving HN are reported here: Girls compared to control group: Significant decrease in total fat intake in HN (mean 3.6, CI 2.1 – 5.1) and SN+HN (mean 2.9, CI 1.5 – 4.3) group, change in polyunsaturated to saturated fat ratio in SN+HN (mean 0.1, CI 0.07 – 0.13) group, significant increase in fitness (leger run) in SN+HN group. Boys compared to control group: Significant decrease in sugar intake (mean 4.2, CI 2.1 – 6.1) in boys in the SN+HN group. , . No change in BMI relative to control	Diet: 2 PA: 2 BW: 2
USA, RCT School Information (I) (Hopper et al., 1992)	Children aged 11−12 y with their parents N= baseline/follow-up School+home based (SH): 45 School-based (S): 43 Control (C): 44 Baseline and 3 months (end of intervention)	School (S): Physical education sessions and physical fitness sessions (3x40 min) per week for 6 weeks. Nutrition education (2x30 min) per week for 6 weeks. School+home (SH) intervention: As school intervention plus weekly packets sent home providing guidelines for setting dietary and exercise goals and developing healthy nutrition and exercise habits through activities and games. Control: No intervention Theory: No	For diet, no effect of parental component in itself. E% from fat differed significantly for both S and SH groups at post-test F (2,122) = 4.66, P < 0.05 compared to control group. SH group increased significantly in sit-and-reach flexibility at post-test F(2,129) = 4.50, P < 0.05 compared to S and control group.	Diet: 2 PA: 2
PA & SEDENTARY England, Cluster RCT	Children aged 3−4.9 y of 77 families from 8 SureStart children's centres in disadvantaged areas.	Intervention: A 10-week active play program (5x70 min) including an active play for children and educational component for the parents to influence children's total PA and	Intervention children participated in 8.76 (CI −12.32 to −5.2) and 23.11 (CI −29.17 to −17.06) minutes less sedentary time during weekday and weekend days, respectively. Intervention children participated in 4.70 (CI 2.96 to 9.44) and	PA: 2

Group education in community centers (G) (O'Dwyer et al., 2012)	N= baseline/follow-up Intervention: 34/ 33 children Control: 45/43 children Baseline and 10 weeks (end of intervention)	sedentary behaviour. A log book to self-monitor their home activity. Control group: Were asked to maintain their usual PA and other routines. Theory: Socio-ecological model	10.24 (CI 10.24 to 18.08) minutes more PA during weekday and weekend day, respectively, compared to controls.	
Canada, RCT Counselling in health care center (FC) (Birken et al., 2012)	Children aged 3 y and their families visiting a health care center. N= baseline/follow-up Intervention: 81/ 64 Control: 79/68 Baseline and 1-year follow-up	Intervention: A 10-minute behavioural counselling on the health impact of screen time in children and strategies to decrease screen time. Control group: Both intervention and control groups received standardized counselling on safe media use. Theory: No	No significant differences in mean total weekday and weekend minutes of screen time between the intervention and control group. BMI: NS	PA: 3 BW: 3
USA, RCT Home Information (I) (Essery et al., 2008)	Children aged 2−5 y and their mothers N= baseline/follow-up Newsletter group: 30/30 Booklet group: 31/30 Control: 31/30 Baseline and 12 weeks (end of intervention)	Newsletter intervention: Information (once a week) on feeding practices, PA session together with mother. Booklet intervention: Intervention contained all of the information as the newsletters, where individual sections of the newsletters were divided into chapters in the booklet. Control: No intervention materials until after the study. Theory: No	No significant change in PA or media use.	PA: 2
Belgium, Cluster RCT School Information (I) (Haerens et al., 2007)	Children aged 11−15 y within 15 schools with technical and vocational education N= baseline/follow-up Intervention with parents (I+P): 1194/ 1124 Intervention without parents (I): 911/ 843 Control (C): 735/714 Baseline, 9 months (end of intervention)	Intervention: Opportunities for physical activity, extra sport materials, fitness test and computer-tailored advice on PA and nutrition, school fruit programme, written materials. Parents in I+P group attended an interactive meeting on healthy food, PA, and the relationship of overweight and health; newsletters, school paper (3 time/y), a free CD-ROM on healthy food and PA to complete at home. Control: No information. Theory: Theory of planned behaviour and trans theoretical model	No effect of parental component in itself. In girls, I+P group had significant increase in self-reported school-related PA of 6.4 minutes/day ($P \geq 0.05$, $d = .40$) compared to the control group, but not significant in boys. In both boys and girls, I+P group decreased PA of light intensity with, 36 minutes/day ($P \geq 0.05$, $d = .54$), compared to the control group. In both boys and girls, I+P group had significant increase in PA of moderate to vigorous intensity with, 4 minutes/day, while it decreased with almost 7 minutes per day in the control group ($P \geq 0.05$, $d = 0.46$).	PA: 2
Finland, RCT 'STRIP study' Counselling in clinic (FC) (Sääkslahti et al., 2004)	Children aged 4.5 y from STRIP cohort , followed for 3 years. N= baseline/follow-up Intervention: 116/86 Control 112/85 Baseline, 1 y, 2 y, 3 y (end of	Intervention: Yearly parent intensive counselling (1 hour) aiming to change children's PA behaviour and printed material sent out twice yearly. Control: Parents provided with information about PA during their routine visit. Theory: Social learning theory	Intervention children played more time outdoors ($F(1,527) = 4.21$; $P = 0.041$) and spent less time playing indoors ($F(1,527) = 3.88$; $P = 0.049$). Control: No change	PA: 3

	intervention			
OVERWEIGHT/OBESITY USA, RCT Group education in health care center (G) (Slusser et al., 2012)	Latino families and their children aged 2−4 y were recruited during health care clinic visits N= baseline/follow-up Intervention: 80/44 Control: 80/37 39 children (n=19) intervention and n=20 control) were excluded from the analysis with baseline BMIs <50th percentile. Baseline (T1), 4 months (T2) and 12 months (T3) (end of intervention)	Intervention: Parent educational sessions (9 x 90 min) over 15−17 weeks with topics of nutrition and PA to build parenting skills to overcome barriers and effectively implement healthy diets and PA with their children. Control: Wait-list received care as usual and a standard nutritional informational pamphlet developed by the WIC Supplemental Food Program. Theory: Social learning theory	Intervention children with BMIs >50th percentile decreased their BMI z-scores significantly by 0.20 (SE= 0.08) compared control children who increased z-scores by 0.04 (SE=0.09) at T3 (P < 0.05) using imputed data (n=121).	BW: 2
Italy, RCT Telephone counselling (TC) (Centis et al., 2012)	Children aged 9−10 y attending fourth grade N= baseline/follow-up Intervention: 103/ 98 Control: 106/100 Baseline and 8 months (end of intervention)	Intervention: Parents were invited to three group-motivational meetings focusing on the benefits of healthy diet and PA, weekly telephone calls during the first 4 months of intervention. Children attended extra sessions during school hours on PA and healthy nutrition. Control: One session on the importance of healthy nutrition and regular PA. Theory: No	BMI sds decreased by 0.06 units in the intervention group and increased by 0.12 units in control group (P < 0.002). Time spent in outdoor activities increased in intervention group from 6.23 h/week to 9.93 h/week (P < 0.001) vs 6.28 h/week to 7.21 h/week (P = 0.279) in control group. A significant reduction in TV watching with -0.96 h/week (P = 0.037) in intervention group and +1.33 h/ week in the control group (P = 0.031).	BW: 2
USA, RCT Group education in community (G) (Barkin et al., 2012)	Latino-American parents and preschool children aged 2−6 y recruited from community agencies N= baseline/follow-up Intervention: 54/ 35 Control: 52/40 Baseline and 3 months (end of intervention)	Intervention: 12 weekly 90-minute skills building sessions to improve family nutritional habits, increase PA, and decrease sedentary activity; a series of 12 group (6–8 parent-child dyads) sessions. Control: Brief school readiness programme, e. g. parents read picture books for their children (3x60 min) over the 12-week study period. Theory: Social cognitive theory and the transtheoretical model of change	The effect of the intervention on children's absolute BMI was B = –0.59 (95% CI: –0.94 to –0.25; P <0. 001), after controlling for child age, gender, and initial BMI and compared to control group. The intervention effect was strongest for obese children.	BW: 3
Belgium, Cluster RCT School Information (I) (Haerens et al., 2006b)	Children aged 11−15 y within 15 schools with technical and vocational education N= baseline/follow-up Intervention with parents (I+P): 1226/ 1071 Intervention without parents	Intervention: Opportunities for physical activity, extra sport materials, fitness test and computer-tailored advice on PA and nutrition, school fruit programme, written materials. Parents in the I+P group attended an interactive meeting on healthy food, PA, and the relationship with overweight and health;	A gender-by-condition interaction was found. In girls, I+P group had significant lower increase in BMI (F=12.52, P < 0.05) and BMI z-score (F = 8.61, P < 0.05), compared to the control group. In girls, a lower increase in BMI z-score (F = 2.68, P < 0.05) in the I+P group was found compared to the I group. In boys, no significant positive effects.	BW: 3

	(I): 1006/ 729 Control (C): 759/591 Baseline, 1 year (mid-term) and 2 years (end of intervention)	newsletters, school paper (3 time/y), a free CD-ROM on healthy food and PA to complete at home Control: No information. Theory: Theory of planned behaviour and trans theoretical model		
Finland, RCT 'STRIP study' Counselling in clinic (FC) (Hakanen et al., 2006)	Children were randomized at 7 months and followed up until age 10 y N= baseline/follow-up Intervention: 540/284 Control 522/301 Baseline, 13 months, 2, 4, 6, 8 and 10 years (end of intervention)	Intervention: Individualized counselling at 1–3 months intervals until child aged 2 years, biannually until 7 years of age and thereafter once a year. Counselling aimed to reduce intake of total fat, saturated fat and cholesterol and to encourage intake of vegetables, fruits, berries, and whole grain products. Control: Families were seen biannually until the child was 7 years old and thereafter once a year. No detailed counselling advice was given and dietary issues were discussed only briefly. Theory: Constructivist theory of learning	Analysis was stratified by gender. Significantly fewer girls in the intervention group were overweight than in control group 10.2% vs 18.8%, P < 0.0439); but no significant difference among boys.	BW: 3

RCT: Randomized controlled trial; NS: Not significant; kJ: Kilojoule; E %: Energy percent; FC: Face-to-face counselling; G: Group education or training; I: Information sent home; TC: Telephone counselling. PA: Physical activity; BW: Body weight. Letters in bold indicate main intervention type. *Some studies used more than one type of involvement but here the grouping is done according to the main type

Highlights:

- We reviewed effectiveness of parental support interventions targeting bodyweight
- Individual counselling can improve children's diet
- Evidence is limited that parental interventions increase children's physical activity
- Group education seems promising regarding prevention of overweight or obesity
- Better reporting of interventions and higher study quality should be a future aim