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A Review of Primary Care-Based Childhood Obesity Prevention and Treatment Interventions

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Abstract

Effective obesity prevention and treatment interventions targeting children and their families are needed to help curb the obesity epidemic. Pediatric primary care is a promising setting for these interventions, and a growing number of studies are set in this context. This review aims to identify randomized controlled trials of pediatric primary care-based obesity interventions. A literature search of 3 databases retrieved 2947 publications, of which 2899 publications were excluded after abstract (*n*=2722) and full-text review (*n*=177). Forty-eight publications, representing 31 studies, were included in the review. Eight studies demonstrated a significant intervention effect on child weight outcomes (e.g., BMI *z*-score, weight-for-length percentile). Effective interventions were mainly treatment interventions, and tended to focus on multiple behaviors, contain weight management components, and include monitoring of weight-related behaviors (e.g., dietary intake, physical activity, or sedentary behaviors). Overall, results demonstrate modest support for the efficacy of obesity treatment interventions set in primary care.

Keywords

Childhood obesity; Prevention; Treatment; Primary care

Introduction

As obesity has emerged as a significant public health concern across the globe, the importance of early prevention and treatment cannot be overstated. Overweight and obesity in childhood tends to track into adulthood, with overweight and obese children at a greater risk for obesity in adulthood [1, 2]. Health conditions associated with obesity, such as type 2

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Compliance with Ethics Guidelines

Conflict of Interest Elisabeth M. Seburg, Barbara A. Olson-Bullis, Dani M. Bredeson, Marcia G. Hayes, and Nancy E. Sherwood declare that they have no conflict of interest.

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diabetes [3] and hypertension [4], can emerge in childhood. Furthermore, there is increasing evidence that childhood adiposity is associated with poor health outcomes in adulthood [5, 6].

Pediatric primary care is a promising setting for behavioral obesity prevention and treatment interventions. Despite differences in the organization and delivery of primary care services around the globe [7–9], pediatric primary care is regarded as an important setting for obesity treatment and prevention efforts [10]. Clinical guidelines and recommendations for pediatric primary care providers have been issued by leading health organizations and expert committees in the USA [11] and internationally, including in Australia [12], Canada [13], and the UK [14]. Primary care settings provide high access to both children and their primary caregivers, given that large numbers of children in the USA and in many industrialized countries are seen in primary care settings. Primary care providers are trusted sources of health information, and interventions can build off of the existing provider relationship with the family. Additionally, primary care providers can link children and families to community resources that provide further support for building and maintaining healthy weight-related behaviors. Despite the fact that primary care is an appealing context for both prevention and treatment interventions, it has been a less frequently adopted setting for obesity interventions. A smaller number of obesity interventions have been conducted in health care settings and have primarily been treatment interventions carried out in specialty care settings.

The advantages of conducting obesity prevention and treatment interventions in primary care are counterbalanced by several major challenges. There are time and space constraints associated with conducting interventions in primary care settings (e.g., availability of clinic rooms, short clinic appointments), and making extra trips to the primary care clinic may be burdensome to families and may create participation barriers. Primary care providers across multiple countries cite time constraints as limiting their implementation of obesity prevention and treatment activities [15–17]. In the USA, there are additional barriers related to the relatively high cost of primary care providers' services and poor reimbursement for provider activities related to obesity monitoring, prevention, and treatment services. Beyond logistical and cost barriers associated with conducting obesity interventions in primary care settings, primary care providers in the USA, Canada, Europe, Australia, and elsewhere have described barriers related to primary care provider training, knowledge and skills, and attitudes about obesity prevention and treatment [17–26]. While recent studies suggest increased provider comfort in screening and counseling for obesity [27, 28], rates of obesity prevention and treatment activities in primary care remain low in many countries, including the USA Israel, Australia, and several European countries [25, 29, 30•, 31–34]. Furthermore, primary care providers have expressed reservations about the effectiveness of provider-delivered obesity prevention and treatment strategies, citing concerns regarding the obesogenic environment, lack of parent motivation to make weight-related behavioral changes for themselves and their family, and low parent concern about child weight [16, 20, 22, 24, 27, 32, 34–36].

Although few behavioral obesity prevention and treatment interventions have been set in primary care, relative to other settings, a growing number of studies have been published

that test the efficacy of primary care-based obesity interventions. These studies provide valuable findings on the efficacy of interventions set in primary care, as well as insight into strategies to minimize the barriers of conducting research in this setting and maximize the advantages. Sargent, Pilotto, and Baur's [37] 2011 systematic review identified 17 obesity treatment interventions set in primary care, 12 of which demonstrated a significant intervention effect on child weight-related outcomes, including body mass index (BMI), dietary intake, and physical activity level. Of the 12 effective interventions identified in this review, 7 were randomized controlled trials (58.3 %). The current review builds upon this prior review article by examining both prevention and treatment intervention, limiting included studies to only randomized controlled trials, and focusing on the impact of interventions on child weight outcomes.

This review paper aims to identify randomized controlled trials (RCTs) focused on obesity treatment or prevention conducted in a primary care setting and to 1) describe the characteristics (e.g., sample, intervention participation, and retention) of *behavioral* pediatric obesity prevention and treatment interventions set in primary care; 2) assess the efficacy of behavioral pediatric obesity prevention and treatment interventions conducted in primary care; and 3) discuss the implications of these findings for future directions in obesity treatment and prevention in primary care.

Methods

A comprehensive search of PubMed (Web based), Cumulative Index to Nursing and Allied Health Literature (CINAHL— EBSCO platform), and PsycINFO (Ovid platform) databases was performed to identify original RCTs or intervention studies on pediatric/childhood obesity in English. Relevant systematic reviews and meta-analyses were also reviewed for background information but not included in this study. Dissertations, books, book chapters, and conference proceedings were excluded.

In PubMed, the Medical Subject Headings (MeSH) terms defined the concepts of obesity, overweight, or body mass index; children, childhood, adolescents, or pediatric; and RCTs or intervention studies. The intervention studies search set was further refined with primary health care terms to eliminate intervention studies done in specialty care, schools, or research settings. For optimal retrieval with all terms, medical subject headings were supplemented with relevant title and text words. Search parameters are available on request.

The search strategies for CINAHL and PsycINFO were adjusted for the syntax appropriate for each database using a combination of thesauri and text/title words. Published reports in the peer-reviewed literature from 1990 to Oct 2013 were identified and retrieved. Bibliographies from identified review articles, meta-analyses, and key original articles were also scanned for potentially relevant papers to include in this study.

Studies included in the review were selected using the following inclusion criteria: 1) randomized controlled trial; 2) completed pilot or full trial study; 3) behavioral obesity prevention and/or treatment interventions; 4) intervention delivered in or connected to primary care setting; 5) health care provider participates in intervention; 6) intervention for

children between the ages of 0 and 18 and/or parents of children in this age range; 7) outcome measures reported include child weight outcome (e.g., BMI, weight for height); and 8) article available in English and published after 1990. For the purpose of this review, studies with published outcomes were considered complete. Studies were excluded if published intervention descriptions did not include specific information about the intervention setting or the role of the health care provider in intervention delivery. Studies in which health care providers participated only in study recruitment were excluded. Studies with an active control condition set in primary care were included, regardless of the intervention condition setting. Active control conditions were defined as conditions providing an alternative intervention with one or more components prescribed by the study.

Figure 1 displays the flow of articles through the search process. The database search and bibliography review yielded 2947 publications after removal of duplicates. The first author (EMS) reviewed the title and abstract for all publications and excluded 2722 publications. Common exclusion reasons were a setting other than primary care, surgical or pharmacological intervention, or adult population. Four reviewers conducted a full-text review of the 225 potentially eligible publications. Each publication was independently reviewed by two authors and classified as eligible or ineligible. Inclusion decisions were compared for each publication, and coding disagreements were discussed by all authors to determine final inclusion in this review. Forty-eight publications, representing 31 studies, met our inclusion criteria and were included in this systematic review.

Data extraction was completed independently by four reviewers. Two reviewers performed a cross-check of data extraction to assure accuracy and completeness of data. For studies with multiple publications, all publications identified in the review were used for data extraction. Data were extracted for all study conditions that included primary care involvement. Intervention effectiveness was evaluated, and interventions were considered effective if there was a significant difference in child weight outcomes (e.g., BMI *z*-score, weight-for-length percentile) between study groups. Measures of child body composition (e.g., waist circumference) were not considered in the assessment of intervention effect. Additionally, interventions were not classified as effective if a significant intervention effect was observed only for a participant subgroup (e.g., boys vs. girls). To aid in interpretation, studies were classified by participant age group (e.g., infant, preschool age, elementary school age, and adolescent) and by prevention or treatment focus. Study samples that spanned multiple age groups were categorized by the mean age of participants at baseline.

Results

Summary of Study Characteristics

Appendix 1 provides information on the study characteristics of the 31 studies included in this review. The majority of studies were conducted in the USA (*n*=17). Of the international studies, studies were conducted in Australia (*n*=4), Belarus (*n*=1), Canada (*n*=1), Finland (*n*=1), Germany (*n*=1), Israel (*n*=1), Italy (*n*=1), Mexico (*n*=1), Sweden (*n*=1), the Netherlands (*n*=1), and the UK (*n*=1). By review design, all studies were RCTs, the majority of the trials were individually randomized trials (*n*=25), and six were cluster-randomized trials. One study included three non-randomly allocated comparison groups, in addition to

two randomized intervention conditions [38]. Studies were primarily treatment studies targeting children who were overweight or obese (*n*=24). Five studies targeted infants; 4 studies were conducted with preschool-age children; 18 studies focused on elementary school-age children; and 4 studies were directed toward adolescents. All studies included a child weight outcome, and this was a primary outcome for most studies (*n*=27). Follow-up duration ranged from 3 months to 20 years, with most follow-up periods lasting 1 year or less (*n*= 23). While the majority of studies had relatively short follow-up periods, a small number followed participants for 5 years or longer (*n*=3). Study retention rates ranged from 52 to 100 %, and the average retention rate was 77.5 %.

Summary of Intervention Features

Table 1 displays study intervention features, grouped by child age group and prevention or treatment focus. Twelve studies had active control conditions in primary care settings, three of which did not have primary care involvement in the intervention condition [69, 71, 88]. Five studies targeted parents only and 26 studies targeted both parents and children. All studies had at least one study component that was delivered in person to participants in individual sessions. Eight studies included in-person, group intervention activities. Eight studies included a phone component. Fourteen studies had intervention components delivered across two or more modalities. For example, Taveras et al. [58] included in-person clinician visits, clinician telephone calls, and changes to the primary care system. In another study [61], intervention components were group sessions delivered by a team of health care providers (primary care provider, health educator, nutritionist, and physical therapist) and individual coaching sessions with a health coach conducted in person or by telephone.

Information regarding intervention intensity and delivery is also included in Table 1. Intervention intensity varied, ranging from brief, low-intensity interventions, such as one 10-min intervention session [55], to moderately intensive interventions involving regular intervention contacts over a period of time, like a 12-month program that involved monthly physician sessions, 12 weekly nutrition sessions followed by monthly nutrition sessions, and 6 parent education sessions [72]. Health care provider involvement in interventions varied, in terms of the type of provider and their role in the intervention. Seventeen studies involved more than one type of provider. Most studies had at least some involvement by a primary care physician, nurse practitioner, or physician assistant (*n*=23), with this type of provider the sole interventionist in eight studies. Other types of providers involved in intervention delivery were health coaches (*n*=10), nutritionists or dietitians (*n*=10), nurses (*n*= 7), exercise professionals (*n*=5), psychologists (*n*=1), and medical assistants (*n*=1). One study used interactive voice technology (IVR) to deliver a telephone counseling program to children and their parents, in conjunction with behavioral counseling from the child's primary care provider [89].

As shown in Table 1, there was heterogeneity in the reporting of intervention participation data. Ten studies did not provide information about intervention participation. Among those studies that reported intervention participation data, the amount and type of information provided varied considerably, limiting comparisons of intervention dose across studies.

Effective Interventions

Obesity-related study outcomes and study results are summarized in Appendix 1. Eight of the 31 studies identified in this review had significant intervention effects on a child weight outcome. For one study, intervention effect was assessed for the two randomized intervention groups compared to a non-randomly allocated, age-, sex-, and BMI-matched control group [38]. Effective interventions targeted infants (*n*=1 of 5 studies in this age group), preschool-age children (*n*= 2 of 4 studies), elementary school-age children (*n*=3 of 18 studies), and adolescents (*n*=2 of 4 studies). Among the effective interventions, only one study, SLeeping and Intake Methods Taught to Infant and Mothers Early in life (SLIMTIME) [50], was a prevention study. Five of the seven effective treatment interventions targeted obese youth. These studies had relatively short follow-up periods; seven had a follow-up period of 1 year or less [38, 50, 56, 57, 72, 91, 93] and Nova, Russo, and Sala [79] had a 2-year follow-up, though results were reported for only the 6- and 12-month measurement points. High participant dropout rates were a concern in several studies [50, 72, 79]; however, despite a high dropout rate, Diaz et al. [72] collected primary outcome measures from 87% of the baseline sample. Most studies reported high retention rates (≥83 %) [38, 56, 57, 91, 93].

All studies demonstrating a significant intervention effect included parent-targeted intervention components; however, the two effective interventions conducted with adolescents focused on the adolescent as the agent of change and had a more limited role for parents [91, 93]. All effective interventions targeted multiple weight-related behaviors, and they tended to use multiple approaches and delivery modes. For example, the behavioral weight control intervention for adolescents by Saelens et al. [93] included 1) computer-guided behavior change plan and behavioral assessment for the adolescent; 2) in-person physician visit to discuss the adolescent's physical activity, nutrition, and sedentary behaviors and their behavior change plan; 3) adolescent and parent session with study PI to learn food self-monitoring; 4) adolescent phone coaching sessions with a study counselor; and 5) informational materials for the adolescent and parent. Another study found that an intervention that was comprised of in-person, clinic-based group education sessions and in-person, home-based individual sessions was more effective than a single intervention session with a pediatrician [57].

Of the eight studies that demonstrated a significant intervention effect, six included daily child calorie goals or dietary plans [56, 57, 72, 79, 91, 93] and six had physical activity goals or plans [38, 56, 57, 72, 91, 93]. Five interventions also incorporated regular assessment of child weight, either at intervention sessions [57, 72, 91] or through self- or parent-weighing [56,93]. Three effective interventions, two targeting preschoolers [56, 57] and one directed at elementary school age children [72], had intervention components targeting parent weight or weight-related behaviors.

Discussion

This review paper identified primary care-based obesity prevention and treatment interventions and assessed the efficacy of these interventions on child weight outcomes. Our search yielded 31 RCTs set in primary care, 8 of which demonstrated a significant effect on

a child weight outcome. We found modest evidence supporting the efficacy of treatment interventions conducted in primary care settings. There was little evidence demonstrating the efficacy of prevention interventions set in this context, though given the small number of prevention studies identified, it is clear that further research is needed before drawing conclusions on the efficacy of obesity prevention in primary care.

Characteristics of Effective Interventions

A common theme across effective interventions was an explicit intervention focus on weight management and/or regular monitoring of weight and weight-related behaviors, such as dietary intake and physical activity. For example, an obesity treatment study for adolescents incorporated self-monitoring activities, such as weekly weighing and calorie intake, and focused on decreasing calorie intake and increasing physical activity to meet individualized calorie and physical activity goals [93]. Another obesity treatment study targeting adolescent girls placed less emphasis on weight and calorie tracking, but included weight measurements at each intervention session, self-monitoring of dietary intake and physical activity, and guidelines related to daily calorie intake, physical activity, and screen time [91].

The two effective interventions targeting preschool-age children included parent behavior change targets and weight loss goals [56, 57]. Both studies emphasized parent modeling of healthy behaviors, and these interventions included physical activity and calorie goals for the parent and child, as well as parent monitoring of their own weight, dietary intake, and physical activity level. Stark et al. [57] also included parent monitoring of child and parent sedentary activities. One of the effective interventions for elementary-age children also targeted parent weight loss, but no specific intervention components directed at parent weight loss were described [72].

Effective interventions tended to be at least moderately intensive (≥10 intervention sessions), with the exception of the obesity prevention study focused on infants and their parents, which involved a relatively brief intervention of two sessions [50]. For example, one study found that brief pediatrician counseling was not as effective compared to a more intensive, multi-component, and multi-setting intervention in decreasing child BMI [57]. This finding is in line with a prior review article of pediatric obesity treatment interventions, which concluded that greater intervention intensity was associated with greater effectiveness [94].

Challenges Associated with Obesity Prevention

Of the 31 studies identified in our review, only 7 were focused on obesity prevention, of which 1 found a significant effect on child growth, over a relatively short follow-up period [50]. Our findings underscore the challenges associated with preventing childhood obesity, as well as the need for a greater number of RCTs assessing obesity prevention interventions delivered in primary care. It is well established that parents are often inaccurate in their perception of their child's weight status and risk for obesity [95], which makes it challenging to motivate parents to engage in behavior change, as many do not view their child as at risk for obesity. Strategies to increase the salience of obesity prevention messages for parents and increase motivation for behavior change include using behavioral counseling

techniques, such as motivational interviewing, to sensitively work through barriers to behavior change [96]. Another potential strategy is to help parents understand BMI and their child's own weight status through discussions of BMI trajectories and obesity risk. Further studies are needed to rigorously evaluate strategies to motivate parents to engage in obesity prevention efforts and make changes to weight-related behaviors.

Role for Primary Care Providers in Obesity Interventions

This review demonstrated considerable heterogeneity in the role of primary care providers in obesity interventions set in primary care, as well as in the level of detail reported about the nature of this involvement. In effective interventions, provider contact with participants varied from brief encounters during routine or supplementary clinic visits augmented by other intervention activities [50, 56, 72] to intervention sessions delivered exclusively by the primary care provider [79]. Analysis of interventions with and without a significant intervention effect on child weight outcomes did not yield consistent themes about the optimal role of providers in obesity prevention and treatment interventions. Relatively little is known about the content and process of the provider role in obesity treatment and prevention counseling, which is a limitation of the existing literature. The quality with which primary care providers engage families around these issues could be important to the effectiveness of their efforts. Findings from a pilot study suggest that physician use of motivational interviewing techniques was significantly associated with adolescent weight loss [96], and a full-scale trial is underway to further evaluate these findings [97•]. Despite the limitations of the existing literature, results indicate the feasibility of engaging primary care providers in efforts to prevent and treat childhood obesity. Future research is needed to assess how interventions can optimize primary care provider involvement in such efforts to develop effective and sustainable obesity prevention and treatment strategies that are feasible in primary care settings.

Linking Primary Care to Community Settings and Resources

While more intensive interventions have demonstrated promise in the treatment of pediatric obesity, primary care obesity interventions with greater participant contacts are resource intensive, in terms of provider time, staff time, cost of services, and participant burden. It is critical to find ways to translate these interventions into sustainable models of obesity treatment that are feasible for implementation in routine primary care. One potential strategy is to leverage the primary care provider's influence and relationship with families by linking primary care interventions to other potential intervention settings (e.g., community based, home based, and phone based) and existing community resources. A recent study by Ariza et al. [98] demonstrated the feasibility of identifying overweight children in pediatric practices and then linking families to existing community-based programs. Linking children and families to community resources is a practice in line with American Academy of Pediatrics recommendations for pediatricians, which highlight the importance of pediatrician community connectedness in the prevention and treatment of public health issues, such as obesity [99, 100].

Two studies in progress are using this approach to childhood obesity prevention and treatment [101, 102]. The Minnesota NET-Works study (Now Everybody Together for

Amazing and Healthful Kids) is a multi-component obesity prevention intervention targeting low-income preschool-age children and their families [101], which aims to prevent obesity through a multi-setting intervention that links primary care-, community-, neighborhood-, and home-based intervention strategies. The Stanford GOALS study uses a similar approach in an obesity treatment intervention for preschool-age children and their families [102]. This study links a counseling intervention delivered by primary care providers to home- and community-based intervention activities, such as an after-school sports program and a home-based health education and behavioral counseling. These studies provide a model for linking primary care-based obesity treatment and prevention strategies to other settings, and results will help shed light on the feasibility and effectiveness of this approach.

Tailoring Interventions to the Developmental Needs of Children

This review of interventions directed at children and parents across infancy, childhood, and adolescence underscores the need for obesity prevention and treatment interventions that are targeted to the developmental needs of the child. As children become more independent and make more decisions that can influence weight, it is necessary for interventions to account for these changes and craft intervention strategies tailored for children and families throughout childhood. It is clear that obesity prevention and treatment interventions have moved in this direction, as most studies identified in this review included intervention components tailored to the developmental stage of the child. For example, adolescent-focused studies described a greater emphasis on the adolescent as the agent of change, through strategies such as adolescent-targeted intervention activities and increased focus on adolescent self-management of weight-related behaviors. These intervention strategies align with what is developmentally appropriate for adolescents [103] and recommendations for adolescent health care [94, 104].

Results of this review also identify areas for improvement. Several studies enrolled wide age ranges of children, without sufficient acknowledgement of the different strategies that may be needed to reach children of different ages enrolled in the study, and the changing parenting experiences and role of parents in weight-related behaviors as children age. Future studies should increase their consideration of children’s developmental needs, and one potential avenue for doing this is through the primary care provider. Primary care providers are particularly well equipped to provide this type of individualized intervention tailoring to children and families.

Conclusions

This review of obesity treatment and prevention interventions found modest support for the efficacy of behavioral treatment interventions set in primary care. We identified only a small number of prevention studies, limiting our ability to draw conclusions on the efficacy of prevention efforts in this context. Heterogeneity in the amount and type of information reported about provider involvement was observed. Examination of studies with a significant intervention effect did not reveal any discernable trends in the role and scope of providers. Further research is needed before making recommendations on the optimal role for providers in obesity prevention and treatment interventions. In addition, there is the need

for future research on obesity prevention interventions in primary care settings, as this is a gap in the current evidence base.

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Appendix 1

Table 2

Study characteristics and relevant significant findings by participant age and type of study (prevention or treatment)

Study author, year	Study design	Study sample	Obesity-related study outcomes	Relevant significant results, comparison of intervention group to control group[a]	Study length	Intervention length	Retention rate
Infant, Prevention (n=5)							
French, 2012 [39, 40]	3 (Condition; I1, I2, UC) × 3 (Time: baseline, 6-, 12-month) cluster RCT	*Sample size*: N=292 mother/infant dyads (I1, n=101; I2, n=101; C, n=104); N=3 clinics (I1, n=1; I2, n=1; C, n=1) *Sample characteristics*: infant≤2 months old; healthy full-term	*Primary*: Infant weight for height *Secondary*: Maternal eating behaviors (breakfast; family meals; location of meals) and maternal feeding behaviors (child intake of milk, fruit, vegetables, and juice; child drinks from cup; and child self feeds)	*12-month*: Less juice (intervention 1 vs. control, p<.05; intervention 2 vs. control, p<.05); more fruit (intervention 1 vs. control, p<.05); intervention 2 vs. control, p<.05 and more vegetables (intervention 1 vs. control, p<.05)	12 months	12 months	64%
Hakanen, 2010 [41–47]	2 (Condition: I, C) × Many (20 year study) RCT	*Sample size*: N=1062 infants (I, n=540; C, n=522) *Sample characteristics*: infant 7 months at randomization; no severe illness	*Primary*: Serum lipid and lipoprotein concentrations, growth (infancy: weight-for-height; childhood: BMI); nutrient intake; physical activity; NO-induced vasodilatation. *Secondary*: Parental eating attitudes	*10-year*: Greater interest in healthy eating among parents (p<.001) and greater interest in light products among parents (p<.001) *Over time (baseline, 13-month, 2-, 3-, 4-, 5 6-, 7-, 8-, 9-, 10-, 11-, 12-, 13-, 14-year)*: Lower serum total cholesterol (p<.001); lower low-density lipoprotein cholesterol (p<.001); lower fat intake (p<.001); lower saturated fat intake (p<.001) *15-year*: Lower diastolic blood pressure (p=0.005); lower proportion with	Ongoing (20 years)	Ongoing (20 years)	52.3 %

Study author, year	Study design	Study sample	Obesity-related study outcomes	Relevant significant results, comparison of intervention group to control group[a]	Study length	Intervention length	Retention rate
				cardiometabolic risk factor cluster (p=0.046) cardiometabolic risk factor cluster (p=0.046) cardiometabolic risk factor cluster (p=0.046)			
Martin, 2013 [48, 49]	2 (Condition: I, C) × 5 (Time: Baseline, 12-month, 6.5 year, 11.5 year, 15.5 year) cluster RCT	*Sample size*: N= 17046 mother/infant dyads (I, 8865; C, 8181); N=31 clinics (I, n=16; C, n=15) *Sample characteristics*: full-term infant (≥37 weeks); birth weight≥2500 g; Apgar score≥5 at 5 minutes; mother planning to breastfeed	*Primary*: Gastrointestinal tract infection; breastfeeding duration; exclusivity breastfeeding *Secondary*: BMI, fat and fat-free mass indices; % body fat; waist circumference, triceps; subscapular skinfold thicknesses; child eating attitudes; maternal adiposity; insulin-like growth factor 1; adiponectin, apolipoprotein A1; glucose; insulin; apolipoprotein B; child blood pressure; maternal blood pressure; child metabolic syndrome	*12-month*: Lower risk≥1 gastrointestinal tract infection (adjusted OR, 0.60; 95 % CI, 0.40-0.91); greater odds any breastfeeding (adjusted OR, 0.47, 95 % CI, 0.32–0.69) *11.5-year*: Greater odds BMI≥ 85th percentile (adjusted OR, 1.18; 95 %CI, 1.01–1.39)	16 years	12–16 months	81.4%
Paul, 2011 [50, 51]	4 (Condition: I1 & C, I2 & C, I1 & I2, C) × 4 (Time: Baseline, 3 week, 16 week, 1 year) pilot RCT	*Sample size*: N=160 mother/infant dyads (I1 & C, n=38; I2 & C, n=39; I1 & I2, n=2; C, n=41). *Sample characteristics*: gestational age≥34 weeks; singleton; primiparous mother; English-speaking mother; mother planning to breastfeed and follow-up with University-affiliated primary care provider.	*Primary*: Weight-for-length percentile *Secondary*: Infant sleep (total daily sleep and nocturnal sleep); Maternal feeding behaviors (total daily feeds; nocturnal feeds; introduction of solid foods; and repeated exposure of vegetables)	*12-month*: **Lower weight-for-length percentile** (I1 & I2 vs. other 3 groups, p=.009)	12 months	4–6 months	68.8 %
Wake, 2011 [52–54]	2 (Condition: I, C) × 5 (Time: Baseline, 2-, 4-, 16-month, 5-year) cluster RCT	*Sample size*: N=328 children (I, n=174; C, n=154); N=49 centers. *Sample characteristics*: children with sleep problems, 7–8 months old from a population-based sample of infants recruited at 4 months; ≥ 32 weeks gestation; English-speaking	*Primary*: BMI z-score, percentage overweight/obese *Secondary*: Waist circumference; infant sleep; child sleep	*10-month*: Lower odds infant sleep issues (adjusted OR, 0.58; 95 % CI, 0.36–0.94) *12-month*: Lower odds infant sleep issues (adjusted OR, 0.50; 95 % CI, 0.31–0.80) *5-year*: NS	5 years	1–3 sessions	58.8 %

Study author, year	Study design	Study sample	Obesity-related study outcomes	Relevant significant results, comparison of intervention group to control group[a]	Study length	Intervention length	Retention rate
		mother.					
Preschool, Prevention (n=1)							
Birken, 2012 [55]	2 (Condition: I, C) × 2 (Time: Baseline, 1-year) RCT	*Sample size*: N=132 (I, n=64; C, n=68). *Sample characteristics*: children age 3 years and their parents; child receives care at participating primary care practices.	*Primary*: Total child screen time previous weekday and weekend day *Secondary*: BMI; TV in child bedroom; meals in front of TV on the last weekday and weekend day	*12-month*: Decrease in weekday meals in front of TV (p=.03)	12 months	1 session	82.5 %
Preschool, Treatment (n=3)							
Quattrin, 2012 [56]	2 (Condition: I, AC) X 3 (Time: Baseline, 3-, 6-month) RCT	*Sample size*: N=105 (I, n=52; IC, n=53). *Sample characteristics*: children ages 2–5 years; BMI≥ 85 percentile; 1 parent/ guardian with BMI≥27; normal developmental milestones; parent English/Spanish reading level≥5th grade; continue care at current primary care practice.	*Primary*: Change in %0BMI[b], parents BMI change score *Secondary*: Child intake of sugared drinks, high energy foods, fruits, and vegetables; child sedentary activities; child physical activity	*6-month*: **Greater decrease in BMI z-score** (p<.001); **greater decrease in %0BMI** (p<.001)	6 months	6 months	91.4%
Stark, 2011 [57]	2 (Condition: I, AC) X 3 (Time: Baseline, 6-, 12-month) pilot RCT	*Sample size*: N=18 (I, n=8; AC, n=10). *Sample characteristics*: Children ages 2–5 years; BMI≥95th percentile but not> 100 % above =the mean BMI; 1+ parent with BMI≥25; physician approval.	*Primary*: BMI z-score; BMI percentile; Parent BMI *Secondary*: Child average caloric intake; child physical activity; home food environment	*6-month*: **Greater decrease in BMI z-score** (p=.003); **Greater decrease in BMI percentile** (p=.03); **Greater decrease in weight gain** (p=.004) *12-month*: **Greater decrease in BMI z-score** (p=.005); **Greater decrease in BMI percentile** (p=.04); **Greater decrease in weight gain** (p=.005)	12 months	6 months	88.9 %
Taveras, 2011 [58–60]	2 (Condition: I, UC) X 3 (Time: Baseline, 1-, 2-year) cluster	*Sample size*: N=475 (I, n=271; UC, n=	*Primary*: Change in BMI *Secondary*: TV viewing behaviors; SSB intake; and fast food intake	*1*-year: Greater decrease in media (TV & video)	2 years	2 years	93.7%

Study author, year	Study design	Study sample	Obesity-related study outcomes	Relevant significant results, comparison of intervention group to control group[a]	Study length	Intervention length	Retention rate
	RCT	204); N=10 primary care practices. *Sample characteristics*: Children ages 2.0–6.9 years; BMI≥95th %tile OR 85th%tile<BMI <95th %tile and 1+ parent overweight; parent English-speaking.		use (p=.01)			
Elementary, Treatment (n= 18)							
Arauz Boudreau, 2013 [61]	2 (Condition: I, WC) × 2 (Time: Baseline, 6-month) pilot RCT	*Sample size*: N=41 (I, n=23; WC, n=18). *Sample characteristics*: children ages 9–12 years; BMI≥ 85th percentile; Latino	*Primary*: BMI; child health-related quality of life; child metabolic indicators of obesity; child physical activity.	*6-month*: NS	6 months	6 months	63.4 %
Banks, 2011 [62–65]	2 (Condition: I, AC) × 2 (Time: Baseline, 12-month) pilot RCT	*Sample size*: N=76 children (I, n=45; AC, n=31). *Sample characteristics*: Children ages 5 to 16 years (mean age: I, 11.5; AC, 11.4); BMI≥98th percentile.	*Primary*: Change in BMI SDS (standard deviation scores) *Secondary*: Treatment adherence	*12-month*: NS	12 months	12 months	68.4 %
Barkin, 2011 [66–68]	2 (Condition: I, AC) X 3 (Baseline, 6-month, 12-month) RCT	*Sample size*: N=159 (I, n=80; AC, n=79). *Sample characteristics*: Children ages 8 to 11 years; BMI≥85th percentile; Latino.	*Primary*: Change in BMI *Secondary*: Perceived body image; parent BMI	*6-month*: Greater decrease in absolute BMI (AC vs. I, p=0.03)	6 months	12 months	68 %[c]
Davis, 2013 [69, 70]	2 (Condition: I, AC) × 2 (Time: Baseline, ≈8-month) RCT	*Sample size*: N=58 (I, n=31; AC, n=27). *Sample characteristics*: Children in Kindergarten thru 5th grade; live in rural Kansas; BMI≥85th percentile; English-speaking.	*Primary*: BMI z-score *Secondary*: Child dietary intake; child physical activity (accelerometer data); child mealtime behavior problems	*8-month*: NS	≈ 8 months	8 months	72.4 %
Davis, 2011 [71]	2 (Condition: I, AC) × 3 (Time: Baseline, 2-month post-treatment, 12-month post	*Sample size*: N=17 families (I, n not reported; AC, n not reported). *Sample characteristics*:	*Primary*: BMI percentile; child physical activity; child eating behaviors	*Post-intervention*: NS *12-month post-intervention*: NS	≈ 14 months	2 months	100 %

Study author, year	Study design	Study sample	Obesity-related study outcomes	Relevant significant results, comparison of intervention group to control group[a]	Study length	Intervention length	Retention rate
	treatment) pilot RCT	Children in 5th grade; BMI≥85th %ile; no major developmental problems.					
Diaz, 2010 [72]	2 (Condition: I, AC) × 3(Time: Baseline, 6-, 12-month) RCT	*Sample size*: N=76 children; Intention-to-treat analysis, N=66 (I, n=33; AC, n=33). *Sample characteristics*: Children ages 9–17 years (mean age 11.6); BMI ≥95th percentile or BMI≥90th percentile and waist circumference ≥ 90th percentile.	*Primary*: BMI and body weight *Secondary*: Body composition; blood pressure; biochemical parameters; other obesity parameters	*12-month*: **Lower body weight** (p=.02); **lower BMI** (p=02)	12 months	12 months	57 %[d]
Duggins, 2010 [73]	2 (Condition: I, AC) × 6 (Time: Baseline, 2-, 4-, 6-, 9-, and 12-month) RCT	*Sample size:*: N=83 children (I, n=44; AC, n=39) *Sample characteristics*: Children ages 5–17 (mean age: I, 10.6; AC, 10.6); BMI≥85th percentile.	*Primary*: Change in BMI percentile *Secondary*: Meeting AMA Expert Committee weight loss targets; eating habits, nutrition class attendance, YMCA attendance	*12-month*: NS	12 months	AC, 9 months I, 12 months	79.5 %
Gillis, 2007 [74]	2 (Condition: I, AC) × 2 (Time: Baseline, 6-month) pilot RCT	*Sample size*: N=27 (I, n=14, AC, n=13). Sample characteristics: Children ages 7–16 years Mean age: I, 11.2; AC, 9.9); BMI≥90th percentile.	*Primary*: BMI SDS *Secondary*: Change in obesity-related attitudes; adverse metabolic effects of obesity	*6-month*: NS	6 months	6 months	66.7 %
Mårild, 2013 [38]	2 [e] (Condition: I1, I2) × 2 (Time: Baseline, 12-month) RCT	*Sample size*: N=64 (I, n=32; C, n=32). Other comparison groups (not-randomized): normal weight n=34; overweight n=29; obese n=138. *Sample characteristics*: children ages 9–13 years; obese according to IOTF criteria and no ongoing or previous treatment for obesity.	*Primary*: Change in BMI SDS *Secondary*: BMI; proportion overweight or obese; neck circumference; waist circumference; waist/height ratio; change in biochemical markers related to metabolic syndrome	*12-month*: **Greater decrease in BMI** (I1 vs. non-randomly allocated obese control, p=.0007; I2 vs. non-randomly allocated obese control, p=. 002); **greater decrease in BMI SDS** (I1 vs. non-randomly allocated	12 months	12 months	85.9 %

Study author, year	Study design	Study sample	Obesity-related study outcomes	Relevant significant results, comparison of intervention group to control group[a]	Study length	Intervention length	Retention rate
				obese control, p=.0005; I2 vs. non-randomly obese control, p=.0005; I2 vs. non-randomly obese control, p=.0005; I2 vs. non-randomly allocated obese control, p=.002)			
McCallum, 2007 [75–78]	2 (Condition: I, C) × 3 (Time: baseline, 9-, 15-month) RCT	*Sample size*: N=163 (intervention=82, control=81). *Sample characteristics*: Children ages 5–9 years; overweight or mild obesity; BMI z-score <3.0; not currently receiving weight-management services; no medical condition affecting growth.	*Primary*: BMI and BMI z scores *Secondary*: Waist circumference; general quality of life; health-related quality of life; physical activity; nutrition; sedentary behaviors; body satisfaction	*9-month*: Improved nutrition score (p<.001) *15-month*: Improved nutrition score (p<.001)	15 months	3 months	89.6 %
Nova, 2001 [79]	2 (Condition: I, UC) × 4 (Time: Baseline, 6-, 12-, 24-month) RCT, randomized at physician-level	*Sample size*: N=186 (I=72, UC=114). N= 13 family pediatrician offices *Sample characteristics*: Children: ages 3–12 years (mean age 8.6); obese (≥20 % of ideal body weight).	*Primary*: Change % overweight; dietary behavior; physical activity; computer and television use; attendance at follow-up visit	*6-month*: **Greater decrease in percentage overweight** defined by EID Index (p=0.0001) *12-month*: **Greater decrease percentage overweight** defined by EID Index (p=.002)	2 years	2 years	69.9 %[f]
O'Connor, 2013 [80, 81]	2 (Condition: I, WC) × 2 (Time: Baseline, 7–8 month) pilot RCT	*Sample size*: N=40 (I, n=20; WC, n=20). *Sample characteristics*: Children 5–8 years old; BMI 85–99 th percentile	*Primary*: Feasibility measures of intervention *Secondary*: BMI and BMI percentile; physical activity; dietary intake; TV viewing; parenting practices to promote fruit and vegetable intake; TV parenting practices; and physical activity parenting practices	*7-month*: Less TV time (p<.05); greater parental support for physical activity (p < .05); greater parental practices (non-directive control) related to intake of fruit and vegetables (p <.05)	7 months	6 months	85%
Small, 2014 [82]	2 (Condition: I, C) × 4 (Baseline, immediately post-I, 3-month post-I, 6-month post-I) pilot RCT	*Sample size*: N=67 parent-child dyads. Analysis sample N=60 (I, n=33, C, n= 27), 7 families did not complete baseline	*Primary*: BMI; Waist circumference, waist-by-height ratio	*Over time (Baseline, immediately post-intervention)*: Decrease in waist circumference (p=.03); decrease in waist-by-	10 months	4 months	62%

Study author, year	Study design	Study sample	Obesity-related study outcomes	Relevant significant results, comparison of intervention group to control group[a]	Study length	Intervention length	Retention rate
		measures and were excluded from measures and were excluded from analyses. *Sample characteristics*: Children: ages 4–8 years (mean age 5.6), overweight or obese.		height ratio (p=.02)			
van Grieken, 2013 [83, 84]	2 (Condition: I, C) × 3 (Time: baseline, 12-, 24-month) cluster RCT	*Sample size*: N=637 (I, n=349, C n=288); N=44 youth health care teams (I, n=22; C, n=22) *Sample characteristics*: Children age 5 years; overweight using international BMI cut points; no chronic medical condition; Dutch-speaking child and parent.	*Primary*: BMI and waist circumference *Secondary*: Levels of overweight; inducing/ reducing behaviors; parenting practices; health related quality of life	*2-year*: NS	2 years	Up to 6 months	79.6 %
Wake, 2009 [85]	2 (Condition: I, C) X 3 (Time: Baseline, 6-, 12-month) RCT	*Sample size*: N=258 (I, n=139, C, n=119 *Sample characteristics*: Children ages 5–9 years; overweight or obese using International Obesity Taskforce cut points and BMI z-score<3.0.	*Primary*: BMI *Secondary*: Mean activity count/ minute; nutrition score; health related quality of life	*6-month*: NS *12-month*: NS	12 months	3 months	94.9 %
Wake, 2013 [86, 87]	2 (Condition: I, UC) × 2 (Time: Baseline, 15-month) RCT	*Sample size*: N=118 (I, n=62; C, n=56) Sample characteristics: Children ages 3–10 years (mean age: I, 7.2; C, 7.4); BMI > 95th percentile.	*Primary*: BMI z score *Secondary*: waist circumference; body fat percentage; body satisfaction; physical appearance and self-worth; health related quality of life; blood pressure; diet quality; physical activity; behavior; parent BMI; parent readiness to change	*15-month*: NS	15 months	12 months	90.7 %
Weigel, 2008 [88]	2 (Condition: I, AC) × 3 (Time: Baseline, 6-, 12-month) RCT	*Sample size*: N=73 children (I, n=37; AC, n=36). *Sample characteristics*: children ages 7 to 15 years (mean age 11.2); BMI>90th percentile	*Primary*: BMI z score	*12 month* [g]: Decrease BMI z-score (p<.01); decrease BMI (p<.001); decrease fat mass (p<.001); increase lean mass (p<.001);	12 months	12 months	Not reported

Study author, year	Study design	Study sample	Obesity-related study outcomes	Relevant significant results, comparison of intervention group to control group[a]	Study length	Intervention length	Retention rate
				decrease systolic BP (p<.01) decrease systolic BP (p<.01)			
Wright, 2013 [89]	2 (Condition: I, WC) × 2 (Time: Baseline, 3-month) pilot RCT	*Sample size*: N=50 (I, n=24; WC, n=26) *Sample characteristics*: children ages 9–12 years; obese; BMI >95th percentile	*Primary*: BMI; dietary intake; screen time; parent BMI; parent dietary intake; parent TV time	*3-month*: Increase fruit consumption parents (p=.046); decrease vegetable consumption parents (p=.012)	3 months	3 months	86%
Adolescent, prevention (n= 1)							
Patrick, 2006 [90]	2 (Condition: I, C) by 3 (Time: Baseline, 6-, 12-month) RCT	*Sample size*: N=819 (I, n=424; C, n=395) *Sample characteristics*: Adolescents ages 11–15 years; no medical condition affecting PA or nutrition	*Primary*: Minutes MVPA; days/week physical activity and sedentary behaviors; percent of energy from fat and daily servings of fruits and vegetables *Secondary*: BMI	*12 month*: Decrease sedentary behaviors (p<.001)	12 months	12 months	84.2 %
Adolescent, treatment (n=3)							
DeBar, 2012 [91]	2 (Condition: I, AC) × 3 (Time: Baseline, 6-, 12-month) RCT	*Sample size*: N=208 (I, n=105; UC, n=103) *Sample characteristics*: Girls; ages 12–17 years; BMI ≥90th percentile	*Primary*: BMI z score *Secondary*: Disordered eating; screen time; physical activity; team sports participation; eating breakfast; family meals; fast food; dietary intake; dieting in previous 6 months; use of professional weight management services	*Over time (baseline, post-I, follow-up)*: **Decrease in BMI z-score** (p=.012); increase in body satisfaction (p=.026); decrease in internalization of appearance attitudes (p=.019); decrease in fast food frequency (p=.021); smaller decrease in family meals (p=.028)	12 months	5 months (teens) 3 months (parents)	83%
MacDonell, 2012 [92]	2 (Condition: I, AC) × 2 (Time: Baseline, 3-month) pilot RCT	*Sample size*: N=44 adolescents (I, n not reported; AC, n not reported) *Sample characteristics*: Adolescents ages 13–17 years old; BMI≥ 85th percentile; African American	*Primary*: BMI; fast food intake; soft drink intake; fruit intake; vegetable intake; intrinsic motivation for nutrition; physical activity; intrinsic motivation for exercise	*3-month*: Decrease in fast food frequency (p=.03)	3 months	10 weeks	70.5 %
Saelens, 2002 [93]	2 (Condition: I, AC) X 3 (Time:	*Sample size*: N=44 (I, n=23; UC, n=21). *Sample characteristics*:	*Primary*: BMI z score *Secondary*: Percentage of overweight; weight; height; total energy intake;	*4 month*: **Decrease in BMI z-score** (p<.02)	7 months	4 months	84.1 %

Study author, year	Study design	Study sample	Obesity-related study outcomes	Relevant significant results, comparison of intervention group to control group[a]	Study length	Intervention length	Retention rate
	Baseline, 4-, 7-months; RCT Baseline, 4-, 7-months; RCT	A) Adolescents ages 12–16 y; BMI ≥ 2 fold; 20 % to 50 % above median BMI %ile (50th %ile)	percent energy from fat; physical activity; sedentary behavior; problematic eating behaviors; weight-related behaviors or beliefs	*Overtime (Baseline, 4-month, 7-month)* **Decrease in BMI z-score** (p<.03)			

Note. Studies in italics found significant effect on measure of child adiposity.

Abbreviations: I=Intervention; C=No treatment control; UC=Usual Care; AC=Active control receiving alternative intervention; WC=Waitlist control; BMI=body mass index.

[a] For studies with>2 study conditions, comparison groups are specified.

[b] %0BMI=child's actual BMI minus BMI at the 50th %ile/BMI at the 50th %ile multiplied by 100.

[c] Retention rate at 6-months.

[d] Overall retention rate at 12-months. Primary outcome retention rate = 87%.

[e] 1 group of obese children randomized to Intervention 1 or Intervention 2; 3 other comparison groups, not random allocation, comprised of 1) normal weight children; 2) overweight children; 3) age-, sex-, and BMI-matched obese children.

[f] Retention rate at 12-months.

[g] Intervention did not include primary care involvement; active control group received in-person and written therapeutic advice from pediatrician.

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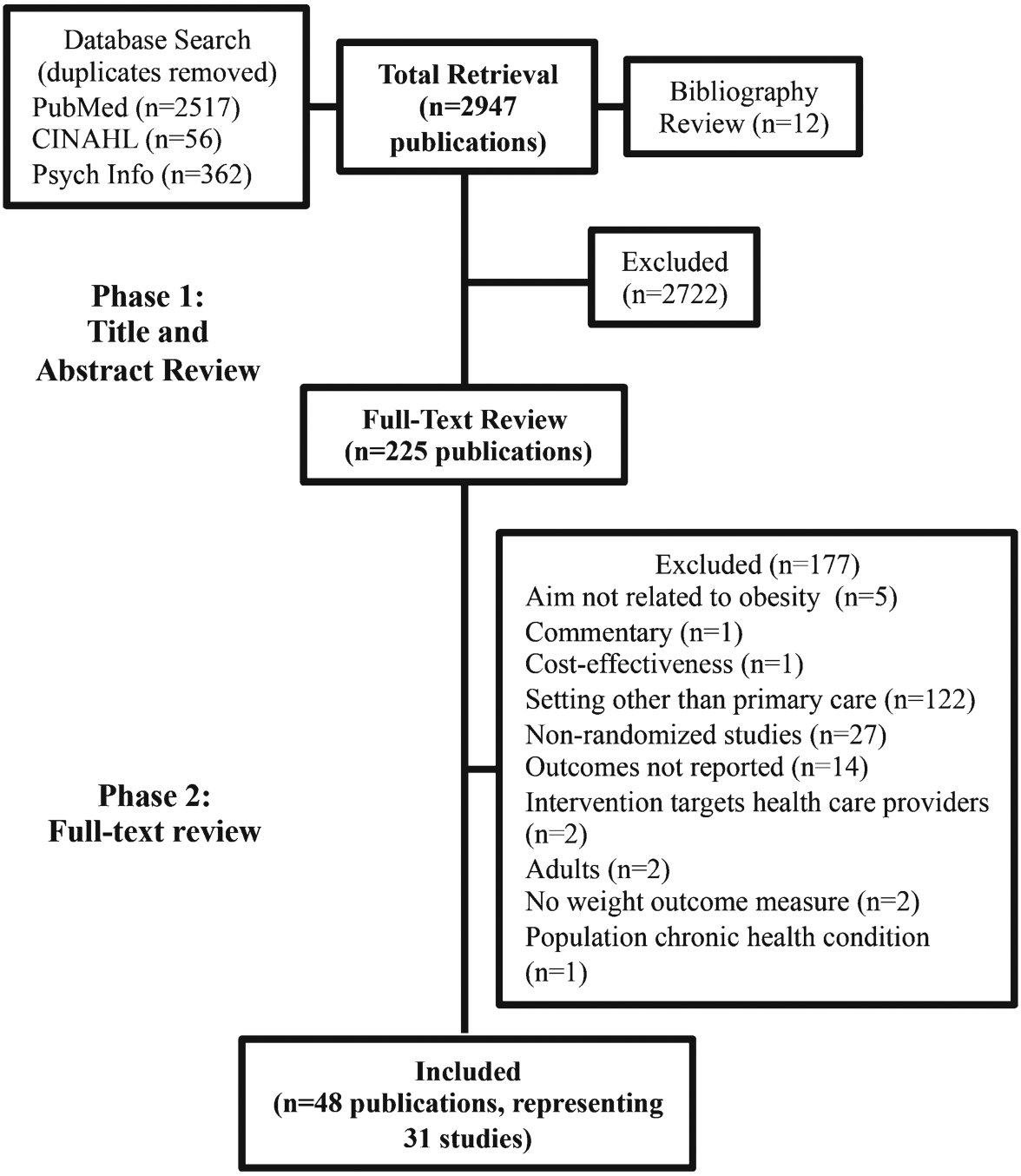

Fig. 1.
Selection process. This figure illustrates the selection process for publications included in this review

Table 1

Intervention characteristics by participant age and type of study (prevention or treatment)

Author, year	Condition	Target		Modality			Provider type			
		Parent	Child	Individual, phone	Individual, in-person	Group, in person	MD, NP, PA	Nurse	Dietitian/ nutritionist	Psychologist
Infant, prevention (*n*=5)										
French, 2012 [39, 40]	I1 and I2	x			x		x	x		
Hakanen, 2010 [41–47]	I	x	x		x		x		x	
Martin, 2013 [48, 49]	I	x			x		x	x		
Paul, 2011 [50, 51]	I	x			x			x		
Wake, 2011 [52–54]	I	x			x			x		
Preschool, prevention (*n*=1)										
Birken, 2012 [55]	I	x	x		x		x		x	
Preschool, treatment (*n*=3)										
Quattrin, 2012 [56]	I	x	x	x	x	x	x			
	AC	x	x	x	x	x	x			
Stark, 2011 [57]	I	x	x		x	x				x
	AC	x	x		x		x			
Taveras, 2011 [58–60]	I	x	x	x	x		x			
Elementary, treatment (*n*=18)										
Arauz Boudreau, 2013 [61]	I	x	x	x[b]	x[b]	x	x		x	
Banks, 2011[c] [62–65]	I	x	x		x			x	x	
Barkin, 2011 [66–68]	I	x	x		x	x	x			
	AC	x	x		x	x	x			
Davis, 2013 [69, 70]	AC	x	x		x		x			
Davis, 2011 [71]	AC	x	x		x		x			
Diaz, 2010[c] [72]	I	x	x		x	x	x		x	
	AC	x	x		x		x			
Duggins, 2010[c] [73]	I	x	x		x	x	x		x	
	AC	x	x		x	x	x		x	
Gillis, 2007[c] [74]	I	x	x	x	x		x			

Author, year	Condition	Target		Modality			Provider type			
		Parent	Child	Individual, phone	Individual, in-person	Group, in person	MD, NP, PA	Nurse	Dietitian/ nutritionist	Psychologist
	AC	x	x		x		x			
Mårild, 2013 [38]	I1	x	x		x	x		x	x	
	I2	x	x		x	x		x	x	
McCallum, 2007 [75–78]	I	x	x		x		x			
Nova, 2001[c] [79]	I	x	x		x		x			
O'Connor, 2011 [80, 81]	I	x	x		x					
Small, 2014[c] [82]	I	x	x	x	x					
van Grieken, 2013 [83, 84]	I	x			x		x	x		
Wake, 2009 [85]	I	x	x		x		x			
Wake, 2013 [86, 87]	I	x	x		x		x		x	
Weigel, 2008[c] [88]	AC	x	x		x		x			
Wright, 2013 [89]	I	x	x	x	x		x			
Adolescent, prevention (*n*=1)										
Patrick, 2006 [90]	I	x	x	x	x		x			
Adolescent, treatment (*n*=3)										
DeBar, 2012 [91]	I	x	x		x	x	x		x	
	AC	x	x		x		x			
MacDonell, 2012 [92]	I	x	x		x				x	
	AC	x	x		x				x	
Saelens, 2002 [93]	I	x	x	x	x		x			
	AC	x	x		x		x			

Author, year	Condition	Provider type				Intervention participation	Intervention dose (length and contacts)			
		PT/exercise processional	Health coach/ counselor	Medical assistant	IVR		≤3 months	4 months–1 year	>1 year	Contacts
Infant, prevention (*n*=5)										
French, 2012 [39, 40]	I1 and I2			x		Unknown		x		5
Hakanen, 2010 [41–47]	I					Unclear			x	46–53[a]
Martin, 2013 [48, 49]	I					Unknown			x	Unknown

Author, year	Condition	Provider type				Intervention participation	Intervention dose (length and contacts)			
		PT/exercise processional	Health coach/ counselor	Medical assistant	IVR		≤3 months	4 months–1 year	>1 year	Contacts
Paul, 2011 [50, 51]	I					Unknown		x		2
Wake, 2011 [52–54]	I					57.5 %	x			1–3
Preschool, prevention (*n*=3)										
Birken, 2012 [55]	I					100 %	x			1
Preschool, treatment (*n*=3)										
Quattrin, 2012 [56]	I		x			88.5 %	x			20
	AC		x			94.3 %				20
Stark, 2011 [57]	I		x			Unknown	x			18
	AC					Unknown				1
Taveras, 2011 [58–60]	I					56 %≥2 sess.			x	Year 1, 7; year 2, unknown
Elementary, treatment (*n*=18)										
Arauz Boudreau, 2013 [61]	I	x	x			100 %≥1 sess.; sess. attendance, *M*= 78 %		x		12
Banks, 2011[c] [62–65]	I	x				Did not attend rate[d]=22 %		x		5
Barkin, 2011 [66–68]	I		x			Unknown		x		6
	AC		x			Unknown		x		2
Davis, 2013 [69, 70]	AC					96.3 %	x			1
Davis, 2011 [71]	AC					100 %	x			1
Diaz, 2010[c] [72]	I					Child sess., *M*=9.3; parent sess., *M*=4.0		x		45
	AC					sess., *M*=4.7		x		12
Duggins, 2010[c] [73]	I	x				67 %≥1 nutrition sess.; nutrition sess., Mdn=3; YMCA sess., Mdn=5		x		11 + 1 year YMCA membership
	AC					30 %≥1 nutrition sess.; nutrition sess., Mdn=2		x		10
Gillis, 2007[c] [74]	I					Unknown		x		Unclear
	AC					Unknown		x		2
Mårild, 2013 [38]	I1	x				Unknown		x		12
	I2					Unknown		x		12
McCallum, 2007 [75–78]	I					41 % 4 sess., 21 % 3 sess., 17 % 2 sess., 14 % 1 sess.	x			4

Author, year	Condition	Provider type				Intervention participation	Intervention dose (length and contacts)			
		PT/exercise processional	Health coach/ counselor	Medical assistant	IVR		≤3 months	4 months–1 year	>1 year	Contacts
Nova, 2001[c] [79]	I					12-month sess., 69.4 %			x	10
O'Connor, 2011 [80, 81]	I		x			Sess., *M*=4.7[c] 80 %≥4 sess.		x		12
Small, 2014[c] [82]	I		x			Unknown		x		7
van Grieken, 2013[83, 84]	I		x			100 % sess. 1, 76.7 % sess. 2, 53.9 % sess. 3, 30.6 % all sess.		x		1–4
Wake, 2009 [85]	I					37 % 4 sess., 22 % 3 sess., 21 % 2 sess., 12 % 1 sess., sess., *M*=2.7	x			4
Wake, 2013 [86, 87]	I					Sess., *M*= 2.4		x		12
Weigel, 2008° [88]	AC					Unknown		x		2
Wright, 2013 [89]	I				x	Child, 81 %≥ 1 sess., child sess., *M*=9.0; parent, 76 %≥1 sess.; parent sess., *M*=9.1	x			12
Adolescent, prevention (*n*= 1)										
Patrick, 2006 [90]	I		x			36 % 0–8 call, 64 % 9–11 call		x		12
Adolescent, treatment (*n*=3)										
DeBar, 2012 [91]	I	x	x			Teen sess., *M*=10.3; parent sess., *M*=7.9		x		18 (teens) 12 (parents)
	AC					100 %	x			1
MacDonell, 2012 [92]	I					27 % all sess., 68 %≥2 sess.	x			4
	AC					36 % all sess., 82 %≥2 sess.	x			4
Saelens, 2002 [93]	I		x			70 %≥9 call; calls, Mdn=9 100 % physician visit		x		13
	AC		x			100 % physician visit	x			1

Studies in italics found significant effect on measure of child weight

I intervention, *C* no treatment control, *AC* active control receiving alternative intervention, *IVR* interactive voice technology, *PT* physical therapist, *sess* sessions, *M* mean, *Mdn* median

[a] Children ages 7 months to 2 years: intervention sessions every 1–3 months. Children ages 2 to 20 years: biannual intervention sessions

[b] Individual sessions completed by phone or in person

[c] Mean age of participants between the ages of 5 and 12 years

[d] Did not attend rate=total did not attend/total sessions

[e] Authors considered the six in-person visits as sessions; six follow-up phone calls were not counted as sessions