Multicomponent Behavioral Interventions for Weight Management in Children and Adolescents Who Are Overweight or With Obesity

A Systematic Evidence Review for the American Psychological Association

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Structured Abstract

Background. The U.S. Preventive Services Task Force recommended that children age 6 and older with obesity be offered or referred to intensive behavioral management intervention, but provided little detailed information about the recommended format or content of these interventions.

Purpose. To systematically review efficacy and comparative effectiveness evidence of comprehensive behavioral management interventions for use in developing a guideline for weight management interventions in children and adolescents.

Data Sources. After identifying previously published relevant systematic reviews, we searched MEDLINE, PubMed, PsychINFO, Cochrane Collaboration Registry of Controlled Trials, and the Education Resources Information Center January 1, 2010 through January 22, 2016 and examined references of relevant reviews.

Methods. We included English-language controlled trials published in or after 1985 of ambulatory weight management interventions for children and adolescents who were overweight or with obesity. Trials were included if they provided dietary, physical activity, and behavioral counseling, parent involvement, and had at least 12 months of followup. Two investigators independently reviewed titles and abstracts and then full-text articles against pre-specified inclusion and quality criteria. Data were extracted from all studies rated as fair or good quality. Weight outcomes of efficacy trials were pooled using random effects meta-analyses. The importance of intervention characteristics and components were examined using comparative effectiveness trials and with meta-regressions of efficacy trials coded to indicate the presence or absence of intervention characteristics and components. Reductions in zBMI of 0.25 or more were considered clinically significant, and we compared the proportion of trials that included specified intervention characteristics and components among trials that did versus did not meet this criterion using Fisher's exact test. We conducted similar analyses examining the effects of intervention characteristics and components on adherence, and the association of adherence on effect size.

Results. We included 65 trials (n=9,299). Of these, 36 efficacy trials showed that interventions were most likely to show improvement with an estimated 26 or more hours of contact at 12 months followup. The standardized mean difference in change [SMD] indicated a medium to large effect that was statistically significant (-0.60 [95% CI, -0.86 to -0.34], I^2=83.5%, k=16), and eight of the 12 interventions reporting zBMI met the criterion for clinical significant reduction (≥0.25). Interventions with fewer than 26 hours were unlikely to reduce excess weight (SMD, -0.14 [95% CI, -0.24 to -0.04], I^2=22.8%, k=18). Other than contact dose, we found no intervention characteristics or components that were clearly associated with effect size, considering both comparative effectiveness trials and efficacy. Interventions that showed clinically significant reductions in zBMI were more likely to include parental modeling than

those that did not, however trials meeting criteria for clinically significant improvement were also more likely to target preschool and elementary age children, with whom these components were most commonly used. Interventions meeting criteria for clinically significant improvement typically included sessions that targeted parents alone, children alone, and parents and children together; professionally trained behavioral and dietary providers; supervised physical activity sessions; treatment components of goals and planning, stimulus control, behavior monitoring, and rewards associated with achieving behavioral goals; and parental modeling and parenting skills training (particularly when targeting younger children).

Limitations. We did not request additional information from study authors when specific characteristics or components were not clearly reported, nor did we confirm our coding of the interventions with study authors, and accurate coding was difficult when interventions were not described in detail. Comparative effectiveness trials showed little replication when testing specific characteristics and components, and findings were often mixed where replications were identified.

Conclusions. Weight management programs for child and adolescent obesity that included at least 26 hours of contact were effective in helping reduce excess weight. We did not identify specific intervention characteristics or components that were clearly associated greater benefit, but effective interventions shared a number of characteristics and components.

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Introduction

Condition Definition

Obesity refers to high adiposity or amount of body fat. Body weight is usually used as a surrogate measure of body fat and obesity given the difficulties with direct assessment of excess body fat.[1] The most common way to express weight adjusted for height is with the body mass index (BMI), which is calculated as weight in kilograms divided by height in meters squared (kg/m^2). Since children's weight varies not only by height but also by sex and age, BMI in children is compared with sex- and age-specific reference values from growth charts, such as those developed by the Centers for Disease Control and Prevention (CDC) in 2000.[2] The cutoff points generally used to define overweight and obesity in children and adolescents were outlined in 2007 recommendations of an Expert Committee comprised of representatives from 15 national health care organizations. These recommendations use the term "overweight" to refer to a sex-specific BMI for age between the 85th and 94th percentile, and the term "obesity" for a BMI at or above the 95th percentile.[3] These cutoff points are based on population norms from majority populations rather than health criteria (**Table 1**).

Prevalence

The prevalence of obesity in children and adolescents has increased substantially over the past several decades, but some surveys have indicated a decline in the rate of increase in recent years. Nevertheless, child obesity rates are still well above CDC Healthy People 2020 targets, which are 9.4 percent for children aged 2 to 5 years, 15.7 percent for children aged 6 to 11 years, and 16.1 percent for adolescents aged 12 to 19 years.[4]

Between the 1976-1980 and 2009-2010 U.S. National Health and Nutrition Examination Surveys (NHANES), the prevalence of obesity in boys and girls aged 2 to 19 years increased from 5.5 to 16.9 percent.[5] The 2011-2012 NHANES data showed that 31.8 percent of boys and girls in this age range were overweight and also that obesity appeared to have stabilized at 16.9 percent.[6] These prevalence estimates were not statistically different from those found in the 2003-2004 NHANES, although prevalence trend tests did reveal a decrease of 5.5 percentage points since 2003-2004 in children aged 2 to 5 years. There were no statistically significant differences in obesity prevalence by sex. However, there were age and race/ethnicity differences: the percentage of children who had obesity was 8.4 percent for children aged 2 to 5 years, 17.7 percent for 6- to 11-year-olds, and 20.5 percent for 12- to 19-year-olds; the prevalence of obesity was lowest in Asian children and adolescents (8.6%) and 14.1 percent in non-Hispanic white youth, 20.2 percent in non-Hispanic black youth, and 22.4 percent in Hispanic youth.[6] In the 2013 National Youth Risk Behavior Survey, among high school students 13.7 percent had obesity and 16.6 percent were overweight, which represents an increase from corresponding 1999 prevalence rates of 10.6 percent and 14.1 percent, respectively. However, no change in prevalence was observed between 2011 and 2013.[7]

Burden of Childhood Obesity

Child and adolescent obesity is associated with short-term harmful effects during childhood as well as long-term risks related to adult disease. In the short term, obesity in children is linked to a higher prevalence of comorbid conditions, such as type 2 diabetes, obstructive sleep apnea, nonalcoholic fatty liver disease, low-grade systemic inflammation, asthma, and major

cardiovascular risk factors.[8, 9] A 2012 review of 63 studies including 49,220 children aged 5 to 15 years found that the levels of blood pressure, cholesterol, fasting glucose, and insulin resistance were significantly higher in children with obesity compared to normal-weight children.[10] The National Longitudinal Study of Adolescent Health found that increased BMI in adolescents in grades 7 to 12 was associated with decreased general health and physical functioning.[11] Similarly, a 2013 systematic review found that children and adolescents with obesity had significantly lower overall and physical health-related quality of life (HRQoL).[12] A 2014 meta-analysis found that children and adolescents with overweight or obesity were more likely to be the victims of bullying (repeated verbal or physical harassment) than were children of normal weight.[13] In addition, weight stigma and weight-based teasing of children and adolescents are pervasive and associated with negative psychosocial, physical, and academic outcomes.[14] Thus, psychosocial difficulties can be another consequence of childhood obesity. Indeed, reductions in self-esteem[15] and psychosocial HRQoL[12] have been found in youth with obesity, although the National Longitudinal Study of Adolescent Health found decreased self-esteem and psychosocial functioning only in 12- to 14-year-old adolescents.[11]

Obesity in childhood increases the likelihood of obesity during the adult years. Data from the 2002 Fels Longitudinal Study showed that men and women with overweight or obesity at age 35 years had significantly higher BMI values during childhood and adolescence than those who were not overweight or obese at age 35.[16] A child or adolescent's risk of having overweight or obesity as an adult increases with age and degree of excess weight during childhood, and is significantly greater for females than males. For example, 31 percent of males and 37 percent of females who had obesity at age 5 also had obesity at age 35, and 54 percent of males and 60 percent of females who had obesity at age 15 had obesity at age 35.[16] An analysis of 11,447 individuals from three British birth cohorts looked at patterns of overweight over the lifespan and found that more than 62 percent of those who had overweight or obesity during childhood and adolescence also had obesity as adults, whereas 26 percent of those who had overweight or obesity only during childhood and 49 percent of those who had overweight or obesity only during adolescence had obesity as adults.[17]

Overweight and obesity during childhood and adolescence may increase the risk of cardiovascular disease (CVD) in adulthood by accelerating the processes that lead to CVD.[18, 19] Several recent reviews examined the relationship between adult cardiometabolic morbidity and obesity during childhood and adolescence.[17, 20-22] Two of those reviews reported on a consistent body of evidence showing that child and adolescent overweight and obesity were significantly associated with increased risk in adulthood of diabetes, stroke, coronary heart disease, and hypertension.[20, 22] Reviews that adjusted for adult BMI to investigate the independent relationship between childhood obesity and adult cardiometabolic risk, however, found weaker and mostly not statistically significant effects for childhood BMI on hypertension, carotid intima-media thickness, type 2 diabetes, coronary heart disease, and stroke.[17, 21, 22] Several reviews also found associations between child and adolescent overweight or obesity and increased risk of all-cause mortality in adulthood.[20, 22] Another recent review found that obesity during adolescence is associated with a higher risk of depression in adulthood.[23]

Risk Factors

Although both genetic and environmental factors contribute to the risk of overweight and obesity in children and adolescents, changes in the environment that encourage sedentary behavior and high consumption of energy-dense (but not nutrient-dense) foods are likely the

predominant cause of dramatic increases in childhood obesity.[3] The primary modifiable risk factors for childhood obesity are excess caloric intake, low physical activity, and sedentary behavior. Other risk factors include parental obesity,[24, 25] mother's gestational weight gain,[25] increased birth weight,[24] chronic maternal depression,[26] inadequate sleep,[24, 27, 28] and low family income.[29]

As discussed above, there are differences in obesity prevalence by race/ethnicity. Racial/ethnic differences in risk factors during pregnancy, infancy, and early childhood may contribute substantially to the variability seen in the prevalence of childhood obesity. For example, a prospective study found that compared with white children and after adjustments for socioeconomic status and parental obesity, black and Hispanic infants did not sleep as long during infancy, had mothers with greater maternal control of infant feeding, and gained weight more rapidly; black and Hispanic children also were more likely to have televisions in the bedroom and to drink or eat more sugar-sweetened beverages and fast food.[30] Interpretation of disparities in the prevalence of childhood obesity by race/ethnicity is further complicated by the fact that body composition varies across race/ethnic groups. For example, while the prevalence of obesity as measured by a BMI $\geq 95^{th}$ percentile for age is higher in non-Hispanic black girls than non-Hispanic white girls, there is no difference in the prevalence of high adiposity between these groups as measured by dual-energy X-ray absorptiometry, a gold standard for measuring adiposity directly.[31]

Multicomponent Behavior-based Interventions

Evidence-based clinical guidelines generally agree that initial management of child and adolescent overweight should be multifaceted and target the major behavioral correlates of childhood obesity: diet, physical activity, and sedentary behavior (**Table 2**). The dietary component typically focus on creating healthier dietary habits by reducing consumption of sugar-sweetened beverages and foods with high fat and calorie content, increasing fruit and vegetable intake, and limiting portion sizes and snacks.[32, 33] A more structured and regulated diet may be necessary for children and adolescents with severe obesity.[32] Treatment elements related to increasing energy expenditure include strategies to change both physical activity levels and sedentary behavior. The goal for children and adolescents is to engage in at least 60 minutes of moderate to vigorous physical activity and less than 2 hours of screen time daily.[32, 33]

Comprehensive lifestyle interventions for weight management in children and adolescents include behavioral components that facilitate and support dietary and activity modification. Behavior change techniques used in multicomponent weight management interventions can include decisional balance charts, goal setting, self-monitoring, cue elimination, parental modeling, and problem solving.[32, 33] Decisional balance charts are used to show that the benefits of making behavior changes outweigh the costs.[33] Goal setting involves the child selecting short- and long-term targets to evaluate progress. Self-monitoring of progress by recording actual diet and activity behaviors can increase self-awareness and motivation and aid in identifying barriers to behavior change.[32, 33] Elimination of cues to reduce exposure to stressors or environments that encourage unhealthy behaviors is a common behavior change technique, as is parental modeling of positive behaviors. Finally, learning problem-solving skills to identify barriers to behavior change and developing solutions to overcome them have been essential elements of some weight management interventions.[32, 33]

Since parents can serve as role models for healthy lifestyle behaviors and have considerable control over the home environment, they can strongly influence weight management behaviors in

children, especially younger children. Therefore, the involvement and cooperation of parents in treatment of childhood obesity can be crucial: a 2012 Scientific Statement from the American Heart Association addressed parents as important agents of change for childhood obesity.[34] Some childhood obesity treatment interventions target parents exclusively. A recent review found that such interventions were either more effective than or as effective as those targeting children alone or parents and children together.[35] Other reviews have shown that childhood obesity interventions that include parental participation are more effective than those that do not.[36, 37] A systematic review of clinical practice guidelines found that all guidelines related to lifestyle interventions for management of child and adolescent obesity recommended treatment involving a parent or the family or stated that involvement of a parent or family is effective.[38] The role of parents can include providing a supportive environment for behavior change, modeling healthy behaviors, making changes to the home environment (e.g., buying and preparing healthy foods, removing televisions and computers from bedrooms), and implementing a reward system when the child reaches behavioral goals.[39-41] In addition, since an authoritative parenting style that includes setting boundaries has been shown to be effective in childhood weight management,[33, 40] interventions may focus on positive parenting strategies.

Besides the involvement of the parent, multicomponent behavior-based interventions for child and adolescent weight management may vary by setting and mode of delivery. Childhood obesity interventions can be provided in a wide range of settings, including primary care offices, outpatient clinics, psychological services centers, community venues, schools, and camps or other residential treatment settings. Interventions may be delivered by an individual health professional or a multidisciplinary team including, for example, physicians, dietitians, and psychologists. The interventions may be provided in individual sessions or in a group setting. Moreover, group settings may offer individual or family supports. The intensity of interventions can vary as well, with differences in frequency and length of treatment sessions and total duration of treatment. More intense interventions have been shown to be more effective.[33, 42] Finally, intervention content can be provided virtually via telephone or mail, and technologically delivered pediatric obesity interventions are becoming more common. A review of health information technology interventions for childhood obesity treatment found that counseling delivered via telemedicine was as effective as in-person counseling and improved access to treatment in rural families.[43] The use of electronic media (e.g., internet-based programs, email, and texting) in childhood obesity interventions provides the benefits of widespread availability, popularity among young people, tailored feedback, and cost effectiveness.[44, 45]

Current Clinical Practice

Many major organizations have developed guidelines for managing overweight and obesity in children and adolescents (**Table 2**). These guidelines are generally consistent in recommending a staged approach. In this approach, lifestyle modification/behavior-based therapy is the initial treatment and more intensive treatment, such as pharmacological therapy and bariatric surgery, is considered only for patients with severe obesity or those who have been unsuccessful in producing weight loss with behavior-based approaches alone. Further, pharmacology and bariatric surgeries are generally only recommended or approved for post-pubertal adolescents with severe obesity. Most organizations specify that initial behavior-based therapy should use comprehensive, multicomponent strategies that focus on diet, physical activity, reduction in sedentary time, and behavioral counseling. Many recommendations also highlight the importance of parent or caregiver engagement.

National policies exist to support interventions to treat overweight and obesity in children and adolescents. For children enrolled in Medicaid, the Early and Periodic Screening, Diagnostic and Treatment (EPSDT) benefit covers all medically necessary obesity-related services, and the Affordable Care Act has also established coverage for childhood obesity counseling for individuals covered through private insurance.[46] In addition, the 2015 Healthcare Effectiveness Data and Information Set (HEDIS) includes a measure of the percentage of children 3 to 17 years of age who had an outpatient visit with a primary care provider or obstetrician/gynecologist with documentation of counseling for nutrition and physical activity.[47]

The provision of interventions to treat child and adolescent overweight and obesity appears to be increasing in clinical practice. After implementation of a pediatric weight management initiative designed to address the 2007 guidelines from the Expert Committee (**Table 2**), a large health maintenance organization reported a significant increase in exercise and nutrition counseling provided to children and adolescents diagnosed with overweight or obesity, from 1 percent in 2007 to 50 percent in 2010.[48] Adolescents' active efforts in weight management may also be increasing. In the 2013 National Youth Risk Behavior Survey, 47.7 percent of high school students who described themselves as slightly or very overweight reported that they were trying to lose weight, which is a significant increase from a prevalence of 41.8 percent in 1991.[7] In addition, 47.3 percent of students reported being physically active for at least 60 minutes per day on 5 or more days per week.[7]

Methods

Scope and Purpose

This systematic review examined the evidence on multicomponent behavioral interventions for treatment of child and adolescent obesity. The American Psychological Association (APA) will use this review to develop its clinical practice guidelines on weight management for children and adolescents.

Key Questions and Analytic Framework

In consultation with APA staff and Obesity Guideline Development Panel members, we developed an analytic framework (**Figure 1**) and five Key Questions (KQs) to guide our review.

1. In children and adolescents who are overweight or have obesity, do family-based multicomponent behavioral interventions reduce and maintain change in age/sex-standardized BMI?

2. How do selected patient and family sociodemographic characteristics (child's age, severity of adiposity, parental obesity, race, socioeconomic status) affect family-based multicomponent behavioral interventions? Specifically, are different approaches or components used or needed for families with different sociodemographic characteristics?

3. What is the impact of selected characteristics of family-based multicomponent behavioral interventions (dosage of contact, setting, interventionist qualifications, mode of delivery, use of multidisciplinary team, involvement of psychologist, cultural tailoring) in the management of age/sex-standardized BMI? Specifically:
    a. Are these characteristics associated with the efficacy of the interventions?
    b. What is the comparative effectiveness of these characteristics?

4. What is the impact of selected components of family-based behavioral management interventions (goals and planning, comparison of outcomes, self-monitoring of behavior, self-monitoring of outcome, reward and threat, stimulus control, modeling of healthy lifestyle behaviors by parents, motivational interviewing, general parenting skills (e.g., positive parenting) or family conflict management) in the management of age/sex-standardized BMI? Specifically:
    a. Are these components associated with the efficacy of the interventions?
    b. What is the comparative effectiveness of these characteristics?

5. What is the effect of patient adherence, engagement, and retention (e.g., percentage of homework complete, percentage of sessions attended)? Specifically:
    a. What interventions or intervention characteristics and components are associated with these factors?
    b. What levels of patient adherence, engagement, and retention are associated with improved efficacy of the interventions?

Data Sources and Searches

Our search strategies are listed in **Appendix A**. Separate searches were conducted for previously existing systematic reviews and original research, which were developed and peer-reviewed by research librarians. We searched the following databases for synthesized literature published between January 1, 2009 and October 17, 2014 on behavioral interventions for treatment of child and adolescent obesity: MEDLINE/PubMed, PsycINFO, Cochrane Database of Systematic Reviews, Database of Abstract of Reviews of Effects, Health Technology Assessment, and ERIC. We also searched the websites of the following organizations for additional literature: Agency for Healthcare Research and Quality, American Academy of Child and Adolescent Psychiatry, American Psychological Association, Campbell Collaboration, Canadian Agency for Drugs and Technologies in Health, Centers for Disease Control and Prevention Community Guide, Dynamed, Institute for Clinical Systems Improvement, Institute of Medicine, National Institute for Health and Clinical Excellence, and National Health Service Health Technology Assessment. We identified recent reviews with good-quality search methods and inclusion criteria consistent with ours.[35, 42, 49-55] We used the reference lists of these reviews to help identify studies that might have met inclusion criteria for our review, covering the time period of January 1, 1985 through December 31, 2009. We also searched for newly published literature from January 1, 2010 (bridging the 2010 U.S. Preventive Services Task Force review on screening and treatment for overweight and obesity in children and adolescents[56]) through January 22, 2016 in the following databases: MEDLINE/PubMed, PsycINFO, Cochrane Central Register of Controlled Trials, PsycINFO, and the Education Resources Information Center. We managed literature search results using EndNote™ version 7.3.1 (Thomson Reuters, New York, NY).

Study Selection

Two investigators independently reviewed titles and abstracts and then full-text articles against pre-specified inclusion and exclusion criteria (**Appendix A Table 1)**. Disagreements were resolved through discussion and consensus between the two investigators or consultation with the other investigators. A list of excluded studies after full text review, including the reasons for exclusion, is available in **Appendix B**.

We included fair- and good-quality randomized controlled trials (RCTs) and non-randomized controlled clinical trials (CCTs) that examined the effect of behavioral weight management interventions on weight reduction in children and adolescents aged 2 to 18 years with overweight or obesity. Studies were included if the entire sample consisted of children and adolescents who had an age- and sex-specific BMI in the ≥85th percentile or met similar criteria for overweight or obesity, or if at least half the sample had an age- and sex-specific BMI in the ≥85th percentile and ≥80 percent had risk factors for overweight (e.g., overweight parents; Hispanic, black, or American Indian/Alaska Native ethnicity) or obesity-related medical problems (e.g., diabetes, metabolic syndrome, hypertension, lipid abnormalities, or other cardiovascular-related disorders). We excluded studies of children and adolescents with an eating disorder, who were pregnant or postpartum, or whose overweight or obesity status was secondary to a genetic or medical condition (e.g., Cushing's syndrome) or was a result of medication use (e.g., antipsychotics).

We required behavioral weight management interventions to involve parents or caregivers in some way and to address, at the least, (1) physical activity or sedentary behavior, (2) diet, and (3)

behavioral management skills (in support of changes in physical activity, sedentary behavior, or diet). These interventions could be compared to usual care, no intervention, waitlist, attention control, or another active intervention (for comparative effectiveness). We included interventions conducted in outpatient settings; school classroom-based interventions and those conducted in inpatient or residential settings were excluded. We also excluded pharmacotherapy trials of weight loss drugs (e.g., metformin, orlistat) even if they included a behavioral weight management component. Self-help and surgical interventions were excluded as well.

We required trials to have weight loss as a primary aim and report at least one weight-related outcome (e.g., BMI z-score [zBMI], BMI, weight, BMI percentile, percent overweight) 12 months or more after baseline assessment. We included trials published in peer-reviewed, English-language publications that were conducted in "economically developed" countries according to membership in the Organisation for Economic Co-operation and Development.[57]

Quality Assessment and Data Abstraction

Two investigators independently assessed the quality of included studies by using criteria defined by the U.S. Preventive Services Task Force[58] (USPSTF) and assigned each a final quality rating of "good," "fair," or "poor" (**Appendix A Table 2**). Investigators resolved disagreements through discussion between raters or by enlisting a 3rd rater. Studies with a "fatal flaw" (e.g., attrition greater than 40%, differential attrition of greater than 20%) or multiple important limitations that could invalidate the results were rated as poor quality and excluded from review analysis and synthesis. Good-quality studies included all or almost all of the following: adequate randomization procedures, allocation concealment, blinding of outcome assessors, reliable outcome measures, comparable groups at baseline (with specified eligibility criteria), low attrition, acceptable statistical methods, and adequate and faithful adherence to the intervention. We rated studies as fair quality if they did not meet most of the good-quality criteria.

One investigator abstracted data from the included studies into a Microsoft Access® database (Microsoft Corporation, Redmond, WA) and a second investigator checked the data for accuracy. We abstracted study design characteristics, population demographics, baseline history of obesity and other related conditions, intervention details, and child weight outcomes.

Data Synthesis and Analysis

General Approach. The primary outcome for this review was zBMI because it was the only widely available measure that could be used to compare relative degree of excess weight across ages. If zBMI was not reported, BMI, weight (in kg), BMI percentile, and percentage in excess of a specified percentile were used, in order of decreasing preference. We also conducted analyses limited to only studies reporting zBMI and found that the standardized pooled effects were very similar to analyses that included trials reporting other measures, so the analyses showing the larger body of evidence are presented as the primary analysis. We selected data from a 12-month assessment if available. If outcomes were not available at 12 months, the first followup after 12 months was used instead. Because hours of contact appeared to be a strong effect modifier, we grouped the trials by estimated hours of contact and generated separate pooled estimates for each subgroup as well as overall estimates for all trials combined.

If a study reported a change from baseline, we used it for analysis. If change scores were not available, they were calculated from baseline and followup measures if possible, assuming a 0.50 correlation between baseline and followup measures. We also conducted a sensitivity analysis

for the primary KQ1 analysis, changing the correlation to 0.80. Since it is more conservative to assume a lower correlation, effects for 17 of the 34 trials were slightly larger when a higher correlation was used. However, the general size of pooled effects were similar and statistical significance did not differ between the two approaches. For example, the standardized mean difference for the KQ1 efficacy trials changed from -0.33 (95% CI, -0.48 to -0.17) with a correlation of 0.50 to -0.38 (95% CI, -0.54 to -0.22) with a correlation of 0.80. We show only results assuming a correlation of 0.50, the more conservative estimate.

When study-reported mean change scores for each group were not adjusted for clustering, we applied our own adjustment by multiplying the sample size in each group by a design effect based on average cluster size and estimated intraclass correlation (0.05).[59]

We used random effects models with the DerSimonian and Laird method.[60] Sensitivity analyses were conducted using a restricted maximum likelihood model with the Knapp-Hartung modification for small samples, which is a more conservative approach when there is substantial statistical heterogeneity or the number of studies is small for behavioral trials.[61, 62] Results were almost identical between these two methods, so we report the DerSimonian and Laird results. When combining different weight measures (e.g., zBMI and BMI), we pooled standardized effect sizes, but when pooling studies that reported zBMI we kept the results in native units (kg/m^2). For data too clinically or statistically heterogeneous for quantitative pooling or when important data were not reported for a substantial proportion of studies, we narratively summarized the results and presented data in tables or forest plots without pooled summary statistics.

Statistical heterogeneity among studies was evaluated using standard χ^2 tests and the magnitude of heterogeneity was estimated using the I^2 statistic.[63] The Cochrane guidelines for interpretation were applied: less than 40 percent likely represents unimportant heterogeneity, 30 to 65 percent moderate heterogeneity, 50 to 90 percent substantial heterogeneity, and greater than 75 percent considerable heterogeneity.[59] These categories are overlapping because other factors such as consistency and precision must also be taken into account when interpreting I^2 values. Funnel plots and Egger's test were used to examine the risk of small-study effects in the trials that included control groups (e.g., efficacy trials) and combined trials of all levels of estimated contact hours. We examined effect modifiers using meta-regressions. Because contact dose was clearly associated with effect size, we included estimated contact hours in these models to examine the modifiers after controlling for contact dose. Analyses were conducted in Stata version 13.1 (StataCorp LP, College Station, TX). All significance testing was two sided and results were considered statistically significant if the p-value was 0.05 or lower.

We summarized the results for the body of evidence addressing each KQ by applying evidence profiles and methods adapted from those developed by the Grading of Recommendations Assessment, Development and Evaluation (GRADE) working group.[64] As part of this process, we rated risk of bias, inconsistency, indirectness, and imprecision for each analysis. The risk of bias summary was based on our quality rating, and because we excluded trials we rated as being "poor" quality, risk of bias was generally rated as not serious. We rated inconsistency as serious if point estimates were wide-ranging or confidence intervals showed minimal overlap, and downgraded to very serious if a substantial portion of the point estimates fell on the opposite side of the null from the hypothesized direction. If trials did not directly test a stated hypothesis, but instead explored the hypothesis by comparing studies with different characteristics, we considered this evidence indirect and rated it as serious. We did not downgrade studies for indirectness based on population characteristics, as our inclusion criteria

limited our included studies to samples that are relevant to outpatient settings in the United States. Imprecision was downgraded to serious when the confidence intervals of the pooled effects spanned a wide range of clinical significance, including effects that are clinically important and clearly not clinically important or even into the potentially harmful range. Imprecision was also downgraded when evidence was sparse, based on small samples or with few cases meeting the criteria of interest.

Approach by KQ. For KQ1 (efficacy/effectiveness of weight management interventions), we used the standard qualitative and meta-analytic approaches described above, focusing on the trials with control groups (efficacy trials). For studies with multiple active treatment conditions, we examined comparisons between control groups and the most intensive (highest contact hours, most comprehensive if contact hours were the same) intervention arm. In addition, we dichotomized study outcomes as meeting or not meeting criteria for clinical significance based on the change in zBMI from baseline to followup: reduction of 0.25 or more, or reduction of 0.50 or more and report the percent meeting these criteria.[65-68]

For KQ2a (impact of patient characteristics on interventions), we categorized and examined all studies based on their inclusion criteria, target populations, or reported sample characteristics to characterize differences in treatment approaches used for subgroups. The population characteristics of interest in this review were child's age, severity of adiposity, parental obesity, race, and socioeconomic status.

Patient age was categorized as preschool (2 to 6 years), elementary (6 to 12 years), adolescent (12 to 18 years), or multiple, based on the age range reported for the trial. Since trials' age ranges did not cleanly adhere to these age group definitions, we applied the categories where it appeared that approximately 75 percent or more of the children fit the age category. We conducted sensitivity analyses using different approaches to categorization and found generally consistent results. For severity of adiposity we identified trials that were limited to children who were overweight and did not have obesity. We planned to also identify trials limited to children with severe obesity, defined as 120 percent of the 95th percentile or greater than the 99th percentile, but found none that met this criterion. We identified trials that required parental overweight or obesity in their inclusion criteria. We also created a series of race/ethnicity indicator variables for studies having at least 50 percent black, Latino, or black or Latino subjects (combined). Because few trials had at least 50 percent black or at least 50 percent Latino participants, we primarily focused on the combined indicator of at least 50 percent black or Latino. Finally, we identified trials that targeted or were limited to economically disadvantaged families based on inclusion criteria, setting, or study aim.

After examining the frequency distributions of these patient characteristic variables and their relationships with all the intervention components, we focused on the relationship between patient age and parental involvement as well as race/ethnicity and intervention characteristics and components due to sparse data for other population characteristics. We constructed two-way tables and used Fisher's exact test to assess the statistical significance of the association because there were many cells with fewer than five trials.

KQ2b, KQ3 and KQ4 (impact of population characteristics [KQ2b], intervention characteristics [KQ3], and intervention components [KQ4]) involved examining both efficacy and comparative effectiveness trials. The population characteristics in this analysis are the same as those listed above: child's age, severity of adiposity, parental obesity, race, socioeconomic status. The intervention characteristics we examined were dosage of contact, setting, interventionist qualifications, mode of delivery, use of multidisciplinary team, involvement of

psychologist, cultural tailoring. The intervention components were examined were: goals and planning, comparison of outcomes, self-monitoring of behavior, self-monitoring of outcome, reward and threat, stimulus control, modeling of healthy lifestyle behaviors by parents, motivational interviewing, general parenting skills (e.g., positive parenting) or family conflict management.

The dosage of contact was examined using the number of sessions as well as the estimated hours of person-to-person contact (in person or via phone). Hours of contact were estimated based on the number of planned treatment sessions and the length of each session. If parents and children had separate sessions, these were counted separately. For example, an intervention that included 30 minutes with the child only, 30 minutes with the parents only, and 30 minutes with the whole family together was assigned a value of 90 minutes, even though only 60 minutes may have elapsed. Thus, contact time is estimated from the perspective of the required person-hours for interventionists.

When information on session length was not provided, we used *a priori*-developed assumptions to estimate contact hours. For example, we considered phone sessions described as "brief" to be 5 minutes long, phone sessions not described as "brief" as 15 minutes long, individual sessions as 30 minutes long, and group sessions as 60 minutes long; the interventions were grouped by hours of contact (0 to 5, 6 to 25, 26 to 51, or 52 or more hours). Of the 65 included trials, 22 did not report the length of one or more pieces of their intervention and required us to employ these assumptions. Half of these reported efficacy comparisons[69-79] and half were limited to comparative effectiveness analyses.[80-90] Several only required us to estimate the time involved in a minor portion of the intervention,[69, 74, 77, 86, 87] for example providing the length of the main individual and group sessions the made up the bulk of the intervention but neglecting to provide the time for some phone calls or provider visits that only accounted for a small portion of the intervention. Of the efficacy trials, we believe the trial by Golley and colleagues[70] to be at highest risk of being placed in the wrong category. We estimated this intervention to involve 24 hours of contact, just under the 25-hour maximum for its category. We felt the remaining trials unlikely to be miscategorized, although the exact contact time may not be accurate. A table showing our contact hour calculations is provided in **Appendix A Table 3**.

Cut points were made based on the cut point used in the previous USPSTF review (26 hours),[42] then we subdivided those two groups *post hoc* based on logic and where there were discontinuities in the frequency distribution of estimated contact hours. For example, several interventions had an estimated 44 to 45 hours of contact, then the next higher intervention involved 67 hours. In that case, we assigned 52 hours to be the cutoff between these groups (extending the logic from the previous review of using a cutoff of 1 hour per week for 6 months to a cutoff of 1 hour per week for 1 year). We also looked that the original 2-group cut-off comparing trials with fewer than 25 hours with those that had an estimated 26 or more hours. Rather than using number of sessions as our primary measure of dose, we used contact hours because it more fully captured the total time and had better distributional properties for analysis (i.e., less skewness and kurtosis). Only estimated hours of contact in the first 12 months are shown on the forest plots because the primary outcome was weight change at 12 months (or closest followup available).

Intervention settings were categorized as medical specialty care, medical primary care, or other. The category "other" included school (not classroom-based, e.g., after-school program), community (e.g., church or community center), or other (e.g., academic research clinic) settings. Interventionist qualifications were assigned for provision of behavioral, diet, and exercise

components and were assigned as follows: 1) professional training in the field, 2) other medical provider with specialty training (specifically for the study or otherwise), 3) medical provider without further training, or 4) other. The category of professional training in the field included, for example, a psychologist or social worker for the behavioral management component; a dietitian or nutrition specialist for the diet component; and a physical therapist, exercise therapist, kinesiologist, or other exercise-related professional for the physical activity component. Graduate students in these fields were considered interventionists with professional training.

Interventions were further described using a series of indicator (yes/no) variables related to the mode of delivery and treatment team composition. These variables included the use of group, individual (single person or single family), family-targeted (parents and children together), parent-only, and child-only sessions. Other variables were use of electronic media (e.g., online, text messages, email), use of print materials, use of phone-based contact, provision of structured physical activity sessions, use of a multidisciplinary team (two or more categories represented by a medical provider, behavioral health specialist, dietary specialist, or physical activity specialist), and involvement of a psychologist or psychology graduate student as a treatment team member. We considered intervention to have involved cultural tailoring if there was special consideration during intervention development to the needs and preferences of a specific patient subgroup, and the study population was limited to (or primarily) persons in the targeted subgroup.

The components of the interventions were characterized using a series of indicator (yes/no) variables and included the following list, which is based on the taxonomy of behavior change technique:[91]

1. *Goals and planning:* goal setting (behavior), problem solving, goal setting (outcome), action planning, review of behavior goals, discrepancy between current behavior and goal, review of outcome goals, behavioral contract, commitment to goal, explicit individualized behavioral or weight goals.
2. *Collaborative goals:* specific goals were identified with input from family or child.
3. *Comparison of outcomes:* credible source, pros and cons, comparative imagining of future outcomes.
4. *Self-monitoring of behavior*: having the child or family record diet-related behaviors, physical activity, or other behavior-change activities.
5. *Self-monitoring of outcome:* having the child or family record weight.
6. *Contingent or differential reward and threat:* material incentive (behavior), material reward (behavior), non-specific reward, social reward, social incentive, non-specific incentive, self-incentive, incentive (outcome), self-reward, reward (outcome), anticipation of future punishment (e.g., rewards or reinforcement contingent on behavior or completion of pre-specified activities).
7. *Stimulus control:* restructuring of physical environment, avoidance/reducing exposure to cues for the behavior (e.g., removing sweets and other high-calorie low-nutrient dense foods from the house).
8. *Modeling of healthy lifestyle behaviors by parents*: parents targeted for their own behavior change (with or without weight loss), encouragement to be active with children, modeling of healthy eating.

9. *Motivational interviewing*: any mention of motivational interviewing or similar approaches (since behavior change components may not fully capture this specific technique).
10. *Parenting skill/family conflict management*: targeted improvement of parenting skills/techniques or family conflict resolution; process-oriented family therapy, including mention of encouraging positive parenting.

For data analysis of these key questions, we first used meta-regressions to examine whether these characteristics or components were associated with effect size among the efficacy trials, controlling for estimated contact hours. We used followup stratified or sort meta-analyses to explore effect modifiers with a statistically significant association. Second, for KQ3 and KQ4 we reported the results of comparative effectiveness trials that specifically tested the impact of intervention characteristics or components. Finally, we compared the proportion of trials with specified characteristics or components among trials that did and did not meet the lower criterion for clinical significance (zBMI reduction of 0.25 or more), using Fisher's exact test to statistically examine associations. For this analysis we only included trials that reported zBMI and also only examined trials with at least 26 hours of estimated contact, to control for contact dose. We examined results only from the primary active intervention group for each trial in this analysis. Where there were multiple active intervention arms, we selected the intervention group with highest contact hours or, if contact hours were the same, the one with the most comprehensive curriculum.

For KQ5 (effect of patient adherence/engagement/retention), we set an *a priori* threshold to dichotomize studies into high adherence (average session attendance greater than 70%, average number of offered sessions completed greater than 75%, or more than 50% of all sessions completed) and not high adherence. We examined intervention characteristics and components to see if they were associated with the dichotomized adherence outcome using simple two-way tables and Fisher's exact test for statistical significance. We examined the relationship between the dichotomized adherence variable and effect size through stratified meta-analysis.

APA Involvement

This research was funded by the APA. We consulted with APA staff and Obesity Guideline Development Panel members at key points in the review in developing the research plan (i.e., KQs, analytic framework, and inclusion/exclusion criteria) and finalizing the systematic review. These individuals had no role in the study selection, quality assessment, or writing of the systematic review.

Results

Literature Search

We screened 9,491 abstracts and 577 full-text articles for inclusion (**Appendix A Figure 1**). We included 65 trials[69-90, 92-134] (n= 9,299) that reported results in a total of 119 publications (**Appendix C**).[67, 69-90, 92-186] Of the included trials, 36 targeted reducing excess weight and included a control group;[69-79, 92-116] in this report we refer to these 36 studies as "efficacy" trials. Two additional trials examined only maintenance interventions that took place after completion of a weight reduction program and are referred to as "maintenance" trials.[117, 118] Thirty-four of the included studies had two or more active comprehensive weight management intervention arms, which we refer to as "comparative effectiveness" trials, and were used to examine benefits of specific components or treatment approaches.[70, 74, 76, 80-90, 102, 103, 111, 118-134] Six of the comparative effectiveness trials also had control groups and were included in the efficacy analyses.[70, 74, 76, 102, 103, 111] In addition, one of the comparative effectiveness trials was also a maintenance trial.[118] **Table 3** shows all included trials in alphabetical order, with columns to indicate whether they are efficacy, comparative effectiveness or maintenance only trials. **Appendix D Tables 1** and **2** shows more detailed study design and population characteristics, respectively, and **Appendix Tables 3** through **6** show more detail about intervention characteristics, provider information and training, and behavioral components.

Results of Included Studies

Key Question 1 (KQ1). In children and adolescents who are overweight or have obesity, do family-based multicomponent behavioral interventions reduce and maintain change in age/sex-standardized BMI?

For KQ1, we focus primarily on the 36 efficacy trials (n=6,820)[69-79, 92-116] but also briefly discuss the two maintenance trials (n=211).[117, 118] We also conducted an analysis that included all efficacy and comparative effectiveness trials that reported zBMI in order to examine the proportion meeting two different criteria for clinically important differences; in that analysis we examined only the single most intensive treatment arm in each trial and did not involve a comparison with other study arms.

Study Characteristics

Of the efficacy trials, 16 (44%) were conducted in the United States,[69, 71, 73-76, 92, 102, 103, 106-111, 116] and the remaining in Europe,[78, 93-99, 101, 104, 105, 113, 115] Israel,[100] Turkey,[77] Australia,[70, 72, 79, 114] or New Zealand.[112] The majority took place in health care settings (primary care, 11 [30%], other health care, 15 [42%]) and the remaining 10 (28%) were in community settings. Among studies reporting their recruitment methods, the most common approaches were population-based screening (e.g., in health care clinics), clinician referral, and volunteer solicitation through such means as flyers and media ads. Many of these studies used multiple recruitment methods; only two relied exclusively on volunteer solicitation.[100, 116]

Population Characteristics

Most of the efficacy trials included children with obesity or both children with obesity and those who were overweight according to published CDC, International Obesity Task Force

(IOTF), or country-specific norms. Four trials specifically targeted children who were overweight but not with obesity[78, 94, 109] or who were with only mild obesity.[72] Across all 36 trials, the average baseline zBMI was 2.1 (weighted by the trials' sample sizes), which is well above the zBMI for the 95th percentile of 1.645. Of studies reporting BMI, the weighted average BMI was 18.9, 22.7, and 32.7 in trials limited to preschool children, elementary-age children, and adolescents, respectively. Five trials required that at least one parent meet criteria for overweight or obesity for study inclusion.[74, 92, 107, 108, 116] Age ranges were highly variable and covered the full range from age 2 to 19 years; the weighted average age across all efficacy trials was 8.6 years. Six (17%) of the trials were limited to children age 6 and younger (preschool),[74, 78, 93, 107, 108, 110] 17 (47%) focused on elementary-age children (between 6 and 12 years old),[70-72, 75-77, 79, 92, 94, 97-99, 103, 109, 111, 112, 114] and three (8%) focused on adolescents (age 12 and older);[69, 101, 102] the remaining trials spanned multiple age groups (10 [28%] trials),[73, 95, 96, 100, 104-106, 113, 115, 116] Across all trials, slightly more than half (58%) of the children were female. Race/ethnicity was frequently not reported, although six trials included at least 50 percent of participants who were black,[92, 116] Latino,[73, 102] or black or Latino.[106, 109]

Interventions

Tables 4 and **5** show intervention characteristics and components, respectively, for the efficacy trials, sorted by descending estimated hours of contact. All of the included trials provided at least dietary and physical activity information or counseling as well as some information about behavior change principles, according to our inclusion criteria. In addition to providing practical information on topics such as healthy eating, safe exercising, and reading food labels, commonly used behavior change strategies included goal setting, monitoring diet and activity behaviors, and problem solving. The number of sessions ranged from 3 to 104, with an estimated 1 to 114 contact hours over 2.5 to 24 months.

All of the interventions with 26 or more estimated contact hours included group sessions,[69, 71, 74, 92, 93, 96, 99, 100, 102, 104-108, 113, 115] and approximately two thirds of these also offered individual family sessions.[69, 71, 74, 93, 100, 102, 104, 105, 107, 108, 113] Among the 16 efficacy trials with at least 26 contact hours, 13 (81%) included supervised physical activity sessions[69, 74, 92, 93, 96, 99, 100, 102, 104-106, 113, 115] and 10 (62%) had a multidisciplinary treatment team.[69, 92, 93, 96, 100, 104-106, 113, 115] Many of the higher-contact trials had separate activities for children and parents as well as sessions involving the whole family. In contrast, interventions with less contact (k=20) were more likely to involve only individual sessions (14 [70%]), motivational interviewing by a primary care provider or another healthy lifestyle counselor (7 [35%]), or collaborative goal-setting (8 [40%]). The lowest-intensity interventions (less than 6 contact hours), which did not included group sessions, were frequently conducted in primary care settings with the involvement of the primary care provider.

Quality Assessment

We gave eight studies a good rating[69, 72, 79, 94, 110-112, 114] and assigned a fair rating for the remaining studies according to USPSTF quality assessment methods. Among the fair-quality trials, several reported generally good methods but attrition greater than 20 percent. More typically, studies that received a fair rating had more than one concern. Aside from attrition, common concerns included failing to report allocation concealment, randomization methods, blinding of outcomes assessment, information about intervention fidelity, or patient adherence or attendance. In addition, approximately half of the studies had fewer than 40 participants in each

treatment arm. Among the studies excluded for poor quality, the most common issues were high attrition (greater than 40%) or differential attrition (greater than a 20 percentage-point difference between groups). Other issues were non-comparability of groups at baseline, such as recruitment through completely different and non-comparable mechanisms. For example, we excluded a trial that required intervention group participants to have had two failed weight loss attempts but no such restriction for control group participants.

We included both randomized and non-randomized clinical trials. Of the efficacy trials, 32 (89%) percent were individual or cluster RCTs. We also included three non-randomized trials[101, 104, 105] and one cluster RCT with only one group per cluster, which we refer to as a single-group cluster randomized trial.[187] None of the non-randomized trials was rated as good quality.

Findings

Summary: Compared to control groups, interventions targeting reduction of excess weight in children and adolescents were most likely to show benefit with at least 26 hours of planned intervention contact (**Figure 2**) with average zBMI reductions of 0.25 or greater in more than half of the intervention groups in these trials (**Figure 3**). Although children in some lower-contact interventions showed greater average improvement than children in control groups did, absolute effects rarely met the threshold for clinical significance of zBMI reduction 0.25 or greater. In these lower-contact intervention trials, group differences generally clustered in the range of very small effect to no effect and were usually not statistically significant.

Detailed Results

Thirty-four of the 36 efficacy trials reported sufficient data to be included in a meta-analysis. **Figure 2** includes all 34 of these trials, showing the standardized mean difference (SMD) for each trial due to the variety of weight measures. Because statistical heterogeneity was very high when all trials were combined, we explored potentially important sources of clinical heterogeneity and found that contact hours were clearly associated with effect size. Therefore, we present both an overall pooled estimate for all 34 trials as well as pooled results for each of the four categories based on estimated contact hours. In addition, for easier assessment of clinical significance, we separately show forest plots limited to trials that reported zBMI, with pooled estimates in zBMI units rather than standardized units (**Figure 3**). Parallel figures are also shown with trials grouped by our *a priori* cutoff of 26 contact hours, but not broken down further by estimated contact hours (**Figures 4** and **5**). In addition, results for all weight outcomes and followup time points are shown in **Appendix D Table 7**, including those that could not be included in the meta-analysis.

52+ Estimated Contact Hours. We found moderate evidence that interventions with at least 52 hours of contact are effective in reducing excess weight. Four trials (n=996) showed a benefit of treatment at 12 months of followup, immediately after the intervention had ended in all trials.[104-106, 115] Standardized effect sizes were all greater than 0.80 (Cohen's suggested "large" effect size) and the pooled SMD was -1.10 (95% confidence interval [CI], -1.31 to -0.90, I^2=36.8%). In the three trials that reported zBMI, zBMI reductions ranged from 0.22 to 0.34 in the intervention groups compared with no change to a 0.26-unit increase in zBMI in the control groups. Two of these three trials met zBMI change criteria for clinical significance of 0.25: the pooled between-group difference in zBMI was -0.38 (95% CI, -0.49 to -0.27, I^2=50.5%). Translating these weight changes into pounds where we had the data to do so, average weight

changes ranged from increases of less than one pound to an 8-pound reduction in the intervention group compared to 9- to 17-pound increases in the control groups (**Appendix D Table 8**). Within-study effects were quite variable, with standard deviations (SDs) larger than average change scores. For example, based on SDs, in the two intervention groups that showed average weight gains of less than one pound each, weight change in the middle 68 percent of the participants ranged from losing 19 pounds to gaining 20 pounds.

Because all of these trials reported results immediately after the last treatment session, we could not determine the degree to which effects were maintained without ongoing contact. However, **Figure 6** shows all trials that had additional assessment points beyond 12 months, including one trial with 52 or more hours of contact.[104] In that trial, improvements shown at 12 months (immediately post-intervention) were maintained at 24-month followup (1 year after the intervention had ended).

In addition to the minimal evidence on the degree to which benefits persist after treatment ends, the evidence for trials with 52 or more estimated hours of contact was downgraded for risk of bias concerns. Two of the four trials were non-randomized controlled trials that used as control groups children who had completed the intake process for the obesity program but lived too far away to participate in the program, which raises concern about the comparability of the groups at baseline.

26-51 Estimated Contact Hours. We judged evidence to be moderate that interventions with 26 to 51 hours of contact helped children reduce excess weight. The pooled SMD for these 12 trials (n=1,354) was smaller than the highest-contact trials (-0.35 [95% CI, -0.52 to -0.17], I^2=39.2%),[188] but half of these trials had 6- to 9-month lags between the end of the intervention and when assessment occurred, suggesting at least some maintenance of effect after treatment ended. This group of trials covered a wide range of ages, including four targeting very young children[74, 93, 107, 108] and two targeting adolescents.[69, 102] Although the forest plot shows statistically significant between-group effects for only three of these trials,[74, 107, 108] five additional trials had statistically significant group differences in a study-reported adjusted or repeated measures analysis.[69, 93, 99, 100, 113] Six of the nine trials that reported zBMI met our threshold for clinical significance of zBMI change of 0.25 or more, with absolute reductions in zBMI ranging from 0.13 to 0.60. Again, SDs were relatively large. For example, in one of the trials of adolescents, the average weight change in the intervention group was a 5-pound increase whereas the change for the middle 68 percent of participants ranged from minus 31 pounds to plus 41 pounds.[69] This is the most extreme example, however: in several trials of preschool-aged children, average weight change in the intervention was typically 4 to 5 pounds, with SDs suggesting ranges from 8- to 12-pound weight gains to reductions of 2 to 4 pounds in the middle 68 percent of participants. Although this was a fairly large body of evidence with twelve trials, we downgraded this group from high to moderate overall quality for imprecision since quite a few studies had very small numbers of participants and wide CIs and because between-group effects were fairly wide-ranging.

26+ Estimated Contact Hours. Combining the two groups of 26 to 51 contact hours and 52+ contact hours, the standardized mean difference was in the medium-large range (SMD, -0.60 [95% CI, -0.86 to -0.34], I^2=83.5%, k=16). When considering only trials that reported zBMI, the weighted mean difference in change between groups was -0.27 (95% CI, -0.38 to -0.16, I^2=80.6%, k=12) and eight of the 12 interventions met the criterion for clinical significance of zBMI reduction of 0.25 or more.

6-25 Estimated Contact Hours. Eight trials (n=839) reported interventions with 6 to 25 hours of contact, [70, 73, 77, 95, 97, 101, 103, 112] which we rated as low quality of evidence due to their inconsistency and imprecision of studies' effects. The pooled estimates showed no benefit from these interventions (SMD, -0.06 [95% CI, -0.28 to 0.17], I^2=42.0%; pooled difference in zBMI units, -0.01 [95% CI, -0.10 to 0.08], I^2=49.7%) and none of the intervention groups reported absolute reductions of 0.25 or more, although one trial was close with a reduction of 0.24.[70] We considered the evidence inconsistent because some trials showed statistically non-significant worse outcomes for intervention group participants and also rated these trials down for imprecision due to relatively small numbers of participants and wide CIs in individual trials.

0-5 Estimated Contact Hours. We found high quality evidence that the interventions with less than 6 hours of contact showed very small to no benefit in reducing excess weight in children.[72, 75, 76, 78, 79, 94, 98, 109-111, 114, 116] This was the largest body of literature, with one third of the included efficacy studies (12/36) and over half of all participants in the efficacy analysis (n=3,631). Although the pooled effect was statistically significant, the point estimate was very small: only one of the intervention groups met criteria for clinical significance, and only four[76, 94, 109, 116] of the twelve trials showed statistically significant between-group differences. Of these four trials with statistically significant group differences, the one with the largest standardized effect size (the only one in the "moderate" range according to Cohen's rules of thumb) involved an extensive interactive email-based intervention, so the relatively minimal person-to-person contact may not fully capture that intervention's "dose".[116] Three trials could not be included in the meta-analysis due to lack of data, and none of them showed group differences.[78, 98, 110] Two of the four interventions in this group that did show a benefit were limited to overweight populations (who did not have obesity),[94, 109] and a third excluded children with a BMI percentile score of 97 or higher.[76] These results suggest that if brief interventions are ever called for, they may be best reserved for children who are overweight or have only mild obesity, or be heavily supplemented with on-line contact with counselors who also provide direct phone or in-person contact.

As with the rest of the trials, SDs were generally larger than average change scores. For example, among several trials with elementary-age children where average intervention-group weight increased by 3 to 4 pounds, the ranges for the middle 68 percent of children were roughly between losing 6 to 9 pounds to gaining 12 to 16 pounds, with some other trials showing considerably wider one-SD ranges.

0-25 Estimated Contact Hours. Combining the two groups of 0-5 contact hours and 6 to 25 contact hours, the standardized mean difference was very small (SMD, -0.14 [95% CI, -0.24 to -0.04], I^2=22.8%, k=18) and none met the criterion for clinically significant change. When considering only trials that reported zBMI, the weighted mean difference in change between groups was -0.04 (95% CI, -0.10 to 0.01, I^2=39.7%, k=11).

Addition of Comparative Effectiveness Trials. We also examined the proportion of studies in which the most intensive intervention arm met criteria for clinical significance, considering both efficacy and comparative effectiveness trials. Altogether 40 trials reported zBMI, allowing us to determine whether an intervention group passed the thresholds of 0.25 and 0.50. These results were consistent with the efficacy trial results. Fifteen trials (37.5%) met the 0.25 threshold for clinical significance, of which 14 involved 26 or more estimated contact hours: 2/4 (50%) for interventions of 52 or more hours and 12/20 (60%) for interventions lasting for 26 to 51 hours. Only four of the 40 trials considered met the criteria for a zBMI reduction of 0.50 or more, and all of them involved 26 to 51 estimated contact hours.

Maintenance of Previous Reductions in Excess Weight. Two trials reported on the effects of three different weight maintenance interventions among children who had previously participated in a program to reduce excess weight (**Table 6**). One trial compared both a behavioral skills approach and a social facilitation approach with no maintenance contact and found no change or small increases in zBMI in any group.[118] The other trial compared continued informational sessions and four calls employing motivational interviewing techniques with a newsletter-only group. This trial found no between-group differences at followup but did not provide detailed results.[117]

Key Question 2 (KQ2). How do selected patient and family sociodemographic characteristics (child's age, severity of adiposity, parental obesity, race, socioeconomic status) affect family-based multicomponent behavioral interventions? Specifically,

KQ2a. Are different approaches or components used or needed for families with different sociodemographic characteristics?

KQ2b. Are selected patient and family sociodemographic characteristics associated with treatment outcome?

Findings

Summary: Interventions targeting preschool and elementary-age children were more likely to encourage parental modeling than were trials targeting older children, but we found no association between target age and whether an intervention offered parent-only sessions or included parenting training more broadly. Trials in which 50 percent or more of children were black or Latino were more likely to involve culturally tailored interventions, provide supervised physical activity sessions, and take place in non-healthcare settings. No other intervention characteristics were clearly related to studies' race/ethnic composition.

Evidence suggested that interventions targeting younger children may be more likely to have a positive effect compared with those targeting older children. Evidence did not support differential effectiveness associated with race/ethnicity. We also found no association between likelihood of benefit and whether the study targeted overweight children (without obesity) and whether parental overweight or obesity was a requirement of participation. Evidence was insufficient to explore the relationship with socioeconomic status.

Detailed Results

Association between Population Characteristics and Intervention Characteristics or Components (Key Question 2a)

All 65 included trials were eligible to contribute to KQ2a. We initially explored simple frequency distributions of the trials according to the specified sociodemographic characteristics. The guideline panel reviewed the initial results and determined that there was sufficient data to examine only two of the pre-specified characteristics: child's age and race/ethnicity.

For child's age, we limited our analysis to 49 trials that could be categorized into one of three age groups: preschool (age 2 to 6 years), elementary (ages 6 to 12 years), or adolescent (age 12

to 18 years). Due to insufficient data for other components and at the guideline panel's instruction, we examined only intervention components related to parental participation. All 49 trials involved parents in the intervention in some way. **Table 7** shows the percentage of trials reporting the use of parent-only sessions, instruction in parental modeling, and parenting skills training for each of the three age categories. Instruction in parental modeling was more commonly reported in trials with preschoolers (3/6 [50.0%]) and elementary-age children (24/36 [66.7%]) than in trials with adolescents (1/7 [14.3%]). However, trials did not cleanly fit our *a priori* age categories, and the relationship between parent modeling and age category was attenuated (p=0.08) when we were more strict with age category definitions (requiring closer adherence to our *a priori* categories); power was also reduced since more trials were counted as spanning multiple age groups and therefore excluded from the analysis. A similar pattern was seen for parenting skills training, but the differences across age groups were smaller and not statistically significant.

For race/ethnicity, we compared 12 trials in which more than 50 percent of the sample was either black or Latino with the remaining 53 trials that either reported a lower proportion of black or Latino participants or did not report race/ethnicity. Three intervention characteristics showed a statistically significant association with racial/ethnic composition: use of cultural tailoring, use of supervised physical activity sessions, and conduct of the intervention in a non-healthcare setting were all more likely in trials with 50 percent or more black and Latino children than in trials with fewer than 50 percent black and Latino children (**Table 8**). In addition, the proportion of trials involving a provider who was a trained professional in behavioral management (e.g., a psychologist or social worker) was lower in trials with 50 percent or more black and Latino children, although this association was not statistically significant. Trials with majority black or Latino participants were statistically less likely to provide parenting skills training than other trials did, but this effect may have been driven by the lack of trials with younger children among trials with 50 percent or more black or Latino participants (**Table 9**). No other intervention characteristics or components showed an association with the racial/ethnic composition of the study sample.

We downgraded these data on factors associated with child's age and race/ethnicity for two primary reasons. First, the studies were quite variable in the level of detail provided about their interventions. Some trials may have offered some intervention components or had some intervention characteristics but did not report them. Second, the number of trials in many cells was very small, leading to imprecision. Thus, we rated this information of low quality for KQ2a.

Effect Modification by Population Characteristics (Key Question 2b)

The impact of patient characteristics (KQ2b) was addressed in two ways. First we ran meta-regressions of efficacy trials, controlling for contact dose. Second, of trials where the primary (most intensive or comprehensive) intervention group (a) met and (b) did not meet the criterion for a clinically significant effect, we examined the proportion that targeted the specified subpopulations. We considered both efficacy and comparative effectiveness trials in this analysis. Because contact dose was in important moderator of effect, we limited this analysis to trials with at least 26 hours of estimated contact. A clinically significant effect was defined as a zBMI reduction of 0.25 or more, so we dropped trials from this analysis that did not report zBMI. Twenty-four trials were included in this analysis (14 that met criteria for clinically significant improvement, 10 that did not).

When exploring the trials that met and did not meet criteria for clinically significant benefit, we found that there was an association with age, whereby trials targeting younger children were

more likely to show a clinically significant benefit (**Table 10**). Of the four trials in preschool-aged children with 26 or more estimated hours of contact, all four showed a benefit. Among the 14 trials that showed a benefit, ten were limited to preschool or elementary age children (71% altogether) and none were limited to adolescents. Among the 10 trials that did not show a benefit, none targeted preschool age children, two targeted elementary age children (20%), and four targeted adolescents (40%). While the meta-regressions did not show a statistically significant association, the regression parameters did show a progression of larger effects with young children. This analysis maintained statistical significance in sensitivity analyses exploring stricter rules for categorizing trials into age groups.

There was also a statistically significant association between clinical significance and race/ethnicity: none of the four trials with 50 percent or more of black and Latino children met criteria for clinical significance. However, none of these four trials targeted young children; two targeted adolescents[81, 102] and two targeted included children ages 10 to 14 years with an average age of 12 years.[130, 131] Since the previous analysis showed that trials in younger children were more likely to show a benefit, we could not clearly disentangle the effects of race/ethnicity and age. In addition, several trials with majority black and Latino children reported measures other than zBMI[[90, 92, 106, 116] or did not provide group-level zBMI change,[117, 130, 131] so were dropped from the analysis of clinical significance, limiting the value of this analysis. The meta-regression, which included the full spectrum of contact dose, showed no hint of an association (regression parameter, 0.0 [95% CI, -0.30 to 0.29], p=0.98).

None of the other intervention characteristics showed a statistically significant association with effect size after controlling for contact dose except for the meta-regression of low socioeconomic status. However, since only two efficacy trials targeted children with low socioeconomic status we concluded that evidence was insufficient.

Key Question 3. What is the impact of selected characteristics of family-based multicomponent behavioral interventions (dosage of contact, setting, interventionist qualifications, mode of delivery, use of multidisciplinary team, involvement of psychologist, cultural tailoring) in the management of age/sex-standardized BMI? Specifically:

Key Question 3a. Are these characteristics associated with the efficacy of the interventions?

Key Question 3b. What is the comparative effectiveness of these characteristics?

Findings

Summary: Contact dose was the only intervention characteristic that was clearly associated with effect size. This relationship was not as strong in the comparative effectiveness trials, although absolute differences did generally demonstrate greater (but usually statistically non-significant) reductions in the groups with more contact hours. We did not find evidence to support an association between effect size and setting (primary care vs. other healthcare vs. non-healthcare), provider qualifications, intervention delivery format, or cultural tailoring. The majority of

interventions that met criteria for clinically significant benefit and that involved interventions of at least 26 contact hours included both individual (single-family) and group sessions; offered separate sessions targeting children, parents and both parents and children together; included supervised physical activity sessions; and had professionally-trained dietary, behavioral, and physical activity providers, such as registered dieticians, psychologists or masters-level health educators, and athletic trainers.

Detailed Results

All 36 efficacy trials contributed to the KQ3a meta-regressions exploring whether intervention characteristics were associated with effect size (**Table 11**). In addition, we examined comparative effectiveness trials that reported comparisons pertinent to intervention characteristics. Intervention characteristics for the comparative effectiveness trials are shown in **Tables 12** through **16**, with trials examining similar effect modifiers grouped together. Results of a trial are shown in forest plots if the study reported sufficient data. As with the efficacy trials, zBMI is shown in the forest plot if available, with the outcome closest to 12 months post-baseline shown; other weight outcomes were selected if zBMI was not available. Results were not pooled because the specific comparisons were very heterogeneous even within the same comparison category, and some trials reported multiple active intervention arms that may be shown on the same forest plot. Full reporting of weight outcomes at all available time points is shown in **Appendix D Table 7**. Finally, we also compared the proportion of trials with and without specified intervention characteristics that met criteria for clinically significant change (zBMI reduction of 0.25 or more). To control for contact dose, we limited this analysis to trials with at least 26 hours of estimated contact time (also shown in **Tables 12** through **16**). In this analysis we examined only the single most intensive or comprehensive intervention arm for all trials reporting zBMI (k=24 trials).

Contact Dose. In meta-regressions, more contact hours was associated with larger effect size, both for contact hours treated as a continuous variable and when treated as a dichotomous variable (≥26 hours vs. 0 to 25 hours). The regression coefficients were negative, indicating that the intervention group showed greater reductions in excess weight as contact hours increased. Estimated number of sessions also showed a clear association, but duration of the intervention was not associated with effect size. Duration ranged from 2.5 to 24 months; however, we censored duration at 12 months when duration was longer than 12 months because our primary outcome was 12-month assessment. We rated this evidence as moderate because it did not involve a direct comparison, since trials did not test different levels of contact dose but instead intervention arms from different trials were compared with each other.

In addition to the efficacy trials, we used 12 comparative effectiveness studies to examine for any association between contact dose and effect size (**Table 12**). Results are shown in a forest plot, along with p-values (if available) reported by the study authors for between-group differences (**Figure 7**). We included the p-values since statistical significance may differ between the unadjusted effect calculated by the meta-analysis and a study-reported adjusted or repeated measures analysis. Within each group of trials shown on the forest plot, the trials are sorted by the difference in estimated contact hours between the two groups and the largest difference in contact hours are listed first.

Two trials compared intervention arms in which both groups appeared to have received similar content, but one group had additional contacts.[76, 111] Neither trial revealed group

differences. In both cases both treatment arms were very brief (no more than 2.5 estimated contact hours in any arm), so may have been insufficient to have had beneficial effect.

Ten trials compared a substantial behavioral module addition to a comprehensive but briefer intervention (**Table 12, Figure 7)**.[70, 81, 88, 90, 102, 126, 130-132, 134] Four compared instructor-led group interventions with self-help or website-based approaches with minimal direct contact,[102, 126, 130, 131] and the other six involved two different instructor-led groups. Of the six trials with two different instructor-led groups, none showed group differences: zBMI reductions in groups with more contact were greater than 0.20 in four of these trials (and two met the threshold for the clinical significance of 0.25[88, 134]), whereas reductions were generally smaller than 0.20 in the group receiving less contact. Thus, although group differences were not statistically significant, absolute effects were generally larger in the group with more contact. Of the four interventions with self-help or web-only comparison groups, two showed greater benefit with instructor-led approaches, although the neither of these had average zBMI reductions of 0.25 or higher.[130, 131] We rated the comparative effectiveness evidence as low because the included studies were generally small and many had fairly wide CIs.

We also conducted an extensive exploratory analysis to examine (a) the robustness of the 26-hour cut-point and (b) how results changed if supervised physical activity hours were not counted in the hours of contact, which we refer to as non-physical activity (non-PA) hours. There were no efficacy trials with 25 to 29 hours of total contact so our *a priori* cut-point of 26 hours could not be directly tested. Analyses suggested that above 30 hours of estimated total contact, including at least 18 hours of non-PA contact, interventions were both likely to show improvements over control conditions and show clinically meaningful improvements. Interventions with fewer than 25 total hours or 18 non-PA hours of contact were much less likely to show such benefits. However, our analyses of these cut-points are limited for several reasons, and there was no clear demarcation showing a minimum necessary or required number of hours (total or non-PA). For more detail on these analyses see **Appendix E**.

Provider Qualifications. We tested whether treatment effects differed in trials that did or did not use professionally trained behavioral, dietary, or physical activity providers; used multidisciplinary teams; and involved a psychologist. Based on meta-regressions, none of these factors showed a statistically significant impact on effectiveness after contact hours were controlled for. Having a behavioral specialist was close to being statistically significant (p=0.058). However, further analysis revealed that simply including contact dose as a covariate might not be sufficient to disentangle behavioral provider qualifications and contact dose. The four trials with 52 or more hours of contact involved a behavioral specialist, and only one of the 11 trials with less than 6 hours of contact involved a behavioral specialist. The group that was most evenly mixed between having and not having a behavioral specialist was the category of 26- to 51-contact hours. The largest effects in this group were seen in two trials with very young children, and both involved a behavioral specialist.[107, 108] Other factors that were somewhat unique to these trials might have influenced effect size (e.g., use of home-based components, focus on very young children, very small trials) and the effects were wide-ranging with or without a behavioral specialist. However, the two trials that showed paradoxically (but statistically non-significantly) worse outcomes in the intervention groups did not have behavioral specialists as a treatment provider. Given the lack of statistical significance and the exploratory nature of the followup analyses, we concluded that the data do not support important differences by provider qualifications, although the use of behavioral specialists may warrant further research. We rated this evidence as low because it was limited to between-study comparisons

that relied on authors' descriptions, which were completed to variable degrees. In addition, provider qualifications were not evenly distributed among trials with different levels of contact, which resulted in little variability within most categories of contact dose.

The proportion of interventions meeting and not meeting criteria for clinical significance did not differ statistically for any of the variables related to interventionist qualifications. More than two thirds of the trials that showed clinically significant effects employed professionally-trained dietary and behavioral providers; 57 percent of these trials had a psychologist on their intervention team. Additionally, 54 percent meeting criteria for clinically significant improvement employed a professionally trained physical activity interventionist. None of the comparative effectiveness trials examined the impact of provider qualifications.

Intervention Delivery: Setting. In meta-regressions of efficacy trials, there were no differences in effectiveness between interventions set in primary care, other health care, or non-health care settings after contact hours were controlled for. Other health care settings were typically specialty obesity clinics but also healthcare-based research facilities. Examples of non-health care settings are schools, community centers, home, and internet-based interventions. We tested a series of dichotomous variables representing each of these three settings in separate meta-regressions and ran a model with the variables representing the primary care setting or the non-healthcare setting to compare each with specialty settings. None of the models indicated that any setting differed in effectiveness. We rated this evidence as low because it was not direct evidence and because some trials provided no or minimal information about the setting. There were no differences in the percent of intervention groups reporting clinically significant improvements in different settings.

One comparative effectiveness trial implemented essentially the same intervention in both a primary care setting and a hospital-based obesity clinic, where the intervention was developed.[80] Results were the same in both settings, with children showing average reductions in zBMI of 0.15 to 0.17 (**Table 13, Figure 8)**. We rated this evidence as very low since it was limited to a single small trial comparing two settings.

Intervention Delivery: Group vs. Individual Sessions. The evidence we examined did not suggest that inclusion of either group or individual sessions were specifically associated with effect size, although data were poorly-suited to explore this issue. Meta-regression indicated that offering individual (i.e., single-family) sessions was associated with greater benefit, however this result must be viewed with caution because almost all trials offered individual sessions, and there may have been some residual confounding with contact dose. Of the five trials that did not offer individual sessions, two were very high-contact trials with large beneficial effects that were entirely comparable to the other two trials in the group with the highest contact hours;[106, 115] the other three that did not provide individual sessions offered between 37 and 48 estimated hours of contact.[92, 96, 99] Two of these three trials had the two smallest effects in the group of trials offering 26 to 51 hours of contact, but the third had an effect size slightly larger than the pooled average. Because so few trials lacked individual sessions, we concluded that data were insufficient to determine an association between offering individual sessions and effect size. Similarly, although the association between offering group sessions and smaller treatment benefit was almost statistically significant, data were actually insufficient to rule in or rule out an association. None of the very low-contact interventions (0 to 5 hours) offered group sessions, and two other trials had no group sessions (estimated 7 and 12 contact hours);[73, 112] these two trials had small, statistically non-significant effects that were similar to other trials offering a like dose. We rated this evidence as low quality because it was indirect and because the delivery format

showed little variability and was not well-distributed along the spectrum of contact dose. Two comparative effectiveness trials found no differences between intervention approaches that varied in whether individual or group treatment was offered (**Table 13, Figure 8**).[127, 128] One of those trials did not provide detailed outcomes data and reported only that groups did not differ at followup.[128] We rated this evidence as very low since it was limited to two small trials, one of which also differed in estimated contact hours.

There were no statistically significant differences between trials that did or did not offer individual and group sessions in terms of likelihood of clinically significant benefit. All trials with 26 or more hours of estimated contact offered group sessions, regardless of whether they found clinically significant benefits, and 71 percent of those with clinically significant findings also offered individual sessions.

Intervention Delivery: Target of Session. Other comparative effectiveness trials examined the target of the sessions (i.e., parent, child, or both). Having sessions targeted at parents (without children), children (without parents), or families (parents and children together) were not associated with effect size in meta-regressions. We rated the efficacy evidence as low quality because it was indirect and because in some studies it was unclear who attended the sessions.

Interventions that did and did not offer sessions with parent-only, child-only, and parent and child targeted sessions were not more or less likely to show clinically significant benefits. All trials with clinical significant improvements offered child-only and parent-only sessions, and 71 percent of these trials also offered sessions with parents and children together.

Moreover, none of the comparative effectiveness trials, including the trial whose results are not shown on the forest plot due to insufficient data, reported group differences (**Table 13, Figure 8**).[119, 122, 125] One trial found almost identical change with and without the addition of two parent support sessions in an intervention for 7- to 12-year-olds. Change in percentage in excess of the 85th percentile for age and sex were very similar between groups (-5.9 with and -6.0 without parent support sessions).[119] The second trial varied the target of only one component of their intervention, a problem-solving module, which was embedded in a larger family-based intervention that had sessions targeting parents only, children only, or both. This trial showed large benefits in all three groups: reductions in zBMI change were 0.5, 0.9, and 1.1, respectively.[122] In the final trial, group sessions were run separately for children and parents in one intervention group, while parents and children attended group sessions together in the other intervention group; children and parents had individual counseling visits together in both intervention groups. Reduction in the percentage in excess of the 50th percentile was not statistically different between groups (-6.9 when parents and children attended group classes together, -2.2 when parents and children attended separate sessions).[125] The evidence was rated low quality because there were only three very small trials (fewer than 20 in all treatment arms) and one of these had only one component that differed from the intervention target.

Intervention Delivery: Electronic, Print, and Phone Components. Meta-regression in efficacy trials showed no association between effect size and having an electronic, print, or phone delivery of part of the intervention. This evidence was rated low quality because it was indirect and the delivery modality was not always clearly described; in particular, print materials were often not mentioned when they may have had handouts. There were also no difference in the likelihood of finding clinically significant improvement with the use of these delivery mechanisms, nor were any of these modalities widely used among trials with clinically significant benefits.

In addition, three comparative effectiveness trials similarly showed no incremental benefit to having an electronic delivery component (**Table 13, Figure 8**). One of those trials added a text-messaging component to a comprehensive 47.5-hour intervention and found that both the messaging and non-messaging groups reduced zBMI by 0.20 or more (mean [SD] reduction -0.25 [0.53] and -0.20 [0.52], respectively.[120] Another trial added a text-messaging component to a self-help website-based intervention and found that both the messaging and non-messaging groups reduced zBMI by 0.10.[102] The third trial added ten automated interactive voice recognition phone calls to a 4-hour individual parent intervention and found minimal average zBMI change in the groups who did and did not receive those phone calls.[126] We rated this evidence as low quality because of the small number of trials and the wide variation in approaches and background interventions.

Intervention Delivery: Supervised Physical Activity Sessions. The meta-regressions did not show an association between the presence of supervised physical activity sessions and effect size after controlled for estimated contact hours. Because use of supervised physical activity sessions was confounded with contact hours, we ran a meta-regression limited to the trials with 26 or more hours of contact but did not include estimated contact hours as a covariate. We also ran a more typical model with all efficacy trials that included contact hours in the model. We rated this evidence low quality because it was indirect and, for some trials, difficult to determine whether there was a supervised physical activity component. There was also no difference in likelihood of showing clinically significant improvement in interventions that included or did not include supervised physical activity sessions; 57 percent of trials showing clinically significant benefits included supervised physical activity sessions (as did 80% of trials that did not show a clinically significant benefit). The results of these analyses were consistent with the one comparative effectiveness trial[82] examining the addition of supervised physical activity sessions, which did not reveal group differences (**Table 13, Figure 8**). This trial found an average reduction of 3.9 kg in the group that included supervised physical activity and 1.4 kg in the group that did not; this difference was not statistically significant. This trial is not shown on the forest plot because measures of dispersion were not reported.

Cultural Tailoring. Only one efficacy trial involved cultural tailoring[116] so we did not consider the meta-regression results valid. This trial was an estimated 4-hour intervention that showed the largest between-group difference among the trials with an estimated 0 to 5 contact hours (0.16 kg/m^2 increase in BMI in the intervention group vs. 1.42 kg/m^2 increase in the control group), but the degree to which cultural tailoring influenced the results could not be determined. We rated this evidence very low quality because it was indirect and this was the only efficacy trial that used cultural tailoring. None of the comparative effectiveness trials compared treatment arms that did and did not involve cultural tailoring, Three comparative effectiveness trials[90, 130, 131] and one maintenance trial[117] did have culturally tailored interventions, but the tailoring was either consistent between groups or not the primary difference between intervention conditions.

Key Question 4. What is the impact of selected components of family-based behavioral management interventions (goal and planning, comparison of outcomes, self-monitoring of behavior, self-monitoring of outcome, reward and threat, stimulus control, modeling of healthy lifestyle behaviors by parents, motivational interviewing, general parenting skills (e.g., positive parenting) or family conflict management) in the management of age/sex-standardized BMI? Specifically:

Key Question 4a. Are these components associated with the efficacy of the interventions?

Key Question 4b. What is the comparative effectiveness of these components?

Findings

Summary: Evidence for most components either did not indicate an association with effect size or showed mixed evidence, with more recent trials showing no association when evidence was mixed. One trial found that using individualized goals was associated with greater benefits than was using goals not individualized to the family. However, we found no trials that replicated this finding, and other promising findings have not held up upon replication. The majority of interventions that met criteria for clinically significant benefit and had 26 or more estimated contact hours included goals and planning, self-monitoring of behavior, contingent reward or threat, stimulus control, parent modeling, and parenting skills training. Trials showing a clinical significant benefit were also likely to target young children, with several targeting preschool-age children (younger than age 6), which may at least partially explain the high use of parent modeling and parenting skills.

Detailed Results

As with KQ3, all 36 efficacy trials contributed to the KQ4a meta-regressions exploring whether intervention components were associated with effect size (**Table 17**). As we described before, a negative regression coefficient means that the presence of the component is associated with greater reduction in excess weight while a positive coefficient means the component is associated with less reduction in excess weight. In addition, we examined comparative effectiveness trials that reported comparisons of the effect of pertinent intervention components (**Tables 12** through **16**). Results of these trials are shown in forest plots if the study reported sufficient data, but the results are not pooled. Full reporting of weight outcomes is shown in **Appendix D Table 7**. We also compared the proportion of trials with and without specified intervention components that met criteria for clinically significant change (zBMI reduction of 0.25 or more). To control for contact dose, we limited this analysis to trials with an estimated 26 or more hours of contact (also shown in **Table 17**). In this analysis we examined only the single most intensive or comprehensive intervention arm for all trials reporting zBMI (k=24 trials).

Goals and Planning. Although the meta-regression showed that the use of goals and planning was not associated with effect size after controlling for estimated contact hours, almost all (33/36, 92%) of the efficacy trials reported using goals and planning. Because of the limited

variability in whether goals and planning was used, the meta-regression did not provide an adequate test of the importance of this component and we considered the results inconclusive. The fact that goals and planning was almost universally employed suggests it is considered a core component by most researchers. Although three trials did not report using goals and planning, it may in fact have been employed in those trials but was not described in the methods. We rated this evidence as low quality because it was indirect and because treatment components were not always clearly reported. Looking at both efficacy and comparative effectiveness trials with an estimated 26 hours of contact or more, again there were no differences in likelihood of reporting clinically significant results, since almost all trials included goals and planning.

Types of Goals. Six comparative effectiveness trials, most by Epstein and colleagues in the context for their family-based treatment program,[84, 85, 103, 121, 123, 124] examined various aspects of goal-setting for diet and physical activity (**Figure 9**). One of the Epstein trials compared two strategies for determining the pace at which families progressed from one level of goal to the next. The first strategy was tailoring the progression of goals to each family's progress ("individualized progression") so that once a certain level of goal was met the family progressed to a more difficult level for that behavior. The second strategy was moving the family through the progression of goals in a stepped fashion, regardless of the family's progress ("paced progression"), such as moving to a more difficult goal after 1 week with an easier goal, regardless of whether they were successful in achieving the easier goal.[84] After 12 months, children of families using individualized progression had made greater reductions in the percentage in excess of the 50th percentile BMI for their age and sex (26.5 and 16.7 percentage-point reduction with individualized progression and paced progression, respectively). However, group differences were smaller and no longer statistically significant at 24 months of followup.

Two additional trials by Epstein and colleagues examined whether benefits were larger if the physical activity target was to increase physical activity or to reduce sedentary activity.[85, 121] While the initial trial showed a larger effect when the goal was only to reduce sedentary behavior (vs. increasing physical activity or both increasing physical activity and reducing sedentary behavior), the followup study did not show differences in treatment effect between these approaches. Epstein and colleagues further examined whether, in order to reduce sedentary behavior, it was more useful to employ reinforcement for meeting sedentary behavior targets or to have families make sedentary activities less available (e.g., by limiting access to the television).[123] In this study both groups showed large reductions in zBMI (-0.6 with the reinforcement approach vs. -0.9 with the stimulus control approach), but the differences between groups were not statistically significant.

Epstein and colleagues similarly tested whether focusing on increasing consumption of healthy foods versus decreasing consumption of unhealthy, energy-dense foods was associated with better weight outcomes.[124] The group increasing consumption of healthy foods showed greater reductions in zBMI than did the group reducing unhealthy, energy-dense foods at the 12-month followups (-0.26 vs. -0.21, adjusted p=0.01) and the 24-month followups (-0.27 vs. -0.11, adjusted p=0.04). The final trial examining behavioral goals found no difference between an approach that encouraged families to increase physical activity and reduce sugar-sweetened beverages compared with an approach that encouraged decreased television viewing and increased consumption of low-fat milk. Thus, results by Epstein and colleagues were not replicated that greater benefits were seen with a focus on decreasing sedentary (vs. increasing physical) activities and increasing healthy (vs. decreasing less healthy) foods.

We rated the evidence examining how to implement goals related to behavior changes as very low for two reasons. First, the evidence was based on a small number of small trials that took a variety of approaches to explore this issue. Second, the early positive findings generally did not hold up with replication.

Collaborative Goals. The meta-regression of efficacy trials did not suggest that, after estimated contact hours were controlled for, the trials describing the use of collaborative goals exhibited larger effects than those without collaborative goals. We rated this evidence as low quality because it was indirect and because the treatment components were not always clearly reported, in particular the details of how goals were determined. There was no difference in likelihood of showing clinically significant results with or without collaborative goals. This finding was confirmed by one comparative effectiveness trial that showed no group differences in weight loss with family-set goals compared with study-set goals (**Figure 9**).[133] The evidence was also rated as low quality because it was limited to a single, relatively small study.

Parent Modeling and Parenting Skills Training. In the meta-regression of efficacy trials neither parent modeling nor parenting skills training was associated with larger effects after controlling for estimated contact hours. This evidence was rated low quality for indirectness and because treatment components were not always clearly reported. Interventions that met criteria for clinically significant improvement were more likely to have included parent modeling, and parenting skills training showed an association that was close to statistically significant (p=0.10) compared to interventions that did not show such benefits; for both parenting skills training and parent modeling, more than 70 percent of trials with a clinically significant benefit included parenting skills training; of those without a clinically significant benefit, only 20 to 30 percent included either of these components. However, trials with a clinically significant benefit were also more likely to have targeted preschool or elementary aged children, which might at least partially explain this association.

Three comparative effectiveness trials showed contradictory results (**Figure 10**), with a single small older trial (n=19 analyzed) showing a greater benefit with the addition of training in parenting management techniques,[83] and both other trials showing no group differences.[87, 89] The largest and most recent trial (n=123) found clinically significant benefits (or nearly so) for both groups at three different time points but no differences between groups.[89] This evidence was rated low quality because it was limited to only three studies, two of which were very small (total n analyzed ≤20).

Other Components. Of the remaining components (comparison of outcomes, motivational interviewing, self-monitoring of behavior and outcome, contingent reward or threat, stimulus control, and parental modeling), none demonstrated an association with effect size in meta-regressions of efficacy trials and controlled for estimated contact hours. This evidence was rated low quality for indirectness and because treatment components were not always clearly reported. There were also no statistically significant associations between the likelihood of meeting criteria for a clinically significant benefit and the use of any other treatment components. Self-monitoring behavior, contingent reward or threat, and stimulus control were all commonly used in trials with clinically significant benefits. There were no comparative effectiveness trials exploring the impact of any of these components.

There were three additional comparative effectiveness trials that explored comparisons that did not cleanly fit into our *a priori* comparisons but nevertheless met the inclusion criteria (**Figure 11**).[86, 118, 129] One of the trials added a coping skills module to an already extensive program that involved 45-minute culturally tailored nutrition counseling sessions for 16 weeks,

supervised physical activity sessions twice weekly, and 12 phone calls and found that the addition of coping skills training did not provide additional benefit.[86] There were also no group differences between a behavioral skills versus a social facilitation weight maintenance group[118] or between an instructor-led structured group vs. the combination of non-structured support group, child activity and nutrition group, and individual weight management counseling.[129] These last two trials held contact hours constant between groups. Absolute effects were small in all groups in these three trials and none met criteria for a clinically important change. Evidence for these comparisons was rated low quality for having only one small trial that examined each approach.

Key Question 5. What is the effect of patient adherence, engagement, and retention (e.g., % homework complete, % of sessions attended)? Specifically:

Key Question 5a. What interventions or intervention characteristics and components are associated with these factors?

Key Question 5b. What levels of patient adherence, engagement, and retention are associated with improved efficacy of the interventions?

Findings

Summary: We could not identify characteristics or components that were associated with adherence, nor was there a consistent relationship between adherence and effect size.

Detailed Results

Factors related to adherence, engagement, and retention were reported extremely heterogeneously. Few trials reported anything related to homework completion, but many reported about attendance of treatment sessions albeit in a wide variety of ways. Therefore, we focused on session attendance for this KQ. A trial had "high" adherence if it reported an average session attendance greater than 70 percent, the average number of sessions completed was greater than 75 percent of the sessions offered, or more than 50 percent of participants completed all sessions. All other trials were considered to have "not high" adherence. Forty-five trials reported sufficient information to rate for adherence level.

For KQ5a we examined the proportion of trials with high adherence among those with and without specified intervention characteristics and components (**Table 18**). All trials reporting adherence data were included in this analysis (i.e., efficacy, maintenance, comparative effectiveness) for a total of 45 trials. None of the characteristics or components was clearly associated with adherence. The largest absolute difference was between trials that offered parent-only sessions and those that did not; 15 out of 34 (44%) trials that offered parent-only sessions had high adherence, but only 1 of 11 (9%) trials that did not offer parent-only sessions had high adherence. Because some characteristics and components were more or less likely in trials with high vs. low contact hours, we also examined the relationship between adherence and intervention characteristics and components only in the subset of trials that offered at least an estimated 26 hours of contact (**Table 19**). As with the full set of trials, none of the characteristics or components showed a statistically significant relationship with adherence. Although absolute

differences in the percent meeting criteria for high adherence between trials with and without some components were large in some cases, the number of trials in many cells was very small, even only 0 or 1 trials. Because of the small number of trials in some cells and the challenges in assigning trials as having "high" or "not high" adherence, we rated this evidence as low quality.

For KQ5b, we tested whether adherence was associated with effect size by conducting meta-analyses that generated separate pooled estimates for "high" and "not high" adherence trials (**Figure 12).** This analysis was limited to the 27 efficacy trials that reported usable adherence data. Although the point estimates showed a larger benefit in trials rated as having high adherence (SMD, -0.34 [95% CI, -0.54 to -0.14], I^2=54.3%, k=8) than those that did not (SMD, -0.16 [95% CI, -0.27 to -0.06], I^2=39.1%, k=19), CIs were overlapping and the difference was not statistically significant. Because adherence could be confounded by contact hours, we also examined the trials by contact hours, as shown in **Figure 13**. We did not test the statistical significance of "high" vs. "not high" within the category of contact hours. In the trials with 26 or more hours of contact, only three were rated as having high adherence, and two of these showed the two largest beneficial effects in that group. However, data were too sparse to draw firm conclusions. Among trials with less than 26 contact hours, the lack of association between adherence and effect size was apparent. We rated this evidence as low quality for the same concerns with KQ5a evidence.

Discussion

Summary of Evidence

The goals of this review were to confirm that comprehensive weight management interventions are effective and to provide information on use of specific intervention characteristics and components to enable a guideline panel to develop recommendations regarding how weight management programs for children and adolescents should be implemented. We found that comprehensive weight management interventions for children and adolescents that included at least 26 hours of contact, provided counseling to improve diet and physical activity, used behavior management skills, and required parent participation were effective in reducing excess weight. We were unable to identify specific intervention characteristics or components that clearly predicted beneficial outcomes after controlling for contact dose. We were also unable to determine whether intervention characteristics or components influenced adherence and whether adherence was associated with effect size. One third of the trials did not report adherence, but for those that did the reporting of adherence was extremely heterogeneous, limiting our confidence in these results. Some of our analyses suggested that trials in younger children and in predominantly white children showed larger effects than their counterparts, although evidence was not entirely consistent and these two factors were confounded; none of the trials of predominantly black or Latino families included children younger than 10 years. Evidence profiles summarizing the results of all KQs are available in **Tables 20** through **26**.

Interventions that were successful, i.e., showed reductions in zBMI of 0.25 of more (our *a priori* definition of clinically significant improvement), typically included both group and individual (single-family) sessions; offered separate sessions targeting the child (without the parent), the parent (without the child), and the parents and children together; and had providers who were professionally trained behavior management specialists and dietary specialists. More than half of these beneficial trials also included supervised physical activity sessions and involved a trained physical activity professional. In addition to providing education about diet and physical activities, successful programs typically involved a number of behavior change techniques, including goals and planning; monitoring behavior, such as keeping a food diary and activity log, frequently with planned rewards for meeting behavioral goals; and stimulus control (e.g., removing tempting, calorie-dense foods from the house). Successful interventions were also more likely to include parental modeling and, to a lesser degree, parenting skills training (including positive parenting) than programs that did not meet our threshold for clinical significance, although this association may be in part due to the younger average age of children in interventions that met criterion for clinically significant improvement.

Although a few interventions that involved less than 26 hours of contact showed statistically significantly better results with intervention children than control children, overall those interventions were much less likely to show a benefit than those with more contact hours. Standardized effect sizes generally ranged from zero to small when there was less than 26 hours of contact, and only one of these trials met our criterion for clinically significant change.

Comparison with Other Reviews

Like the current review, the review conducted for the USPSTF, on which their recommendation to screen and counsel or refer children age 6 and older with obesity to intensive

counseling interventions is based, found that interventions with 26 or more hours of estimated intervention contact were more likely than those with less hours to show benefits.[42] Because that review was published in 2010 and research on childhood obesity has increased in recent years, the majority of the trials we included in our review were published after the USPSTF review was conducted. Our findings are consistent with the older evidence and the evidence base is now much more robust. In addition, a recent review of comprehensive behavioral family lifestyle interventions for pediatric obesity by Janicke and colleagues[49] found that several measures of contact dose (number of sessions, minutes of contact with child, minutes of contact with parents) were associated with effect size. The overall standardized effect size for the included efficacy trials was 0.47 (95% CI, 0.36 to 0.58), which is very similar to our overall estimate of 0.34 (95% CI, 0.19 to 0.49), flipping the signs on our results to match the Janicke approach. However, unlike the review by Janicke and colleagues, our review was limited to countries with very high human development index scores, required a minimum of 12 months of followup, and searched for almost 3 additional years. Thus, our results may have greater applicability to the current U.S. environment and may have had a more rigorous test of longer-term weight change with our longer followup requirement. We also added comparative effectiveness trials in an attempt to explore the importance of intervention characteristics and components, but these trials did not clearly identify or specify important characteristics or components.

The review by Janicke and colleagues[49] identified additional factors associated with effect size, including larger effects with individual treatment, larger effects with in-person contact (vs. phone), and duration of treatment. In our review, neither treatment duration nor group versus individual contact was associated with effect size after controlling for contact dose. The review by Janicke and colleagues did not appear to control for contact hours when examining these factors. None of our trials was limited to phone contact so we were unable to test this variable. Another review of clinical practice guidelines identified parental involvement as an important component of treatment for childhood and adolescent obesity.[38] Our own review found that parent-only treatment sessions, parent training skills, and promotion of parent modeling were commonly included in interventions that showed clinically significant benefits. Further, these components were more likely to be present in the successful interventions than in interventions in the same contact dose range but did not meet our criterion for clinically significant change.

Limitations of the Review

There are a number of limitations to our review, some related to the body of evidence and others due to our methods. Regarding the body of evidence, it was difficult to accurately code intervention characteristics and components from trials with limited descriptions of their methods. Some trials provided very detailed information but many did not. Adherence also was difficult to categorize because the way in which it was reported varied widely across studies and this information was not available for a third of the trials. Additionally, it was very difficult to determine the relative importance of characteristics and components because the trials demonstrated heterogeneity along many dimensions in terms of population characteristics as well as intervention characteristics and components. Moreover, where we compared trials with and without intervention characteristics and components, analysis was limited because the trials were not designed to test this comparison, so comparisons were indirect rather than direct. Where we did have comparative effectiveness trials with direct comparisons, replication of results was minimal. Additionally, many trials were small and few had followup beyond 12 months.

One important limitation of our review methods is that, due to time and resource constraints, we did not contact authors to obtain more detailed information about intervention protocols or to confirm the accuracy of how we coded intervention characteristics and components, and we had to employ our default assumptions for approximately one third of the trials due to session lengths not being reported. Another limitation was that, although they were based on the logic of the calendar year and the distribution of contact hours in the included studies, our cutoffs for categorizing contact hours were somewhat arbitrary; only the 26-hour cutoff was established *a priori*. Finally, we focused only on weight outcomes. There may have been additional beneficial effects of these interventions, but we did not capture those outcomes.

Further, this review is predicated on the assumption that the potential harms of these interventions are minimal, but we did not directly assess harms. Harms results were very rarely reported, but if they were reported, usually there was a statement noting only that there were no adverse events, often with no further detail. One trial did report that, among families who had withdrawn from the intervention, some parents reported that the struggles to motive children between appoints often led to conflict between parent and child, thus disrupting family life.[80] Given the potential difficulty in helping a child make changes they may not be personally motivated to make, some conflict may be inevitable, and actively coaching of parents in how to support their children may be important. In addition, another trial reported that 14 percent of parents felt their child was upset by being told that they were overweight or had obesity. Given the high level of stigma associated with obesity, sensitive handling of the material is important but was not something we directly examined in this review.

Conclusion

Weight management programs for child and adolescent obesity that included at least 26 hours of contact were effective in helping reduce excess weight. We did not identify specific intervention characteristics or components that were clearly associated with the amount of benefit, but effective interventions shared a number of important characteristics and components. Common elements included sessions that targeted parents alone, children alone, or parents and children together; use of professionally trained behavioral and dietary providers; and often supervised physical activity sessions. Effective interventions almost universally incorporated goals and planning and they frequently involved stimulus control, behavior monitoring, and rewards associated with achieving behavioral goals. Parental modeling and training were also frequently a part of successful interventions, particularly those that targeted preschool and elementary-aged children.

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Tables and Figures

Table 1. Illustrative weight for girls and boys at selected percentile cutoffs (and corresponding zBMI value according to CDC norms) for girls and boys at ages 4, 8, 12, and 16 years

Sex	Age (y)	85th Percentile for age and sex (zBMI=1.036)		95th Percentile for age and sex (zBMI=1.645)		Difference between 95th and 85th percentiles
		BMI	Lbs.*	BMI	Lbs.*	Lbs.
Girl	4	16.8	37.8	18.0	40.5	2.8
	8	18.3	65.9	20.7	74.5	8.6
	12	21.7	109.9	25.3	127.6	17.8
	16	24.7	143.5	28.9	168.2	24.7
Boy	4	16.9	38.0	17.8	40.1	2.0
	8	18.0	64.6	20.1	72.2	7.6
	12	21.0	106.2	24.2	122.4	16.2
	16	24.2	140.9	27.6	160.4	19.5

Weight calculations assume 50th percentile height for age and sex

Note: Height, 85th and 95th BMI percentiles from the Centers for Disease Control and Prevention growth charts (http://www.cdc.gov/growthcharts/html_charts/statage.htm and http://www.cdc.gov/growthcharts/html_charts/bmiagerev.htm)

Abbreviations: BMI = body mass index; CDC = Centers for Disease Control and Prevention; lb(s) = pound(s); zBMI = body mass index z-score; yr(s) = year(s)

Table 2. Childhood obesity intervention recommendations from major health organizations

Organization	Date	Weight Management Recommendation
American Heart Association[19, 34, 45, 189]	2013 2012 2005	*AHA 2013 recommendations (endorsed by the Obesity Society)[19]:* Among children and adolescents with severe obesity (i.e., BMI ≥ 120% of the 95% percentile or an absolute BMI ≥ 35 kg/m^2, whichever is lower based on age and sex), conservative lifestyle modification/behavioral therapy is indicated as initial treatment, although it appears to have modest short-term efficacy in terms of BMI/weight reduction and cardiometabolic risk factor improvement, and long-term sustainability of these improvements is poor. Orlistat, the only FDA-approved medication for adolescents (≥ 12 years), has been shown to have modest weight loss efficacy in children and adolescents with obesity. Although orlistat has a good safety profile, tolerability issues are relatively common. In light of the limited effectiveness of lifestyle modification and medical therapy shown to date for severe obesity, surgical procedures that have an evidence base that supports their efficacy and safety should be considered for patients who demonstrate medical necessity and psychosocial readiness. Bariatric surgery is the most effective treatment for severe obesity in adolescents. Available at: http://circ.ahajournals.org/content/128/15/1689.full *AHA 2013 recommendations regarding the role of social networks and use of social media:[45]* Steps to using social networks in the management of childhood obesity include: define the goal of the intervention, identify the social network, develop and pilot test the intervention, implement the intervention, and spread the intervention. Social media and electronic technology is a promising component of weight management programs, but more research is needed. Available at: http://circ.ahajournals.org/content/127/2/260 *AHA 2012 recommendation regarding caregiver involvement in treating obesity[34]:* There is limited and inconsistent evidence that greater compared with less parental involvement necessarily promotes better weight-related outcomes in children with obesity receiving family-based treatments. Available at: http://circ.ahajournals.org/content/125/9/1186.full *AHA 2005 recommendations[189]:* Five guiding principles are important for the treatment of overweight in children: (1) establish individual treatment goals and approaches based on the child's age, degree of overweight, and presence of comorbidities; (2) involve the family or major caregivers in the treatment; (3) provide assessment and monitoring frequently; (4) consider behavioral, psychological, and social correlates of weight gain in the treatment plan; and (5) provide recommendations for dietary changes and increases in physical activity that can be implemented within the family environment and that foster optimal health, growth, and development. Data supporting the use of pharmacological therapy for pediatric overweight are limited and inconclusive. Surgical therapy should be reserved for full-grown adolescents with the severest obesity-related morbidity, offered only by experienced multidisciplinary teams, and presented to families with appropriate informed consent procedures. Available at: http://circ.ahajournals.org/content/111/15/1999.full
Academy of Nutrition and Dietetics[190]	2013	For weight management, comprehensive, multicomponent interventions that include diet, physical activity, behavioral counseling, and parent or caregiver engagement are recommended. For children between 2 and 5 years of age, active participation of the parent or caregiver is necessary, and weight goals should be monitored closely to encourage adequate growth and development. For an older child (older than 6 years) or adolescent who has extreme obesity (> 99th percentile), the child and family should be evaluated to determine the course of treatment, which may include more intensive therapies, such as more structured nutrition prescriptions as well as pharmacologic agents or bariatric surgery for adolescents. Registered dietitians and, when applicable, registered dietetic technicians, should be actively involved and engaged as an integral part of the obesity management team. Available at: http://www.ncbi.nlm.nih.gov/pubmed/24054714
Bariatric	2013	In adolescents with severe obesity, bariatric surgery can be considered if the patient has a

Organization	Date	Weight Management Recommendation
Scientific Collaboration Group (BSCG)[191]		BMI > 40 kg/m^2 (or 99.5th percentile for age) and at least one comorbidity; has followed at least 6 months of organized weight reduction attempts in a specialized center; shows skeletal and developmental maturity; is capable to commit to comprehensive medical and psychological evaluation before and after surgery; is willing to participate in a postoperative multidisciplinary treatment program; and can access surgery in a unit with specialist pediatric support (nursing, anesthesia, psychology, postoperative care). Available at: http://easo.org/wp-content/uploads/2013/10/EASO-IFSO-EC-Guidelines-on-Metabolic-and-Bariatric-Surgery.pdf
Community Preventive Services Task Force[192]	2013	The Community Guide recommends behavioral interventions to reduce recreational sedentary screen time among children aged 13 years and younger. This finding is based on strong evidence of effectiveness in reducing recreational sedentary screen time, increasing physical activity, improving diet, and improving or maintaining weight-related outcomes. Evidence includes studies of interventions that focus only on reducing recreational sedentary screen time (screen-time-only) and studies that focus on reducing recreational sedentary screen time and improving physical activity and/or diet (screen-time-plus). Insufficient evidence was found to determine the effectiveness of the following to prevent and control obesity among children, adolescents, or adults: provider education alone, provider feedback alone, provider reminders alone, multi-component provider-oriented strategies, or a combination of multicomponent provider-oriented interventions. Insufficient evidence was found to determine the effectiveness of school-based programs to prevent or reduce overweight and obesity among children and adolescents because interventions varied and reported outcomes that were not comparable. Available at http://www.thecommunityguide.org/obesity/communitysettings.html.
Institute for Clinical Systems Improvement (ICSI)[193]	2013	ICSI has a series of recommendations on management and treatment of obesity in children and adolescents: • Management intervention strategies are available and include nutrition, physical activity, behavior and lifestyle changes, medication and surgical considerations. • Clinicians should use motivational interviewing techniques as a tool for encouraging behavior change. • Pediatric patients and their families should be counseled on nutritional interventions including limiting sugar-sweetened beverages, eating nutrient-dense breakfasts, limiting eating out at fast food restaurants, and families eating together, among other nutritional strategies. • Clinicians should encourage engagement in moderately intense physical activity for at least 60 minutes per day, identify barriers the child, youth or parent might have against increasing physical activity, and recommend parents become good role models. • Lifestyle interventions should be provided for youths with overweight or obesity and their primary adult caregiver which may include establishing target behaviors, encouraging self-monitoring, goal setting, promoting self-efficacy skills, teaching parenting skills, cognitive restructuring and problem-solving. Available at: https://www.icsi.org/_asset/tn5cd5/ObesityChildhood.pdf
National Health and Medical Research Council of Australia (NHMRC)[194]	2013	For children and adolescents, focus lifestyle programs on parents, carers and families. (C recommendation: evidence provides some support of recommendation but care should be taken in its application) For children and adolescents, plan weight management programs that involve frequent contact with healthcare professionals. (B recommendation: evidence can be trusted to guide practice in most situations) For children who are managing overweight or obesity, advise that weight maintenance is an acceptable approach in most situations. (D recommendation: evidence is weak and recommendation must be applied with caution) For children and adolescents who are overweight or have obesity, recommend lifestyle

Organization	Date	Weight Management Recommendation
		change—including reduced energy intake and sedentary 47ne47enti, increased physical activity and measures to support behavioural change. (B recommendation: evidence can be trusted to guide practice in most situations) For postpubertal adolescents with a BMI > 40 kg/m^2 (or > 35 kg/m^2 with obesity-related complications), laparoscopic adjustable gastric banding via specialist bariatric/paediatric teams may be considered if other interventions have been unsuccessful in producing weight loss. (C recommendation: evidence provides some support of recommendation but care should be taken in its application) Available at: https://www.nhmrc.gov.au/guidelines/publications/n57
National Institute for Health and Care Excellence (NICE)[195]	2013	NICE has 15 recommendations on lifestyle weight management services for managing overweight and obesity among children and young people. Recommendations relating to the core components of lifestyle weight management programs include: • Ensure all lifestyle weight management programmes for children and young people with overweight or obesity are multicomponent. They should focus on: diet and healthy eating habits, physical activity, reducing sedentary time, and behavior change strategies for the child or young person and all close family members. • Ensure the following core components are included: behavior change techniques, positive parenting skills training, emphasis on importance of encouraging all family members to eat healthily and to be physically active, a tailored plan to meet individual needs, information and help to master skills in nutritional labelling, help to identify opportunities to become less sedentary and to build physical activity into their daily life, a range of physical activities (such as games, dancing and aerobics), information for family members about programme's aims and objectives and how they can provide support, ongoing support and follow-up for participants who have completed the programme. Several obesity guidelines are currently being updated: prevention and lifestyle weight management in children; prevention, identification, assessment and management of overweight and obesity in children, young people and adults; and maintaining a healthy weight and preventing excess weight gain among children and adults. Available at: http://www.worldobesity.org/site_media/uploads/NICE-Child.pdf
The American Society for Metabolic and Bariatric Surgery (ASMBS)[196]	2012	The selection criteria for adolescents being considered for a bariatric procedure should include a BMI of ≥ 35 kg/m^2 with major comorbidities (i.e., type 2 diabetes mellitus, moderate to severe sleep apnea [apnea-hypopnea index > 15], pseudotumor cerebri, or severe nonalcoholic steatohepatitis) or a BMI of ≥ 40 kg/m^2 with other comorbidities (e.g., hypertension, insulin resistance, glucose intolerance, substantially impaired quality of life or activities of daily living, dyslipidemia, sleep apnea with apnea-hypopnea index > 5). Available at: http://asmbs.org/wp/uploads/2011/09/PediatricBestPracticeGuidelines-January2012.pdf
NHLBI Expert Panel[197]	2011	**2-5 years** BMI 85th-95th%ile: Recommend excess weight gain prevention with parents as focus for energy-balanced diet, reinforce physical activity recommendations X 6 months BMI ≥ 95th%ile: Strongly recommend specific assessment for comorbidities (hypertension, dyslipidemia, type 2 diabetes mellitus); Recommend family-based weight gain prevention with parents as focus, registered dietitian counseling and follow-up for energy-balanced diet, moderate-to-vigorous physical activity prescription, limit sedentary time, 3 month follow-up **6-11 years** BMI 85th-95th%ile: Recommend excessive weight gain prevention with parents as focus for energy-balanced diet, reinforce physical activity recommendations, 6 months follow-up BMI ≥ 95th%ile: Strongly recommend specific assessment for comorbidities (hypertension, dyslipidemia, type 2 diabetes mellitus) BMI ≥ 95th%ile with no comorbidities: Strongly recommend office-based weight loss plan: family-centered program with parents as focus for behavior modification, (-) energy-balanced diet counseling by registered dietitian, prescription for increased moderate-to-vigorous physical activity, decreased sedentary time X 6 months BMI ≥ 95th%ile with comorbidities, BMI > 97th%ile, or progressive rise in BMI despite

Organization	Date	Weight Management Recommendation
		therapy: Strongly recommend referral to comprehensive multidisciplinary weight loss program for intensive management X 6 months **12-21 years** BMI 85th-95th%ile: Recommend excess weight gain prevention with adolescent as change agent for energy-balanced diet, reinforced physical activity recommendations X 6 months BMI ≥ 95th%ile: Strongly recommend specific assessment for comorbidities (hypertension, dyslipidemia, type 2 diabetes mellitus) BMI ≥ 95th%ile with no comorbidities: Strongly recommend office-based weight loss plan: family-centered program with adolescents as change agent for behavior modification counseling, registered dietitian counseling for (-) energy-balanced diet, prescription for increased moderate-to-vigorous physical activity, decreased sedentary time X 6 months BMI ≥ 95th%ile with comorbidities or BMI > 35 kg/m^2: Strongly recommend referral to comprehensive lifestyle weight loss program for intensive management X 6-12 months Available at: https://www.nhlbi.nih.gov/files/docs/peds_guidelines_sum.pdf
American Association of Family Practitioners (AAFP)[198]	2010	[Endorsement of USPSTF Recommendation] Clinicians should offer or refer to comprehensive, intensive behavioral interventions to promote improvement in weight status. (B recommendation: high certainty that net benefit is moderate or moderate certainty that net benefit is moderate-to-substantial; offer to provide this service). Available at: http://www.aafp.org/dam/AAFP/documents/patient_care/clinical_recommendations/cps-recommendations.pdf
Scottish Intercollegiate Guidelines Network (SIGN)[199]	2010	Treatment programmes for managing childhood obesity should incorporate 48ne48enti change components, be family based, involving at least one parent/carer and aim to change the whole family's lifestyle. Programmes should target decreasing overall dietary energy intake, increasing levels of physical activity and decreasing time spent in sedentary behaviours (screen time). (B recommendation: evidence rated high, directly applicable to target population, and demonstrating overall consistency of results or extrapolated evidence from higher quality studies) In most children with obesity (BMI ≥ 98th centile), weight maintenance is an acceptable treatment goal. (D recommendation: evidence consisted of non-analytic studies or expert opinion or extrapolated evidence from observational studies) Weight maintenance and/or weight loss can only be achieved by sustained behavioural changes (D recommendation: evidence consisted of non-analytic studies or expert opinion or extrapolated evidence from observational studies), e.g.,: • Healthier eating, and decreasing total energy intake. • Increasing habitual physical activity (e.g., brisk walking). In healthy children, 60 minutes of moderate-vigorous physical activity/day is recommended. • Reducing time spent in sedentary 48ne48enti (e.g., watching television and playing computer games) to < 2 hours/day on average or the equivalent of 14 hours/week. The following groups should be referred to hospital or specialist paediatric services before treatment is considered (D recommendation: evidence consisted of non-analytic studies or expert opinion or extrapolated evidence from observational studies): • Children who may have serious obesity-related morbidity that requires weight loss (e.g., benign intracranial hypertension, sleep apnea, obesity hypoventilation syndrome, orthopaedic problems and psychological morbidity). • Children with a suspected underlying medical (e.g., endocrine) cause of obesity, including all children under 24 months of age who have severe obesity (BMI ≥ 99.6th centile). Orlistat should only be prescribed for adolescents with severe obesity (those with a BMI ≥ 99.6th centile of the UK 1990 reference chart for age and sex) with comorbidities or those with very severe to extreme obesity (BMI ≥ 3.5 SD above the mean of the UK 1990 reference chart for age and sex) attending a specialist clinic. There should be regular reviews throughout the period of use, including careful monitoring for side effects. (D

Organization	Date	Weight Management Recommendation
		recommendation: evidence consisted of non-analytic studies or expert opinion or extrapolated evidence from observational studies) Bariatric surgery can be considered for postpubertal adolescents with very severe to extreme obesity (BMI ≥ 3.5 SD above the mean on 1990 UK charts) and severe comorbidities. (D recommendation: evidence consisted of non-analytic studies or expert opinion or extrapolated evidence from observational studies) Available at: http://www.sign.ac.uk/pdf/sign115.pdf
U.S. Preventive Services Task Force (USPSTF)[200]†	2010	The USPSTF recommends that clinicians screen children aged 6 years and older for obesity and offer them or refer them to comprehensive, intensive behavioral intervention to promote improvement in weight status (B recommendation: high certainty that net benefit is moderate or moderate certainty that net benefit is moderate-to-substantial; offer to provide this service). Available at: http://www.uspreventiveservicestaskforce.org/uspstf/uspschobes.htm
International Pediatric Endosurgery Group (IPEG)[201]	2009	Surgical weight loss is appropriate for adolescents with a BMI > 35 kg/m^2 with severe comorbidities (i.e., type 2 diabetes mellitus, moderate or severe sleep apnea, or pseudotumor cerebri), and adolescents with BMI ≥ 40 kg/m^2 with less serious obesity-related comorbidities (e.g., hypertension, dyslipidemia) should also be considered for surgical intervention. A comprehensive psychological evaluation, involving both patient and caregiver interviews, should occur prior to an operation. Available at: http://www.ncbi.nlm.nih.gov/pubmed/19371154
Endocrine Society[202]	2008	The Endocrine Society recommends that clinicians prescribe and support intensive lifestyle (dietary, physical activity, and behavioral) modification to the entire family and to the patient, in an age-appropriate manner, and as the prerequisite for all overweight and obesity treatments for children and adolescents. Dietary recommendations include: • Avoiding the consumption of calorie-dense, nutrient-poor foods • Controlling caloric intake through portion control in accordance with the guidelines of the American Academy of Pediatrics • Reducing saturated dietary fat intake for children older than 2 years of age • Increasing the intake of dietary fiber, fruits, and vegetables • Eating timely, regular meals, particularly breakfast, and avoiding constant 'grazing' during the day, especially after school. Physical activity recommendations include: • 60 minutes of daily moderate to vigorous physical activity • Decrease in time spent in sedentary activities. Screen time should be limited to 1-2 hours per day, according to the American Academy of Pediatrics. Psychosocial recommendations include: • Educating parents about the need for healthy rearing patterns related to diet and activity • Probing for and diagnosing unhealthy intrafamily communication patterns and support rearing patterns that seek to enhance the child's self-esteem. Pharmacotherapy (in combination with lifestyle modification) should be considered in: 1) children with obesity only after failure of a formal program of intensive lifestyle modification; and 2) overweight children only if severe comorbidities persist despite intensive lifestyle modification, particularly in children with a strong family history of type 2 diabetes or premature cardiovascular disease. Pharmacotherapy should be provided only by clinicians who are experienced in the use of anti-obesity agents and aware of the potential for adverse reactions. The Endocrine Society suggests bariatric surgery for adolescents with BMI above 50 kg/m^2, or BMI above 40 kg/m^2 with severe comorbidities in whom lifestyle modifications and/or pharmacotherapy have failed. Candidates for surgery and their families must be psychologically stable and capable of adhering to lifestyle modifications. Access to experienced surgeons and sophisticated multidisciplinary teams who assess the benefits and risks of surgery is obligatory.

Organization	Date	Weight Management Recommendation
		Available at: https://www.endocrine.org/~/media/endosociety/Files/Publications/Clinical%20Practice%20Guidelines/FINAL-Standalone-Pediatric-Obesity-Guideline.pdf
Society of American Gastrointestinal and Endoscopic Surgeons (SAGES)[203]	2008	Adolescent bariatric surgery (age < 18 years) has been proven effective but should be performed in a specialty center (grade B recommendation: based on high-level, well-performed studies with varying interpretation and conclusion by the expert panel). Patient selection criteria should be the same as used for adult bariatric surgery (grade C recommendation: based on lower-level evidence with inconsistent findings and/or varying interpretations or conclusion by expert panel). Available at: http://www.sages.org/publications/guidelines/guidelines-for-clinical-application-of-laparoscopic-bariatric-surgery/
The Expert Committee[3]*	2007	The Expert Committee recommends that treatment of children between the ages of 2 and 19 years whose BMI is > 85th percentile be approached with a staged method based on the child's age, BMI, related comorbidities, parents' weight status, and progress in treatment and that the child's primary caregivers and family be involved in the process. This approach promotes brief, office-based intervention for the greatest number of children with overweight or obesity and then a systematic intensification of efforts, tailored to the capacity of the clinical office, the motivation of the family, and the degree of obesity, with the most aggressive treatment stage being considered only for those who have not responded to other interventions. Stage 1: Prevention Plus protocol • Consume ≥ 5 servings of fruits and vegetables per day • Minimize or eliminate sugar-sweetened beverages • Limit screen time to ≤ 2 hours per day • Engage in ≥ 1 hour of daily physical activity The patient and the family of the patient should be counseled to facilitate: • Eating a daily breakfast • Limiting meals outside the home • Eating family meals at least 5 or 6 times per week • Allowing child to self-regulate meals; avoiding overly restrictive behaviors The goal should be weight maintenance, with growth resulting in decreasing BMI as age increases. Stage 2: Structured Weight Maintenance protocol • Balanced macronutrient diet with small amounts of energy-dense foods • Provision of structured daily meals and snacks • Supervised active play of ≥ 60 minutes per day • Screen time of ≤ 1 hour per day • Increased monitoring by provider, patient, and/or family • Reinforcement for achieving targeted behavior goals (not weight goals) The goal should be weight maintenance that results in decreasing BMI as age and height increase; however, weight loss should not exceed 1 lb/month for children 2 to 11 years of age or an average of 2 lb/week for older children and adolescents who are overweight or have obesity. Stage 3: Comprehensive Multidisciplinary intervention • Eating and activity goals are the same as in stage 2 • Planned negative energy balance achieved through structured diet and physical activity • Structured behavioral modification program, including food and activity monitoring and development of short-term diet and physical activity goals • Involvement of primary caregivers/family members for behavioral modification for children < 12 years of age • Provision of training for all families to improve the home environment • Frequent office visits The goal should be weight maintenance or gradual weight loss until BMI is < 85th percentile. Weight loss should not exceed 1 lb/month for children 2 to 5 years of age or 2 lbs/week for older children and adolescents with obesity.

Organization	Date	Weight Management Recommendation
		Stage 4: Tertiary Care protocol The expert committee recommends stage 4 for children > 11 years of age with BMI of > 95th percentile who have significant comorbidities and who have not been successful in stages 1 to 3 or children with BMI of > 99th percentile who have shown no improvement in stage 3. Stage 4 is referral to a pediatric tertiary weight management center, operating under a designed protocol, which should include continued diet and activity counseling and the consideration of such additions as meal replacement, very low-calorie diet, medication, and surgery. Available at: http://pediatrics.aappublications.org/content/120/Supplement_4/S164.abstract
Spanish National Healthcare System[204]	2007	For the treatment of children and adolescents with overweight or obesity, the following are recommended: • Healthy, balanced diet according to the healthy eating pyramid and caloric intake must be lower than energy expended; the use of restricted, unbalanced diets is not recommended; and advice on changes to diet must be given by healthcare professionals who regularly interact with children. • The dietary intervention must be carried out as part of a multi-component intervention including physical activity, behavioral therapy, and family-centered actions for a change in lifestyle. • Physical activity should be increased to more than one hour per day and suited to the age and interests of the child; intensity and duration should be gradually increased. • Reduce sedentary activities to less than 1.5 hours each day; electronic devices should be removed from the child's bedroom. • Psychological support (behavioral or cognitive behavioral therapy) is recommended and should be aimed at reducing stress. Individual or group psychological treatment should be included in combined interventions. • Combined interventions in clinical and family settings which include diet, physical activity, and behavior change with family involvement are recommended in children aged 6-16 years. • Orlistat may be considered as part of a program of lifestyle change for adolescents aged 12-18 years suffering from obesity and severe comorbidities and should be supplemented with a multivitamin. • Bariatric surgery should only be performed in adolescents suffering from severe obesity (BMI ≥ 40 kg/m^2) and severe comorbidity or extreme obesity (BMI ≥ 50 kg/m^2) and only when attempts to control weight via intensive actions to alter lifestyle, with or without pharmacotherapy, for ≥ 6 months have failed. • The use of alternative treatments is not recommended. Available at: http://www.guiasalud.es/GPC/GPC_452_obes_infantojuv_AATRM_compl_en.pdf
American Dietetic Association (ADA)[205]	2006	The ADA takes the position that pediatric overweight intervention requires a combination of family- and school-based multicomponent programs that include physical activity promotion, parent training/modeling, behavioral counseling, and nutritional education. The ADA found limited evidence to support routine recommendation of individual-based intervention for 5- to 12-year-old children. The ADA found the following for family-based intervention for 5- to 12-year-old children: multicomponent interventions should be routinely recommended; parent training – recommended as part of a multicomponent program; individual psychotherapy – lack of evidence to base any recommendation; dietary counseling/nutrition education – recommended as part of a multicomponent program; altered macronutrient approaches – limited evidence to support routine recommendation; physical activity – recommended as part of a multicomponent program; sedentary behaviors – recommended in conjunction with methods to increase physical activity within a multicomponent program; behavioral counseling – recommended as part of a multicomponent program. The ADA found limited evidence to support routine recommendation of school-based secondary prevention of child and adolescent overweight.

Organization	Date	Weight Management Recommendation
		Available at: http://www.ncbi.nlm.nih.gov/pubmed/16812927
Obesity Canada Clinical Practice Guidelines Expert Panel[206]	2006	Obesity Canada recommends a comprehensive healthy lifestyle intervention for people with overweight or obesity. Primary care health professionals are encouraged to work with other healthcare team members to develop a comprehensive weight management program. Obesity Canada recommends an energy-reduced diet and regular physical activity as the first treatment option for children who are overweight or have obesity, with ongoing follow-up for a minimum of three months. The primary care physician or health care team should encourage children and adolescents to reduce sedentary pursuits and "screen time". Individuals willing to participate in weight management programs should be provided with education and support in behavior modification techniques. Obesity Canada suggests using family-oriented behavior therapy for treating obesity in children. Obesity Canada suggests that orlistat be considered to aid in weight reduction and maintenance when added to a regimen of lifestyle intervention among adolescents. Because of lack of data for prepubertal children, the use of pharmacologic agents in this group should be considered only within the context of a supervised clinical trial. Bariatric surgery should be limited to exceptional cases among adolescents. There is insufficient evidence to recommend in favor or against the use of herbal remedies, dietary supplements, or homeopathy for weight management. Available at: http://www.cmaj.ca/content/176/8/S1.full
American Association of Clinical Endocrinologists (AACE) and American College of Endocrinology (ACE)[207]	1998	The AACE/ACE recommends that all patients with obesity should undergo basic treatment that encourages lifestyle changes and includes counseling, caloric restriction, behavior therapy, and physical activity. When treating adolescents and children with obesity, the physician should consider developing an alliance with family, treating the parents also, using positive reinforcement, emphasizing the importance of family involvement in a physical activity program, promoting a conservative approach to caloric restriction for most patients, and prescribing more restrictive diets only for those with comorbidities. Available at: https://www.aace.com/files/obesityguide.pdf
Canadian Task Force on the Periodic Health Examination[208]†	1994	There is insufficient evidence to include counseling about nutrition and exercise in or exclude it from the routine treatment of children with severe obesity (grade C recommendation: poor evidence regarding the inclusion of the condition in a periodic health examination but recommendations be made on other grounds). There is fair evidence to exclude very-low-kilojoule diets from the routine treatment of preadolescent children with obesity (grade D recommendation: fair evidence to support the condition be excluded from consideration in a periodic health examination). There is conflicting evidence concerning the inclusion or exclusion of exercise in the routine treatment of children with obesity (grade C recommendation: poor evidence regarding the inclusion of the condition in a periodic health examination but recommendations be made on other grounds). Available at: http://canadiantaskforce.ca/ctfphc-guidelines/2015-obesity-children/protocol/

*****Convened by American Medical Association, Health Resources and Services Administration, and Centers for Disease Control and Prevention, endorsed by the American Academy of Pediatrics
†Currently being updated, expected date when evidence review and/or recommendation will be available to the public not reported

Abbreviations: AACE = American Association of Clinical Endocrinologists; AAFP = American Association of Family Practitioners; ACE = American College of Endocrinology; ADA = American Dietetic Association; AHA = American Heart Association; ASMBS = American Society for Metabolic and Bariatric Surgery; BMI = body mass index; BSCG = Bariatric Scientific Collaboration Group; e.g.: exempli gratia; FDA = U.S. Food and Drug Administration; ICSI = Institute for Clinical Systems Improvement; IPEG = International Pediatric Endosurgery Group; kg = kilogram(s); lb(s) = pound(s); m = meter(s); mg = milligram(s); NHMRC = National Health and Medical Research Council of Australia; NHLBI = National Heart, Lung, and Blood Institute; NICE = National Institute for Health and Care Excellence; SAGES = Society of American Gastrointestinal and

Endoscopic Surgeons; SD = standard deviation; SIGN = Scottish Intercollegiate Guidelines Network; UK = United Kingdom; USPSTF = U.S. Preventive Services Task Force

Table 3. Study design characteristics of included studies, sorted alphabetically

Author, Year and Quality	N Rand.	Followup months (% followed at timepoint closes to 12 months)	Country	Design	Population	Baseline BMI and zBMI (mean)	Est Hours Contact (Sessions)*	Efficacy	CE	Maintenance Only
Banks, 2012[80] Fair	76	12 (68.4)	United Kingdom	RCT	5 to 16 years with BMI ≥ 98th percentile (UK norms)	NR 3.05	2.5 (5)		X	
Bathrellou, 2010[119] Fair	47	18 (76.2)	Greece	RCT	7 to 12 year olds who are overweight or have obesity (IOTF)	27.0 NR	21 (21)		X	
Berkowitz, 2012[81] Fair	173	12 (67.5)	United States	RCT	12 to 16 year olds who have obesity (BMI ≥ 28 kg/m2 [CDC])	36.7 2.3	38.5 (23)		X	
Berry, 2014[92] Fair	358	12; 18 (NR)	United States	Cluster RCT	7 to 10 year olds who are overweight or have obesity (BMI ≥ 85th percentile for age and sex [CDC]) with at least one overweight parent	NR	36.75 (21)	X		
Bocca, 2012[93] Fair	75	12 (76.0)	Netherlands	RCT	3 to 5 year olds who are overweight or have obesity (IOTF)	21.1 2.7	30 (25)	X		
Broccoli, 2016[94] Good	372	12; 24 (95.4)	Italy	RCT	4 to 7 year olds who are overweight (85th-95th BMI percentile [CDC])	18.25 1.35	3.75 (5)	X		
Bryant, 2011[95] Fair	70	12 (75.7)	United Kingdom	RCT	8 to 16 year olds with obesity (BMI > 98th percentile, [NR])	NR 2.99	24 (16)	X		
Coppins, 2011[96] Fair	65	12 (84.6)	United Kingdom	RCT	6 to 14 year olds who have obesity (BMI ≥ 91st percentile [UK norms])	27.5 2.7	48 (78)	X		
Davis, 2012[117] Fair	61	8 (86.9)	United States	RCT	Adolescent African Americans or Latinos in grades 9 through 12 who had completed initial 4-month weight loss intervention and are overweight or have obesity (≥85th percentile [CDC])	34.9 2.2	16 (14)			X
de Niet, 2012[120] Fair	141	12 (78.0)	Netherlands	RCT	7 to 12 year olds who are overweight or have obesity (IOTF)	NR 2.6	47.5 (11)		X	

Author, Year and Quality	N Rand.	Followup months (% followed at timepoint closes to 12 months)	Country	Design	Population	Baseline BMI and zBMI (mean)	Est Hours Contact (Sessions)*	Efficacy	CE	Maintenance Only
DeBar, 2012[69] Good	208	12 (83.2)	United States	RCT	12 to 17 year old females who are overweight or have obesity (BMI ≥ 90th percentile [CDC])	31.9 2.00	36.5 (18)	X		
Epstein, 1985a[82] Fair	23	12 (82.6)	United States	RCT	8 to 12 year old females who have obesity (at least 20% over ideal weight for height and age [WHO])	NR	66.5 (54)		X	
Epstein, 1985b[83] Fair	24	12; 24 (75.0)	United States	RCT	5 to 8 year old females who have obesity (NR)	22.7 NR	64 (25)		X	
Epstein, 1994[84] Good	44	24 (88.6)	United States	RCT	8 to 12 year olds who have obesity (between 20-100% over average weight for height [CDC])	NR	64 (32)		X	
Epstein, 1995[85] Fair	61	12 (90)	United States	RCT	8 to 12 year olds who have obesity (btwn 20-100% overweight [CDC])	NR	40.5 (18)		X	
Epstein, 2000a[121] Good	90	24 (84.4)	United States	RCT	8 to 12 year olds who have obesity (btwn 20-100% overweight, comparing to population standards based on sex and age [CDC])	NR	30 (20)		X	
Epstein, 2000b[122] Fair	67	12; 24 (77.6)	United States	RCT	Children who are overweight (> 20% overweight; based on 50th BMI percentile [CDC])	27.4 2.7	30 (20)		X	
Epstein, 2004[123] Good	72	12 (95.2)	United States	RCT	8 to 12 year olds who have obesity (BMI > 85th percentile [CDC])	27.7 3.2	30 (20)		X	
Epstein, 2008b[124] Fair	41	12; 24 (65.8)	United States	RCT	8 to 12 year olds who are overweight (BMI > 85th percentile [CDC])	NR 2.3	32.5 (13)		X	
Epstein, 2014[125] Fair	54	12 (66)	United States	RCT	8 to 12 year olds who are overweight or have obesity with at least one overweight parent (BMI ≥ 85th percentile [NR])	29.2 NR	26.25 (15)		X	

Author, Year and Quality	N Rand.	Followup months (% followed at timepoint closes to 12 months)	Country	Design	Population	Baseline BMI and zBMI (mean)	Est Hours Contact (Sessions)*	Efficacy	CE	Maintenance Only
Estabrooks, 2009[126] Fair	220	12 (70.4)	United States	RCT	8 to 12 year olds who are overweight (BMI ≥ 85th percentile for age [CDC])	27.2 2.04	4 (2)		X	
Garipagaoglu, 2009[127] Fair	80	12 (95.0)	Turkey	RCT	6 to 14 years who have obesity (BMI >97th percentile [Turkish norms])	27.7 2.46	10.5 (7)		X	
Gerards, 2015[97] Fair	86	12 (77.9)	Netherlands	RCT	4 to 8 year olds who are overweight or have obesity (IOTF)	20.5 1.84	16.5 (14)	X		
Goldfield, 2001[128] Fair	31	12 (77.4)	United States	RCT	8 to 12 year olds who have obesity (btwn 20-100% overweight [CDC])	NR 2.8	21.67 (13)		X	
Golley, 2007[70] Fair	111	12 (82.0)	Australia	RCT	6 to 9 year olds who are overweight or have obesity, but zBMI≤3.5 (IOTF)	24.3 2.75	23.75 (18)	X	X	
Grey, 2004[86] Fair	41	12 (100)	United States	SG-CRCT	10 to 14 years who have obesity (BMI≥95th percentile [norms NR])	36.4 NR	39 (60)		X	
Hughes, 2008[98] Fair	134	12 (64.2)	United Kingdom	RCT	5-11 year olds who have obesity (≥ 98th percentile [UK norms])	NR 3.2	5 (8)	X		
Hystad, 2013[129] Fair	99	24 (80.8)	Norway	RCT	7 to 12 year olds who have obesity (zBMI ≥ 2 [norms NR])	28.6 3.00	65 (25)		X	
Israel, 1985[87] Fair	24	12 (83.3)	United States	RCT	8 to 12 year olds who are overweight or have obesity (≥ 20% overweight [1977 NCHS norms])	NR	35.5 (37)		X	
Johnston, 2010[130] Fair	60	12; 24 (95.0)	United States	RCT	10 to 14 year old Mexican Americans who are overweight or have obesity (>85th percentile [CDC])	25.7 1.6	47.25 (72)		X	

Author, Year and Quality	N Rand.	Followup months (% followed at timepoint closes to 12 months)	Country	Design	Population	Baseline BMI and zBMI (mean)	Est Hours Contact (Sessions)*	Efficacy	CE	Maintenance Only
Johnston, 2013[131] Fair	71	12; 24 (91.5)	United States	RCT	10 to 14 year old Mexican Americans who are overweight or have obesity (>85th percentile [CDC])	27.0 1.8	47.25 (72)		X	
Kalarchian, 2009[71] Fair	192	12; 18 (72.4)	United States	RCT	8 to 12 year olds with severe obesity (BMI ≥ 97th percentile [CDC])	32.12 NR	43.75 (26)	X		
Kalavainen, 2007[99] Fair	70	12; 24; 36 (98.6)	Finland	RCT	7 to 9 year olds with obesity (weight for height 120-200% of median [UK norms])	23.2 2.6	43.5 (15)	X		
Larsen, 2015[88] Fair	80	24 (92.5)	Denmark	RCT	5 to 9 year olds who are overweight (IOTF)	NR 2.84	18 (21)		X	
Magarey, 2011[89] Fair	169	12; 18; 24 (72.8)	Australia	RCT	5 to 9 year olds who are overweight (IOTF)	24.1 2.72	33 (16)		X	
McCallum, 2007[72] Good	163	15 (89.6)	Australia	RCT	5 to 9 year olds who are overweight or have mild obesity (IOTF [but zBMI <3.0])	20.3 1.9	1 (4)	X		
Nemet, 2005[100] Fair	54	12 (74.1)	Israel	RCT	6 to 16 year olds with obesity (definition NR)	28.2 NR	32.5 (34)	X		
Nguyen, 2012[132] Fair	151	12; 24 (70.9)	Australia	RCT	13 to 16 year olds who are overweight or have mild obesity (zBMI 1.0-2.5 [CDC])	30.8 2.02	26.8 (28)		X	
Norman, 2015[73] Fair	106	12 (80.2)	United States	RCT	11 to 13 year olds with obesity (BMI ≥ 95 percentile for age and gender [CDC])	29.3 2.1	8.25 (27)	X		
Nowicka, 2008[101] Fair	95	12 (92.6)	Sweden	CCT	12 to 19 year olds with obesity (IOTF)	34.5 3.25	16 (4)	X		

Author, Year and Quality	N Rand.	Followup months (% followed at timepoint closes to 12 months)	Country	Design	Population	Baseline BMI and zBMI (mean)	Est Hours Contact (Sessions)*	Efficacy	CE	Maintenance Only
Patrick, 2013[102] Fair	101	12 (63.4)	United States	RCT	12 to 16 year olds who are overweight or have obesity (>85th percentile, or 120% of ideal weight [CDC] and at-risk for type 2 diabetes (based on family hx, race/ethnicity, insulin resistance)	NR 2.2	38 (18)	X	X	
Quattrin, 2014[74] Fair	105	12; 18; 24 (76.2)	United States	RCT	2 to 5 year olds who are overweight or have obesity (BMI ≥ 85th percentile [norms NR]) with at least one overweight parent	20.2 2.11	39.25 (29)	X	X	
Raynor, 2012b[103] Fair	81	12 (91.4)	United States	RCT	4 to 9 year olds who are overweight or have obesity (≥ 85th BMI percentile [CDC])	NR 2.27	6 (8)	X	X	
Reinehr, 2006[104] Fair	240	12; 24 (87.9)	Germany	CCT	6 to 14 year olds with obesity (BMI ≥ 97th percentile [German norms])	26.9 2.4	77.5 (52)	X		
Reinehr, 2009[105] Fair	474	12 (100)	Germany	CCT	10 to 16 year olds with obesity (minimum BMI NR [German norms])	NR 2.46	77.5 (52)	X		
Resnick, 2009[75] Fair	46	12 (93.5)	United States	RCT	Parents of children in grades K through 5 who are overweight or have obesity (BMI ≥ 85th percentile [CDC])	NR	1.7 (3)	X		
Resnicow, 2005[90] Fair	147	12 (73)	United States	Cluster RCT	12 to 16 year old African-American females who are overweight or have obesity (BMI >90 percentile for age and gender [CDC])	32.0 NR	45.5 (29)		X	
Resnicow, 2015[76] Fair	645	24 (70.9)	United States	Cluster RCT	2 to 8 year olds who are overweight or have obesity (BMI 85-97th percentile [CDC])	NR	2.5 (10)	X	X	

Author, Year and Quality	N Rand.	Followup months (% followed at timepoint closes to 12 months)	Country	Design	Population	Baseline BMI and zBMI (mean)	Est Hours Contact (Sessions)*	Efficacy	CE	Maintenance Only
Saelens, 2013[133] Fair	89	12; 24 (66.3)	United States	RCT	7 to 11 year olds who are overweight or have obesity (≥85th percentile, but not >75% above median [CDC]) with at least one overweight parent	26.5 2.1	40 (20)		X	
Savoye, 2007[106] Fair	209	12 (68.4)	United States	RCT	8 to 16 year olds with obesity (BMI > 95th percentile [CDC])	36.0 NR	82.33 (64)	X		
Stark, 2011[107] Fair	18	12 (88.9)	United States	RCT	2 to 5 year olds with at least one overweight parent and who have obesity (≥ 95th BMI percentile but < 100% above the mean BMI [CDC])	NR	38.25 (18)	X		
Stark, 2014[108] Fair	27	12 (85.2)	United States	RCT	2 to 5 year olds with at least one overweight parent and who have obesity (≥ 95th BMI percentile but < 100% above the mean BMI [CDC])	NR 2.4	30 (10)	X		
Steele, 2012[134] Fair	93	12 (62.4)	United States	RCT	7 to 17 year olds who are overweight or have obesity (BMI ≥ 85th 59ne59entile [CDC])	NR 2.22	28.3 (10)		X	
Stettler, 2014[109] Fair	173	12; 24 (69.9)	United States	Cluster RCT	8 to 12 year olds who are overweight (75th-95th percentile [CDC]) and consuming average of ≥ 4 ounces of sugar sweetened beverages/day	21.6 1.24	4 (12)	X		
Taveras, 2011[110] Good	475	12; 24 (93.7)	United States	Cluster RCT	2 to 6 year olds who are overweight (≥ 85th percentile [CDC]) and have an overweight parent (BMI ≥ 25), or are obese (≥ 95th percentile)	19.2 1.85	2.67 (8)	X		
Taveras, 2015[111] Good	549	12 (94.4)	United States	Cluster RCT	6 to 12 years olds with obesity (≥ 95th percentile [CDC])	25.8 2.06	1.25 (5)	X	X	

Author, Year and Quality	N Rand.	Followup months (% followed at timepoint closes to 12 months)	Country	Design	Population	Baseline BMI and zBMI (mean)	Est Hours Contact (Sessions)*	Efficacy	CE	Maintenance Only
Taylor, 2015[112] Good	206	12; 24 (87.9)	New Zealand	RCT	4 to 8 years old who are overweight or have obesity (BMI ≥ 85th percentile [CDC])	19.4 1.63	7.2 (14)	X		
Toruner, 2010[77] Fair	84	12 (NR)	Turkey	SG-CRCT	4th graders who are overweight or have obesity (>90th percentile [Turkish norms])	23.1 NR	9.75 (7)	X		
Van Grieken, 2013[78] Fair	637	24 (79.6)	Netherlands	Cluster RCT	5 year olds who are overweight but do not have obesity (IOTF)	18.13 NR	2 (4)	X		
Vos, 2011[113] Fair	81	12 (82.7)	Netherlands	RCT	8 to 17 year olds with obesity (IOTF)	32.5 4.3	46.25 (19)	X		
Wake, 2009[79] Good	258	12 (95.0)	Australia	RCT	5 to 10 year olds who are overweight or have obesity but zBMI <3.0 (IOTF and UK norms)	20.2 1.9	1 (4)	X		
Wake, 2013[114] Good	118	12 (90.7)	Australia	RCT	3 to 10 year olds with obesity (≥95th percentile [CDC])	22.5 2.2	2.5 (6)	X		
Weigel, 2008[115] Fair	73	12 (90.4)	Germany	RCT	7 to 15 year olds with obesity (>97th percentile [German norms])	28.6 2.36	114.1 (104)	X		
Wilfley, 2007[118] Good	150	12; 24 (86)	United States	RCT	7 to 12 year olds who are overweight or have obesity (20-100 above median [CDC]) with at least one overweight parent	27.5 NR	60 (36)		X	X
Williamson, 2006[116] Fair	61	12; 15; 24 (65.6)	United States	RCT	11 to 15 year old African American females who are overweight or obese (BMI > 85th percentile for age and sex [NHANES]) with at least one obese parent	36.4 NR	4 (4)	X		

*Estimated hours of contacts and number of sessions of the most intensive intervention

Abbreviations: BMI = body mass index; CDC = Centers for Disease Control and Prevention; hx = history; IOTF = International Obesity TaskForce; NCHS = National Center for Health Statistics; NHANES = National Health and Nutrition Examination Survey; NR = not reported; RCT = randomized, controlled trial; UK = United Kingdom; WHO = World Health Organization; zBMI = body mass index z-score

Table 4. Intervention characteristics of included efficacy and maintenance trials, in order of descending estimated contact hours

Author, Year and Quality	Description	Est contact hours	# Sessions	Duration, mos	Setting	Delivery				Format		Target			Interventionist Professional in Field		
						In-Person	Phone	Web-based	Print	Individual	Group	Parent	Child	Family	Behavior	Diet	PA
Weigel, 2008[115] Fair	Twice weekly 45-60-min child group sessions for 12 months, including PA, dietary education, and coping strategies; 12 separate monthly 2-hour parent support meetings that included some parent-child activities	114.1	104	12	Local sports center and health association	X					X	X	X	X	X	X	X
Reinehr, 2006[104] Fair	Intensive year-long comprehensive program; 9-session parent group course, 6-session behavior therapy and nutrition education groups for children, weekly PA sessions, 6 individual family therapy sessions (more as needed)	77.5	52	12	Obesity clinic	X				X	X	X	X	X	X	X	X
Reinehr, 2009[105] Fair	Intensive year-long comprehensive program; 9-session parent group course, 6-session behavior therapy and nutrition education groups for children, weekly PA sessions, 3 individual family therapy sessions (more as needed)	77.5	52	12	Treatment centers	X				X	X	X	X	X	X	X	X
Savoye, 2007[106] Fair	Twenty-six weekly nutrition education and behavioral management sessions using Smart Moves Workbook, twice-weekly physical activity sessions tapering to twice-monthly after 6 months	82.33	64	12	Pediatric obesity clinic	X			X		X	X	X	X	X	X	X
Coppins, 2011[96] Fair	Two family-based multidisciplinary workshops (8 total hours) and 2 PA sessions/week during the school term; workshops involved separate group sessions for parents and children with some joint content	48	78	12	School	X					X	X	X	X	X	X	X

Author, Year and Quality	Description	Est contact hours	# Sessions	Duration, mos	Setting	Delivery				Format		Target			Interventionist Professional in Field		
						In-Person	Phone	Web-based	Print	Individual	Group	Parent	Child	Family	Behavior	Diet	PA
Vos, 2011[113] Fair	Two individual family assessment and advice visits followed by 7 2.5-hr group comprehensive behavioral lifestyle meetings, parents and children usually separate, plus 2-3 booster group sessions yearly	46.25	19	24	Not reported—assumed health care	X				X	X	X	X	X	X	X	X
Kalarchian, 2009[71] Fair	Twenty 60-min separate adult and child group sessions including weekly family meeting with lifestyle coach; adult also set goals, modeled behavior change; 6 booster sessions (3 group, 3 phone)	43.75	26	12	University Medical Center	X	X			X	X	X	X	X			
Kalavainen, 2007[99] Fair	15 90-min group sessions, parents and children mostly separate; parents targeted as main agents of change; interactive activities and PA for children; manuals for parents, workbooks for children and homework assigned	43.5	15	6	Pediatric outpatient clinic	X			X		X	X	X	X		X	
Quattrin, 2014[74] Fair	Sixteen 60-minute parent group sessions, 16 brief individual parent meetings, 13 phones calls for weight management education program, plus 16 child active game sessions	39.25	29	24	Pediatric Patient Centered Medical Home	X	X			X	X	X	X		X		X
Stark, 2011[107] Fair	Nine clinic-based 90-min comprehensive behavioral lifestyle group sessions for parents and children separately plus 9 home vis; vegetable taste tests, pedometers, parents received 2 weeks' worth of vegetables, child sessions included 15-min PA.	38.25	18	6	Cincinnati Children's Hospital Medical Center	X				X	X	X	X	X	X	X	
Patrick, 2013[102] Fair	Access to website and tutorials to promote weight loss and healthy behaviors + 12 monthly 90-minute group sessions for adolescents and parents and brief bi-monthly phone calls for adolescent	38	18	12	Group meeting setting not described—assumed health care	X	X	X	X	X	X		X	X			

Author, Year and Quality	Description	Est contact hours	# Sessions	Duration, mos	Setting	Delivery				Format		Target			Interventionist Professional in Field		
						In-Person	Phone	Web-based	Print	Individual	Group	Parent	Child	Family	Behavior	Diet	PA
Berry, 2014[92] Fair	21-session nutrition/exercise education and coping skills weight management program for parents and children	36.75	21	12	School	X					X	X	X	X		X	X
DeBar, 2012[69] Good	Sixteen 90-min group developmentally-tailored multicomponent behavioral intervention sessions for adolescent girls; 12 with concurrent parent sessions; trained PCP to support behavioral weight management goals; 2 PCP meetings	36.5	18	5	Health maintenance organization	X	X			X	X	X	X			X	
Nemet, 2005[100] Fair	4 evening lectures for parents, 6 dietician meetings, and twice-weekly PA sessions for 3 months	32.5	34	3	Child health and sports center of a general hospital	X			X	X	X	X	X	X		X	X
Bocca, 2012[93] Fair	25-session multidisciplinary intervention consisting of dietician visits, PA sessions for children, and behavioral therapy sessions for parents	30	25	4	Outpatient clinic in a hospital (Groningen Expert Center for Kids with Obesity)	X				X	X	X	X	X		X	X
Stark, 2014[108] Fair	Ten 90-min comprehensive behavioral lifestyle group sessions for parents and children separately; vegetable taste tests, pedometers, parents received 2 weeks' worth of vegetables, child sessions included 15-min of moderate-to-vigorous PA.	30	10	6	Cincinnati Children's Hospital	X				X	X	X	X				

Author, Year and Quality	Description	Est contact hours	# Sessions	Duration, mos	Setting	Delivery				Format		Target			Interventionist Professional in Field		
						In-Person	Phone	Web-based	Print	Individual	Group	Parent	Child	Family	Behavior	Diet	PA
Bryant, 2011[95] Fair	16 weekly 30-min individual sessions for support and encouragement and 1-hr PA group sessions; motivational enhancement and solution-focused approach to lifestyle change	24	16	12	NHS-sponsored medical clinic; took place in community settings (community centers, sports centers)	X				X	X		X	X			X
Golley, 2007[70] Fair	Four 2-hr group sessions + 7 individual phone calls aimed at changing parenting practices and general parenting styles, and 7- session behavioral healthy lifestyle group for parents and concurrent child PA sessions	23.75	18	5	Metropolitan teaching hospitals	X	X		X	X	X	X	X			X	
Gerards, 2015[97] Fair	10 90-minute group sessions and four individual 15-30 minute phone sessions aimed at changing parenting practices and styles with specific strategies around lifestyle change; workbook, recipes and active games booklet	16.5	14	3.5	Public health service	X	X		X	X	X	X					
Nowicka, 2008[101] Fair	Four 4-hr family group comprehensive behavioral lifestyle meetings, emphasizing communication skills, mutual support, consistency, establishing appropriate limits; 10-min individual meeting with pediatrician each session	16	4	12	Childhood obesity center	X				X	X	X	X	X	X	X	X

Author, Year and Quality	Description	Est contact hours	# Sessions	Duration, mos	Setting	Delivery				Format		Target			Interventionist Professional in Field		
						In-Person	Phone	Web-based	Print	Individual	Group	Parent	Child	Family	Behavior	Diet	PA
Norman, 2015[73] Fair	Brief PCP visits + "stepped-down" care tailored to progress of individuals; Step 1: 4 health ed visits + 8 calls, Step 2: 2 visits + 8 calls, Step 3: 4 calls	8.25	27	12	Pediatric primary care	X	X		X	X		X	X	X			
Toruner, 2010[77] Fair	School-based intervention consisting of seven 40-70 minute group child sessions, 2 parent group sessions and 30-50 minute individual parent counseling	9.75	7	2.5	School	X				X	X	X	X				
Taylor, 2015[112] Good	One individual 1-2 hour multidisciplinary session with parents followed by 16 brief contacts for tailored behavioral lifestyle change support.	7.2	14	24	University clinic and home	X	X			X		X			X	X	X
Raynor, 2012b[103] Fair	Eight 45-minute parent group sessions covering behavioral strategies to increase PA and reduce sugar-sweetened beverage consumption; growth assessed at 0, 3, 6 months with accompanying letter providing anthropometric information and interpretation	6	8	6	Medical-school research setting	X					X	X			X		
Hughes, 2008[98] Fair	Eight individual family appointments w/ dietitian (7 outpatient, 1 home visit) over 6 months (total contact time of 5 hours) for family behavior change counseling.	5	8	6	Royal Hospitals for Sick Children in Glasgow and Edinburgh	X				X				X		X	
Stettler, 2014[109] Fair	Twelve 15-25 min sessions targeting healthy beverages, increased PA, and reduced sedentary activity, incorporating behavior change techniques	4	12	12	Pediatric primary care practices	X				X				X			

Author, Year and Quality	Description	Est contact hours	# Sessions	Duration, mos	Setting	Delivery				Format		Target			Interventionist Professional in Field		
						In-Person	Phone	Web-based	Print	Individual	Group	Parent	Child	Family	Behavior	Diet	PA
Williamson, 2006[116] Fair	2-year internet-based family weight management program, including website access, 4 face-to-face counseling sessions during first 12 weeks and on-going email-based counseling, culturally tailored for African-American families.	4	4	24	Internet-based	X		X		X		X	X	X	X		
Broccoli, 2016[94] Good	Five individual motivational interviewing sessions with parent and child and pediatrician; families decided on goals, progress discussed at subsequent meetings	3.75	5	3	Pediatric offices	X				X		X	X	X			
Taveras, 2011[110] Good	4 25-min in-person + 3 15-min phone motivational interviewing sessions with nurse practitioner. Pediatricians endorsed messages during well-child visits. Tailored materials, behavior monitoring tools, enhanced electronic medical record.	2.67	8	12	Pediatric primary care	X	X	X	X	X				X			
Resnicow, 2015[76] Fair	Four brief motivational interviewing (MI) counseling sessions by PCP + 6 MI counseling sessions from RD conducted over 2 years, targeting diet and activity behaviors	2.5	10	24	Pediatric primary care clinics	X	X		X	X		X				X	
Wake, 2013[114] Good	One hour-long family visit with obesity specialist team to develop plan and goals, followed by GP visits every 4-8 weeks using brief solution-focused techniques; web-based software (HopSCOTCH) used to track progress and link specialist team with GP	2.5	6	12	Primary care and tertiary weight management service	X				X				X		X	
Van Grieken, 2013[78] Fair	Prevention protocol involving motivational interviewing during a well-child visit. 3 additional structured healthy lifestyle counseling sessions matched to parents' stage of change could be offered.	2	4	12	Youth Health Care Centers	X			X	X				X			

Author, Year and Quality	Description	Est contact hours	# Sessions	Duration, mos	Setting	Delivery				Format		Target			Interventionist Professional in Field		
						In-Person	Phone	Web-based	Print	Individual	Group	Parent	Child	Family	Behavior	Diet	PA
Resnick, 2009[75] Fair	Five educational mailings over 30 weeks plus at least one home visit or phone call to discuss lifestyle topic of parent's choice.	1.7	3	7.5	At home	X	X		X	X		X					
Taveras, 2015[111] Good	Computerized clinical decision support system with point of care prompts at well-child visit, motivational interview, pt materials + 4 phone motivational interviewing sessions by health coach and optional text msg program	1.25	5	12	Pediatric clinics	X	X	X	X	X		X		X			
McCallum, 2007[72] Good	Four GP consultations using brief solution-focused family therapy for healthy lifestyle goals; 16-page folder of materials including topic sheets, wall chart, reward stickers, and shopping tips	1	4	3	Primary care	X			X	X				X			
Wake, 2009[79] Good	Four GP consultations using brief solution-focused family therapy for healthy lifestyle goals; 16-page folder of materials including topic sheets, wall chart, reward stickers, and shopping tips	1	4	3	Family medical practices	X			X	X				X			
Maintenance trials																	
Davis, 2012[117] Fair	Eight 90-min group classes for adolescents after completion of weight loss program, reinforcing the content previously covered; 4 additional motivational telephone calls to explore and resolve ambivalence; separate parent classes, asked to attend 2.	16	14	8	Medical research facility	X	X			X	X	X	X				X
Wilfley, 2007[118] Good	Combined maintenance groups: 20-session Family-based comprehensive weight management program + either behavioral skills or social facilitation maintenance	60	36	9	University research setting	X				X	X	X	X	X	X		
	Behavioral skills maintenance : 20-session Family-based comprehensive weight management program + behavioral skills maintenance component	60	36	9	University research setting	X				X	X			X	X		

Author, Year and Quality	Description	Est contact hours	# Sessions	Duration, mos	Setting	Delivery				Format		Target			Interventionist Professional in Field		
						In-Person	Phone	Web-based	Print	Individual	Group	Parent	Child	Family	Behavior	Diet	PA
	Social facilitation maintenance : 20-session Family-based comprehensive weight management program + social facilitation maintenance component	60	36	9	University research setting	X				X	X	X	X	X	X		

Abbreviations: CDS = clinical decision support; CG = control group; ed = education; EMR = electronic medical records; hr = hour(s); GP = general practice; IG = intervention group; IVR = interactive voice response; MI = motivational interview; min = minute(s); msg = message; NHS = National Health System; PA = physical activity; PCP = primary care provider; pt = patient; RD = registered dietician; SMS = short messaging service; tx = treatment

Table 5. Intervention components of included efficacy and maintenance trials, in order of descending estimated contact hours

Author, Year and Quality	Description	Est hours	Goals & Planning	Collaborative Goals	Comparison of Outcomes	Self-Monitoring	Self-Monitoring Outcome	Contingent Reward	Stimulus Control	MI	Parental Modeling	Parenting Skills	Supervised PA	Cultural Tailor.
Weigel, 2008[115] Fair	Twice weekly 45-60-min child group sessions for 12 months, including PA, dietary education, and coping strategies; 12 separate monthly 2-hour parent support meetings that included some parent-child activities	114.1				X							X	
Savoye, 2007[106] Fair	Twenty-six weekly nutrition education and behavioral management sessions using Smart Moves Workbook, twice-weekly physical activity sessions tapering to twice-monthly after 6 months	82.33	X					X	X		X		X	
Reinehr, 2006[104] Fair	Intensive year-long comprehensive program; 9-session parent group course, 6-session behavior therapy and nutrition education groups for children, weekly PA sessions, 6 individual family therapy sessions (more as needed)	77.5	X				X	X			X		X	
Reinehr, 2009[105] Fair	Intensive year-long comprehensive program; 9-session parent group course, 6-session behavior therapy and nutrition education groups for children, weekly PA sessions, 3 individual family therapy sessions (more as needed)	77.5	X				X	X			X		X	
Coppins, 2011[96] Fair	Two family-based multidisciplinary workshops (8 total hours) and 2 PA sessions/week during the school term; workshops involved separate group sessions for parents and children with some joint content	48	X		X							X	X	
Vos, 2011[113] Fair	Two individual family assessment and advice visits followed by 7 2.5-hr group comprehensive behavioral lifestyle meetings, parents and children usually separate, plus 2-3 booster group sessions yearly	46.25	X		X			X	X		X	X	X	
Kalarchian, 2009[71] Fair	Twenty 60-min separate adult and child group sessions including weekly family meeting with lifestyle coach; adult also set goals, modeled behavior change; 6 booster sessions (3 group, 3 phone)	43.75	X	X		X		X	X		X			
Kalavainen, 2007[99] Fair	15 90-min group sessions, parents and children mostly separate; parents targeted as main agents of change; interactive activities and PA for children; manuals for parents, workbooks for children and homework assigned	43.5	X				X		X		X		X	
Quattrin, 2014[74] Fair	Sixteen 60-minute parent group sessions, 16 brief individual parent meetings, 13 phones calls for weight management education program, plus 16 child active game sessions	39.25	X			X		X	X		X	X	X	

Author, Year and Quality	Description	Est hours	Goals & Planning	Collaborative Goals	Comparison of Outcomes	Self-Monitoring	Self-Monitoring Outcome	Contingent Reward	Stimulus Control	MI	Parental Modeling	Parenting Skills	Supervised PA	Cultural Tailor.
Stark, 2011[107] Fair	Nine clinic-based 90-min comprehensive behavioral lifestyle group sessions for parents and children separately plus 9 home vis; vegetable taste tests, pedometers, parents received 2 weeks' worth of vegetables, child sessions included 15-min PA.	38.25	X			X		X	X		X	X		
Patrick, 2013[102] Fair	Access to website and tutorials to promote weight loss and healthy behaviors + 12 monthly 90-minute group sessions for adolescents and parents and brief bi-monthly phone calls for adolescent	38	X			X	X	X					X	
Berry, 2014[92] Fair	21-session nutrition/exercise education and coping skills weight management program for parents and children	36.75	X	X							X		X	
DeBar, 2012[69] Good	Sixteen 90-min group developmentally-tailored multicomponent behavioral intervention sessions for adolescent girls; 12 with concurrent parent sessions; trained PCP to support behavioral weight management goals; 2 PCP meetings	36.5	X	X	X	X			X	X		X	X	
Nemet, 2005[100] Fair	4 evening lectures for parents, 6 dietician meetings, and twice-weekly PA sessions for 3 months	32.5	X						X		X		X	
Bocca, 2012[93] Fair	25-session multidisciplinary intervention consisting of dietician visits, PA sessions for children, and behavioral therapy sessions for parents	30	X	X		X		X	X			X	X	
Stark, 2014[108] Fair	Ten 90-min comprehensive behavioral lifestyle group sessions for parents and children separately; vegetable taste tests, pedometers, parents received 2 weeks' worth of vegetables, child sessions included 15-min of moderate-to-vigorous PA.	30	X			X		X	X		X	X		
Bryant, 2011[95] Fair	16 weekly 30-min individual sessions for support and encouragement and 1-hr PA group sessions; motivational enhancement and solution-focused approach to lifestyle change	24		X	X					X			X	
Golley, 2007[70] Fair	Four 2-hr group sessions + 7 individual phone calls aimed at changing parenting practices and general parenting styles, and 7- session behavioral healthy lifestyle group for parents and concurrent child PA sessions	23.75	X		X	X		X	X		X	X	X	
Gerards, 2015[97]	10 90-minute group sessions and four individual 15-30	16.5	X	X	X	X		X	X		X	X		

Author, Year and Quality	Description	Est hours	Goals & Planning	Collaborative Goals	Comparison of Outcomes	Self-Monitoring	Self-Monitoring Outcome	Contingent Reward	Stimulus Control	MI	Parental Modeling	Parenting Skills	Supervised PA	Cultural Tailor.
Fair	minute phone sessions aimed at changing parenting practices and styles with specific strategies around lifestyle change; workbook, recipes and active games booklet													
Nowicka, 2008[101] Fair	Four 4-hr family group comprehensive behavioral lifestyle meetings, emphasizing communication skills, mutual support, consistency, establishing appropriate limits; 10-min individual meeting with pediatrician each session	16	X	X								X		
Norman, 2015[73] Fair	Brief PCP visits + "stepped-down" care tailored to progress of individuals; Step 1: 4 health ed visits + 8 calls, Step 2: 2 vistis + 8 calls, Step 3: 4 calls	8.25	X			X	X		X					
Toruner, 2010[77] Fair	School-based intervention consisting of seven 40-70 minute group child sessions, 2 parent group sessions and 30-50 minute individual parent counseling	9.75	X								X			
Taylor, 2015[112] Good	One individual 1-2 hour multidisciplinary session with parents followed by 16 brief contacts for tailored behavioral lifestyle change support.	7.2	X	X							X	X		
Raynor, 2012b[103] Fair	Eight 45-minute parent group sessions covering behavioral strategies to increase PA and reduce sugar-sweetened beverage consumption; growth assessed at 0, 3, 6 months with accompanying letter providing anthropometric information and interpretation	6	X			X			X		X	X		
Hughes, 2008[98] Fair	Eight individual family appointments w/ dietitian (7 outpatient, 1 home visit) over 6 months (total contact time of 5 hours) for family behavior change counseling.	5	X	X	X	X		X		X		X		
Stettler, 2014[109] Fair	Twelve 15-25 min sessions targeting healthy beverages, increased PA, and reduced sedentary activity, incorporating behavior change techniques	4	X			X		X	X		X			
Williamson, 2006[116] Fair	2-year internet-based family weight management program, including website access, 4 face-to-face counseling sessions during first 12 weeks and on-going email-based counseling, culturally tailored for African-American families.	4	X	X		X		X			X			X
Broccoli, 2016[94] Good	Five individual motivational interviewing sessions with parent and child and pediatrician; families decided on goals, progress discussed at subsequent meetings	3.75	X	X	X					X				
Taveras,	4 25-min in-person + 3 15-min phone motivational	2.67	X		X	X				X				

Author, Year and Quality	Description	Est hours	Goals & Planning	Collaborative Goals	Comparison of Outcomes	Self-Monitoring	Self-Monitoring Outcome	Contingent Reward	Stimulus Control	MI	Parental Modeling	Parenting Skills	Supervised PA	Cultural Tailor.
2011[110] Good	interviewing sessions with nurse practitioner. Pediatricians endorsed messages during well-child visits. Tailored materials, behavior monitoring tools, enhanced electronic medical record.													
Resnicow, 2015[76] Fair	Four brief motivational interviewing (MI) counseling sessions by PCP + 6 MI counseling sessions from RD conducted over 2 years, targeting diet and activity behaviors	2.5	X	X	X	X				X				
Wake, 2013[114] Good	One hour-long family visit with obesity specialist team to develop plan and goals, followed by GP visits every 4-8 weeks using brief solution-focused techniques; web-based software (HopSCOTCH) used to track progress and link specialist team with GP	2.5	X			X	X							
Van Grieken, 2013[78] Fair	Prevention protocol involving motivational interviewing during a well-child visit. 3 additional structured healthy lifestyle counseling sessions matched to parents' stage of change could be offered.	2	X							X				
Resnick, 2009[75] Fair	Five educational mailings over 30 weeks plus at least one home visit or phone call to discuss lifestyle topic of parent's choice.	1.7												
Taveras, 2015[111] Good	Computerized clinical decision support system with point of care prompts at well-child visit, motivational interview, pt materials + 4 phone motivational interviewing sessions by health coach and optional text msg program	1.25	X		X					X				
McCallum, 2007[72] Good	Four GP consultations using brief solution-focused family therapy for healthy lifestyle goals; 16-page folder of materials including topic sheets, wall chart, reward stickers, and shopping tips	1	X			X		X			X			
Wake, 2009[79] Good	Four GP consultations using brief solution-focused family therapy for healthy lifestyle goals; 16-page folder of materials including topic sheets, wall chart, reward stickers, and shopping tips	1	X			X		X			X			
Maintenance trials														
Davis, 2012[117] Fair	Eight 90-min group classes for adolescents after completion of weight loss program, reinforcing the content previously covered; 4 additional motivational telephone calls to explore	16			X					X			X	X

Author, Year and Quality	Description	Est hours	Goals & Planning	Collaborative Goals	Comparison of Outcomes	Self-Monitoring	Self-Monitoring Outcome	Contingent Reward	Stimulus Control	MI	Parental Modeling	Parenting Skills	Supervised PA	Cultural Tailor.
	and resolve ambivalence; separate parent classes, asked to attend 2.													
Wilfley, 2007[118] Good	Combined maintenance group: 20-session Family-based comprehensive weight management program + either behavioral skills or social facilitation maintenance	60	X			X		X	X		X			
	Behavioral skills maintenance: 20-session Family-based comprehensive weight management program + behavioral skills maintenance component	60	X			X		X	X		X			
	Social facilitation maintenance: 20-session Family-based comprehensive weight management program + social facilitation maintenance component	60	X			X		X	X		X			

Abbreviations: CDS = clinical decision support; CG = control group; ed = education; EMR = electronic medical records; hr = hour(s); GP = general practice; IG = intervention group; IVR = interactive voice response; MI = motivational interview; min = minute(s); msg = message; NHS = National Health System; PA = physical activity; PCP = primary care provider; pt = patient; RD = registered dietician; SMS = short messaging service; tx = treatment

Table 6. Results of weight maintenance trials, zBMI (Key Question 1)

Author, Year Quality	Followup (months)	Group	N	Baseline, mean (SD)	Followup, mean (SD)	Change from baseline, mean (SD)	Between group difference (vs. CG), mean (95% CI)
Davis, 2012[117] Fair	8*	IG1	30	2.2 (0.5)	NR (NR)	NR (NR)	NSD
		CG	23	2.2 (0.5)	NR (NR)	NR (NR)	.
Wilfley, 2007[118] Fair	12	IG1†	100	1.98 (0.38)	2.01 (0.45)	0.03 (NR)	-0.08 (-0.16 to 0.01), p=0.07
		IG2	50	1.94 (0.34)	1.99 (0.39)	0.06 (NR)	-0.06 (-0.16 to 0.03), p=0.19
		IG3	50	2.03 (0.42)	2.03 (0.51)	0.0 (NR)	-0.09 (-0.19 to 0.00), p=0.06
		CG	48	1.99 (0.39)	2.07 (0.38)	0.08 (NR)	.
	24	IG1†	100	1.98 (0.38)	2.00 (0.49)	0.02 (NR)	-0.06 (-0.16 to 0.04), p=0.25
		IG2	50	1.94 (0.34)	1.98 (0.48)	0.04 (NR)	-0.04 (-0.16 to 0.08), p=0.51
		IG3	50	2.03 (0.42)	2.02 (0.50)	-0.01 (NR)	-0.08 (-0.20 to 0.04), p=0.17
		CG	48	1.99 (0.39)	2.11 (0.36)	0.12 (NR)	.

*Eight months after completion of a 4-month weight loss intervention
†Two maintenance arms (IG2 and IG3) combined

Abbreviations: CG = control group; CI = confidence interval; IG = intervention group; NR = not reported; SD = standard deviation

Table 7. Use of parent-related components across age groups, no. (%) of studies reporting "Yes" for each component (k=49)* (Key Question 2)

Component	Preschool (k=6)[74, 78, 93, 107, 108, 110]	Elementary (k=36)[70-72, 75-77, 79, 82-85, 87-89, 92, 94, 97-99, 103, 109, 111, 112, 114, 118-126, 128, 129, 133]	Adolescent (k=7)[69, 81, 90, 101, 102, 117, 132]	Fisher's exact p-value
Parent-only sessions	4 (66.7%)[74, 93, 107, 108]	30 (83.3%)[70, 71, 75-77, 82-85, 87, 89, 92, 94, 97, 99, 103, 111, 112, 118-126, 128, 129, 133]	6 (85.7%)[69, 81, 90, 101, 117, 132]	0.607
Instruction in parent modeling	3 (50.0%)[74, 107, 108]	24 (66.7%)[70-72, 77, 79, 82-85, 89, 92, 97, 99, 103, 109, 112, 118, 121-126, 128]	1 (14.3%)[132]	0.033
Parenting skills training	4 (66.7%)[74, 93, 107, 108]	21 (58.3%)[70, 82-85, 87, 89, 97, 98, 103, 112, 119-126, 128, 129]	2 (28.6%)[69, 101]	0.301

*Excluded trials that spanned multiple age groups

Table 8. Intervention characteristics for studies with ≥50% Black and Latino families (k=12) vs. <50% (k=51), no. (%) of studies reporting use of intervention characteristic, sorted by descending difference in percentage points (Key Question 2)

Characteristic	≥50% Black and Latino (k=12) 73, 81, 86, 90, 92, 102, 106, 109, 116, 117, 130, 131	<50% Black and Latino (k=53) 69-72, 74-80, 82-85, 87-89, 93-101, 103-105, 107, 108, 110-115, 118-129, 132-134	Absolute Difference in percentage points	Fisher's exact p-value
Cultural tailoring	5 (41.7%)[90, 116, 117, 130, 131]	0 (0%)	41.7	<0.001
Included PA sessions	All: 8 (66.7%)[86, 90, 92, 102, 106, 117, 130, 131] 26+ hrs: 7/8 (87.5%)	All: 18 (34.0%)[69, 70, 74, 82, 83, 89, 93, 95, 96, 99, 100, 104, 105, 113, 115, 120, 129, 132] 26+ hrs: 16/30 (53.3%)	All: 32.7 26+ hrs: 34.2	0.052
Other setting	7 (58.3%)[86, 90, 92, 116, 117, 130, 131]	13 (31.0%)[75, 77, 95, 96, 103, 107, 112, 115, 118, 125, 128, 132, 134]	27.3	0.036
Behavioral provider specialist in field	4 (33.3%)[81, 90, 106, 116]	26 (55.3%)[69, 74, 82, 83, 85, 87, 88, 93, 96, 101, 103-105, 107, 108, 112, 113, 115, 118, 120-123, 128, 129, 134]	22.0	0.209
Health care setting (non-primary care)	3 (25.0%)[81, 102, 106]	18 (42.9%)[69-71, 89, 93, 98-101, 104, 105, 108, 113, 114, 120, 126, 127, 129]	17.9	0.737
Delivery via electronic device	3 (25.0%)[90, 102, 116]	4 (7.5%)[110, 111, 120, 132]	17.5	0.111
Dietary provider specialist in field	5 (41.7%)[81, 86, 90, 92, 106]	27 (57.4%)[69, 70, 74, 76, 80, 88, 89, 93, 96, 98-101, 104, 105, 112-115, 119, 120, 126-129, 132, 134]	15.7	0.353
Treatment team included a psychologist	2 (16.7%)[90, 116]	15 (28.3%)[69, 87, 88, 93, 96, 104, 105, 107, 108, 112, 113, 115, 120, 129, 134]	11.6	0.494
26+ estimated contact hours	8 (66.7%)[81, 86, 90, 92, 102, 130, 131]	30 (56.6%)[69, 71, 74, 85, 87, 89, 93, 96, 99, 100, 107, 108, 113, 120-125, 132-134]	10.1	0.747
Primary health care setting	2 (16.7%)[73, 109]	11 (26.2%)[72, 74, 76, 78-80, 88, 94, 97, 110, 111]	9.5	1.000
52+ estimated contact hours	1 (8.3%)[106]	8 (15.1%)[82-84, 104, 105, 115, 118, 129]	6.8	1.000
Parent-only sessions	9 (75.0%)[73, 81, 90, 92, 106, 116, 117, 130, 131]	43 (81.1%)[69-71, 74-77, 82-85, 87, 89, 93, 94, 96, 97, 99-101, 103-105, 107, 108, 111-113, 115, 118-126, 128, 129, 132-134]	6.1	0.694
Multidisciplinary team	5 (41.7%)[73, 86, 90, 92, 106]	19 (35.8%)[69, 80, 88, 89, 93, 95, 96, 100, 101, 104, 105, 112-115, 120, 127, 129, 134]	5.9	0.748
Physical activity provider specialist in field	5 (41.7%)[86, 90, 92, 106, 117]	17 (36.2%)[74, 80, 88, 89, 93, 95, 96, 100, 101, 104, 105, 112, 113, 115, 120, 128, 129]	5.5	0.748
Individual sessions (single family sessions)	10 (83.3%)[73, 81, 86, 90, 102, 109, 116, 117, 130, 131]	45 (84.9%)[69-72, 74-80, 82-85, 87, 88, 93-95, 97, 98, 100, 101, 104, 105, 107, 108, 110-114, 118-124, 126, 128, 129, 132, 133]	1.6	1.000
Intervention targets family all together	9 (75.0%)[73, 81, 86, 90, 92, 102, 106, 109, 116]	39 (73.6%)[71, 72, 78-80, 82-85, 87, 88, 93-96, 98-101, 104, 105, 107, 110, 111, 113-115, 118, 119, 121-125, 127-129, 133, 134]	1.4	1.000
Group sessions (multiple families together)	9 (75.0%)[81, 86, 90, 92, 102, 106, 117, 130, 131]	40 (75.5%)[69-71, 74, 77, 82-85, 87-89, 93, 95-97, 99-101, 103-105, 107, 108, 113, 115, 118, 120-129, 132-134]	0.5	1.000

Abbreviations: PA = physical activity

Table 9. Intervention components for studies with ≥50% Black and Latino families (k=12) vs. <50% (k=53), no. (%) of studies reporting use of intervention component, sorted by descending difference in percentage points (Key Question 2)

Component	≥50% Black and Latino (k=12) 73, 81, 86, 90, 92, 102, 106, 109, 116, 117, 130, 131	<50% Black and Latino (k=53) 69-72, 74-80, 82-85, 87-89, 93-101, 103-105, 107, 108, 110-115, 118-129, 132-134	Absolute Difference in percentage points	Fisher's exact p-value
Parenting skills training	0 (0%)	29 (54.7%)[69, 70, 74, 82-85, 87, 89, 93, 96-98, 101, 103, 107, 108, 112, 113, 119-126, 128, 129]	54.7	0.001
Parent modeling	5 (41.7%)[86, 92, 106, 109, 116]	31 (58.5%)[70-72, 74, 77, 79, 82-85, 89, 97, 99, 100, 103-105, 107, 108, 112, 113, 118, 121-126, 128, 132, 134]	16.8	0.346
Comparison of outcomes	1 (8.3%)[117]	12 (22.6%)[69, 70, 76, 89, 94-98, 110, 111, 113]	14.3	0.432
Self-monitoring: weight	2 (16.7%)[73, 102]	14 (26.4%)[82-85, 99, 104, 105, 114, 121-125, 128]	9.7	0.714
Collaborative goals	4 (33.3%)[86, 90, 92, 116]	13 (24.5%)[69, 71, 76, 93-95, 97, 98, 101, 112, 119, 132, 133]	8.8	0.717
Self-monitoring: behavior	7 (58.3%)[73, 81, 102, 109, 116, 130, 131]	34 (64.1%)[69-72, 74, 76, 79, 82-85, 87, 89, 93, 97, 98, 103, 107, 108, 110, 114, 115, 118-125, 128, 129, 132, 133]	5.8	0.748
Stimulus control	6 (50%)[73, 81, 106, 109, 130, 131]	29 (54.7%)[69-71, 74, 82-85, 89, 93, 97, 99, 100, 103, 107, 108, 113, 118, 119, 121-128, 133, 134]	4.7	1.000
Use of contingent rewards	7 (58.3%)[81, 102, 106, 109, 116, 130, 131]	30 (56.6%)[70-72, 74, 79, 82-85, 87, 89, 93, 97, 98, 104, 105, 107, 108, 113, 118, 119, 121-125, 128, 129, 133, 134]	1.7	1.000
Goals and planning	11 (91.7%)[73, 81, 86, 90, 92, 102, 106, 109, 116, 130, 131]	48 (90.6%)[69-72, 74, 76-79, 82-85, 87, 89, 93, 94, 96-101, 103-105, 107, 108, 110-114, 118-129, 132-134]	1.1	1.000
Motivational interviewing	2 (16.7%)[90, 117]	9 (17.0%)[69, 76, 78, 94, 95, 98, 110, 111, 133]	0.3	1.000

Table 10. Association between population characteristics and effect size: meta-regression results and percent of trials with specified population characteristics among interventions that did and did not meet minimum criteria for clinically significant change (zBMI reduction of 0.25), among trials reporting zBMI and at least 26 estimated hours of contact (Key Question 2b)

Characteristic	Meta-regression results (k=36, efficacy trial)			Clinically significant change, among trials with ≥26 estimated contact hours (k=24, efficacy and comparative effectiveness trials)			
	No. of Studies with character-istic	Regression coefficient† (95% CI)	P-value	No. (%) met criterion (k=14)	No. (%) did not meet criterion (k=10)	Absolute difference in percentage points	Fisher's exact p-value
Population characteristics							
Age‡ category: preschool vs. elementary	6[74, 78, 93, 107, 108, 110]	-0.19 (-0.51 to 0.12)	0.22	4 (28.6)	0 (0)	28.6	0.02
Age‡ category: elementary	14[70-72, 75-77, 79, 98, 99, 103, 109, 111, 112, 114]	NA (reference group)	NA	6 (42.9)	2 (20.0)	22.9	
Age‡ category: adolescents vs. elementary	3[69, 101, 102]	0.02 (-0.42 to 0.45)	0.94	0 (0)	4 (40.0)	40.0	
Age‡ category: range covering multiple age groups vs. elementary	10[73, 95, 96, 100, 104-106, 113, 115, 116]	-0.06 (-0.40 to 0.27)	0.71	4 (28.6)	4 (40.0)	11.4	
Target children who are overweight	4[72, 78, 94, 109]	-0.09 (-0.42 to 0.23)	0.56	0 (0)	1 (10.0)	10.0	0.42
Required at least one parent to have overweight or obesity	5[74, 92, 107, 108, 116]	-0.16 (-0.50 to 0.19)	0.36	3 (21.4)	1 (10.0)	11.4	0.62
≥50% Black or Latino	6[73, 92, 102, 106, 109, 116]	-0.00 (-0.30 to 0.29)	0.98	0 (0)	4 (40.0)	40.0	0.02
Targeted low socioeconomic status	2[92, 95]	0.55 (0.20 to 0.91)	0.003	0 (0)	0 (0)	0	NA

*Three studies[72, 76, 78] with outcomes reported at greater than 12 months excluded

†Controlling for estimated contact hours, except where predictor is contact hours or analysis is limited to trials offering ≥26 contact hours

‡In meta-regression, age tested by including 3 dummy variables representing preschool, adolescent, and multiple age ranges vs. elementary age target; in analysis of clinical significance, 4x2 table examined comparing 4 age groups (preschool, elementary, adolescent, multiple age groups) by whether or not the trial met criteria for clinical significance.

Table 11. Association between intervention characteristics and effect size: meta-regression results and percent of trials with specified intervention characteristics among interventions that did and did not meet minimum criteria for clinically significant change (zBMI reduction of 0.25), among trials reporting zBMI and at least 26 estimated hours of contact (Key Questions 3a)

Characteristic	Meta-regression results (k=36, efficacy trial)			Clinically significant change, among trials with ≥26 estimated contact hours (k=24, efficacy and comparative effectiveness trials)			
	No. of Studies with character-istic	Regression coefficient† (95% CI)	P-value	No. (%) met criterion (k=14)	No. (%) did not meet criterion (k=10)	Absolute difference in percentage points	Fisher's exact p-value
Contact Dose							
Contact hours	36[69-79, 92-116]	-0.01 (-0.01 to -0.01)	<0.001	NA	NA	NA	NA
Number of sessions	36[69-79, 92-116]	-0.01 (-0.02 to -0.00)	0.001	NA	NA	NA	NA
High (≥26) contact hours	16[69, 71, 74, 92, 93, 96, 99, 100, 102, 104-108, 113, 115]	-0.43 (-0.68 to -0.18)	0.002	NA	NA	NA	NA
Duration*	36[69-71, 73-75, 77, 79, 92-116]	-0.01 (-0.03 to 0.01)	0.52	NA	NA	NA	NA
Provider Qualifications							
Interventionist who provided the behavioral component was a behavioral specialist	15[69, 74, 93, 96, 101, 103-108, 112, 113, 115, 116]	-0.28 (-0.56 to 0.01)	0.06	11 (84.6)	5 (50.0)	34.6	0.17
Psychologist on team	11[69, 93, 96, 104, 105, 107, 108, 112, 113, 115, 116]	-0.17 (-0.44 to 0.10)	0.21	8 (57.1)	4 (40.0)	17.1	0.68
Interventionist who provided the dietary component was a dietary specialist	18[69, 70, 74, 76, 92, 93, 96, 98-101, 104-106, 112-115]	0.04 (-0.25 to 0.33)	0.78	9 (69.2)	6 (60.0)	9.2	0.68
Interventionist who provided the physical activity component was a physical activity specialist	13[74, 92, 93, 95, 96, 100, 101, 104-106, 112, 113, 115]	0.13 (-0.18 to 0.45)	0.40	7 (53.8)	3 (30.0)	23.8	0.40
Multidisciplinary team	15[69, 73, 92, 93, 95, 96, 100, 101, 104-106, 112-115]	0.16 (-0.09 to 0.42)	0.19	7 (50.0)	4 (40.0)	10.0	0.70
Setting							
Primary care	11[72-74, 76, 78, 79, 94, 97, 109-111]	-0.02 (-0.29 to 0.25)	0.88	1§ (7.1)	0§ (0)	7.1	1.00
Other health care	15[69-71, 93, 98-102, 104-106, 108, 113, 114]	-0.10 (-0.36 to 0.17)	0.46	7§ (50.0)	5§ (50.0)	0	1.00
Non-health care/community	10[75, 77, 92, 95, 96, 103, 107, 112, 115, 116]	0.12 (-0.14 to 0.38)	0.36	3§ (21.4)	4§ (40.0)	18.6	0.39
Delivery Format							
Offered group sessions	22[69-71, 74, 77, 92, 93, 95-97, 99-108, 113, 115]	0.30 (-0.01 to 0.61)	0.054	14 (100)	10 (100)	0	NA
Offered individual (single-family) sessions	30[69-79, 93-95, 97, 98, 100-102, 104, 105, 107-114, 116]	-0.34 (-0.67 to -0.00)	0.05	10 (71.4)	9 (90.0)	18.6	0.36

Characteristic	Meta-regression results (k=36, efficacy trial)			Clinically significant change, among trials with ≥26 estimated contact hours (k=24, efficacy and comparative effectiveness trials)			
	No. of Studies with character-istic	Regression coefficient† (95% CI)	P-value	No. (%) met criterion (k=14)	No. (%) did not meet criterion (k=10)	Absolute difference in percentage points	Fisher's exact p-value
Offered individual (single-family) sessions, among trials that also provided group sessions	16[69-71, 74, 77, 93, 95, 97, 100-102, 104, 105, 107, 108, 113]	-0.34 (-0.73 to 0.05)	0.08	10 (71.4)	9 (90.0)	18.6	0.36
Offered sessions targeting family all together	26[71-73, 78, 79, 92-96, 98-102, 104-107, 109-111, 113-116]	-0.01 (-0.27 to 0.24)	0.91	10 (71.4)	6 (60.0)	11.4	0.67
Offered sessions targeting child only (without parent)	23[69-71, 73, 74, 77, 92-96, 99-102, 104-108, 113, 115, 116]	-0.02 (-0.32 to 0.27)	0.86	14 (100)	10 (100)	0	NA
Offered sessions targeting parent only (without child)	27[69-71, 73-77, 92-94, 96, 97, 99-101, 103-108, 111-113, 115, 116]	-0.04 (-0.31 to 0.24)	0.79	14 (100)	9 (90.0)	10.0	0.42
Included an electronic delivery component	4[102, 110, 111, 116]	-0.20 (-0.53 to 0.13)	0.23	1 (7.1)	2 (20.0)	12.9	0.55
Included a print-based delivery component	14[70, 72, 73, 75, 76, 78, 79, 97, 99, 100, 102, 106, 110, 111]	0.07 (-0.16 to 0.30)	0.53	4 (28.6)	4 (40.0)	11.4	0.67
Included a phone-based delivery component	12[69-71, 73-76, 97, 102, 110-112]	0.11 (-0.12 to 0.34)	0.33	2 (14.3)	3 (30.0)	15.7	0.62
Included supervised physical activity sessions	15[69, 70, 74, 92, 93, 95, 96, 99, 100, 102, 104-106, 113, 115]	0.27 (-0.06 to 0.60)	0.10	8 (57.1)	8 (80.0)	22.9	0.39
Included supervised physical activity sessions, among interventions offering ≥26 contact hours	13[69, 74, 92, 93, 96, 99, 100, 102, 104-106, 113, 115]	0.16 (-0.59 to 0.92)	0.65	NA	NA	NA	NA
Cultural Tailoring							
Cultural tailoring†	1[116]	Insufficient evidence	NA	0 (0)	2 (20.0)	20.0	0.16

*Three studies[72, 76, 78] with outcomes reported at greater than 12 months excluded

†Controlling for estimated contact hours, except where predictor is contact hours or analysis is limited to trials offering ≥26 contact hours

‡In meta-regression, age tested by including 3 dummy variables representing preschool, adolescent, and multiple age ranges vs. elementary age target; in analysis of clinical significance, 4x2 table examined comparing 4 age groups (preschool, elementary, adolescent, multiple age groups) by whether or not the trial met criteria for clinical significance.

§Setting could not be determined in four of the comparative effectiveness trials

Table 12. Intervention details of included comparative effectiveness trials: Trials comparing approaches with greater vs. lesser contact dose (Key Question 3b)

Author, Year Quality	Group	Brief Description	Contact hrs	Goals & Planning	Collab Goals	Compar of Outcomes	Self-monitor Behav	Self-monitor Outcome	Contingent Reward	Stimulus Control	Motivational Interview	Parent Modeling	Parenting Skill	Supervised PA Sessions	Parent Target	Child Target	Family Target	Individual Tx	Group Tx
Greater vs. less contact hours, similar content between groups																			
Resnicow, 2015[76] Fair	IG1: PCP + RD MI	Four brief motivational interviewing (MI) counseling sessions by PCP + 6 MI counseling sessions from RD conducted over 2 years, targeting diet and activity behaviors	2.5	X	X	X	X				X				X			X	
	IG2: PCP MI	Four brief MI counseling sessions over 2 years conducted by PCP, targeting diet and activity behaviors	1	X	X	X	X				X				X			X	
Taveras, 2015[111] Good	IG1: CDS+coaching	Computerized clinical decision support system with point of care prompts at well-child visit, motivational interview, pt materials + 4 phone motivational interviewing sessions by health coach and optional text msg program	1.25	X		X					X				X		X	X	
	IG2: CDS	Computerized clinical decision support system with point of care prompts at well-child visit, motivational interview, pt materials	0.25	X		X					X						X	X	
Two direct-contact, instructor-led groups, one with additional behavioral module																			
Berkowitz, 2012[81] Fair	IG1: Group-based lifestyle modification program	Detailed print curriculum for family with 6 45-minute individual family clinic visits and 17 group child sessions with concurrent parent group sessions	38.5	X			X		X	X					X	X	X	X	X

Author, Year Quality	Group	Brief Description	Contact hrs	Goals & Planning	Collab Goals	Compar of Outcomes	Self-monitor Behav	Self-monitor Outcome	Contingent Reward	Stimulus Control	Motivational Interview	Parent Modeling	Parenting Skill	Supervised PA Sessions	Parent Target	Child Target	Family Target	Individual Tx	Group Tx
	IG2: Individual family counseling + printed curriculum	Detailed print curriculum for family with 6 45-minute individual family clinic visits	4.5	X			X		X	X							X	X	
Golley, 2007[70] Fair	IG1: Triple P + healthy lifestyle group	Four 2-hr group sessions + 7 individual phone calls aimed at changing parenting practices and general parenting styles, and 7-session behavioral healthy lifestyle group for parents and concurrent child PA sessions	23.75	X		X	X		X	X		X	X	X	X	X		X	X
	IG2: Triple P	Four 2-hr group sessions and 7 individual phone followup sessions aimed at changing parenting practices and general parenting styles (no behavioral lifestyle component); workbook, and healthy lifestyle pamphlet	9.75	X			X		X			X	X		X			X	X
Larson, 2015[88] Fair	IG1: Educational program + GP consultations	Three 3-hr group education sessions, monthly GP consultations for one year, then bi-monthly for one year; focus on lifestyle habits, diet, and PA	18														X	X	X
	IG2: GP consultations	Monthly GP consultations for one year, then bi-monthly for one year; focus on lifestyle habits, diet, and PA	9														X	X	

Author, Year Quality	Group	Brief Description	Contact hrs	Goals & Planning	Collab Goals	Compar of Outcomes	Self-monitor Behav	Self-monitor Outcome	Contingent Reward	Stimulus Control	Motivational Interview	Parent Modeling	Parenting Skill	Supervised PA Sessions	Parent Target	Child Target	Family Target	Individual Tx	Group Tx
Nguyen, 2012[132] Fair	IG1: Loozit + additional therapeutic contact	Seven 75-minute weekly Loozit group sessions (Phase 1) separately for adolescents and parents; then adolescents attended 7 60-minute booster sessions, had 14 brief phone sessions and SMS messaging through 24 months	26.8	X	X		X					X		X	X	X		X	X
	IG2: Loozit only	Seven 75-minute weekly Loozit group sessions (Phase 1) separately for adolescents and parents; then adolescents attended 7 60-minute booster sessions	24.5	X	X		X					X		X	X	X			X
Resnicow, 2005[90] Fair	IG1: High-intensity lifestyle intervention	20-26 weekly group behavioral sessions of a culturally tailored program for girls delivered in African American churches; 12 parental sessions, two-way paging device and MI calls	45.5	X	X						X			X	X	X	X	X	X
	IG2: Moderate-intensity lifestyle intervention	6 monthly group behavioral sessions of a culturally tailored program for girls delivered in African American churches; 3 parental sessions	9											X	X	X	X		X
Steele, 2012[134] Fair	IG1: Family-based behavioral group treatment	Ten 90-minute weekly "Positively Fit" group treatment sessions including nutrition/PA education and behavior therapy; parents and children met separately for most of session but jointly attended goal-setting sessions	28.3	X					X	X		X			X	X	X		X

Author, Year Quality	Group	Brief Description	Contact hrs	Goals & Planning	Collab Goals	Compar of Outcomes	Self-monitor Behav	Self-monitor Outcome	Contingent Reward	Stimulus Control	Motivational Interview	Parent Modeling	Parenting Skill	Supervised PA Sessions	Parent Target	Child Target	Family Target	Individual Tx	Group Tx
	IG2: Brief individual family intervention	Trim Kids: 3 60-minute individual family visits with a registered dietitian and manual with assigned reading	3	X			X	X	X	X		X	X				X	X	
Johnston, 2010[130] Fair	IG1: Instructor-led intervention	12-week daily (Mon-Fri) instructor-led healthy lifestyle intervention class during school hours with PA sessions and 12 weeks bi-weekly followup; monthly parent information meetings	47.25	X			X		X	X				X	X	X		X	X
	IG2: Self-help intervention	Parent-guided self-help book (TrimKids)	0	X			X	X	X	X		X	X		X				
Self-help approach vs. direct contact, instructor-led intervention																			
Johnston, 2013[131] Fair	IG1: Instructor-led intervention	12-week daily (Mon-Fri) instructor-led healthy lifestyle intervention class during school hours with PA sessions and 12 weeks bi-weekly followup; monthly parent information meetings	47.25	X			X		X	X				X	X	X		X	X
	IG2: Self-help intervention	Parent-guided self-help book (TrimKids)	0	X			X	X	X	X		X	X		X				
Patrick, 2013[102] Fair	IG1: Website + group sessions	Access to website and tutorials to promote weight loss and healthy behaviors + 12 monthly 90-minute group sessions for adolescents and parents and brief bi-monthly phone calls for adolescent	38	X			X	X	X					X		X	X	X	X
	IG3: Website only	Weekly check-in/reminder emails and access to website and tutorials to promote weight loss and healthy behaviors.	0	X			X	X	X							X	X	X	

Author, Year Quality	Group	Brief Description	Contact hrs	Goals & Planning	Collab Goals	Compar of Outcomes	Self-monitor Behav	Self-monitor Outcome	Contingent Reward	Stimulus Control	Motivational Interview	Parent Modeling	Parenting Skill	Supervised PA Sessions	Parent Target	Child Target	Family Target	Individual Tx	Group Tx
Estabrooks, 2009[126] Fair	IG1: Workbook + group sessions + IVR system	Family Connections self-help workbook + 2 group sessions with parents covering healthy lifestyle information and parenting skills + 10 telephone-based interactive voice response system calls	4	X						X		X	X		X			X	X
	IG3: Workbook only	Family Connections self-help workbook only	0	X						X		X	X		X				

Abbreviations: CDS = clinical decision support; CG = control group; ed = education; EMR = electronic medical records; hr(s) = hour(s); GP = general practice; IG = intervention group; IVR = interactive voice response; MI = motivational interview; min = minute(s); msg = message; NHS = National Health System; PA = physical activity; PCP = primary care provider; pt = patient; RD = registered dietician; SMS = short messaging service; tx = treatment

Table 13. Intervention details of included comparative effectiveness trials: trials testing the effects of different setting, format, target, delivery, and use of supervised physical activity sessions (Key Question 3b)

Author, Year Quality	Group	Brief Description	Contact hrs	Goals & Planning	Collab Goals	Compar of Outcomes	Self-monitor Behav	Self-monitor Outcome	Contingent Reward	Stimulus Control	Motivational Interview	Parent Modeling	Parenting Skill	Supervised PA Sessions	Parent Target	Child Target	Family Target	Individual Tx	Group Tx
Setting																			
Banks, 2012[80] Fair	IG1: Primary care-based	Primary care-based sociocognitive intervention consisting of 5 individual family appointments over 1 year conducted by multidisciplinary team (practice nurse, dietitian, and exercise specialist)	2.5														X	X	
	IG2: Hospital-based obesity clinic	Hospital-based childhood obesity clinic sociocognitive intervention consisting of 5 individual family appointments over 1 year conducted by multidisciplinary team (consultant, dietitian, and exercise specialist)	2.5														X	X	
Group vs. individual format																			
Garipagaoglu, 2009[127] Fair	IG1: Family-based group treatment	Seven 90-minute family-based group treatment sessions with multidisciplinary team	10.5	X						X							X		X
	IG2: Individual treatment	Seven 30-minute individual family-based treatment sessions with multidisciplinary team	3.5	X						X							X	X	
Goldfield, 2001[128] Fair	IG1: Individualized + group treatment	Thirteen group (40 minute) each for parents and children separately plus and individual (15-20 minute) family sessions in comprehensive weight management program	21.67	X			X	X	X	X		X	X		X	X	X	X	X
	IG2: Group treatment	Thirteen 60-minute comprehensive family-based weight management group and	21.67	X			X	X	X	X		X	X		X	X	X		X

Author, Year Quality	Group	Brief Description	Contact hrs	Goals & Planning	Collab Goals	Compar of Outcomes	Self-monitor Behav	Self-monitor Outcome	Contingent Reward	Stimulus Control	Motivational Interview	Parent Modeling	Parenting Skill	Supervised PA Sessions	Parent Target	Child Target	Family Target	Individual Tx	Group Tx
		individual family sessions																	
Parent vs. child vs. family target																			
Bathrellou, 2010[119] Fair	IG1: Child-and-parent group	21-session multidisciplinary individual weight management program, with parent support for child's weight loss	21	X	X		X		X	X			X		X	X	X	X	
	IG2: Child only	19-session child-only multidisciplinary individual weight management program (no parent support)	19	X	X		X		X	X						X		X	
Epstein, 2000b[122] Fair	IG1: Problem-solving for parent and child	20-session comprehensive family-based weight management group and individual family intervention with problem-solving for parent and child	30	X			X	X	X	X		X	X		X	X	X	X	X
	IG2: Problem-solving for child only	20-session comprehensive family-based weight management group and individual family intervention with problem-solving for child	30	X			X	X	X	X		X	X		X	X	X	X	X
	IG3: Family-based treatment	20-session comprehensive family-based weight management group and individual family intervention, no problem-solving	30	X			X	X	X	X		X	X		X	X	X	X	X
Epstein, 2014[125] Fair	IG1: Family-based treatment	15-session comprehensive family-based weight management group intervention, parents and children treated both separately and together	26.25	X			X	X	X	X		X	X		X	X	X		X

Author, Year Quality	Group	Brief Description	Contact hrs	Goals & Planning	Collab Goals	Compar of Outcomes	Self-monitor Behav	Self-monitor Outcome	Contingent Reward	Stimulus Control	Motivational Interview	Parent Modeling	Parenting Skill	Supervised PA Sessions	Parent Target	Child Target	Family Target	Individual Tx	Group Tx
	IG2: Parent-child treated separately	15-session comprehensive family-based weight management group intervention, parents and children treated separately	30	X			X	X	X	X		X			X	X	X		X
Electronic delivery component																			
de Niet, 2012[120] Fair	IG1: Healthy lifestyle intervention + SMS	11-session comprehensive group healthy lifestyle intervention for children and parents + SMS messages	47.5	X			X						X	X	X	X		X	X
	IG2: Healthy lifestyle intervention only	11-session comprehensive group healthy lifestyle intervention for children and parents without SMS messages	47.5	X			X						X	X	X	X		X	X
Estabrooks, 2009[126] Fair	IG1: Workbook + group sessions + IVR system	Family Connections self-help workbook + 2 group sessions with parents covering healthy lifestyle information and parenting skills + 10 telephone-based interactive voice response system calls	4	X								X	X		X			X	X
	IG2: Workbook + group sessions	Family Connections self-help workbook + 2 group sessions with parents covering healthy lifestyle information and parenting skills	4	X								X	X		X		X		X
Patrick, 2013[102] Fair	IG2: Website + SMS	Weekly check-in/reminder emails and access to website and tutorials to promote weight loss and healthy behaviors + 3 SMS messages weekly and option to contact health counselor as needed.	0	X			X	X	X							X	X	X	

Author, Year Quality	Group	Brief Description	Contact hrs	Goals & Planning	Collab Goals	Compar of Outcomes	Self-monitor Behav	Self-monitor Outcome	Contingent Reward	Stimulus Control	Motivational Interview	Parent Modeling	Parenting Skill	Supervised PA Sessions	Parent Target	Child Target	Family Target	Individual Tx	Group Tx
	IG3: Website only	Weekly check-in/reminder emails and access to website and tutorials to promote weight loss and healthy behaviors.	0	X			X	X	X							X	X	X	
Supervised PA sessions																			
Epstein, 1985a[82] Fair	IG1: Family-based lifestyle + PA sessions	18-session comprehensive weight management group and individual family intervention and 18 phone calls, plus 24 exercise sessions for children	66.5	X			X	X	X	X		X	X	X	X	X	X	X	X
	IG2: Family-based lifestyle	18-session comprehensive weight management group and individual family intervention and 18 phone calls, with no exercise sessions	42.5	X			X	X	X	X		X	X		X	X	X	X	X

Abbreviations: CDS = clinical decision support; CG = control group; ed = education; EMR = electronic medical records; hr(s) = hour(s); GP = general practice; IG = intervention group; IVR = interactive voice response; MI = motivational interview; min = minute(s); msg = message; NHS = National Health System; PA = physical activity; PCP = primary care provider; pt = patient; RD = registered dietician; SMS = short messaging service; tx = treatment

Table 14. Intervention details of included comparative effectiveness trials: trials examining different types of goal or goal-setting approaches (Key Question 4b)

Author, Year Quality	Group	Brief Description	Contact hrs	Goals & Planning	Collab Goals	Compar of Outcomes	Self-monitor Behav	Self-monitor Outcome	Contingent Reward	Stimulus Control	Motivational Interview	Parent Modeling	Parenting Skill	Supervised PA Sessions	Parent Target	Child Target	Family Target	Individual Tx	Group Tx
Physical Activity and Diet goal/reinforcement approach																			
Epstein, 1994[84] Good	IG1: Individualized progression	32-session comprehensive family-based lifestyle group and individual family intervention with skills mastery approach, families systematically moving through 5 levels of goals for 7 behaviors, only moving to next goal when mastery achieved.	64	X			X	X	X	X		X	X		X	X	X	X	X
	IG2: Paced progression	32-session comprehensive family-based lifestyle group and individual family intervention without skills mastery approach; families systematically moving through 5 levels of goals for 7 behaviors, progressing in goals according to skill mastery rate of IG1	64	X			X	X	X	X		X	X		X	X	X	X	X
Epstein, 1995[85] Fair	IG1: Decrease sedentary+ increase physical activity	18-session comprehensive family-based weight management group and individual family intervention, participants reinforced for decreasing sedentary activity and increasing physical activity	40.5	X			X	X	X	X		X	X		X	X	X	X	X
	IG2: Increase physical activity	18-session comprehensive family-based weight management group and individual family intervention, participants reinforced for increasing physical activity	40.5	X			X	X	X	X		X	X		X	X	X	X	X

Author, Year Quality	Group	Brief Description	Contact hrs	Goals & Planning	Collab Goals	Compar of Outcomes	Self-monitor Behav	Self-monitor Outcome	Contingent Reward	Stimulus Control	Motivational Interview	Parent Modeling	Parenting Skill	Supervised PA Sessions	Parent Target	Child Target	Family Target	Individual Tx	Group Tx
	IG3: Decrease sedentary behavior	18-session comprehensive family-based weight management group and individual family intervention, participants reinforced for decreasing sedentary activity	40.5	X			X	X	X	X		X	X		X	X	X	X	X
Epstein, 2000a[121] Good	IG1: High dose sedentary activity reduction	20-session comprehensive family-based weight management group and individual family intervention, goal ≤10 hr/week of (non-schoolwork) sedentary activity	30	X			X	X	X	X		X	X		X	X	X	X	X
	IG2: High dose physical activity increase	20-session comprehensive family-based weight management group and individual family intervention, goal energy equivalent of 32.2 km (20 miles)/week increase in exercise	30	X			X	X	X	X		X	X		X	X	X	X	X
	IG3: Low dose sedentary activity reduction	20-session comprehensive family-based weight management group and individual family intervention, goal ≤20 hr/week of (non-schoolwork) sedentary activity	30	X			X	X	X	X		X	X		X	X	X	X	X
	IG4: Low dose physical activity increase	20-session comprehensive family-based weight management group and individual family intervention, goal energy equivalent of 16.1 km (10 miles)/week increase in exercise	30	X			X	X	X	X		X	X		X	X	X	X	X

Author, Year Quality	Group	Brief Description	Contact hrs	Goals & Planning	Collab Goals	Compar of Outcomes	Self-monitor Behav	Self-monitor Outcome	Contingent Reward	Stimulus Control	Motivational Interview	Parent Modeling	Parenting Skill	Supervised PA Sessions	Parent Target	Child Target	Family Target	Individual Tx	Group Tx
Epstein, 2004[123] Good	IG1: Reinforced reduced sedentary behaviors	20-session family-based comprehensive weight management program plus point system with rewards to reinforce meeting sedentary behavior targets (final goal ≤15 hrs/wk)	30	X			X	X	X	X		X	X		X	X	X	X	X
	IG2: Stimulus control of sedentary behaviors	20-session family-based comprehensive weight management program plus families encouraged to change home environment (e.g., limit access to TV), children reinforced for self-monitoring	30	X			X	X	X	X		X	X		X	X	X	X	X
Epstein, 2008b[124] Fair	IG1: Increase healthy foods	13-session comprensive family-based weight management group and individual family intervention, focus on increasing healthy foods	32.5	X			X	X	X	X		X	X		X	X	X	X	X
	IG2: Reduce high energy-dense foods	13-session comprensive family-based weight management group and individual family intervention, focus on reducing high energy-dense foods	32.5	X			X	X	X	X		X	X		X	X	X	X	X
Raynor, 2012b[103] Fair Fair	IG1: TRADITIONAL + Growth Monitoring	Eight 45-minute parent group sessions covering behavioral strategies to increase PA and reduce sugar-sweetened beverage consumption; growth assessed at 0, 3, 6 months with accompanying letter providing anthropometric information and interpretation	6	X			X			X		X	X		X				X

Author, Year Quality	Group	Brief Description	Contact hrs	Goals & Planning	Collab Goals	Compar of Outcomes	Self-monitor Behav	Self-monitor Outcome	Contingent Reward	Stimulus Control	Motivational Interview	Parent Modeling	Parenting Skill	Supervised PA Sessions	Parent Target	Child Target	Family Target	Individual Tx	Group Tx
	IG2: SUBSTITUTES + Growth Monitoring	Eight 45-minute parent group sessions covering behavioral strategies to increase low-fat milk and decrease TV as substitute behaviors; growth assessed at 0, 3, 6 months with accompanying letter providing anthropometric information and interpretation	6	X			X			X		X	X		X				X
Use of collaborative goals																			
Saelens, 2013[133] Fair	IG1: Family-based tx with family-set goals	20 weekly 20-30 min individual family sessions and separate 40-50 min child and parent group sessions; MI-based style to encourage more family autonomy and self-efficacy around behavioral skills use	40	X	X		X		X	X	X				X	X	X	X	X
	IG2: Family-based tx with study-set goals	20 weekly 20-30 min individual family sessions and separate 40-50 min child and parent group sessions; interventionist reinforced behavioral skills use and set weekly child and parent goals without family input	40	X			X		X	X					X	X	X	X	X

Abbreviations: CDS = clinical decision support; CG = control group; ed = education; EMR = electronic medical records; hr(s) = hour(s); GP = general practice; IG = intervention group; IVR = interactive voice response; MI = motivational interview; min = minute(s); msg = message; NHS = National Health System; PA = physical activity; PCP = primary care provider; pt = patient; RD = registered dietician; SMS = short messaging service; tx = treatment

Table 15. Intervention details of included comparative effectiveness trials: trials examining the addition of parenting skills training (Key Question 4b)

Author, Year Quality	Group	Brief Description	Contact hrs	Goals & Planning	Collab Goals	Compar of Outcomes	Self-monitor Behav	Self-monitor Outcome	Contingent Reward	Stimulus Control	Motivational Interview	Parent Modeling	Parenting Skill	Supervised PA Sessions	Parent Target	Child Target	Family Target	Individual Tx	Group Tx
Epstein, 1985b[83] Fair	IG1: Healthy lifestyle education + parent behavior change skills	25-session (including child PA sessions) family-based weight management group and individual family intervention covering diet and physical activity education + parent management techniques	64	X			X	X	X	X		X	X	X	X	X	X	X	X
	IG2: Healthy lifestyle education only	25-session (including child PA sessions) family-based weight management group and individual family intervention covering diet and physical activity education	64							X		X		X	X	X	X	X	X
Israel, 1985[87] Fair	IG1: Behavioral weight reduction + parent training	Two 1-hour child management skills classes for parents, nine 90-minute weekly group weight management sessions with separate parent and child meetings, and phone calls between sessions	35.5	X			X		X				X		X	X	X	X	X
	IG2: Behavioral-weight reduction	Nine 90-minute weekly group weight management sessions with separate parent and child meetings, and phone calls between sessions	33.5	X			X		X						X	X	X	X	X
Magarey, 2011[89] Fair	IG1: Triple P + healthy lifestyle group	4 2-hr group sessions and 4 individual phone followup sessions aimed at changing parenting practices and general parenting styles and 8- session behavioral healthy lifestyle group for parents and optional	33	X		X	X		X	X		X	X	X	X	X			X

Author, Year Quality	Group	Brief Description	Contact hrs	Goals & Planning	Collab Goals	Compar of Outcomes	Self-monitor Behav	Self-monitor Outcome	Contingent Reward	Stimulus Control	Motivational Interview	Parent Modeling	Parenting Skill	Supervised PA Sessions	Parent Target	Child Target	Family Target	Individual Tx	Group Tx
		concurrent child PA sessions																	
	IG2: Healthy lifestyle group	Eight 90-minute group lifestyle support sessions and 4 phone calls for parents and optional concurrent child fun, non-competative PA sessions.	25	X					X			X		X	X	X			X

Abbreviations: CDS = clinical decision support; CG = control group; ed = education; EMR = electronic medical records; hr(s) = hour(s); GP = general practice; IG = intervention group; IVR = interactive voice response; MI = motivational interview; min = minute(s); msg = message; NHS = National Health System; PA = physical activity; PCP = primary care provider; pt = patient; RD = registered dietician; SMS = short messaging service; tx = treatment

Table 16. Intervention details of included comparative effectiveness trials: trials test the effect of a specific behavioral component add-on to an already comprehensive and intensive intervention (Key Question 4b)

Author, Year Quality	Group	Brief Description	Contact hrs	Goals & Planning	Collab Goals	Compar of Outcomes	Self-monitor Behav	Self-monitor Outcome	Contingent Reward	Stimulus Control	Motivational Interview	Parent Modeling	Parenting Skill	Supervised PA Sessions	Parent Target	Child Target	Family Target	Individual Tx	Group Tx
Grey, 2004[86] Fair	IG1: Nutrition ed + PA sessions + coping skills training	16 weekly 45-minute culturally-tailored nutrition education sessions for parents and children together, 32 twice-weekly PA sessions for children, 12 followup phone calls + coping skills training	39	X	X							X		X		X	X	X	X
	IG2: Nutrition ed + PA sessions	16 weekly 45-minute culturally-tailored nutrition education sessions for parents and children together, 32 twice-weekly PA sessions for children, 3 followup phone calls	36.75	X	X							X		X		X	X		X
Hystad, 2013[129] Fair	IG1: Structured weight management group	Fifteen 2-hour parent therapist-led group sessions and simultaneous child nutrition and activity sessions, and 10 30-minute individual family sessions with a dietician and physiotherapist.	65	X			X		X				X	X	X	X	X	X	X
	IG2: Parent-led support group	Fifteen 2-hour parent self-help group sessions and simultaneous child nutrition and activity sessions, and 10 30-minute individual family sessions with a dietician and physiotherapist.	65	X										X	X	X	X	X	X
Wilfley, 2007[118] Good	IG2: Behavioral skills maintenance	20-session Family-based comprehensive weight management program + behavioral skills maintenance component	60	X			X		X	X		X					X	X	X

Author, Year Quality	Group	Brief Description	Contact hrs	Goals & Planning	Collab Goals	Compar of Outcomes	Self-monitor Behav	Self-monitor Outcome	Contingent Reward	Stimulus Control	Motivational Interview	Parent Modeling	Parenting Skill	Supervised PA Sessions	Parent Target	Child Target	Family Target	Individual Tx	Group Tx
	IG3: Social facilitation maintenance	20-session Family-based comprehensive weight management program + social facilitation maintenance component	60	X			X		X	X		X			X	X	X	X	X

Abbreviations: CDS = clinical decision support; CG = control group; ed = education; EMR = electronic medical records; hr(s) = hour(s); GP = general practice; IG = intervention group; IVR = interactive voice response; MI = motivational interview; min = minute(s); msg = message; NHS = National Health System; PA = physical activity; PCP = primary care provider; pt = patient; RD = registered dietician; SMS = short messaging service; tx = treatment

Table 17. Association between intervention components and effect size: meta-regression results and percent of trials with specified population and intervention characteristics among interventions that did and did not meet minimum criteria for clinically significant change (zBMI reduction of 0.25), among trials reporting zBMI and at least 26 estimated hours of contact. (Key Question 4a)

Component*	Meta-regression results (k=36)			Clinically significant change, among trials with ≥26 estimated contact hours (k=24)			
	No. of Studies with character-istic	Regression coefficient* (95% CI)	P-value	No. (%) met criterion (k=14)	No. (%) did not meet criterion (k=10)	Absolute difference in percentage points	Fisher's exact p-value
Goals and planning	33[69-74, 76-79, 92-94, 96-114, 116]	-0.31 (-0.75 to 0.13)	0.16	13 (92.9)	10 (100)	7.1	1.00
Collaborative goals	12[69, 71, 76, 92-95, 97, 98, 101, 112, 116]	0.15 (-0.07 to 0.37)	0.16	1 (7.1)	3 (30.0)	22.9	0.27
Comparison of outcomes	12[69, 70, 76, 78, 94-98, 110, 111, 113]	0.20 (-0.03 to 0.43)	0.08	2 (14.3)	2 (20.0)	5.7	1.00
Motivational interviewing	8[69, 76, 78, 94, 95, 98, 110, 111]	0.03 (-0.23 to 0.29)	0.80	0 (0)	2 (20.0)	20.0	0.16
Self-monitoring behavior	20[69-74, 76, 79, 93, 97, 98, 102, 103, 107-110, 114-116]	-0.04 (-0.26 to 0.18)	0.71	10 (71.4)	8 (80.0)	8.6	1.00
Self-monitoring of weight	6[73, 99, 102, 104, 105, 114]	-0.15 (-0.44 to 0.15)	0.32	5 (35.7)	2 (20.0)	15.7	0.65
Contingent reward or threat	17[70-72, 74, 79, 93, 97, 98, 102, 104-109, 113, 116]	-0.15 (-0.38 to 0.07)	0.17	11 (78.6)	7 (70.0)	8.6	0.66
Stimulus control	15[69-71, 73, 74, 93, 97, 99, 100, 103, 106-109, 113]	0.07 (-0.16 to 0.30)	0.55	11 (78.6)	5 (50.0)	28.6	0.20
Parental modeling	20[70-72, 74, 77, 79, 92, 97, 99, 100, 103-109, 112, 113, 116]	-0.08 (-0.30 to 0.15)	0.49	11 (78.6)	2 (20.0)	58.6	0.01
Parenting skills training	13[69, 70, 74, 93, 96-98, 101, 103, 107, 108, 112, 113]	0.08 (-0.16 to 0.33)	0.49	10 (71.4)	3 (30.0)	41.4	0.10

*Controlling for estimated contact hours

Table 18. No. (%) of trials with and without specified intervention characteristics or components that had high adherence, sorted by descending difference in percentage points (Key Question 5)

Intervention characteristic or components	No. (%) That Had High Adherence*		Absolute Difference in Percentage Points	Fisher's Exact p-Value
	Yes (trials that had characteristic/ component)	No (trials that did not have characteristic/ component)		
Offered sessions targeting parent only (without child)	15/34 (44.1%)	1/11 (9.1%)	35	0.07
Collaborative goals	7/13 (53.8%)	9/32 (28.1%)	25.7	0.17
Included an electronic delivery component	1/7 (14.3%)	15/38 (39.5%)	25.2	0.39
Parenting skills training	9/19 (47.4%)	7/26 (26.9%)	20.5	0.21
Goals and planning	13/39 (33.3%)	3/6 (50.0%)	16.7	0.65
Offered sessions targeting child only (without parent)	12/29 (41.4%)	4/16 (25.0%)	16.4	0.34
High (≥26) contact hours	9/21 (42.9%)	7/24 (29.2%)	13.7	0.37
Motivational interviewing	5/11 (45.4%)	11/34 (32.4%)	13.0	0.48
Cultural tailoring	1/4 (25.0%)	15/41 (36.6%)	11.6	1.00
Multidisciplinary team	4/14 (28.6%)	12/31 (38.7%)	10.1	0.74
Stimulus control	6/20 (30.0%)	10/25 (40.0%)	10.0	0.54
Psychologist on team	5/12 (41.7%)	11/33 (33.3%)	8.4	0.73
Parental modeling	7/22 (31.8%)	9/23 (39.1%)	7.3	0.76
Included a print delivery component	6/19 (31.6%)	10/26 (38.5%)	6.9	0.76
Contingent reward or threat	8/21 (38.1%)	8/24 (33.3%)	4.8	0.76
Comparison of outcomes	5/13 (38.5%)	11/32 (34.4%)	4.1	1.00
Included an phone delivery component	6/18 (33.3%)	10/27 (37.0%)	3.7	1.00
Offered group sessions	11/30 (36.7%)	5/15 (33.3%)	3.4	1.00
Offered sessions targeting family all together	10/29 (34.5%)	6/16 (37.5%)	3.0	1.00
Self-monitoring of behavior	10/29 (34.5%)	6/16 (37.5%)	3.0	1.00
Offered individual (single-family) sessions	14/39 (35.9%)	2/6 (33.3%)	2.6	1.00
Self-monitoring of weight	3/8 (37.5%)	13/37 (35.1%)	2.4	1.00

*k=16 trials with "high" adherence, k=29 trials with "not high" adherence; "high" adherence defined as average session attendance >70%, average number of sessions completed >75% of the sessions offered, or >50% completed all sessions

Table 19. No (%) of trials with and without specified characteristics or components that had high adherence among trials with 26 or more contact hours, sorted by descending difference in percentage points (Key Question 5)

Intervention characteristic or components	No. (%) That Had High Adherence*		Absolute Difference in Percentage Points	Fisher's Exact p-Value
	Yes (trials that had characteristic/ component)	No (trials that did not have characteristic/ component)		
Goals and planning	8/20 (40.0%)	1/1 (100%)	60.0	0.43
Cultural tailoring	0/2 (0%)	9/19 (47.4%)	47.4	0.49
Included parent-only sessions	9/20 (45.0%)	0/1 (0%)	45.0	1.00
Included a phone delivery component	2/8 (25.0%)	7/13 (53.8%)	28.8	0.37
Included an electronic delivery component	1/4 (25.0%)	8/17 (47.1%)	22.1	0.60
Comparison of outcomes	1/4 (25.0%)	8/17 (47.1%)	22.1	0.60
Self-monitoring of behavior	8/17 (47.1%)	1/4 (25.0%)	22.1	0.60
Included an print delivery component	4/7 (57.1%)	5/14 (35.7%)	21.4	0.40
Multidisciplinary team	2/7 (28.6%)	7/14 (50.0%)	21.4	0.64
Offered sessions targeting family all together	7/14 (50.0%)	2/7 (28.6%)	21.4	0.64
Contingent reward or threat	7/14 (50.0%)	2/7 (28.6%)	21.4	0.64
Parental modeling	6/12 (50.0%)	3/9 (33.3%)	16.7	0.66
Parenting skills training	6/12 (50.0%)	3/9 (33.3%)	16.7	0.66
Psychologist on team	4/8 (50.0%)	5/13 (38.5%)	11.5	0.67
Motivational interviewing	1/3 (33.3%)	8/18 (44.4%)	11.1	1.00
Self-monitoring of weight	3/6 (50.0%)	6/15 (40.0%)	10.0	1.00
Offered individual (single-family) sessions	7/16 (43.8%)	2/5 (40.0%)	3.8	1.00
Collaborative goals	2/5 (40.0%)	7/16 (43.8%)	3.8	1.00
Stimulus control	6/14 (42.9%)	3/7 (42.9%)	0	1.00

*k=9 trials with "high" adherence, k=12 trials with "not high" adherence; "high" adherence defined as average session attendance >70%, average number of sessions completed >75% of the sessions offered, or >50% completed all sessions

Table 20. Evidence profile for Key Question 1: In children and adolescents who are overweight or obese, do family-based multicomponent behavioral interventions reduce and maintain change in age/sex standardized BMI?

Outcome	Quality assessment						No. of participants analyzed		Effect			Quality
	No. of trials No. rand.	Risk of bias	Inconsist-ency	Indirect-ness	Imprecision	Other consider-ations	IG[a]	CG	Relative (95% CI) Range of mean change, for zBMI only	No. (%) studies with mean zBMI reduction ≥0.25 in IG	No. (%) studies with mean zBMI reduction ≥0.50 in IG	
Any contact hours, studies with goal to reduce excess weight												
Any weight outcome *Efficacy trials*	36[69-79, 92-116] 6,820	Not serious	Serious[b]	Not serious	Not serious	Dose-response[c]	2,969	2,508	SMD -0.34 (-0.49 to -0.19), I^2=81.6%, k=34[d, e]	NA	NA	⊕⊕⊕◯ Moderate
zBMI *Efficacy trials*	27[69, 70, 72-74, 78, 93-99, 101-105, 107-115] 4,913	Not serious	Serious[b]	Not serious	Not serious	Dose-response[c]	2,226	1,813	WMD -0.16 (-0.24 to -0.07), I^2=85.5%, k=23[d, e, k, l] IG: -0.60 to 0.05 CG: -0.21 to 0.26	8/24 (33.3%)	2/24 (8.3%)	⊕⊕⊕◯ Moderate
zBMI *Efficacy and CE trials*	40 5349	Not serious	Serious[b]	Not serious	Not serious	Dose-response[c]	2,322	NA	NA	15/40 (37.5%)	4/40 (10%)	⊕⊕⊕◯ Moderate
52+ contact hours, studies with goal to reduce excess weight												
Any weight outcome *Efficacy trials*	4[104-106, 115] 996	Serious[f]	Not serious	Not serious	Not serious	None	603	322	SMD -1.10 (-1.31 to -0.90), I^2=36.8%, k=4	NA	NA	⊕⊕⊕◯ Moderate
zBMI *Efficacy trials*	3[104, 105, 115] 787	Serious[f]	Not serious	Not serious	Not serious	None	498	253	WMD -0.38 (-0.49 to -0.27), I^2=50.5%, k=3 IG: -0.34 to -0.22 CG: 0 to 0.26	2/3 (66.7%)	0/3 (0%)	⊕⊕⊕◯ Moderate

Outcome	Quality assessment						No. of participants analyzed		Effect			Quality
	No. of trials No. rand.	Risk of bias	Inconsist-ency	Indirect-ness	Imprecision	Other consider-ations	IG[a]	CG	Relative (95% CI) Range of mean change, for zBMI only	No. (%) studies with mean zBMI reduction ≥0.25 in IG	No. (%) studies with mean zBMI reduction ≥0.50 in IG	
zBMI *Efficacy and CE trials*	4 886	Serious[f]	Not serious	Not serious	Not serious	None	534	NA	NA	2/4 (50.0%)	0/4 (0%)	⊕⊕⊕◯ Moderate
26-51 contact hours, studies with goal to reduce excess weight												
Any weight outcome *Efficacy trials*	12[188] 1,354	Not serious	Not serious	Not serious	Serious[g]	Small studies	564	559	SMD -0.35 (-0.52 to -0.17), I^2=39.2%, k=12	NA	NA	⊕⊕⊕◯ Moderate
zBMI *Efficacy trials*	9[69, 74, 93, 96, 99, 102, 107, 108, 113] 750	Not serious	Not serious	Not serious	Serious[g]	Small studies	295	299	WMD -0.19 (-0.30 to -0.08), I^2=55.9%, k=9 IG: -0.60 to -0.13 CG: -0.30 to 0.40	6/9 (66.7%)	2/9 (22.2%)	⊕⊕⊕◯ Moderate
zBMI *Efficacy and CE trials*	20 1877	Not serious	Not serious	Not serious	Serious[g]	Small studies	759	NA	NA	12/20 (60.0%)	4/20 (20.0%)	⊕⊕⊕◯ Moderate
6-25 contact hours, studies with goal to reduce excess weight												
Any weight outcome *Efficacy trials*	8[70, 73, 77, 95, 97, 101, 103, 112] 839	Not serious	Serious[b]	Not serious	Serious[g]	None	377	333	SMD -0.06 (-0.28 to 0.17), I^2=42.0%, k=7[e]	NA	NA	⊕⊕◯◯ Low
zBMI *Efficacy trials*	7[70, 73, 95, 97, 101, 103, 112] 755	Not serious	Serious[b]	Not serious	Serious[g]	None	336	293	WMD -0.01 (-0.10 to 0.08), I^2=49.7%, k=6[e] IG: -0.24 to 0.05 CG: -0.13 to 0.09	0/7 (0%)	0/7 (0%)	⊕⊕◯◯ Low

Outcome	Quality assessment						No. of participants analyzed		Effect			Quality
	No. of trials No. rand.	Risk of bias	Inconsist-ency	Indirect-ness	Imprecision	Other consider-ations	IG[a]	CG	Relative (95% CI) Range of mean change, for zBMI only	No. (%) studies with mean zBMI reduction ≥0.25 in IG	No. (%) studies with mean zBMI reduction ≥0.50 in IG	
zBMI *Efficacy and CE trials*	9 915	Not serious	Serious[b]	Not serious	Serious[g]	None	415	NA	NA	1/9 (11.1%)	0/9 (0%)	⊕⊕◯◯ Low
0-5 contact hours, studies with goal to reduce excess weight												
Any weight outcome *Efficacy trials*	12[72, 75, 76, 78, 79, 94, 98, 109-111, 114, 116] 3,631	Not serious	Not serious	Not serious	Not serious	None	1,425	1,294	SMD -0.17 (-0.26 to -0.07), I^2=6.2%, k=11[d]	NA	NA	⊕⊕⊕⊕ High
zBMI *Efficacy trials*	8[72, 78, 94, 98, 109-111, 114] 2,621	Not serious	Not serious	Not serious	Not serious	None	1,097	968	WMD -0.09 (-0.15 to -0.04), I^2=0.0%, k=5[d, k, l] IG: -0.20 to 0 CG: -0.10 to 0.10	0/5 (0%)	0/5 (0%)	⊕⊕⊕⊕ High
zBMI *Efficacy and CE trials*	7 1671	Not serious	Not serious	Not serious	Not serious	None	614	NA	NA	0/7 (0%)	0/7 (0%)	⊕⊕⊕⊕ High
High (≥26) contact hours, studies with goal to reduce excess weight												

Outcome	Quality assessment						No. of participants analyzed		Effect			Quality
	No. of trials No. rand.	Risk of bias	Inconsist-ency	Indirect-ness	Imprecision	Other consider-ations	IG[a]	CG	Relative (95% CI) Range of mean change, for zBMI only	No. (%) studies with mean zBMI reduction ≥0.25 in IG	No. (%) studies with mean zBMI reduction ≥0.50 in IG	
Any weight outcome *Efficacy trials*	16[69, 71, 74, 92, 93, 96, 99, 100, 102, 104-108, 113, 115] 2,350	Not serious	Not Serious	Not serious	Serious[g]	None	1,167	881	SMD -0.60 (-0.86 to -0.34), I^2=83.5%, k=16	NA	NA	⊕⊕⊕◯ Moderate
zBMI *Efficacy trials*	12[69, 74, 93, 96, 99, 102, 104, 105, 107, 108, 113, 115] 1,537	Not serious	Serious[b]	Not serious	Not serious	None	793	552	WMD -0.27 (-0.38 to -0.16), I^2=80.6%, k=12 IG: -0.60 to -0.13 CG: -0.30 to 0.40	8/12 (66.7%)	2/12 (16.7%)	⊕⊕⊕◯ Moderate
zBMI *Efficacy and CE trials*	24 2,763	Not serious	Serious[b]	Not serious	Not serious	None	1,293	NA	NA	14/24 (58.3%)	4/24 (16.7%)	⊕⊕⊕◯ Moderate
Not high (<26) contact hours, studies with goal to reduce excess weight												
Any weight outcome *Efficacy trials*	20[70, 72, 73, 75-79, 94, 95, 97, 98, 101, 103, 109-112, 114, 116] 4,470	Not serious	Serious[b]	Not serious	Not serious	None	1,802	1,627	SMD -0.14 (-0.24 to -0.04), I^2=22.8%, k=18[d,e]	NA	NA	⊕⊕⊕◯ Moderate

Outcome	Quality assessment						No. of participants analyzed		Effect			Quality
	No. of trials No. rand.	Risk of bias	Inconsist-ency	Indirect-ness	Imprecision	Other consider-ations	IG[a]	CG	Relative (95% CI) Range of mean change, for zBMI only	No. (%) studies with mean zBMI reduction ≥0.25 in IG	No. (%) studies with mean zBMI reduction ≥0.50 in IG	
zBMI *Efficacy trials*	13[70, 72, 73, 78, 94, 95, 97, 98, 101, 103, 109-112, 114] 3,376	Not serious	Serious[b]	Not serious	Not serious	None	1,433	1,261	WMD -0.04 (-0.10 to 0.01), I^2=39.7%, k=11[d, e, k, l] IG: -0.24 to 0.05 CG:-0.13 to 0.10	0/12 (0%)	0/12 (0%)	⊕⊕⊕◯ Moderate
zBMI *Efficacy and CE trials*	16 2,586	Not serious	Serious[b]	Not serious	Not serious	None	1,029	NA	NA	1/16 (6.2%)	0/16 (0%)	⊕⊕⊕◯ Moderate
Any contact hours, studies with goal to maintain reduction in excess weight												
zBMI	2[117, 118] 211	Not serious	Not serious	Not serious	Very serious[h]	Minimal evidence[i]	130‡	71	Mean difference -0.08 (-0.16 to 0.01), p=0.07[118] IG: 0.03[j] CG: 0.08 NSD between group; data by group NR[117]	0/1 (0%) (NR for 1 study)	0/1 (0%) (NR for 1 study)	⊕◯◯◯ Very Low

[a]Intervention group with the highest intensity included in analysis

[b]Two studies in other direction from remaining studies

[c]Dose response evident with greater changes in effect sizes with increasing intensity (hours of contact)

[d]Hughes, 2008[98] did not provide sufficient data for meta-analysis. At 12 months followup, the median change from baseline in zBMI was -0.07 (IQR, -0.32 to 0.04) in the IG and -0.19 (IQR, -0.31 to 0.02) in the CG ($p<0.01$ for both group); the between group difference was not statistically significant (median difference in change, -0.04 [95% CI, -0.17 to 0.07]. p=0.50).

[e]Raynor, 2012[103] did not provide sufficient data for meta-analysis. At 12 months followup, the mean change from baseline in zBMI was similar between groups (IG, -0.22 and CG, -0.22)

[f]Blinding and allocation concealment not reported or unlikely across all trials; two studies (Reinehr, 2006[104] and Reinehr, 2009[105]) were controlled clinical trials

[g]Wide-ranging effect sizes, many with small sample sizes, +/- upper and lower confidence intervals not within clinical action

[h]One study (Davis, 2012[117]) did not report confidence intervals

[i]Only two studies; 107one trial did not provide detailed results

[j]Wilfley, 2007[118] included two maintenance arms: behavioral skill maintenance and social facilitation

[k]Taveras, 2011[110] did not provide sufficient data for meta-analysis or to determine zBMI reduction. At 12 months followup, the between group difference in zBMI was -0.05 (95% CI, -0.14 to 0.04), p=0.28.

[l]Van Grieken, 2013[78] did not provide sufficient data for meta-analysis or to determine zBMI reduction. At 24 months followup, the between group difference in zBMI was not statistically significant (p=0.07).

Abbreviations: CE = comparative effectiveness CG = control group; CI = confidence interval; IG = intervention group; No. = number; SMD = standardized mean difference; WMD = weighted mean difference

Table 21. Evidence profile for Key Question 2a: How do selected patient and family sociodemographic characteristics (child's age, severity of adiposity, parental obesity, race, socioeconomic status) affect family-based multicomponent behavioral interventions? Specifically, are different approaches or components used or needed for families with different sociodemographic characteristics?

Quality assessment						Effect		Quality
No. of trials	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Narrative**	**Absolute**	
Use of parent-related component across age groups								
49[69-72, 74-79, 81-85, 87-90, 92-94, 97-99, 101-103, 107-112, 114, 117-126, 128, 129, 132, 133]	Not serious	NA	Not serious	Serious[a]	Limited data due to variable age ranges in included trials, so many trials covered multiple age categories and could not be examined; trial age ranges did not cleanly map to our *a priori* age categories; elementary age category heterogeneous in specific included ages Coding intervention components reliant on study reporting, which was variable in completeness	Parent modeling more likely included in interventions targeting preschool and elementary-aged children, however relationship no longer statistically significant when more strict categorization approach was used (p=0.08) No clear association between child's age category and use of parent skills training or offering parent-only sessions	See **Table 7** % included parent modeling: *Preschool:* 3/6 (50.0%) *Elementary:* 24/36 (66.7%) *Adolescent:* 1/7 (14.3%) p=0.03	⊕⊕◯◯ Low
Intervention characteristics for studies with ≥50% black or Latino families vs. <50%								
12[73, 81, 86, 90, 92, 102, 106, 109, 116, 117, 130, 131] Cultural tailoring, PA sessions, non-health care settings	Not serious	NA	Not serious	Serious[a]	Many trials did not report race/ethnicity, so were assumed to be majority white. Coding intervention components reliant on study reporting, which was variable in completeness	Trials with ≥50% black or Latino families were more likely to use culturally tailored interventions (CT), include supervised physical activity sessions (PA), and be conducted in non-healthcare settings (S)	See **Table 8** %Yes ≥50% vs. <50% black or Latino CT: 41.7 vs. 0 PA: 66.7 vs. 34.0 S: 58.3 vs. 31.0	⊕⊕◯◯ Low

Quality assessment						Effect		Quality
No. of trials	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**	**Narrative**	**Absolute**	
12[73, 81, 86, 90, 92, 102, 106, 109, 116, 117, 130, 131] All other intervention characteristics	Not serious	NA	Not serious	Serious[a]	Same as above	No association between race/ethnicity composition of trials and other intervention characteristics	See **Table 8**	⊕⊕◯◯ Low
Intervention components for studies with ≥50% black or Latino families vs. <50%								
12[73, 81, 86, 90, 92, 102, 106, 109, 116, 117, 130, 131] All examined intervention components	Not serious	NA	Not serious	Serious[a]	Same as above	No association between race/ethnicity composition of trials and intervention components. Apparent association with parenting skills training mitigated by differences in ages targeted	See **Table 9**	⊕⊕◯◯ Low
Other sociodemographic characteristics (severity of adiposity, parental obesity, socioeconomic status)								
NA	NA	NA	NA	NA	NA	Insufficient data, effect not examined		NA

[a]Small number of studies in subpopulation(s) of interest

Abbreviations: NA = not applicable

Table 22. Evidence profile for Key Question 2b: How do selected patient and family sociodemographic characteristics (child's age, severity of adiposity, parental obesity, race, socioeconomic status) affect family-based multicomponent behavioral interventions? Specifically, are selected patient and family sociodemographic characteristics associated with treatment outcome?

Quality assessment						Narrative Summary	Effect	Quality
No. of trials	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations			
Population characteristics for efficacy studies								
Age, degree of excess weight, parental overweight, race/ ethnicity								
36[69-79, 92-116] *Efficacy trials*	Not serious	NA	Serious[a]	Serious[b]		No association between population characteristics and effect size	See **Table 10.** P-value for meta-regression >0.20 in all cases	⊕⊕◯◯ Low
25[69, 74, 81, 89, 93, 96, 99, 102, 104, 105, 107, 108, 113, 115, 118, 120, 122-124, 129-134] *Efficacy and CE trials with ≥26 estimated hours of contact*	Not serious	NA	Serious[a]	Serious[b]		Likely association with age (greater likelihood of effect in trials targeting younger children); apparent association with race/ethnicity likely driven by age; no association between other population characteristics and effect size	See **Table 10.** Of trials meeting criteria for clinical significance: Preschool: 28.6% Elementary: 42.8% Adolescent: 0% Multiple: 28.6% ≥50% black/Latino: 0% <50% black/Latino: 100% 0 trials targeting preschool or elementary children, among trials with ≥50% black/Latino chidlren	⊕⊕◯◯ Low
Low socio-economic status								
36[69-79, 92-116] *Efficacy trials*	Not serious	NA	Serious[a]	Very serious[c]		Insufficient evidence to determine whether low socioeconomic status is associated with effect size	Regressions coefficient: 0.55 (0.20 to 0.91), p-value=0.003 *(negative number=benefit [reduction in excess weight])*	⊕◯◯◯ Very Low

Quality assessment						Narrative Summary	Effect	Quality
No. of trials	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**			
25[69, 74, 81, 89, 93, 96, 99, 102, 104, 105, 107, 108, 113, 115, 118, 120, 122-124, 129-134] *Efficacy and CE trials with ≥26 estimated hours of contact*	Not serious	NA	Serious[a]	Very serious[c]		Insufficient evidence to determine whether low socioeconomic status is associated with effect size	None of the 25 trials included in this analysis targeted families with low socioeconomic status	⊕◯◯◯ Very Low

[a] Based on comparison of trials with and without the characteristics; trials did not directly test the importance of the characteristic

[b] Few trials (4-6) reporting the presence (or absence) the characteristic, trials had small n, not evenly distributed along distribution of contact hours

[c] Very few trials (1-3) reporting the presence (or absence) the characteristic, trials had small n, not evenly distributed along distribution of contact hours

[d]Generally small trials with wide confidence intervals

[e]Very few trials (1-3) examined the characteristic, trials had small ns

Abbreviations: CE = comparative effectiveness; CG = control group; IG = intervention group; NA = not applicable; SD = standard deviation

Table 23. Evidence profile for Key Question 3: What is the impact of selected characteristics of family-based multicomponent behavioral interventions (dosage of contact, setting, interventionist qualifications, mode of delivery, use of multidisciplinary team, involvement of psychologist, cultural tailoring) in the management of age/sex standardized BMI? Specifically: 3a. Are these characteristics associated with the efficacy of the interventions? 3b. What is the comparative effectiveness of these characteristics?

Quality assessment						Narrative Summary	Effect	Quality
No. of trials	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**			
Intervention characteristics for efficacy studies								
Contact Dose								
36[69-79, 92-116] *Efficacy trials, KQ3a*	Not serious	NA	Serious[a]	Not serious	Coding intervention characteristics reliant on study reporting, which was variable in completeness; however this limitation is less problematic for contact dose than dichotomous predictors because inaccurate calculations are likely to be off by only a small % of the true dose.	Estimated contact hours, number of session, and high (≥26 hours) vs. low contact all showed an association with effect size. Duration (months) of the intervention did not show an association	See **Table 11.** P-value for meta-regression <0.01 in all cases except duration (p=0.52)	⊕⊕⊕◯ Moderate

Quality assessment						Narrative Summary	Effect	Quality
No. of trials	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**			
12[70, 76, 81, 88, 90, 102, 111, 126, 130-132, 134] *CE trials, KQ3b*	Not serious	Not serious	Not serious	Serious[d]	Additional contact also likely involved additional content in most cases, trials not testing simply more vs. less contact	Possible association between contact hours and effect size, however effects were small and usually not statistically significant; group differences primarily seen only when the lower-contact group involved no or minimal one-on-one contact	See **Table 12** and **Figure 7**	⊕⊕◯◯ Low
Provider qualifications								
36[69-79, 92-116] *Efficacy trials, KQ3a*	Not serious	NA	Serious[a]	Not serious	Coding intervention characteristics reliant on study reporting, which was variable in completeness	Evidence suggested no association between provider characteristics and effect size.	See **Table 11.**	⊕⊕◯◯ Low
25[69, 74, 81, 89, 93, 96, 99, 102, 104, 105, 107, 108, 113, 115, 118, 120, 122-124, 129-134] *Efficacy and CE trials with ≥26 estimated hours of contact, KQ3a*	Not serious	NA	Serious[a]	Not serious	Coding intervention characteristics reliant on study reporting, which was variable in completeness	Evidence suggested no clear association between provider characteristics and effect size.	See **Table 11.**	⊕⊕◯◯ Low
0 *CE trials, KQ3b*	NA	NA	NA	NA	None	No trials		NA
Intervention Delivery: Setting								

Quality assessment						Narrative Summary	Effect	Quality
No. of trials	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**			
36[69-79, 92-116] *Efficacy trials, KQ3a*	Not serious	NA	Serious[a]	Not serious	Coding intervention characteristics reliant on study reporting, which was variable in completeness	Evidence suggested no association between setting (primary care, other health care, or non-health care) and effect size.	See **Table 11.** P-value for meta-regressions all >0.05	⊕⊕◯◯ Low
25[69, 74, 81, 89, 93, 96, 99, 102, 104, 105, 107, 108, 113, 115, 118, 120, 122-124, 129-134] *Efficacy and CE trials with ≥26 estimated hours of contact, KQ3a*	Not serious	NA	Serious[a]	Not serious	Coding intervention characteristics reliant on study reporting, which was variable in completeness	Evidence suggested no association between setting (primary care, other health care, or non-health care) and effect size.	See **Table 11.** Fisher's exact p-values all >0.05	⊕⊕◯◯ Low
1[80] *CE trials, KQ3b*	Not serious	NA	Not serious	Very serious[e]	Only two settings compared	No difference in intervention effectiveness when same intervention delivered in primary care (PC) or hospital-based specialty clinic (SC)	ΔzBMI, Mean (SD) PC: -0.17 (0.56) SC: -0.14 (0.27) p-value, NR	⊕◯◯◯ Very Low
Intervention Delivery: Session Target (Parent, Child, Both); Electronic, Print, or Phone Delivery Component, Supervised Physical Activity Sessions								

Quality assessment						Narrative Summary	Effect	Quality
No. of trials	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**			
36[69-79, 92-116] *Efficacy trials, KQ3a*	Not serious	NA	Serious[a]	Not serious	Coding intervention characteristics reliant on study reporting, which was variable in completeness	Evidence suggested no association between effect size and use of group sessions; parent-only, child-only, or family sessions; electronic, print, or phone delivery component; or supervised physical activity sessions. Evidence inconclusive on whether use of individual (single-family) sessions was associated with effect size	See **Table 11.** P-value for meta-regression >0.05 in all cases except for use individual sessions (p=0.047), but insufficient data to test this because almost all trials offered individual sessions.	⊕⊕◯◯ Low
25[69, 74, 81, 89, 93, 96, 99, 102, 104, 105, 107, 108, 113, 115, 118, 120, 122-124, 129-134] *Efficacy and CE trials with ≥26 estimated hours of contact, KQ3a*	Not serious	NA	Serious[a]	Not serious	Coding intervention characteristics reliant on study reporting, which was variable in completeness	Evidence suggested no association between effect size and intervention delivery	See **Table 11.** Fisher's exact p-value for meta-regression >0.05 in all cases	⊕⊕◯◯ Low

Quality assessment						Narrative Summary	Effect	Quality
No. of trials	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**			
2 (group vs. individual sessions)[127, 128] 3 (session target)[119, 122, 125] 3 (electronic delivery)[102, 120, 126] 1 (supervised physical activity sessions)[82] *(based on CE trials, KQ3b)*	Not serious	Not serious	Not serious	Very serious[e]		None of the trials reported an association between format and effect size.	See **Table 13** and **Figure 8** (detailed results not provided for supervised PA sessions, authors only stated that there were no group differences)	⊕⊕◯◯ Low
Cultural Tailoring								
36[69-79, 92-116] *Efficacy trials, KQ3a*	Not serious	NA	Serious[a]	Very serious[c]	Only one efficacy trial reported cultural tailoring	Data were insufficient to determine whether cultural tailoring is associated with effect size.	Mean (SD) BMI change from baseline in single trial with cultural tailoring: IG: 0.16 (1.64) kg/m^2 CG: 1.42 (1.67) kg/m^2	⊕◯◯◯ Very Low
0 *CE trials, KQ3b*	NA	NA	NA	NA	None	No trials		NA

[a] Based on comparison of trials with and without the characteristics; trials did not directly test the importance of the characteristic

[b] Few trials (4-6) reporting the presence (or absence) the characteristic, trials had small n, not evenly distributed along distribution of contact hours

[c] Very few trials (1-3) reporting the presence (or absence) the characteristic, trials had small n, not evenly distributed along distribution of contact hours

[d]Generally small trials with wide confidence intervals

[e]Very few trials (1-3) examined the characteristic, trials had small ns

Abbreviations: CE = comparative effectiveness; CG = control group; IG = intervention group; NA = not applicable; SD = standard deviation

Table 24. Evidence profile for Key Question 4: What is the impact of selected components of family-based behavioral management interventions (goals and planning, comparison of outcomes, self-monitoring of behavior, self-monitoring of outcome, reward and threat, stimulus control, modeling of healthy lifestyle behaviors by parents, motivational interviewing, general parenting skills (e.g., positive parenting) or family conflict management) in the management of age/sex standardized BMI? Specifically: 4a. Are these characteristics associated with the efficacy of the interventions? 4b. What is the comparative effectiveness of these characteristics?

Quality assessment						Narrative Summary	Effect	Quality
No. of trials	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**			
Intervention components for efficacy studies								
Goals and planning								
36[69-79, 92-116] *Efficacy trials, KQ4a*	Not serious	NA	Serious[a]	Very serious[b]	Coding intervention characteristics reliant on study reporting, which was variable in completeness	Almost all trials (33/36) noted use of goals and planning, so there was insufficient variability to yield valid meta-regression results	Regression coefficient: -0.31 (-0.75 to 0.13) *(negative number=benefit [greater reduction in excess weight])*	⊕◯◯◯ Very Low
25[69, 74, 81, 89, 93, 96, 99, 102, 104, 105, 107, 108, 113, 115, 118, 120, 122-124, 129-134] *Efficacy and CE trials with ≥26 estimated hours of contact, KQ4a*	Not serious	NA	Serious[a]	Very serious[b]	Coding intervention characteristics reliant on study reporting, which was variable in completeness	Almost all trials (33/36) noted use of goals and planning, so there was insufficient variability to yield valid results	% Using goals and planning: Meeting criteria for clinical significance: 92.9% Not meeting criteria for clinical significance: 100% (p=1.0)	⊕◯◯◯ Very Low

Quality assessment						Narrative Summary	Effect	Quality
No. of trials	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**			
6[84, 85, 103, 121, 123, 124] *CE trials, KQ4b*	Not serious	Serious[b]	Not serious	Very serious[d]		A single trial indicated that individual pacing of progress through behavioral goals is preferable to a non-individualized plan. No consistent association between effect size and the type of physical activity and dietary goal.	See **Table 14** and **Figure 9**	⊕◯◯◯ Very Low
Collaborative Goals								
36[69-79, 92-116] *Efficacy trials, KQ4a*	Not serious	NA	Serious[a]	Not serious	Coding intervention characteristics reliant on study reporting, trials commonly did not provide detail on how goals were determined, so use of collaborative goals likely under-represented in this analysis.	Evidence suggested no association between use of collaborative goals and effect size.	Regression coefficient: 0.15 (-0.07 to 0.37) *(negative number=benefit [greater reduction in excess weight])*	⊕⊕◯◯ Low

Quality assessment						Narrative Summary	Effect	Quality
No. of trials	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**			
25[69, 74, 81, 89, 93, 96, 99, 102, 104, 105, 107, 108, 113, 115, 118, 120, 122-124, 129-134] *Efficacy and CE trials with ≥26 estimated hours of contact, KQ4a*	Not serious	NA	Serious[a]	Not serious	Coding intervention characteristics reliant on study reporting, trials commonly did not provide detail on how goals were determined, so use of collaborative goals likely under-represented in this analysis.	Evidence suggested no association between use of collaborative goals and effect size.	% Using collaborative goals: Meeting criteria for clinical significance: 7.1% Not meeting criteria for clinical significance: 30.0% (p=0.27)	⊕⊕◯◯ Low
1[133] *CE trials, KQ4b*	Not serious	NA	Not serious	Very serious[d]		Family-set (FS) goals not associated with larger benefit than study-set (SS) goals.	ΔzBMI, Mean (SD): FS: -0.22 (0.43), n=35 SS: -0.15 (0.44), n=37 p=0.25	⊕⊕◯◯ Low
Parental modeling								
36[69-79, 92-116] *Efficacy trials, KQ4a*	Not serious	NA	Serious[a]	Not serious	Coding intervention characteristics reliant on study reporting, which was variable in completeness	Evidence suggested no association between use of parenting skills training and effect size.	Regression coefficient: -0.08 (-0.30 to 0.15) *(negative number=benefit [greater reduction in excess weight])*	⊕⊕◯◯ Low

Quality assessment						Narrative Summary	Effect	Quality
No. of trials	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**			
25[69, 74, 81, 89, 93, 96, 99, 102, 104, 105, 107, 108, 113, 115, 118, 120, 122-124, 129-134] *Efficacy and CE trials with ≥26 estimated hours of contact, KQ4a*	Not serious	NA	Serious[a]	Not serious	Coding intervention characteristics reliant on study reporting, which was variable in completeness	Association between use of parental modeling and presence of clinically significant effect may be results of imbalance in target ages	% Using parental modeling: Meeting criteria for clinical significance: 78.6% Not meeting criteria for clinical significance: 30.0% (*p*=0.01)	⊕⊕◯◯ Low
3[83, 87, 89] *CE trials, KQ4b*	Not serious	Not serious	Not serious	Very Serious[d]		Contradictory results, but largest, most recent trial showed no association between parenting training and effect size at 3 followups.	See **Table 15** and **Figure 10**	⊕⊕◯◯ Low
Other intervention components (comparison of outcomes, motivational interviewing, self-monitoring of behavior and outcome, contingent reward or threat, stimulus control, and parenting skills training)								
36[69-79, 92-116] *Efficacy trials, KQ4a*	Not serious	NA	Serious[a]	Not serious	Coding intervention characteristics reliant on study reporting, which was variable in completeness	Evidence did not suggest an association between use of intervention components and effect size.	See **Table 17**	⊕⊕◯◯ Low
0 *CE trials, KQ4b)*	NA	NA	NA	NA	None	No trials		NA
Additional intervention components not identified a priori (coping skills training, non-structured support group, social facilitation)								
0 *Efficacy trials, KQ4a*	NA	NA	NA	NA	None	Not addressed in efficacy trials		NA

Quality assessment						Narrative Summary	Effect	Quality
No. of trials	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**			
3 *CE trials, KQ4b*	Not serious	NA	Not serious	Very serious[d]	Only 1 trial examining each approach, so inconsistency NA	No difference in effect size with addition of coping skills module, support group, or social facilitation maintenance condition (compared with a behavioral skills condition)	See **Table 16** and **Figure 11**	⊕◯◯◯ Very Low

[a] Based on comparison of trials with and without the characteristics; trials did not directly test the importance of the characteristic

[b] Very few trials (1-3) reporting the presence (or absence) the characteristic, trials had small n, not evenly distributed along distribution of contact hours

[c] Initial findings of group differences were not replicated in subsequent trials

[d] Very few trials (1-3) examined the characteristic, trials had small ns

Abbreviations: CE = comparative effectiveness; NA = not applicable

Table 25. Evidence profile for Key Question 5a: What is the effect of patient adherence, engagement, and retention (e.g., % homework complete, % of sessions attended)? Specifically, what interventions or intervention characteristics and components are associated with these factors?

Quality assessment						Effect	Quality
No. of trials	**Risk of bias**	**Inconsistency**	**Indirectness**	**Imprecision**	**Other considerations**		
45	Not serious	NA	Not serious	Serious[a]	Definitions of adherence vary widely	See **Tables 18** and **19.** None of the intervention characteristics or components were associated with adherence	⊕⊕◯◯ Low

[a]Very small to small number of studies reporting adherence for some characteristics and components

Abbreviations: NA = not applicable

Table 26. Evidence profile for Key Question 5b: What is the effect of patient adherence, engagement, and retention (e.g., % homework complete, % of sessions attended)? Specifically, what levels of patient adherence, engagement, and retention are associated with improved efficacy of the interventions?

Outcome	Quality assessment						No. of participants analyzed		Effect	Quality
	No. of trials	Risk of bias	Inconsistency	Indirectness	Imprecision	Other considerations	IG	CG	Relative (95% CI) Range of mean change	
Efficacy studies reporting any adherence										
Any weight outcome	27 8 High, 19 Not High	Not serious	Not serious	Not serious	Serious[a]	Definitions of adherence vary widely and small number of studies reporting adherence	High[b]: 594 Not High[c]: 1,526	High[b]: 557 Not High[c]: 1,383	High: SMD -0.34 (-0.54 to -0.14), I^2=54.3%, k=8 Not High: SMD -0.16 (-0.27 to -0.06), I^2=39.1%, k=19	⊕⊕◯◯ Low
Efficacy studies with 0-25 contact hours										
Any weight outcome	18 5 High, 13 Not High	Not serious	Not serious	Not serious	Serious[a]	Definitions of adherence vary widely and small number of studies reporting adherence	High[b]: 515 Not High[c]: 1,216	High[b]:: 480 Not High[c]: 1,077	High: SMD -0.24 (-0.37 to -0.12), I^2=0.0%, k=5 Not High: SMD -0.09 (-0.17 to -0.00), I^2=4.1%, k=13	⊕⊕◯◯ Low
Efficacy studies with 26+ contact hours										
Any weight outcome	9 3 High, 6 Not High	Not serious	Not serious	Not serious	Serious[a]	Definitions of adherence vary widely and small number of studies reporting adherence	High[b]: 79 Not High[c]: 310	High[b]: 77 Not High[c]: 306	High: SMD -0.76 (-1.39 to -0.13), I^2=69.8%, k=3 Not High: SMD -0.31 (-0.50 to -0.12), I^2=23.5%, k=6	⊕⊕◯◯ Low

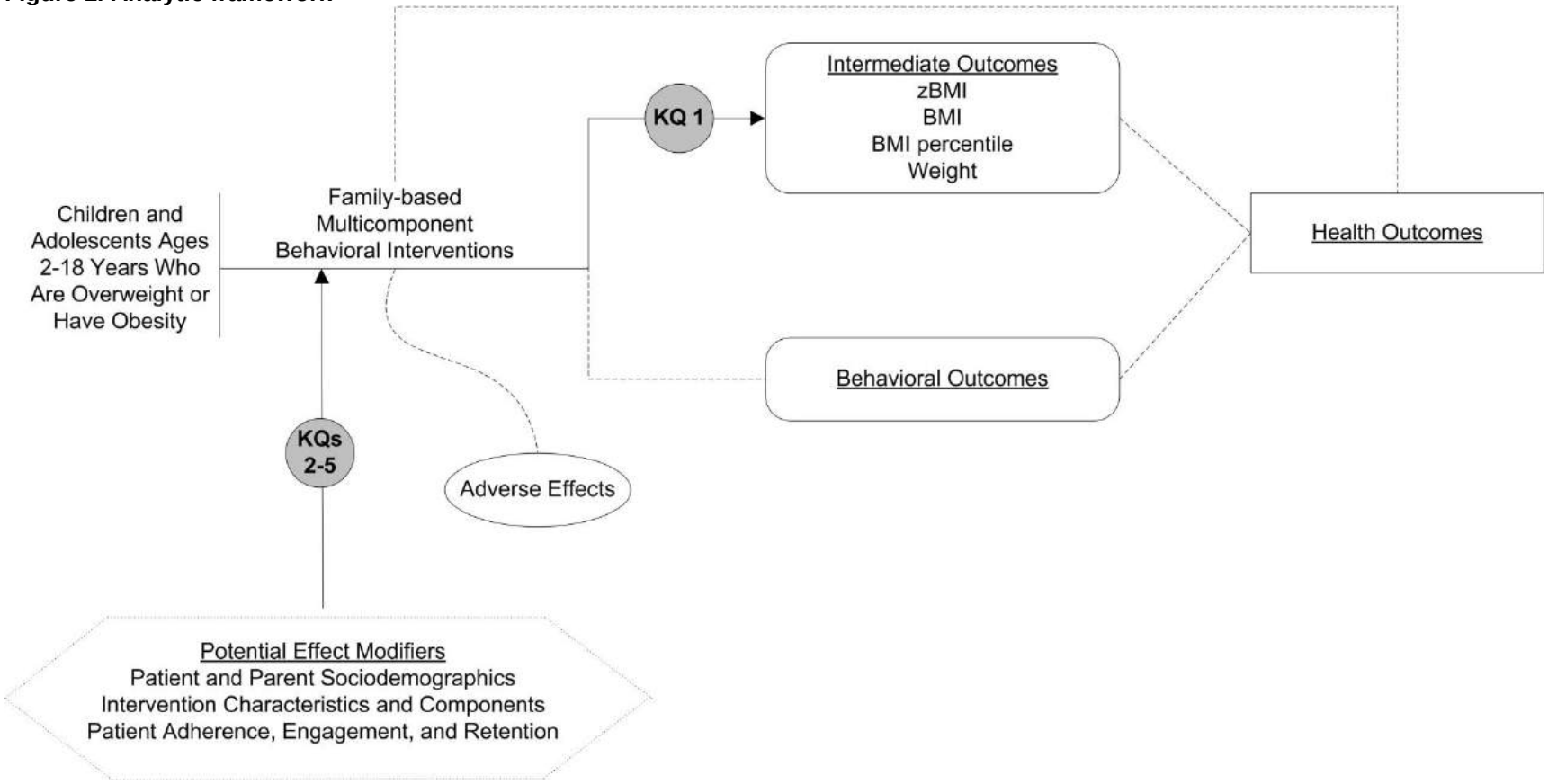
[a]Wide-ranging effect sizes, upper and lower confidence intervals not within clinical action

[b]"High" adherence defined as average session attendance >70%, average number of sessions completed >75% of the sessions offered, or >50% completed all sessions

[c]"Not high" adherence defined as having adherence information available but not meeting criteria for "High" adherence

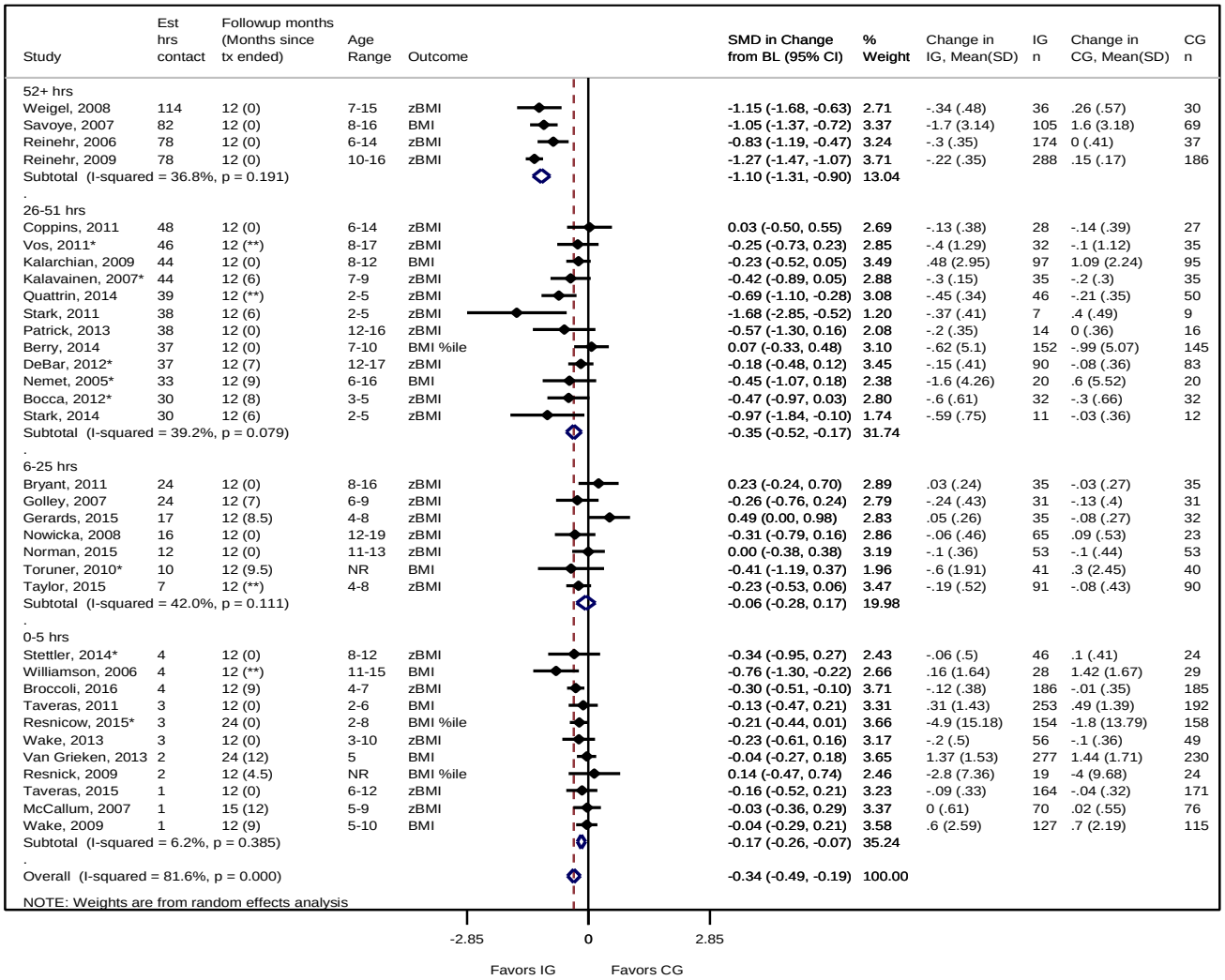
Abbreviations: CG = control group; CI = confidence interval; IG = intervention group; SMD = standardized mean difference

Figure 1. Analytic framework



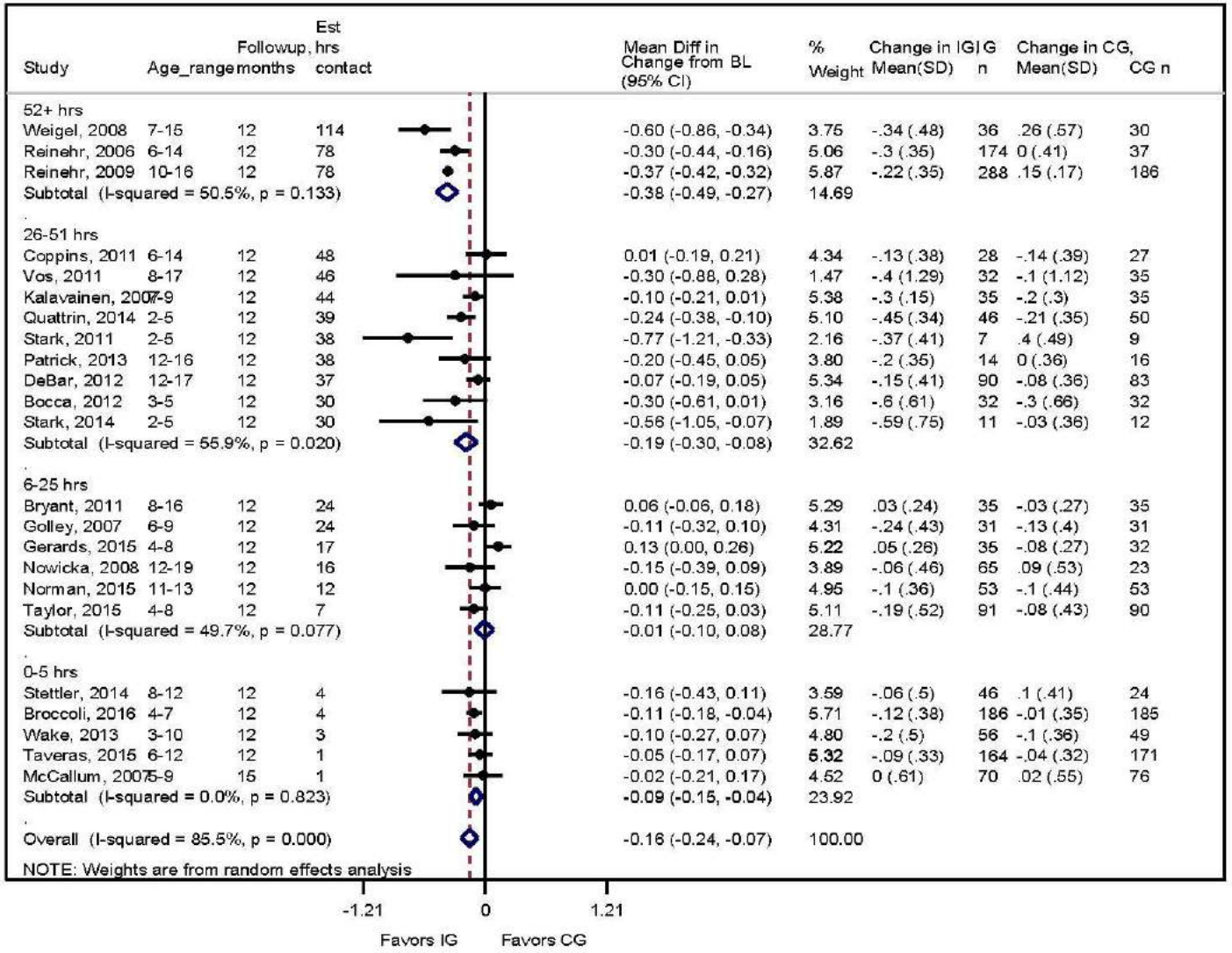
Abbreviations: BMI = body mass index; KQ = Key Question; zBMI = body mass index z-score

Figure 2. Results of efficacy trials, forest plot of change in any weight outcome, by estimated hours of contact (Key Question 1)



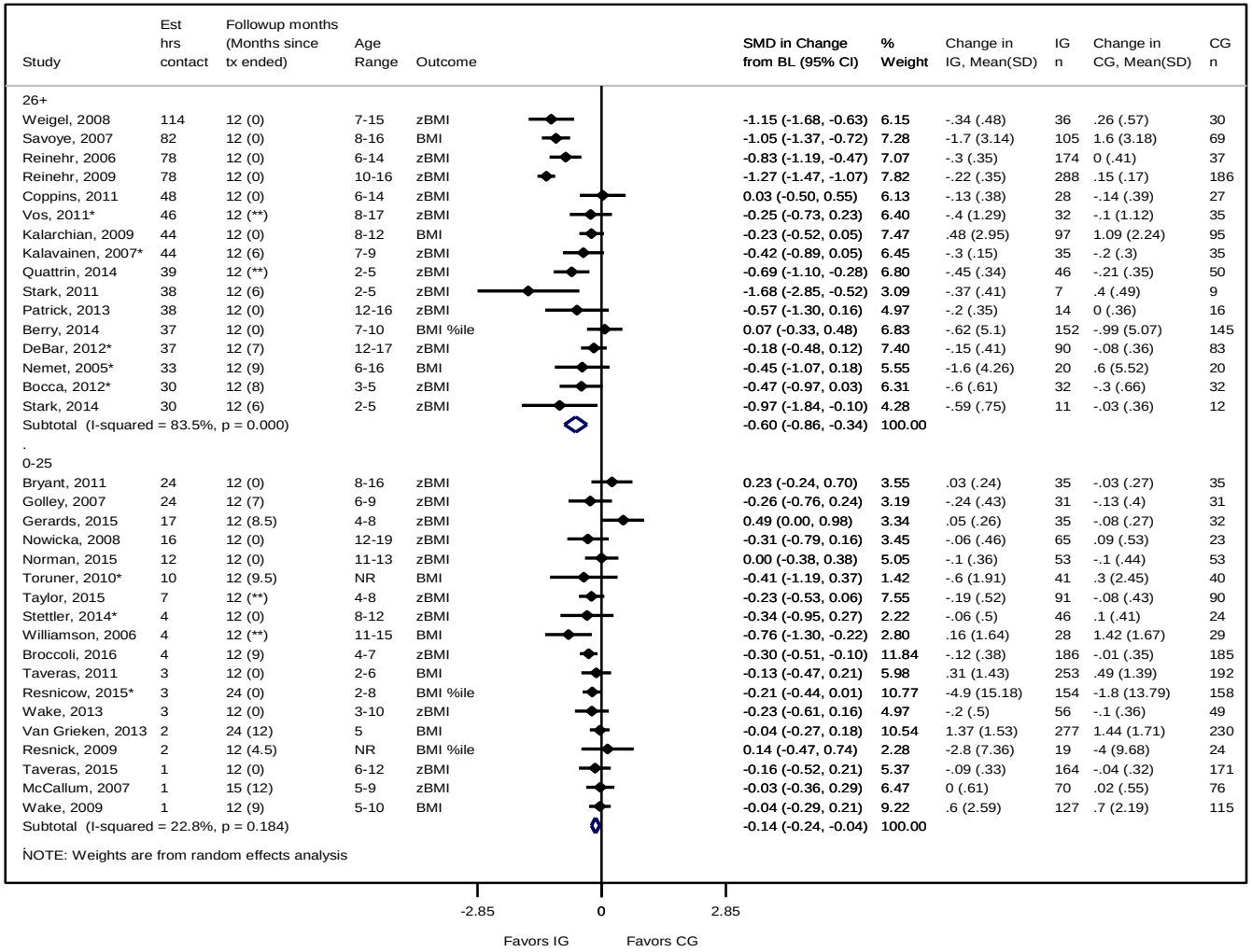
Abbreviations: BL = baseline; CG = control group; CI = confidence interval; est = estimated; hr(s) = hour(s); IG = intervention group; SD = standard deviation; tx = treatment

Figure 3. Results of efficacy trials, forest plot of change in zBMI, by estimated hours of contact (Key Question 1)



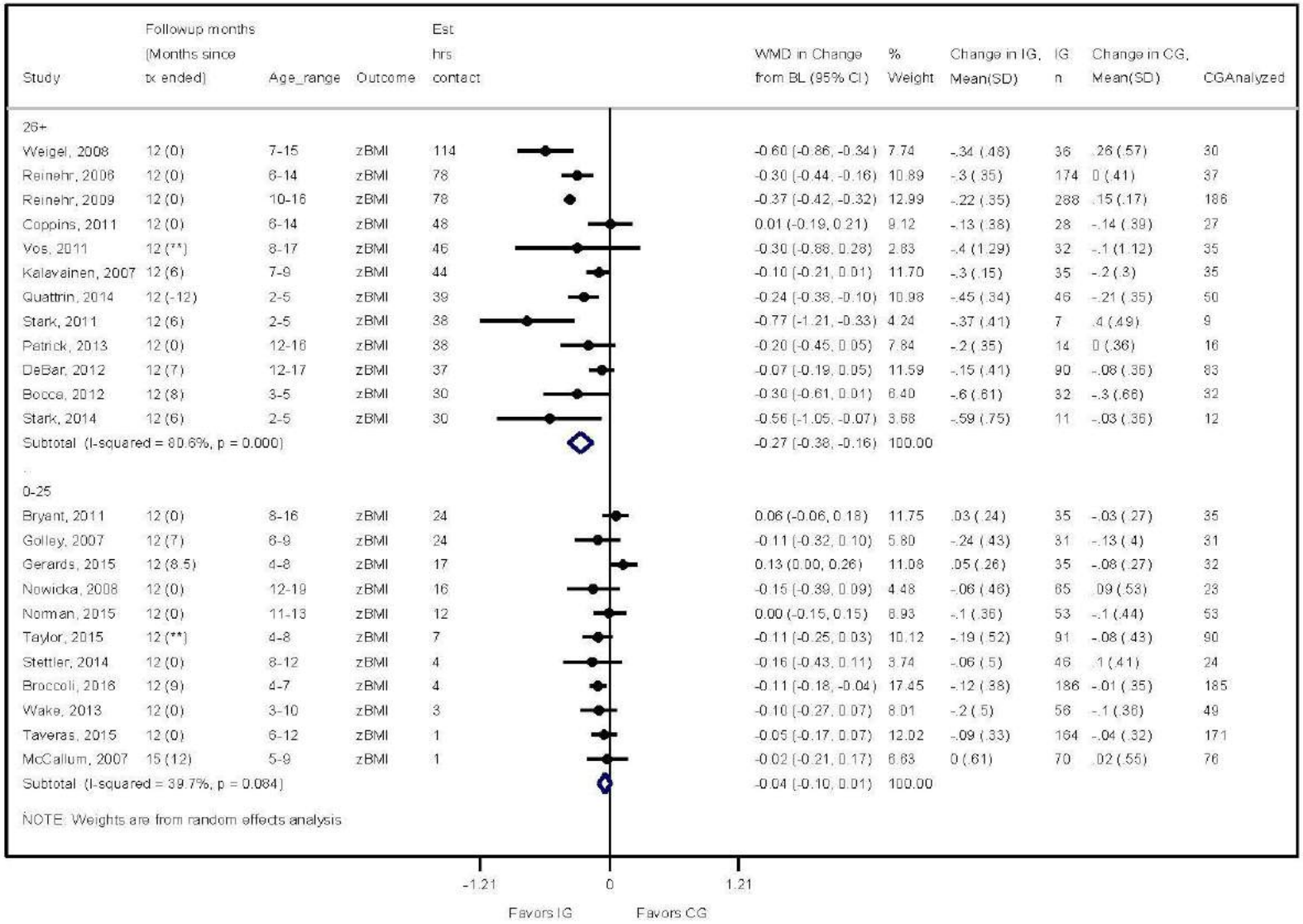
Abbreviations: BL = baseline; CG = control group; CI = confidence interval; est = estimated; hr(s) = hour(s); IG = intervention group; SD = standard deviation

Figure 4. Results of efficacy trials, forest plot of change in any weight outcome, by estimated contact hours—26 or more hours vs. 0-25 hours (Key Question 1)



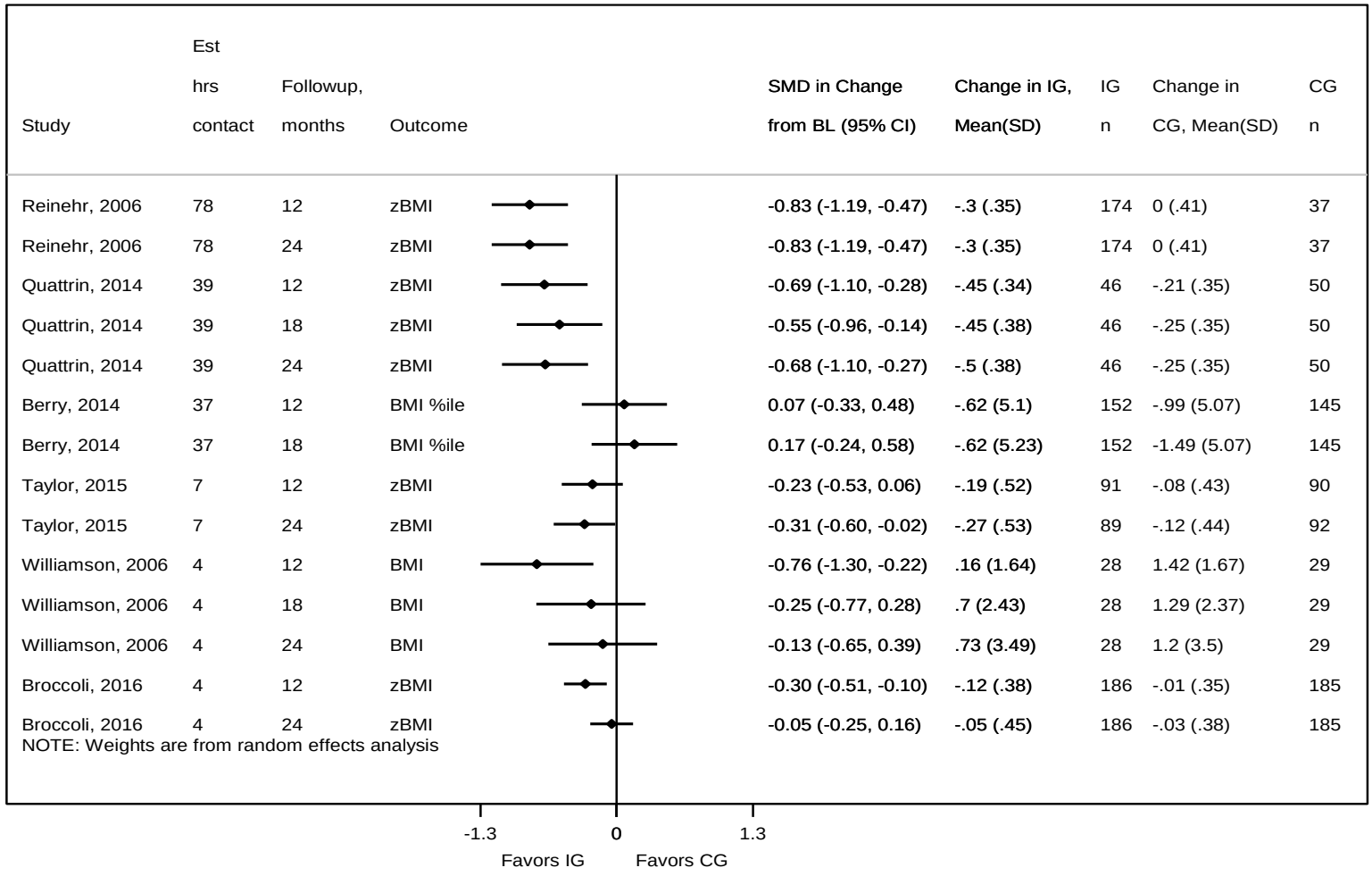
Abbreviations: BL = baseline; CG = control group; CI = confidence interval; est = estimated; hr(s) = hour(s); IG = intervention group; SD = standard deviation; tx = treatment

Figure 5. Results of efficacy trials, forest plot of change in zBMI, by estimated contact hours—26 or more hours vs. 0-25 hours (Key Question 1)



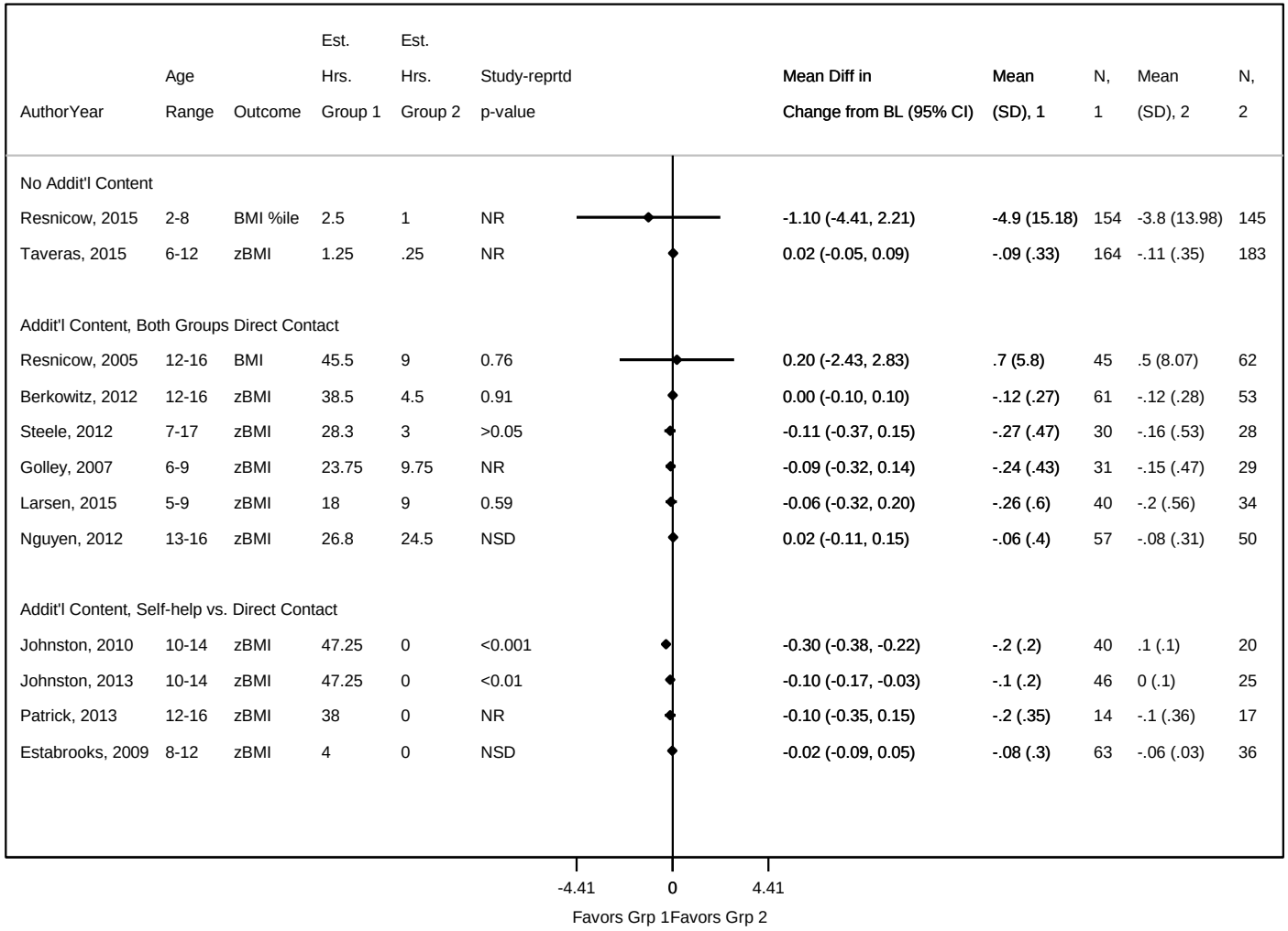
Abbreviations: BL = baseline; CG = control group; CI = confidence interval; est = estimated; hr(s) = hour(s); IG = intervention group; SD = standard deviation; tx = treatment

Figure 6. Results efficacy trials with multiple followup assessments, forest plot sorted by estimated contact hours (Key Question 1)



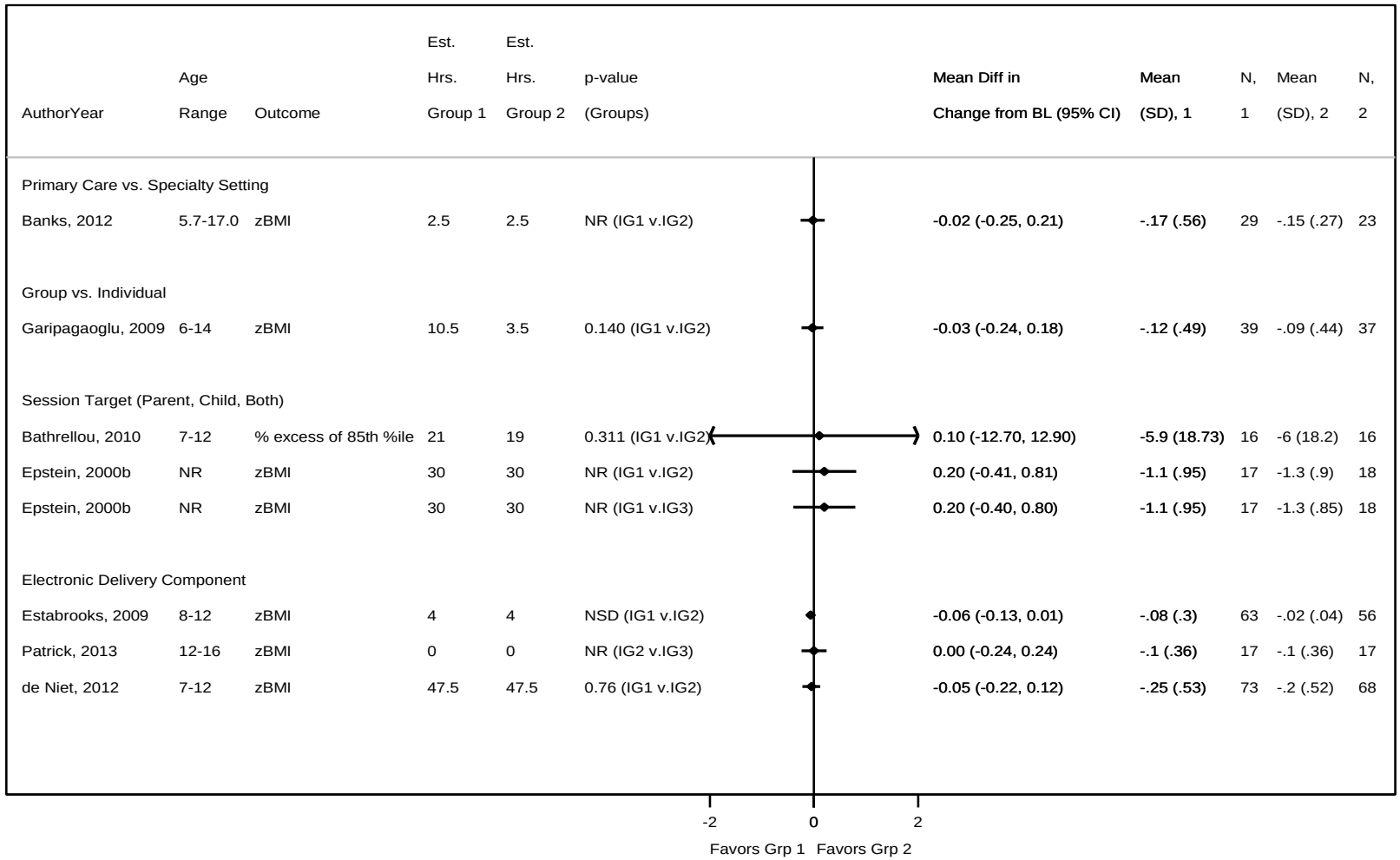
Abbreviations: BL = baseline; BMI = body mass index; CG = control group; CI = confidence interval; Est = estimated; Grp = group; hr(s) = hour(s); IG = intervention group; NR = not reported; SD = standard deviation; SMD = standardized mean difference; zBMI = body mass index z-score

Figure 7. Results of comparative effectiveness trials comparing contact dose, forest plot of trials comparing lower vs. higher dose (Key Question 4)



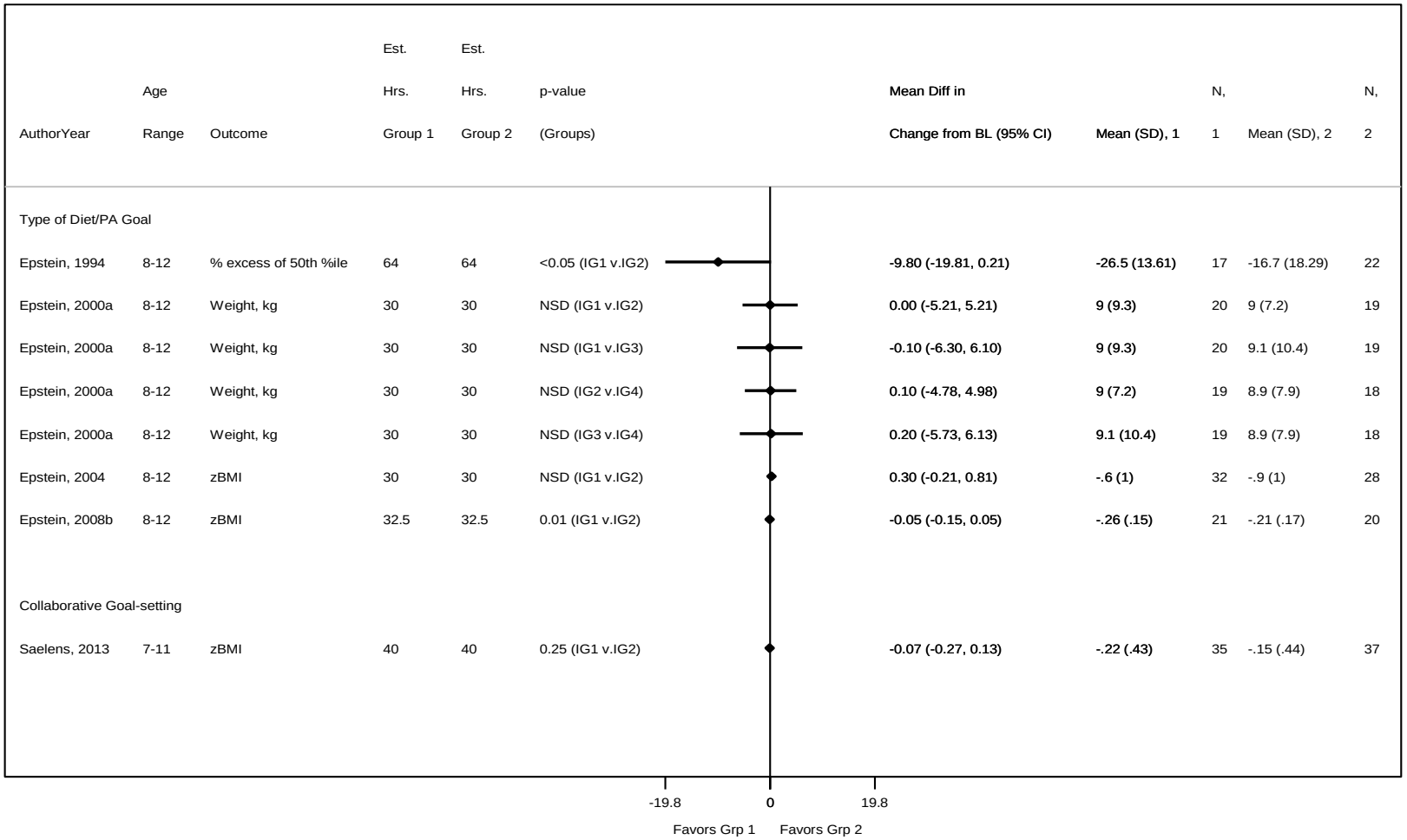
Abbreviations: BL = baseline; BMI = body mass index; CI = confidence interval; Diff = difference; Est = estimated; Grp: group; IG = intervention group; NR = not reported; NSD: no statistically significant difference; SD = standard deviation; zBMI = body mass index z-score

Figure 8. Results of comparative effectiveness trials, forest plot of trials evaluating the intervention setting, format, target, and use of electronic delivery component (Key Question 4)



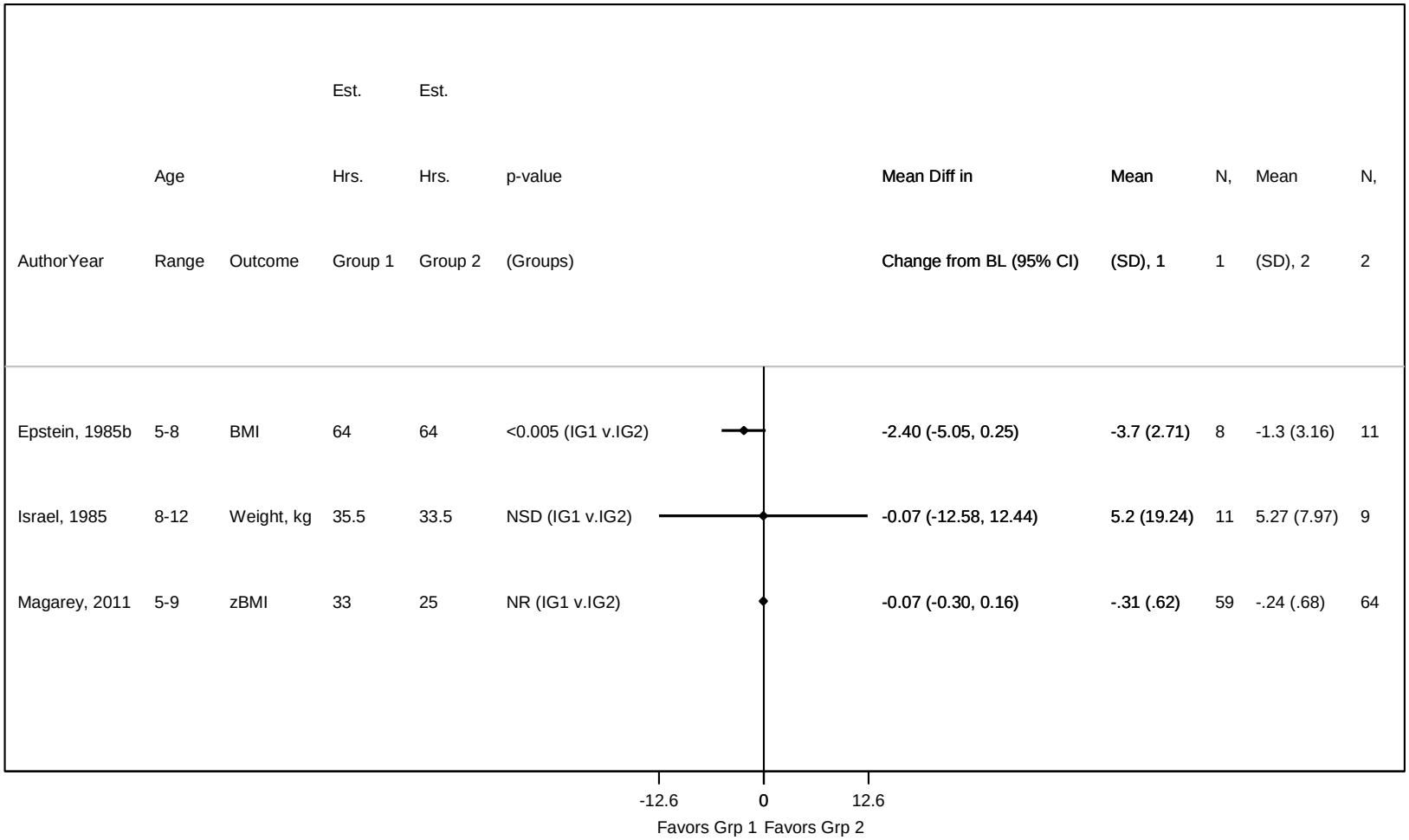
Abbreviations: BL = baseline; BMI = body mass index; CI = confidence interval; Diff = difference; Est = estimated; Grp: group; IG = intervention group; NR = not reported; NSD: no statistically significant difference; SD = standard deviation; zBMI = body mass index z-score

Figure 9. Results of comparative effectiveness trials, forest plot of trials evaluating a physical activity and/or diet goal or reinforcement approach (Key Question 4)



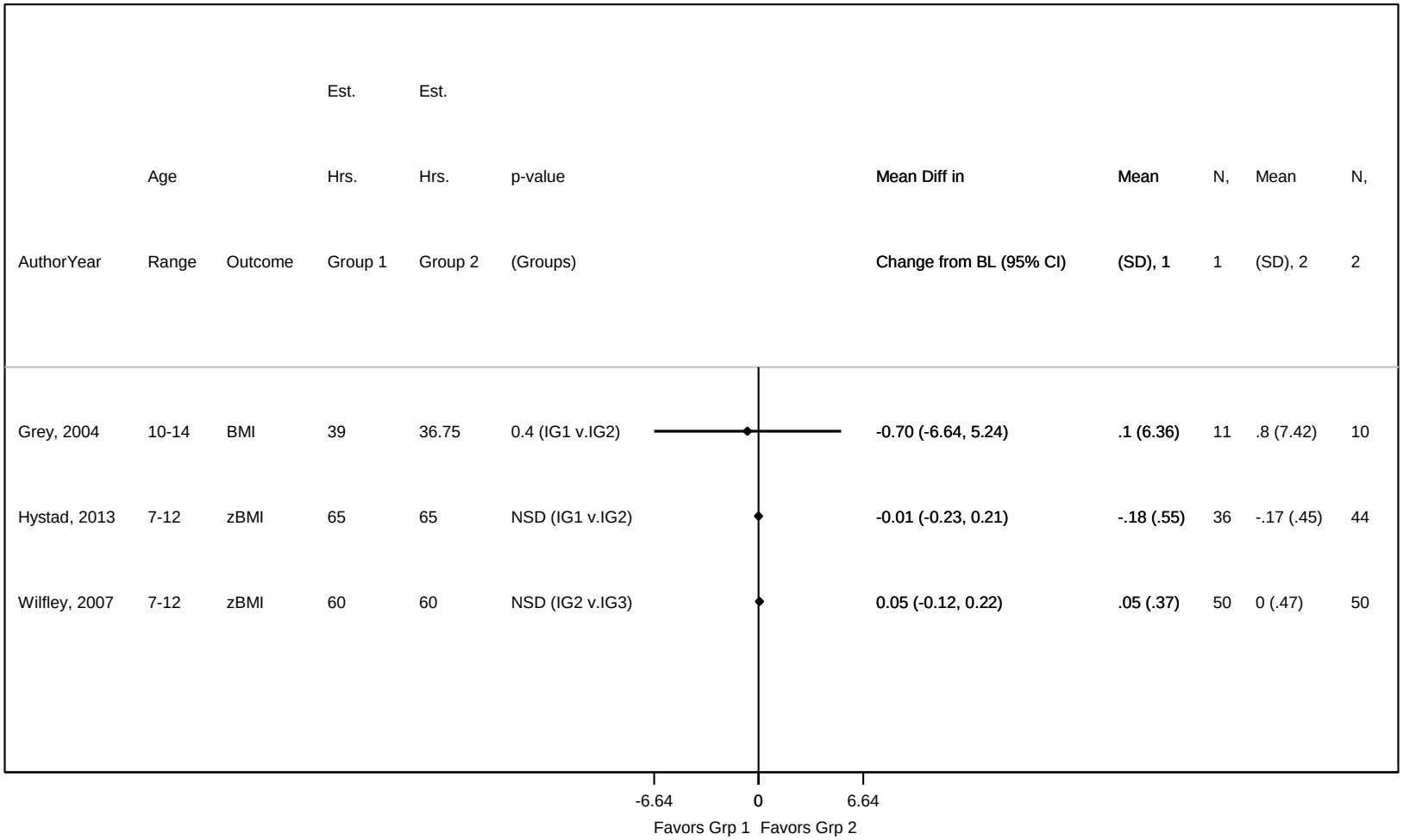
Abbreviations: BL = baseline; BMI = body mass index; CI = confidence interval; Diff = difference; Est = estimated; Grp: group; IG = intervention group; kg = kilogram; NR = not reported; NSD: no statistically significant difference; SD = standard deviation; zBMI = body mass index z-score

Figure 10. Results of comparative effectiveness trials, forest plot of trials evaluating parenting information and/or training (Key Question 4)



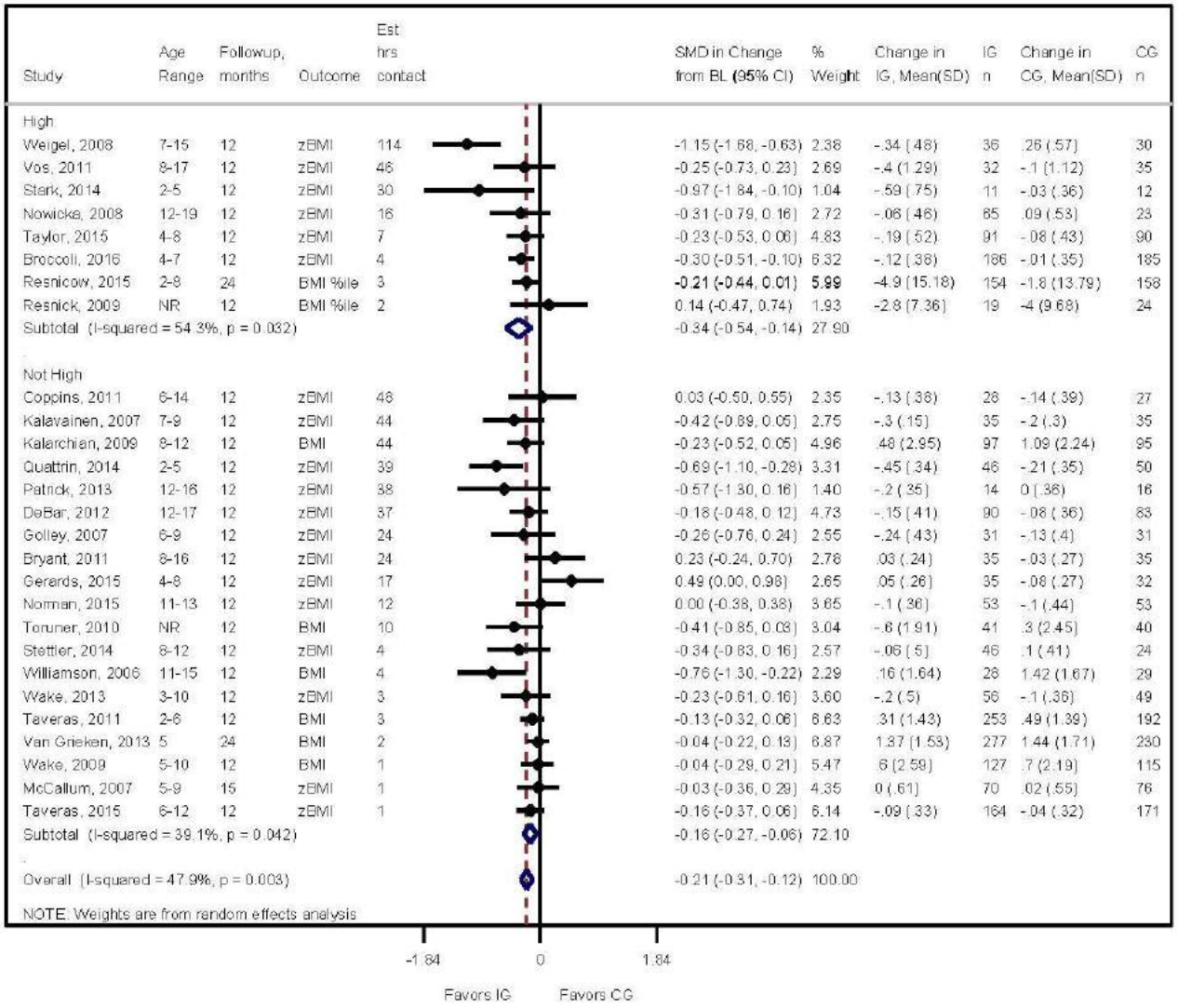
Abbreviations: BL = baseline; BMI = body mass index; CI = confidence interval; Diff = difference; Est = estimated; Grp: group; IG = intervention group; kg = kilogram; NR = not reported; NSD: no statistically significant difference; SD = standard deviation; zBMI = body mass index z-score

Figure 11. Results of comparative effectiveness trials, forest plot of trials evaluating the addition of another specific behavioral component (Key Question 4)



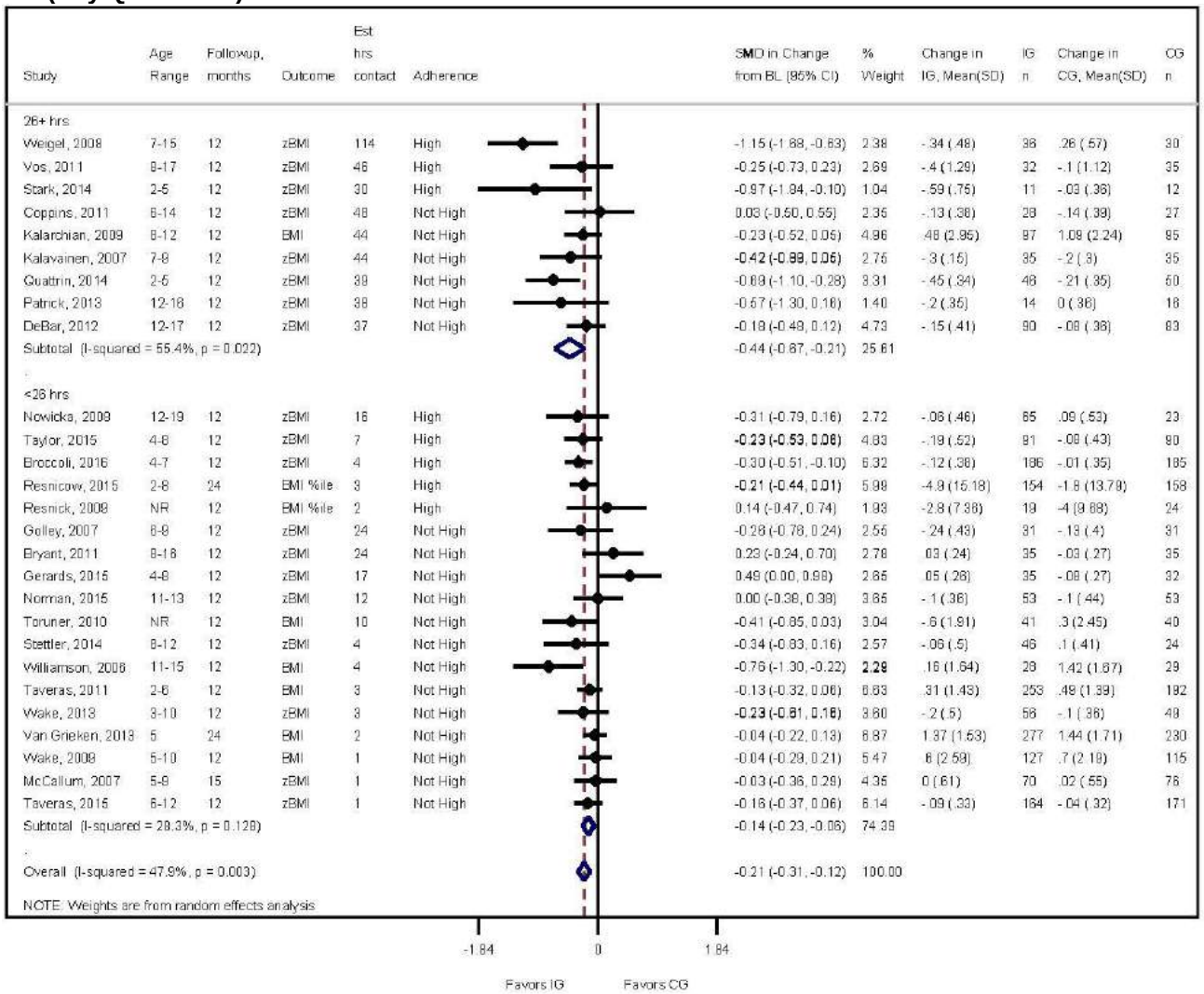
Abbreviations: BL = baseline; BMI = body mass index; CI = confidence interval; Diff = difference; Est = estimated; Grp: group; IG = intervention group; kg = kilogram; NR = not reported; NSD: no statistically significant difference; SD = standard deviation; zBMI = body mass index z-score

Figure 12. Forest plot of standardized mean difference in excess weight change in trials reporting intervention adherence, separately for trials with high adherence and those that did not meet criteria for high adherence (Key Question 5)



Abbreviations: BL = baseline; BMI = body mass index; CI = confidence interval; Est = estimated; hr(s) = hour(s); IG = intervention group; NR = not reported; SD = standard deviation; SMD = standardized mean difference; zBMI = body mass index z-score

Figure 13. Forest plot of standardized mean difference in excess weight change in trials reporting intervention adherence, separately for trials with at least 26 estimated contact hours and those with fewer hours, showing whether each trial met criteria for high adherence or not (Key Question 5)



Abbreviations: BL = baseline; BMI = body mass index; CI = confidence interval; Est = estimated; hr(s) = hour(s); IG = intervention group; NR = not reported; SD = standard deviation; SMD = standardized mean difference; zBMI = body mass index z-score