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Screening for Obesity and Intervention for Weight Management in Children and Adolescents: A Systematic Evidence Review for the U.S. Preventive Services Task Force

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Prepared by:
Kaiser Permanente Research Affiliates Evidence-based Practice Center
Kaiser Permanente Center for Health Research
Portland, OR

Investigators:
Elizabeth A. O'Connor, PhD
Corinne V. Evans, MPP
Brittany U. Burda, MPH
Emily S. Walsh, MPH
Michelle Eder, PhD
Paula Lozano, MD, MPH

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Structured Abstract

Background: Overweight and obesity are common in children and adolescents in the United States, are associated with a number of negative health effects, and increase the likelihood of obesity in adulthood.

Purpose: To systematically review the benefits and harms of screening and treatment for obesity and overweight in children and adolescents.

Methods: We searched MEDLINE, PubMed, PsychINFO, Cochrane Collaboration Registry of Controlled Trials, and the Education Resources Information Center through January 22, 2016 and examined references of relevant reviews. We included English-language studies of benefit or harm of screening or treatment (behavior-based, orlistat, metformin) for overweight or obesity in children aged 2 through 18 years conducted in or recruited from health care settings. Two investigators independently reviewed titles and abstracts and then full-text articles against pre-specified inclusion and quality criteria, then data were extracted from all studies rated as fair or good quality. Weight outcomes were pooled using random effects meta-analyses for lifestyle-based weight loss management programs, stratified by estimated intervention contact hours, and metformin.

Results: Among 45 (n=7,099) behavior-based interventions, larger benefits were seen with higher contact hours. Lifestyle-based weight loss programs (including those aiming to minimize weight gain with growth in height) with an estimated 26 hours of contact or more consistently demonstrated small average reductions in excess weight in children and adolescents who were overweight or had obesity compared to usual care or other control groups, with no evidence of causing harm. Relative reductions in zBMI of 0.20 or more were typical, with intervention groups typically showing absolute reductions in zBMI of 0.20 or more, maintaining their baseline weight within approximately five pounds on average. Control groups generally showed small increases or no change in zBMI, which typically equated to gaining five to 17 pounds on average. The absolute amount of excess weight lost was highly variable within studies, suggesting a wide range of benefit. The interventions offering 52 or more hours of contact showed fairly consistent improvements in blood pressure: pooled mean differences in change between groups were -6.4 mm Hg (95% CI, -8.6 to -4.2, k=6, I^2=51%) for systolic blood pressure and -4.0 mm Hg (95% CI, -5.6 to -2.5, k=6, I^2=17%) for diastolic blood pressure. There were mixed findings for insulin/glucose parameters and no benefit for lipids. Benefits in cardiometabolic outcomes were not observed in trials with fewer than 52 estimated hours of contact, and were sparely reported. Use of metformin (eight trials, n=616) and orlistat (three trials, n=779) were associated with BMI reductions of -0.86 kg/m^2 (95% CI, -1.44 to -0.29, k=6; I^2=0%) for metformin and -0.50 to -0.94 kg/m^2, for orlistat, representing very small BMI reductions of about 2 percent from baseline. Medications showed small to no benefit for intermediate cardiometabolic outcomes, including fasting glucose. Metformin trials were primarily limited to youth with abnormalities of insulin or glucose metabolism, most of whom met adult criteria for severe obesity. Non-serious harms were common with medication use, although discontinuation due to adverse effects was usually less than 5 percent. We found no direct evidence on benefits or harms of screening children and adolescents for excess weight.

Conclusion: Evidence suggests that lifestyle-based weight loss interventions with 26 or more hours of intervention contact are likely to help reduce excess weight in children and adolescents; average effect sizes were relatively small and highly variable. The clinical significance of the small benefit of medication use is unclear.

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Chapter 1. Introduction

Condition Definition and Measures of Excess Weight

An excess of body fat is associated with a variety of health risks in children and adolescents.[1] Because direct measurement of their body fat is difficult, is expensive due to specialized equipment requirements,[2] and exposes youth to radiation, excess fat is usually estimated using height and weight and compared with age- and sex-based norms from reference populations to determine the percentile ranking associated with the patient's body mass index (BMI, calculated in kilograms [kg] divided by height in meters squared [m^2]). In the U.S., obesity in children and adolescents is defined as a BMI at or above the 95th percentile for the child's age and sex or, among older adolescents, a BMI of more than 30.0 kg/m^2 (the definition of adult obesity). Children and adolescents with BMIs in the 85th to 94th percentile, respectively, are categorized as overweight. Healthcare providers in the United States usually use U.S.-specific norms developed by the Centers for Disease Control and Prevention (CDC) for children age 2 and older,[3] the ages covered by this review, but other norms are also available.[4-7] Definitions of severe obesity have also been proposed, including using the 99th percentile (approximately equivalent to BMI ≥34 kg/m^2 in 14- to 16-year-olds)[1] and 120 percent of the 95th percentile or BMI greater than 35 kg/m^2 (the definition of adult level II obesity).[8] The latter definition is generally preferred because percentile scores about the 97th percentile are based on small numbers of children so are not robust. Norms also differ slightly in how they categorize the adiposity of children; the CDC reference norms are more likely to categorize children as having obesity than the International Obesity Task Force (IOTF) curves.[9] Other common measures of excess weight are the BMI z-score (zBMI) or BMI standard deviation score (BMI-SDS). Although zBMI and BMI-SDS are derived differently, they are effectively the same measure, and refer to the number of standard deviations (SDs) the child's BMI falls from the median according to CDC or IOTF norms. For reference, **Table 1** shows BMI and weight at the 85th and 95th percentiles, along with corresponding zBMI values, assuming a 50th percentile height.

Prevalence

Almost 17 percent of U.S. 2- to 19-year-olds have obesity according to the 2011-2012 National Health and Nutrition Evaluation Survey (NHANES), and 31.8 percent are either overweight or have obesity.[10] Younger children (age 2 to 5 years) are less likely to have obesity than older children and there is substantial variability across race/ethnic groups. Obesity prevalence is generally 21 to 25 percent among Hispanic and black children aged 6 years or older, whereas the prevalence in non-Hispanic white and Asian children ranges from a low of 3.7 percent for Asian 6- to 11-year-old girls to a high of 20.9 percent for non-Hispanic white adolescent girls.[10] These prevalence figures represent substantial increases over the past three decades, although overall the rate of obesity may be stabilizing in recent years; the prevalence of obesity in children and adolescents in 2011-2012 does not differ statistically from 2003-2004 figures (**Figure 1**). However, the proportion of children meeting criteria for severe (Class II and Class III) obesity have increased since 2003.[11] Other data support the NHANES evidence that childhood obesity rates have stopped increasing, including state-level data showing similar trends and surveys of

declines in calories from sweetened drinks and fast food restaurants.[12] However, obesity rates continue to increase in some subpopulations such as Hispanic males and African American girls, exacerbating ethnic disparities in obesity.[12]

Burden

Excess adiposity can have a direct harmful effect on physical health prior to adulthood; however, the primary concern in most cases of excess weight in childhood and adolescence is the associated continued obesity into adulthood (**Appendix A**). Estimates of adult obesity for children who meet criteria for obesity are wide ranging, and, not surprisingly, increase with age and degree of excess weight in childhood.[13] A 2015 systematic review of 23 large, prospective longitudinal studies found that close to 80 percent of adolescents with obesity go on to have obesity as adults; this figure is slightly lower (approximately 70%) when adult BMI is measured at age 30 years or older. Approximately 64 percent of pre-adolescents with obesity also have obesity in adulthood. Meta-analyses of 20 of the 23 studies showed a strong association between childhood obesity and adult obesity, with children with obesity being about five times more likely to have obesity as adults than children without obesity (pooled relative risk [RR], 5.21 [95% confidence interval (CI), 4.50 to 6.02]).[14] In addition, the risk is higher among children who are overweight throughout their childhood; 62 percent of youth in a prospective cohort in the United Kingdom who were overweight or had obesity at age 7 years as well as in adolescence had obesity as an adult, but only 49 percent who were overweight or had obesity during adolescence but not at age 7 years had obesity as an adult (**Table 2**).[15]

Although cardiovascular disease takes many years to develop, obesity is associated with poor cardiovascular and metabolic parameters during childhood, including high blood pressure, abnormal lipids levels, and insulin resistance,[16-22] Childhood obesity appears to detrimentally alter cardiovascular structure and function prior to adulthood.[23] Childhood obesity has also been associated with other near-term health effects, such as increased risk of asthma, obstructive sleep apnea, orthopedic difficulties, early maturation, polycystic ovarian syndrome, and hepatic steatosis.[24] Non-alcoholic steatohepatitis (NASH) is a serious condition that can lead to cirrhosis and the need for liver transplant. The proportion of children experiencing these health effects increases with increasing BMI z-score.[25]

In addition, children and adolescents who are overweight or have obesity report lower self-esteem and health-related quality of life (particularly related to physical function and mobility) than normal-weight youth.[26-28] Weight-based victimization (e.g., teasing and bullying) has been cited as the primary reason for victimization in school settings among adolescents and elementary school-aged children.[29-31] However, many of the studies of psychosocial issues compared youth identified through clinic settings with healthy controls (with overweight or obesity) from the community or schools. Youth seeking care for their weight may not be broadly representative of children and adolescents who are overweight or have obesity. Surveys of representative community samples of children and adolescents who currently have or previously had obesity have not reported poorer psychosocial outcomes (self-esteem, depression, school/social functioning) despite respondents' awareness of their (past or present) excess weight.[32,33]

Obesity maintained into adulthood can significantly affect health. Long-term prospective studies show that childhood BMI is associated with an increased risk of all-cause mortality, cardiovascular- and metabolic-related conditions/risk factors, and several types of cancers.[34-41] For example, one study found an increased risk of future heart disease of approximately 5 percent for every additional BMI unit in adolescence, not controlling for adult BMI[36] and BMI during late adolescents has been associated with increased risk of cardiovascular death over 40 years followup.[42] However, studies that control for adult BMI have generally found no such associations, suggesting that childhood obesity alone has minimal direct impact on adult morbidity and mortality.[34,35] Indeed, prospective data show that risks of adult cardiovascular disease-related factors in non-obese adults are similar for those who had obesity as children and those who were never obese, which suggests that harmful cardiovascular effects in childhood may be reversible with weight loss.[43]

Future physical health risks in children categorized as overweight (but not having obesity) are assumed to vary depending on body composition, BMI trajectory, family history, and other factors.[1] However, they likely primarily function through increasing the risk of adult obesity.

Etiology and Natural History

Genetics play a substantial role in the development of obesity; based on studies of twins and adoptees, heritability is estimated to be 0.6 or higher.[44,45] However, genetic susceptibility is a continuous trait, thought to be multi-determined, and involves interaction between genetics and environment in most cases.[44] In recent decades, numerous changes in the social, cultural, food, and built environments in the United States have made it increasingly easy to eat more calorie-dense food and exercise less,[46] in stark contrast to conditions of periodic energy stress under which adipose tissue and its function evolved.[47] Some of the more obvious changes include increased availability of inexpensive fast food, sugar-sweetened beverages, and processed convenience foods high in sugars, fats, and salt; widespread use of cars or other automated transport; labor-saving machines in the home and workplace; and dramatic increases in screen time. More subtle changes, such as lack of sleep, widespread use of indoor heating and air conditioning, and pharmaceutical iatrogenesis, may also be contributing to the high rates of obesity.[48]

Young people can develop obesity at any point during their childhood or adolescence. Conversion from overweight to obesity is quite high among young children: in a large longitudinal cohort study in the United States, 20 percent of children who were overweight (but did not have obesity) in kindergarten met criteria for obesity in the next year, and the annual incidence of obesity was 10 percent or higher through 3rd grade among those who had been overweight.[49] In contrast, the annual incidence of obesity among children who were not overweight ranged from 1.2 to 2.4 percent.

BMI is somewhat stable across the lifespan. Correlations between childhood BMI and BMI 10 years later range from 0.67 to 0.78, and remain at about 0.40 after 30 years for children age 10 years and older.[50] Once a person develops obesity, the body's biochemical feedback mechanisms conspire to maintain the excess weight and to regain lost weight.[51,52] For example, one study

found that adults who previously had obesity requires 15 percent fewer calories to maintain a normal weight than someone who never had obesity.[44] This mechanism is compounded by the fact that among persons who previously had obesity, changes in neuronal signaling in response to food decreases satiation and perceptions of the amount of food eaten, among other effects.[52] Thus, once excess weight is established, weight loss can be very difficult. Another example of the tenacity of excess weight is that in clinical trials control groups generally show very little improvement in excess weight, in contrast to studies of other conditions where control groups frequently improve simply as a function of participating in a trial.[53]

Risk Factors

The strength of the association of some risk factors for childhood obesity appears to change with age, although some are more consistent across the age span. Parental obesity is a strong risk factor for all ages.[45,54-56] A recent large study of the transmission of excess weight in biological and adoptive families concluded that while overweight (without obesity) in children is largely related to environmental factors, obesity exhibits a highly genetic component.[57] For children of all ages, poor diet (e.g., consumption of sugar sweetened beverages and calorie-dense foods), low levels of physical activity, short sleep duration, and sedentary behaviors (e.g., high amounts of screen time) are risk factors for childhood obesity.[58-62] Dieting to lose weight and loss of control of eating are both associated with greater weight gain in later childhood and adolescence, among children who are already overweight or with obesity or have a parent who is overweight or has obesity.[63]

Similarly, a low family income in childhood increases the risk for obesity and overweight throughout childhood.[64,65] Environmental factors specific to the neighborhood in which an adolescent lives, such as food and retail scale and physical disorder, have been associated with increased odds of being obese among adolescent girls.[66] Among younger children, factors associated with obesity include maternal diabetes, maternal smoking, gestational weight gain, rapid infant growth, and short sleep duration.[54,55,67-69] In addition, a decrease in physical activity participation in the pre-teen years is a risk factor for excess weight in adolescence.[58]

The prevalence of obesity by race/ethnicity is clearly variable (**Figure 2**).[10] Racial/ethnic differences in both non-genetic factors and genetic risk factors likely contribute to disparities in obesity prevalence, with socioeconomic status being one of the strongest factors.[70,71] Other factors may also play a role. For example, black and Latino children are more likely to have a television in the bedroom and higher intake of sugar sweetened beverages and fast food (controlling for child gender and socioeconomic factors) compared with white children.[72] Genetic variability might be due to adaptation to longer-term stresses in the geographic region in which different groups evolved, perhaps related to climate and local disease load.[47] In addition, body composition differs across race; non-Hispanic black children have lower levels of body fat at a given BMI level than Mexican American and non-Hispanic white children. For example, among children meeting the definition of obesity based on their BMI, 92 to 95 percent of Non-Hispanic white and Mexican American children but 86 percent of non-Hispanic black children were at or above the 70th percentile for adiposity based on direct measures of body fat with dual-energy X-ray absorptiometry. Differences were even more striking among those meeting the

BMI-based definition of overweight; 66 to 67 percent of Mexican-American children but 58 percent of the non-Hispanic white children and only 30 percent of the non-Hispanic black children were at or above the 70th percentile for adiposity.[73] On the other hand, cardiometabolic risk is increased at a given BMI in persons of south Asian ancestry compared with persons of European ancestry, at least among adults.[74]

Rationale for Screening in Children

Screening enables clinicians to identify children needing a more thorough assessment of obesity risk and to provide an appropriate level of counseling. Counseling may range from simple healthy lifestyle messages for those with a BMI below the 85th percentile, to in-office weight management counseling, to tertiary care referral. Because many parents do not recognize that their children are overweight or have obesity,[75] providers could play an important role in initiating early intervention when weight management efforts (stabilizing weight with growth in height, or actual weight reduction) might be more likely to be successful. As the Expert Committee recommendation notes,[1] health care visits provide a good opportunity to identify excess weight because of the private setting and because the setting frames excess weight as a health issue.

For children with severe obesity where weight reduction is the goal, losing a substantial amount of weight can be very difficult due at least in part to the body's inclination to maintain body weight.[76] In adulthood, approximately 0.8 percent of women and 0.4 percent of men with a BMI between 30 and 35 kg/m^2 will attain a non-overweight body weight in a given year; the rates are much lower in adults with severe obesity.[77] For children who are still growing, it may be easier to lose a small amount of weight or slow the increase in weight as they grow in order to bring weight and height in line. For example, a 4-year-old girl at the 95th percentile for age and sex (and 50th percentile for height) is only approximately three pounds above the cut-off for normal weight, but a 16-year-old girl is almost 25 pounds above normal weight (**Table 1**).[78] Similarly, it might be difficult for a child to change long-entrenched eating and activity habits, but helping parents and families adopt healthy habits early in the child's life could make this task easier.

Screening Strategies

Both the 2007 Expert Committee and the 2011 National Heart Lung and Blood Institute (NHLBI) Expert Panel recommend using BMI to screen for obesity risk[79] starting at age 2 years. BMI is recommended due to its feasibility, acceptable accuracy in identifying young people with excess weight (particularly at higher BMI levels), and evidence linking BMI to cardiovascular risk factors.[76] The Expert Committee further describes the health care setting as a good place to identify children with excess weight "because the setting frames the condition as a health problem and because the visit is private."[1] Both groups advocate using BMI as a screening measure and not as a definitive measure of risk; instead, they recommend that elevated BMI should lead to further evaluation rather than directly to intervention, since this index is not a perfect measure of adiposity or future health risk (as seen, for example, by the variability in association between BMI and body fat across racial/ethnic groups), particularly in the 85th to 95th

percentile range.

A systematic review of studies comparing BMI to direct measures of body fat (e.g., dual-energy X-ray absorptiometry [DXA], air-displacement plethysmography [ADP], hydrostatic weighing [HW], bioelectrical impedance analysis [BIA], or equivalent) found that specificity was generally 95 percent or higher for youth with BMI-for-age at the 95th percentile or greater. In other words, the vast majority of young people without excess adiposity had a BMI that also indicated they did not have obesity (usually defined as less than 20 to 30 percent body fat, or below the 95th percentile for body fat). Sensitivity was wide ranging (depending on the reference standard used, among other factors) and uniformly lower than specificity. Across all studies, about 73 percent of young people with excess adiposity were identified as having obesity by their BMI. Thus, at the 95th percentile BMI-for-age cutoff, 27 percent are misclassified as not having excess adiposity when they really do.[80] As percentile scores rise higher than the 95th percentile, the likelihood of excess adiposity also grows higher.

Waist circumference is another potential useful measure that correlates with central adiposity. There is growing interest that waist circumference may provide additional, unique information. Some research shows that waist circumference is a better predictor than BMI of physiologic risk factors (e.g., insulin resistance, high blood pressure, and high serum cholesterol, metabolic syndrome), but the norms and cutoffs are not well established and the Expert Committee did not recommend its routine use.[76]

Once a child is identified as being overweight or having obesity, the discussion with parents must be handled sensitively. The Expert Committee provides some sample language for such a conversation and notes that use of the terms “fatness”, “excess fat”, and “obesity” are perceived as derogatory, and suggests using terms such as “overweight”, “weight”, “excess weight”, and “BMI” instead.[1]

Treatment Approaches

Although not all have been rigorously evaluated, interventions have been designed across the full spectrum of obesity prevention and management, from interventions to promote healthy lifestyle habits in children without excess weight to help them avoid future obesity, to intensive multidisciplinary approaches to help adolescents with severe obesity lose weight to avoid or reverse deleterious health effects of obesity. In fact, in some cases, the same intervention could be viewed as preventive for a child who has a normal BMI but as a treatment intervention for a child who is overweight or has obesity. Some adolescents who have obesity may be prescribed adjunctive medication to facilitate weight loss, and adolescents with extreme obesity experiencing ill health effects may be candidates for weight loss surgery.

At minimum, all patients and their parents can be counseled on the importance of physical activity, what constitutes a healthy diet, and other actions that promote healthy weight (e.g., eating breakfast daily, encouraging family meals, limiting eating out). For children and adolescents meeting the BMI criterion for obesity or overweight along with other risk factors, the Expert Panel recommends a systematic series of increasingly intensive interventions based on

degree of obesity, associated health effects, motivation for weight management, clinic resources, and other factors.[1] Brief descriptions of the intervention stages are provided in **Table 3**, although this stage approach has not been specifically tested.

For patients who have severe obesity and for whom behavioral approaches alone have not been successful, medications may be used in conjunction with behavioral approaches. Orlistat (Xenical) is the only approved drug for those age 12 years old or older. Orlistat is available by prescription only in adolescents, but is available as Alli™ over-the-counter for adults age 18 years and over. The Food and Drug Administration (FDA) has approved four new medications for weight management in adults since 2012: Belviq (lorcaserin), Qsymia (phentermine-topiramate), Saxenda (liraglutide), and Contrave (naltrexone-bupropion). None are recommended for those younger than 18 years because the safety and effectiveness have not been established for that group, nor have any short-term use weight-loss medications. Metformin and, to a lesser degree, bupropion are cited as being used off-label for weight loss but are not approved for this purpose, including in children and adolescents.

Adolescents who have severe obesity and have not had success with other intervention approaches may be candidates for bariatric surgery. Gastric banding devices have been approved by the FDA for patients 18 years or older. The National Institute of Diabetes and Digestive and Kidney Diseases (NIDDK) statement on bariatric surgery for severe obesity indicates that childhood obesity experts suggest that surgery may be considered for youth who have tried for at least 6 months to lose weight and not had success, have extreme obesity (BMI >40), be their adult height, and have serious health problems linked to weight.[81] The American Society for Metabolic and Bariatric Surgery recommends that BMI selection criteria for a bariatric procedure include BMI $\geq$35 kg/m^2 with major comorbidities (e.g., diabetes, severe steatohepatitis, pseudotumor cerebri, and moderate-to-severe obstructive sleep apnea) or BMI $\geq$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). Adolescents undergoing bariatric surgery should be carefully assessed for their ability to comply with the medical regimens and followup care.[82]

Current Clinical Practice in the United States

Routine assessment of BMI percentiles appears to have increased substantially in the past decade, starting from approximately 5 percent of visits in the mid-2000s, soon after the CDC's 2000 growth charts were published.[1,83] A study of 10 large health plans showed a range of 21 to 81 percent of children with visits had BMI percentile recorded in 2005-2006, with most plans reporting a range of 62 to 73 percent.[84] A large managed care organization with an electronic medical record reported that after clinical practice guidelines (including automatic calculation of BMI and BMI percentile upon entry of pertinent data) were implemented, BMI percentile calculation increased from 66 percent of visits with pediatric patients in 2007 to 94 percent of visits in 2010.[85] These data are consistent with focus group data in which physicians reported that access to electronic medical records was an important facilitator of BMI percentile calculations.[86]

The proportion of youth who are overweight or have obesity who have been identified as such by their providers is difficult to determine and undoubtedly varies across settings. The Health Maintenance Organization (HMO) implementation project noted an increase in documented recognition of excess weight in children and adolescents, from 12 percent (combining youth who are overweight and those with obesity) before implementation of the guidelines to 61 percent afterwards.[85] Other data suggests that providers are much more likely to recognize and note excess weight in the charts of youth who have obesity than those in the overweight range. In a study examining chart notes and physician visit surveys, 86 percent of youth with a BMI in the obese range were identified as having obesity in the charts but only 27 percent of those who were overweight.[87] NHANES and chart review data from around the year 2000 suggest that approximately half of youth with a BMI in the obese range were typically identified as having obesity by their doctors,[88,89] but more recent chart review data in single locations showed identification rates of 21 to 53 percent for children with obesity.[90-92] Based on NHANES data only, 17 percent of youth who were overweight (but did not have obesity) were identified as such.[89] These disparate data suggest that recognition of obesity varies considerably across settings and is substantially lower for overweight than obesity.

Once a child or adolescent was recognized as being overweight or having obesity, 50 percent had documentation of weight management counseling in a large HMO after clinical practice guidelines for childhood obesity were implemented, measured in 2010.[85] These results are not out of line with studies of chart review from the 2000s, in which half to three-quarters of patients recognized and noted in charts as being overweight or having obesity were counseled to change their diet or physical activity level.[1,88,92]

Weight Loss Activities in U.S. Adolescents

According to the 2011 Youth Risk Behavior Survey Philadelphia sample, 79.0 percent of females and 63.9 percent of males who were overweight or had obesity reported wanting to lose weight. Further, 52.2 percent of girls and 29.6 percent of boys who wanted to lose weight were actively trying. Of those who wanted to lose weight, approximately a third performed physical activity 5 to 7 days per week and more than two-thirds reported two or more hours of screen time per day. Almost a third of girls and a fifth of boys who wanted to lose weight reported extreme dieting behaviors (fasting, diet pills, or vomiting for weight loss).[93] Similarly, a separate study of middle school students reported high rates of weight loss behaviors that are longitudinally associated with *increased* risk of overweight or obesity, such as fasting, using energy powders or drinks as food substitutes, smoking cigarettes, using laxatives or diuretics, and taking diet pills: 82 percent of girls and 36 percent of boys.[94]

National Initiatives Related to Childhood and Adolescent Obesity

Multiple national initiatives at the provider and population levels target reduction in childhood and adolescent obesity. At the provider level, major organizations have developed guidelines for screening and intervention (**Table 4**). These guidelines are generally consistent in recommending that providers screen for obesity using BMI and CDC growth charts and offer or refer to weight control interventions or behavior change counseling. Some recommendations are specific to age,

BMI percentile, and treatment progress.[1,79]

Because of the multiple layers of influence on eating and physical activity and the limited long-term success of obesity treatment, major organizations have called for population-based obesity prevention approaches as a necessary complement to clinical preventive strategies and treatment programs for those who already have obesity.[95] Population-based approaches involve educational and motivational messages targeted at the entire population as well as efforts from worksite, government, public health, and health care organizations to promote health consciousness and accessibility of healthy choices; such programs are designed to "make healthy eating and physically active lifestyles easier to adopt and more socially acceptable and reinforcing."[95,96]

HealthyPeople 2020, for example, established multiple population-oriented objectives, which included improving access to healthier food in schools and communities, encouraging daily physical education and recess in schools, reducing screen time, and encouraging physical activity opportunities in child care settings. Population-based guidelines and policies from other bodies are shown in **Table 5**.

Additionally, performance measures are used at the health systems level to encourage screening and intervention for childhood obesity. The 2014 Healthcare Effectiveness Data and Information Set (HEDIS) measures include a metric for "Weight Assessment and Counseling for Nutrition and Physical Activity for Children/Adolescents." This measure assesses the percentage of members 3 to 17 years of age who had an outpatient visit with a primary care physician or obstetrician/gynecologist and who had evidence of BMI percentile documentation, counseling for nutrition, and counseling for physical activity during the year of measurement.[97]

Previous USPSTF Recommendation

In 2010, the U.S. Preventive Services Task Force (USPSTF) recommended that clinicians screen children aged 6 years and older for obesity and offer them or refer them to comprehensive, intensive behavioral interventions to promote improvement in weight status (B recommendation).[98] This recommendation was based on the USPSTF's conclusion that there was moderate certainty that the net benefit is moderate for screening for obesity in children aged 6 years and older and offering or referring children to moderate- or high-intensity interventions to improve weight status.

Chapter 2. Methods

Scope and Purpose

This systematic review examined the evidence for screening for obesity in children and adolescents and addressed the benefits and harms of weight management interventions in primary care or primary care-relevant settings for children and adolescents. The USPSTF will use this review to update its 2010 recommendation on screening for obesity in children and adolescents.[98]

Key Questions and Analytic Framework

In consultation with the Agency for Healthcare Research and Quality (AHRQ) and members of the USPSTF, we developed an analytic framework (**Figure 3**) and five Key Questions (KQs) to guide our review. These KQs were adapted from questions addressed in the 2010 review.[99]

1. Do screening programs for obesity in children and adolescents lead to reductions in excess weight or age-associated excess weight gain, improve health outcomes during childhood, or reduce incidence of obesity in adulthood?
   a. Are there effects of screening on cardiometabolic measures, i.e., blood pressure, lipid levels, and insulin resistance?
   b. Are there common components of efficacious screening programs?
   c. Does efficacy differ by key patient subgroups, i.e., age, race/ethnicity, sex, degree of excess weight, and socioeconomic status?
2. Does screening for obesity in children and adolescents have adverse effects?
3. Do weight management interventions* for children and adolescents embedded in primary care, or to which primary care providers refer, improve health outcomes during childhood or reduce incidence of obesity in adulthood?
   a. Are there common components of efficacious interventions?
   b. Does efficacy differ by key patient subgroups, i.e., age, race/ethnicity, sex, degree of excess weight, and socioeconomic status?
4. Do weight management interventions* for children and adolescents that are embedded in primary care, or to which primary care providers refer, reduce excess weight or age-associated excess weight gain?
   a. Are there effects of interventions on cardiometabolic measures, i.e., blood pressure, lipid levels, and insulin resistance?
   b. Are there common components of efficacious interventions?
   c. Does efficacy differ by key patient subgroups, i.e., age, race/ethnicity, sex, degree of excess weight, and socioeconomic status?
5. Do weight management interventions* for children and adolescents have adverse effects?

*Weight management interventions are behavioral counseling, pharmacotherapy, and health care system-level approaches.

Data Sources and Searches

In addition to evaluating all previously included studies for inclusion in the current review, we conducted an initial search for existing synthesized literature and guidelines related to screening for obesity in children and adolescents in MEDLINE/PubMed, the Database of Abstracts of Reviews of Effects, Cochrane Database of Systematic Reviews, Institute of Medicine, National Institute for Health and Clinical Excellence, PsycINFO, the Education Resources Information Center, the Agency for Healthcare Research and Quality, the American Academy of Child & Adolescent Psychiatry, the American Psychological Association, the Campbell Collaboration, Dynamed, the Canadian Agency for Drugs and Technologies in Health, the Institute for Clinical Systems Improvement, the National Health Services Health Technology Assessment Programme, and the Centre for Reviews and Dissemination from January, 2009 through March 31, 2014. The search strategies are listed in **Appendix B**.

We searched for newly published literature in the following databases: MEDLINE/PubMed, PsycINFO, Cochrane Central Register of Controlled Trials, PsycINFO, and the Education Resources Information Center through January 22, 2016, and starting January 2005 for screening studies (bridging from the 2005 USPSTF review[13]) and from January 2010 for treatment studies (bridging from the 2010 USPSTF review,[100] which only covered the treatment literature) (**Appendix B**). We also reviewed reference lists of reviews and other studies to identify additional potentially relevant studies published on or after 1985 that were not identified by our literature searches. We managed literature search results using EndNote version 7.3.1 (Thomson Reuters, New York, NY).

To reduce the risk of reporting bias for the pharmacotherapy interventions included in our review (metformin and orlistat), we used both the Drugs@FDA and clinicaltrials.gov websites. For Drugs@FDA, we searched for the drug approval package for orlistat using the method described by Turner.[101] We did not search for the metformin drug approval package as metformin is a generic name and FDA reviews for generics are focused on bioequivalence rather than efficacy and safety.[101] We examined the package inserts for both drugs to note known harms and side effects. We searched clinicaltrials.gov using the terms “orlistat” and “metformin,” restricting results to studies conducted in children (n=13 for orlistat and n=129 for metformin). For study titles appearing relevant, the full records were reviewed by two investigators; studies meeting eligibility criteria were matched with published articles where possible (one study published results in clinicaltrials.gov without a subsequent journal publication[102]).

Study Selection

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

We included fair- and good-quality studies published in the English language that were

conducted among children and adolescents aged 2 to 18 years in "economically developed" countries according to membership in the Organisation for Economic Co-operation and Development,[103] including:

- Randomized controlled trials (RCTs) and non-randomized controlled clinical trials (CCTs) that examined the benefits or harms of screening or weight management interventions (behavioral counseling, pharmacotherapy, and health care system-level approaches) in children and adolescents.
- Large comparative cohort or case-control studies with appropriate comparison groups, large case series, or large event monitoring studies that examined harms of weight loss medications in children or adolescents.

Included trials had to have a primary aim of reducing excess weight (through weight loss or limited weight gain with growth in height), or maintaining previous reductions in excess weight that were either conducted in or recruited from health care settings or systems. We limited our examination of pharmacotherapy interventions to orlistat or metformin. We excluded studies with components that could not be implemented in primary care settings, such as surgical interventions, changes to the built environment, and interventions providing most or all of the participants' food.

We required that studies assessing the benefits and harms of screening be conducted in a primary care setting. Studies of weight management interventions could also take place in phone, mobile, or virtual (i.e., online or computer-based) settings or in community or research settings as long as there was some connection to a health setting (e.g., recruitment exclusively from a health care setting). We excluded studies in community or university research laboratories or other nonmedical centers, college settings, and mental health clinics unless they recruited participants through a health care setting. In addition, we excluded studies conducted in correctional facilities, school classrooms, worksites, inpatient or residential treatment facilities, and emergency departments.

We required that weight management intervention studies be comprised of individuals with either an age- and sex-specific BMI in the ≥85th percentile or met other similar criteria for overweight or obese. These study populations could have had excess weight previously and currently be engaged in maintenance of weight loss. We also included studies if most (≥50 percent) of the sample met the criteria for overweight or obesity and the study targeted a population at high risk (at least 80% had risk factors for overweight [e.g., overweight parents; Hispanic, black, or American Indian/Alaska Native ethnicity] or obesity-related medical problems [e.g., type 2 diabetes, metabolic syndrome, hypertension, lipid abnormalities, or other cardiovascular-related disorders]). For example, we would have included a trial with up to 49 percent normal-weight children in a Native American community with very high obesity prevalence. We excluded studies limited to youth who had an eating disorder, were pregnant or postpartum, were overweight or had obesity secondary to a medical condition (i.e., polycystic ovarian syndrome, hypothyroidism, Cushing's syndrome, growth hormone deficiency, insulinoma, hypothalamic disorders, cancer, or medication use), had an intellectual or developmental disability, or were in college.

Control groups in weight management intervention studies could include usual care, no intervention, waitlist, attention control, or a minimal intervention (e.g., pamphlets, one to two annual sessions presenting information similar to what intervention groups receive through usual care in a primary care setting, no more than 60 minute total estimated direct contact), and we required a placebo control for drug studies. We excluded comparative effectiveness studies.

We required that all included studies report at least one weight outcome (e.g., weight, BMI, zBMI, BMI percentile, percent overweight, total adiposity, body composition, waist circumference). Other outcomes of interest included child health outcomes (e.g., reduced orthopedic pain, sleep apnea, and asthma; decreased morbidity from diabetes mellitus or hypertension; improved depression or quality of life), adult health outcomes (obesity), intermediate outcomes (e.g., reduction or appropriate maintenance of weight or adiposity, cardiometabolic measures when weight-related measures are also reported, liver dysfunction), or adverse effects of screening or treatment (e.g., labeling, stigma or increased body image concerns, eating disorder, exercise-induced injury. We required at least 6 months post-baseline followup for all outcomes except harms, and used 12 months as the preferred outcome if it was available. We refer to "followup" to characterize months since baseline, without regard for whether the measure was taken immediately post-treatment or after some time has elapsed since treatment ended.

Quality Assessment and Data Abstraction

Two investigators independently assessed the quality of included studies using criteria defined by the USPSTF[104] and assigned each a final quality rating of "good," "fair," or "poor" (**Appendix B Table 2**). Investigators resolved disagreements through discussion.

Studies with a single "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. Good-quality studies included all or most 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, statistical methods that revealed no important concerns, 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 but had not significant flaws that could invalidate the results.

One investigator abstracted data from all 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, screening and intervention details (if applicable), health outcomes (e.g., quality of life), child weight outcomes, other intermediate outcomes (e.g., blood pressure, lipid and glucose levels), and adverse events.

Data Synthesis and Analysis

For pharmacotherapy trials and behavior-based trials (examined separately), we used summary tables of study characteristics, population characteristics, intervention characteristics, and outcomes for each KQ. These tables and forest plots of the results were used to examine the consistency, precision, and relationship of effect size with key potential modifiers. Weight-related measures at 12 months of followup from baseline were the primary outcome for this review. Specifically, zBMI or BMI-SDS score was selected as the primary outcome if it was available, since that was the only widely available measure that could be used to compare relative degree of excess weight across ages (we refer to either of these measures as zBMI). If zBMI was not reported, BMI, weight (in kg), waist circumference (in centimeters [cm]), and BMI percentile were used, in order of decreasing preference. BMI percentile was chosen last because it was not frequently reported, the CDC does not recommend using percentiles above the 97th percentile, and because of the ceiling effect at the 99th percentile. Because we included different measures in this analysis, we pooled standardized mean differences in change between groups. 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, indicating that confounding by measure is minimal or absent, so further present a zBMI-specific forest plot showing non-standardized mean differences in change, to ease interpretation.

Twelve months was selected as the primary outcome, even though trials could be included if only reported a 6-month followup. However, given the questionable value of short-term weight loss that is not maintained, we selected 12 months as the primary outcome because we considered it to be long enough to have demonstrated some level of weight maintenance. In addition, it was the most commonly reported time to followup among the included trials. If outcomes were not available at 12 months, the closest followup to 12 months was used instead (range was 6 to 24 months). Because hours of contact appeared to be a strong effect modifier in the behavioral weight loss trials, these trials were grouped by estimated hours of contact and separate pooled estimates were generated for each subgroup.

If reported, change from baseline was used for analysis. Where 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 of weight. We also ran sensitivity analyses assuming a higher correlation (0.80) and found that the pooled results were very similar but slightly less conservative using the higher correlation, so we report the results using the lower (0.50) value. We adjusted six trials for clustering[105] and calculated a design effect based on average cluster size and estimated intraclass correlation (0.05).

We used the DerSimonian & Laird estimation method for pooling weight outcomes,[106] with sensitivity analyses using a restricted maximum likelihood model (REML) 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.[107,108] Because there were even fewer pharmacotherapy trials for pooling, we used the profile likelihood (PL) method for sensitivity analysis.[109] The I^2 statistic was used to assess statistical heterogeneity[110] and 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.[105] We had insufficient data to pool other outcomes (such as cardiometabolic outcomes) but present results in forest plots without pooling.

Funnel plots and the Egger's test were used to examine the risk of small study effects for the behavior-based weight loss trials, combining trials of all levels of estimated contact hours. We did not have sufficient data to perform these analyses for pharmacotherapy trials.

Meta-regressions were used to examine potential *a priori*-specified effect modifiers for the behavior-based weight loss interventions. These potential modifiers included intervention duration (in months), year of publication, study quality, whether the trial was randomized, percent followup at 12 months (or closest time), estimated hours of contact in the control group, whether supervised physical activity sessions were included in the intervention, and, among interventions offering group sessions, whether individual sessions were also offered.

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 less.

Hours of contact were estimated based on number of planned treatment sessions and the length of each session. When information on session length was not provided, we used *a priori*-developed assumptions to estimate contact hours, for example, assigning phone sessions described as "brief" to be 5 minutes in length, phone sessions not described as "brief" as 15 minutes, individual sessions as 30 minutes, and group sessions as 60 minutes. Interventions were grouped by hours of contact (0 to 5 hours, 6 to 25 hours, 26 to 51 hours, 52 or more hours). Cutpoints were decided first based on the cutpoint used in the previous USPSTF review (which used a cutpoint of 26 hours),[99] and then subdivided those two groups post hoc based on logic and where there were discontinuities in the frequency distribution of estimated contact hours. For example, there were several interventions estimated to involved 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. 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). Estimated hours of contact in the first 12 months only are shown on the forest plots because the primary outcome was weight change at 12 months (or closest followup available).

Expert Review and Public Comment

A draft Research Plan for this review was available for public comment from October 23 to November 19, 2014. The draft version of this report was reviewed by experts and USPSTF Federal Partners. Comments received during any period were reviewed, considered, and addressed as appropriate.

USPSTF Involvement

This research was funded by the AHRQ under a contract to support the USPSTF. We consulted with USPSTF liaisons at key points in the review, including the development of the research plan (i.e., KQs, analytic framework, and inclusion/exclusion criteria) and the finalization of the systematic review. An AHRQ Medical Officer provided project oversight, reviewed the draft and final versions of the review, and assisted with public comment on the research plan and draft review. The USPSTF and AHRQ had no role in the study selection, quality assessment, or writing of the systematic review.

Chapter 3. Results

Literature Search

We screened 9,491 abstracts and 464 full-text articles for inclusion. We included 59 studies[102, 111-167] that reported results in 102 publications,[102,111-211] with one publication reporting results of two separate studies.[142] All studies were included for the benefits and/or harms of weight management interventions. We did not identify any studies on the benefits and harms of screening (KQ1 and KQ2).

Results of Included Studies

We identified 59 trials that met our inclusion criteria; all reported benefits or harms of treatment for weight management. None of the trials addressed the questions related to screening. Study and population characteristics are shown in **Tables 6** and **7** and are summarized in more detail below, primarily under KQ4. Forty-five of these examined the benefits of behavior-based interventions compared with a control group[111-114, 18-120,123-127, 30-133,136-151,153-164] and 11 examined the benefits of metformin (eight trials)[117,122,129,134,152,165-167] or orlistat (three trials)[102,116,135] compared with a placebo pill. Some of the efficacy trials also reported on adverse effects, and three additional trials were included that reported harms of orlistat or metformin use for weight loss but did not have sufficient followup to be included in our examination of treatment benefits.[115,121,128]

Of the 45 trials (n=7,099) of behavior-based interventions (**Table 8**), 42 (n=6,956) used counseling on diet, physical activity, and behavior change management with the aim of reducing excess weight in young people, either through weight loss or limiting further weight gain as the child grows, and all reported weight outcomes.[111,113,114,118,120,123-127,130-133,136-151,153-155,157-164] We refer to these as "lifestyle-based weight loss trials." An additional trial assessed the benefits of a weight maintenance program for high schoolers who had completed a 4-month weight loss intervention.[119] Two additional trials provided interventions with minimal focus on general diet and physical activity, and instead focused on limiting overeating by using a "regulation of cues" intervention (based on appetite awareness and cue exposure treatment)[112] and on interpersonal issues as a source of excess weight gain.[156] These last three trials will be discussed separately from the lifestyle-based weight loss trials.

Of the included behavior-based intervention trials, only seven were included in the previous review.[124,136-138,143,148,150] Six trials that had been included in the previous review were excluded from the current review, four because they were not conducted in or recruited from a health care setting[212-215] and two due to concerns of quality.[216,217] Both of the included orlistat trials were included in the previous review[116,135] and we found no new trials of orlistat in adolescents. We carried forward all three of the metformin trials that were included in the previous review[122,134, 152] and identified seven newly published trials, including three used only for the key question related to harms.[115,121,128,129,165-167]

Key Question 1. Do Screening Programs for Obesity in Children and Adolescents Reduce Excess Weight or Age-Associated Excess Weight Gain, Improve Health Outcomes During Childhood, or Reduce Obesity in Adulthood? a. Are There Effects of Screening on Cardiometabolic Measures? b. Are There Common Components of Efficacious Screening Programs? c. Does Efficacy Differ by Key Patient Subgroups?

We found no studies meeting our inclusion criteria that addressed the benefits of screening for obesity.

Key Question 2. Does Screening for Obesity in Children and Adolescents Have Adverse Effects?

We found no studies meeting our inclusion criteria that addressed the harms of screening for obesity.

Key Question 3. Do Weight Management Interventions for Children and Adolescents That Are Primary Care Feasible or Referable From Primary Care Improve Health Outcomes During Childhood or Reduce Incidence of Obesity in Adulthood? a. Does Efficacy Differ by Key Patient Subgroups? b. Are There Common Components of Efficacious Interventions?

Behavior-Based Interventions

Eleven trials reported results of their behavior-based interventions on a health outcome, specifically measures of quality of life or functioning, self-esteem or body self-esteem, and depression (**Appendix D Table 1**).[111,120,125,126,136,147,154,159,161-163] All of these were lifestyle-based weight loss trials. No trials reported other health outcomes, such as orthopedic pain, sleep apnea, or morbidity associated with type 2 diabetes or hypertension. None of the trials offering 52 or more hours of estimated intervention contract reported health outcomes. Across all health outcomes, few trials reported group differences, but where differences were found, interventions involved 26 or more hours of contact in all cases.

Ten of these trials reported measures of health-related quality of life and/or functioning using the Pediatric Quality of Life Inventory (PedsQL),[111,120,125,136,154,159,162,163] the Child Health Questionnaire (CHQ),[125,126] and DISABKIDS.[161] Results at the followup closest to 12 months are shown in **Figure 4** for the seven studies with sufficient data to show in a forest plot. All of these trials involved 1 to 45 hours of intervention contact, and most trials did not find greater improvement in intervention over control group youth, including the three trials that are not shown in the figure due to insufficient data.[111,162,163] Only two trials found greater improvement in the intervention group youth at any followup. One very small (n=18) U.S. primary care-based

trial in 2- to 5-year-olds with 38 hours of intervention contact reported greater improvements in parent-reported physical functioning at 6 and 12 months: 10 and 14-point improvements at 6 and 12 months in the intervention group versus 2- and 3-point declines in the control group, on a 100-point scale.[154] Another U.S. trial, which targeted 8- to 12-year olds and involved an estimated 44 hours of intervention contact, reported greater improvements in parent-reported global health score in the child at 6 months but not at 12 months of followup.[126]

Measures of self-esteem or self-perception were assessed in five trials using variants of the Harter Scale[136,147,162,163] or the Rosenburg Self-Esteem Scale.[120] Statistically significant differences between groups were reported for only one trial, which reported improvements of 0.4 and 0.1 for intervention and control group children, respectively, on a four-point scale.[147] Contact hours were estimated at 36 hours for this trial. Similarly, five trials reported an outcome related specifically to body satisfaction or esteem,[120,125,136,162,163] and only one reported greater improvement among youth in the intervention group, in a trial of adolescent females who received an estimated 37-hour intervention.[120]

Finally, one trial reported on depression, but found no difference in the proportion screening positive on the Patient Health Questionnaire for Adolescents (PHQ-A) between groups (7.3% screened positive in the intervention group vs. 5.3% in the control group).[120]

Given the sparse reporting, the wide range of specific outcomes reported, and low variability in effect sizes, data were insufficient to examine the association between effect size and treatment components (KQ3a) or patient characteristics (KQ3b).

Pharmacotherapy Interventions

Only one of 11 pharmacotherapy trials reported quality of life measures.[135] This was an orlistat study that reported no quality of life differences between orlistat and placebo groups at 6 months. No other health outcomes were reported.

Key Question 4. Do Weight Management Interventions for Children and Adolescents That Are Primary Care Feasible or Referable From Primary Care Reduce Excess Weight or Age-Associated Excess Weight Gain? a. Do Weight Management Interventions Affect Cardiometabolic Measures? b. Are There Common Components of Efficacious Interventions? c. Does Efficacy Differ by Key Patient Subgroups?

Behavior-Based Interventions: Lifestyle-Based Weight Loss Programs

Study Characteristics

Of the 42 lifestyle-based weight loss trials, 50 percent were conducted in the United States, and the remaining in Europe, Australia, or Israel. Most trials were conducted in primary care (43%) or another healthcare setting (43%); the others involved healthcare-based recruitment but the

intervention was outside of a healthcare setting. Twenty-six percent of the studies used screening to identify patients for recruitment, and an additional 21 percent recruited exclusively through clinician referral, where clinician identified children in need of weight management through any means without necessarily using a systematic screening approach. Most of the remaining studies used multiple recruitment strategies, usually including at least clinician referral and solicitation of community volunteers through media advertising.

Populations

Most trials included children with obesity or both children with obesity and those who were overweight according to published CDC, IOTF, or country-specific norms. Five of the trials specifically targeted youth who were overweight but did not have obesity.[113,145,151,155,160] In addition, five trials targeted children who had more severe obesity (at or above the 97th or 98th percentile for their age and sex),[114,126,143,147,164] although only one of these was based on CDC norms.[126] Across all 33 lifestyle-based weight loss trials that reported baseline zBMI, the mean value ranged from 0.94 to 4.3, and the weighted average zBMI was 2.3. The 85th percentile for age and sex corresponds to a zBMI of 1.036 and the 95th percentile to a zBMI of 1.645, according to CDC norms (**Table 1**). Average weighted baseline BMIs were 18.7 kg/m^2 in trials of preschool-aged children, 23.5 kg/m^2 in trials of elementary-aged children, and 32.2 kg/m^2 in trials of adolescents.

The included lifestyle-based weight loss trials covered the full age range, including children as young as 2 years[153,154,157] and up to age 18 years[125,133,137] or 19 years.[140] Almost half of the trials were limited to elementary school-aged children, generally from age 6 to 8 years up to age 12 years, and an additional 28 percent included a range covering both prepubescent children and adolescents. Six studies targeted adolescents only[120,130,133,137,140,148] and five targeted preschool to kindergarten-aged children.[151,153,154,157,160] One trial was limited to girls only[120] and the remaining included both boys and girls (median percent female was 56.1%). Most trials either failed to report the race/ethnicity breakdown of their sample or had a predominantly white sample. One study, however, targeted Latino 9- to 12-year-olds,[111] and four others included samples that were majority Latino.[130,133,139,141] Black children were not widely represented; however, in four studies 26 to 42 percent of participants were black.[126,149,150,155]

Interventions

All of the lifestyle-based weight loss trials specifically reported providing at least dietary counseling and some information about behavior change principles, and most also explicitly stated that they also provided information or counseling regarding physical activity or sedentary behavior. The number of sessions ranged from four to 122 and contact hours ranged from an estimated 1 to 122 over 2.25 to 24 months. Many of the most intensive interventions included supervised physical activity sessions and usually included group meetings, with or without individual parent or family meetings as well. These more intensive group interventions frequently involved separate groups for parents and children, as well as joint activities. In addition to providing practical information on such topics as healthy eating, safe exercising, and reading food labels, these interventions typically incorporated behavior change techniques such as goal setting, monitoring diet and activity behaviors, and problem-solving. The lowest-intensity

interventions (fewer than six contact hours) did not include group sessions. These interventions were frequently conducted in primary care settings with the involvement of the primary care provider and in several cases included motivational interviewing by the primary care provider or another healthy lifestyle counselor.[113,130,133,146,151,157,158,160]

For studies with multiple active intervention arms, we selected the most intensive or comprehensive intervention arm for analysis. Additional intervention arms are shown in **Appendix D Table 2** but are not shown in the forest plots or the non-appendix tables.

Most trials reported some measure of adherence. Where reported, the average percent of sessions completed generally ranged from the mid-60s to low 80s[118,120,126,132,137,140,142,146,148,151,155,159] and the percentage of participants who attended each session ranged from 79 to 87 in four trials that reported this outcome.[111,127,147,164] The percentage completing all sessions varied considerably: in two trials offering four visits with participants' primary care providers, only 37 percent[162] and 41 percent[136] completed all four consultations. In other trials outside of primary care settings, 68 to 95 percent of participants completed all of the offered group[113,130,151,153,161] or phone[158] sessions (range, 5 to 14 sessions, in trials reporting this outcome).

Quality Assessment

We gave eight studies a good rating,[113,120,136,157-159,162,163] excluded 15 for poor quality, and the remaining were assigned a fair rating. Among the fair-quality trials, several reported generally good methods, but attrition greater than 20 percent.[123,124,149,166] More typically, there was more than one concern if studies received a fair rating. Aside from attrition, common concerns included failing to report allocation concealment, randomization methods, outcomes assessment blinding, information about intervention fidelity, or patient adherence or attendance. Many trials had small samples: 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 (>40%) or differential attrition (greater than a 20 percentage-point difference between groups). The next most common problem was non-comparability of groups at baseline, such as recruitment through completely different and non-comparable mechanisms, such as a trial that required intervention group participants to have had two failed weight loss attempts, but this restriction was not in place for control group participants.

We included both randomized and non-randomized clinical trials. Of the lifestyle-based weight loss interventions, 90 percent were individual or cluster RCTs. We also included three non-randomized trials[140,143,144] and one cluster RCT with only one group per cluster, which we refer to as a single-group cluster randomized trial.[130] None of the non-randomized trials was rated as good quality.

Findings

Summary. Weight management interventions above a threshold of 26 estimated contact hours were generally effective in reducing excess weight in children and adolescents after 6 to 12 months, typically with absolute zBMI reductions of 0.2 or more compared with little or no reduction in control groups (**Figures 5** and **6**). Effects were generally larger and more likely to

be statistically significant in programs with more hours of contact. Although several interventions with fewer than 26 hours of contact were effective,[113,148,155] most did not show statistically significant group differences and standardized effect sizes were usually small (generally reflecting absolute reductions in zBMI of 0.10 or less in intervention groups), especially as the number of contact hours diminished. Two of the three lower-intensity interventions that showed a benefit of treatment targeted children who were overweight but did not have obesity.[113,155] Even when results were not statistically significant, on average the intervention group children almost always showed greater reductions than control group children, although children in both groups showed a wide range of effects as demonstrated by large SDs relative to the average change. In other words, some children in both groups showed fairly large reductions in excess weight, some showed no or modest changes, and some continued to gain excess weight.

The interventions offering 52 or more hours of contact showed fairly consistent improvements in blood pressure (systolic blood pressure [SBP] pooled mean difference in change between groups, -6.4 mm Hg [95% CI, -8.6 to -4.2], k=6, I^2=51%; diastolic blood pressure [DBP] pooled mean difference in change between groups, -4.0 mm Hg [95% CI, -5.6 to -2.5], k=6, I^2=17%) and some improvements in insulin/glucose parameters other than fasting plasma glucose (homeostatic model assessment, 2-hour oral glucose test, insulin levels). However, even the highest contact interventions did not improve fasting plasma glucose (FPG) or lipids compared to control groups. Less intensive interventions were generally not associated with improvements in blood pressure, insulin/glucose level, or lipids.

Weight. Twenty-eight of the behavior-based weight loss trials reported sufficient data for us to calculate change in zBMI at followup for each group and include in the meta-analysis (**Figure 5**). Eight additional studies that did not report zBMI could be included in the meta-analysis, using BMI,[126,138,150,157,160,162] weight in kilograms,[130] or BMI percentile[146] (**Figure 6**). Because statistical heterogeneity was very high when all trials were included together (I^2=81.5%) and estimated hours of contact was clearly related to effect size, we divided the body of evidence into four categories based on of hours of contact. All weight outcomes for all time points are shown in **Appendix D Table 3**. In addition, a forest plot showing native units, rather than standardized mean differences, without pooling, is included for ease of interpretation of effect sizes (**Figure 7**).

The seven trials with 52 or more contact hours all showed clear benefits of treatment,[131,143-145,149,150,164] with a pooled standardized mean difference of -1.10 (95% CI, -1.30 to -0.89; k=6, I^2=43.4%).[143-145,149,150,164] Results were very similar using the REML method with the Knapp-Hartung adjustment for all analyses (**Table 9**). One trial with an estimated 122 hours of contact is not shown in the figure due to insufficient data, but it did report a greater reduction in zBMI in the intervention group than the control group (-0.16 vs. -0.01, p=0.002) (**Table 10**).[131] Five of these seven trials with the highest contact hours reported zBMI, the measure most valid to compare across the range of ages. Absolute zBMI reductions of 0.16 to 0.34 were seen in all studies except one, while control groups generally reported small to moderate-sized zBMI increases (**Appendix D Table 4**). **Appendix D Table 5** shows how these translate to change in pounds, estimated based on BMI or zBMI if weight was not reported. In terms of absolute change in pounds, on average, children in intervention groups showed very little weight change

over the course of the intervention period, while those in the control groups typically gained eight to 17 pounds. Only a few trials reported dichotomous outcomes, such as the percent with obesity at followup (**Figure 8**). Although the 2010 trial by Reinehr and colleagues[145] targeted children who were overweight (but not with obesity), the vast majority of children in the other trials in this group met criteria for obesity. These trials covered a wide age range, and both of the U.S. trials by Savoye and colleagues included a substantial proportion of non-white children.

Six of these seven studies reported results immediately after the last treatment session, so we could not determine the degree to which effects were maintained without ongoing contact. One trial did report results one year after the 12-month intervention had ended and found that beneficial effects were maintained (**Figure 9**).[143] None of these highest-intensity trials were rated good quality, and two were non-randomized trials that used as controls children who had undergone the intake process but lived too far away to participate in their program, which is an inferior design to a truly randomized controlled trial.[143,144] These factors may exaggerate the true effects of high contact interventions. The best-quality study, which reported 23 percent attrition and only 6 months of followup but otherwise generally good methods (including multiple imputation to analyze results in all randomized participants), showed the smallest treatment effect.[149] In this U.S.-based study of 10- to 16-year-olds with average baseline BMI of 33, intervention group youth showed an average drop of 0.37 in their BMI and gained less than one kilogram on average (1.3 pounds), while the control group youth increased their BMI by an average of 0.67 and gained 3.7 kilograms (8.1 pounds).

The nine interventions with an estimated 26 to 51 contact hours generally showed smaller effects than trials with 52 or more contact hours did. Seven of the nine demonstrated statistically significant group differences based on study-reported analyses or our calculations based on reported means and standard deviations.[118,120,126,127,138,147,153,154,161] These trials had a pooled standardized mean difference of -0.34 (95% CI, -0.52 to -0.16; k=9, I^2=24%). Five of these trials reported results anywhere from 3.75 to 9 months after the last treatment session, and all five demonstrated a statistically significant benefit of treatment, suggesting some degree of post-contact maintenance of weight loss,[120,138,147,153,154] which is supported by generally maintained effects at longer post-treatment followup (**Figure 9**). Change in zBMI in the seven of these studies reporting zBMI ranged from -0.11 (SD 0.16)[118] to -0.59 (SD 0.75)[154] in the intervention groups, whereas the values were 0.10 or less in the control groups. Absolute weight changes were highly variable, but typically intervention groups averaged around 1 to 5 pound weight gains compared with average 5 to 10 pound gains in control groups.

Studies with an estimated fewer than 26 hours of contact were unlikely to show statistically significant group differences. Moreover, the effect sizes were generally small, usually with standardized effect sizes less than 0.30, and in three trials the control group paradoxically showed greater improvement than the intervention group did.[111,114,123] However, none of these were statistically significant. The pooled estimate for trials with interventions of 6 to 25 hours was -0.02 (95% CI, -0.25 to 0.21; k=7, I^2=37%), and none of these trials showed a statistically significant group difference,[111,114,123-125,139,140] nor did the three trials in this group not included in the meta-analysis. [137,142] Trials with interventions up to 5 hours[113,130,132,133,136,141,146,148,151,155,157-160,162,163] had a pooled effect of -0.17 (95% CI, -0.25 to -0.08; k=14, I^2=0%).[113,130,132,136,146,148,155,157-160,162,163] While this difference was statistically significant, it was small and only three[113,148,155]

of the 16 trials, including the two trials that were not included in the meta-analysis,[133,141] showed statistically significant benefits. Of the three very brief interventions that showed a benefit, two were limited to overweight populations (who did not have obesity),[113,155] which suggested that if brief interventions are ever called for, they may be best reserved for overweight children only.

Appendix D Tables 4 and **5** include columns showing one SD around the mean change in each direction for zBMI (**Appendix D Table 4**) and pounds (**Appendix D Table 5**), to highlight the wide range of effects within each study. For example, in the best-quality trial by Savoye and colleagues with an intervention of 52 hours or more reported,[149] two-thirds of the intervention participants ranged from losing 9 pounds to gaining 12 pounds over the course of 6 months, based on the reported standard deviations. In the control group, two-thirds of participants ranged from losing 2 pounds to gaining 19 pounds. In another U.S.-based trial by the same author, two-thirds of the intervention group participants ranged from a 19 pound weight loss to a 20 pound weight gain over 1 year, versus losing 5 pounds to gaining 39 pounds in the control group.[150] While wide difference in weight change would be expected in trials with a wide range of ages such as these two trials, zBMI values also had a surprisingly large degree of variability. For example, in the 6-month trial by Savoye and colleagues, two-thirds of participants ranged from a zBMI reduction of 0.18 to an increase of 0.08, and variability was substantially higher in most other trials, regardless of intensity or duration.[149] In general, among trials with an estimated 26 or more hours of intervention contact, two-thirds of children ranged from zBMI reductions of approximately 0.50 and higher to almost no change in zBMI or, in the low end of this intensity range, increases of up to 0.26. Among the interventions with fewer contact hours, change in zBMI in the middle two-thirds of the children generally ranged from zBMI reductions of 0.2 to 0.7 to zBMI increases of 0.2 or more. Across all of the include lifestyle-based weight loss trials, control groups exhibited wide-ranging changes in their zBMI scores but shifted to less favorable results than the intervention groups did.

Other intermediate outcomes (KQ4a). Fifteen of the lifestyle-based weight loss trials, including nine of the 10 trials with highest contact hours, reported cardiometabolic outcomes.[111, 124-127,130,133,143-145,147,149,150,161,164] While these outcomes were rather sparsely reported overall, most of the trials with 52 or more hours of contact did report cardiometabolic outcomes. Therefore we pooled these outcomes only for the highest contact group, for blood pressure,[143-145, 149,150,164] lipid levels,[143,144,149,150] and fasting plasma glucoselevels.[143,144,149,150] SBP was reduced in five of the six trials with 52 or more contact hours reporting this outcome (**Figure 10**; **Appendix D Table 6**),[143-145,149,164] and the pooled estimate was -6.4 mm Hg (95% CI, -8.6 to -4.2, k=6, I^2=51.3%) (**Table 11**). In those trials for which a reduction occurred, SBP was reduced by 2 to 7 mm Hg in the intervention groups and ranged from a reduction of 1 mm Hg to an increase of 5 mm Hg in the control groups. DBP showed smaller effects that were statistically significant in only the two trials with the weakest design, resulting in relative improvements of 2 to 5 mm Hg,[143,144] with a pooled estimate of -4.0 mm Hg (95% CI, -5.6 to -2.5, k=6, I^2=17.3%) (**Table 11**). Most of the trials with fewer contact hours did not show group differences for either SBP or DBP.

A variety of glucose and insulin parameters were reported (**Figure 11**; **Appendix D Table 7**). Again, improvements were seen primarily in the four studies with 52 or more contact hours that reported these outcomes. Although none of these trials with the highest contact hours reported

statistically significant greater improvements in fasting plasma glucose, between-group differences were reported for the 2-hour oral glucose tolerance test,[144,149] homeostatic model assessment,[144,149,150] and insulin levels.[144,149,150] The pooled estimate for fasting plasma glucose was -0.7 mg/dL, which was not statistically significant (95% CI, -2.6 to 0.4, k=4, I^2=0%) (**Table 11**). In addition, one non-randomized controlled trial showed reductions in metabolic syndrome in youth in the intervention group but not in the control group.[144] In this study, 19 percent of intervention youth and 20 percent of control youth met International Diabetes Federation (IDF) criteria for metabolic syndrome at baseline, but at the 1-year followup 8 percent of the intervention group and 21 percent of the control group met the criteria. Results generally showed no group differences for the remaining trials that reported one or more of these outcomes.[124,125,127,130,161] One trial reported no cases of diabetes onset in either group[149] and another reported onset in two of 83 control group participants (2.4%) but none in the intervention group.[133]

The only trials to show improvements in lipid levels were those with 52 or more hours of contact, but these differences did not show a clear pattern of benefit (**Figure 12**; **Appendix D Table 8**) and none of the pooled effects were statistically significant (**Table 11**). One trial showed greater improvement in the amount of low-density lipoprotein (LDL) (-7.7 milligram [mg] per deciliter [dL] and +7.7 mg/dL, in intervention vs. control group, respectively),[144] a second trial showed greater improvement in total cholesterol level (-9.2 vs. +3.7),[150] and a third showed greater improvement in triglyceride levels (-28.4 vs. -4.6).[149] For all of these lipid outcomes, other high-intensity trials did not show a benefit, and none of the interventions with 52 or more hours showed between-group differences in high-density lipoprotein levels.

Effect modifiers, including intervention components (KQ4b). Applying meta-regression, we examined a number of potential effect modifiers, including several quality-related variables (overall quality rating, RCT/cluster RCT vs. other designs, year of publication, percent followup), intervention components (estimated hours of contact, number of sessions, duration of the intervention, whether group sessions were offered, whether individual sessions were offered, whether supervised physical activity sessions were offered, whether sessions were offered to children without parents in the room, whether sessions were offered that included both parents and children together) and other study characteristics (type of control group, use of population-based screening for recruitment). Of all these factors, only the estimated contact hours and number of sessions were clearly associated with effect size (meta-regression $p<0.001$ for both). However, of five trials that included multiple intervention groups with differing hours of contact, none reported statistically significant larger effects in the more intensive arm.[124,131,132,146,158] In most cases there was a non-statistically significant difference in favor of the more intensive treatment arm, with differences that were larger and more consistent across outcomes in studies with greater differences in contact hours between the groups.[124,131] Trials with a higher percentage of followup also tended to have larger effect sizes, even after controlling for estimated contact hours, allaying fears that effect sizes are artificially inflated due to study limitations.

We found no evidence for or against the importance of any specific intervention component or approach. Most successful interventions took place outside of the primary care setting, targeted both the parent and child (separately, together, or both), provided didactic information, helped

parents and children engage in stimulus control (e.g., limiting access to tempting foods, limiting screening time), identified or helped participants identify specific goals, and encouraged self-monitoring and problem-solving to help achieve the goals. These trials typically included some supervised physical activity sessions. Other common components included contingent use of rewards or reinforcement, motivational interviewing, teaching of coping skills, and the option of individual family counseling to address family-specific issues. Parents were frequently asked to modify their behavior and were sometimes actively engaged in weight loss interventions themselves. Three studies had multiple comparison groups designed to contrast specific approaches: two encouraged participants to primarily reduce unhealthy behaviors versus increase healthy behaviors[142] and one compared targeting unhealthy beverage reduction only versus targeting multiple diet and physical activity behaviors.[155] No notable differences between approaches were found in any of these trials.

We conducted several sensitivity analyses to explore the impact of our analysis methods on effect sizes and found our results to be highly robust (**Table 9**). First, when we used the REML method of pooling with the Knapp-Hartung adjustment, which is an appropriate and more conservative approach to pooling than that of DerSimonian & Laird when the number of trials to be pooled is relatively small (<10), the point estimates were identical to two decimal places or very slightly attenuated and CIs slightly wider, but the statistical significance never changed. Next, poor-quality trials were included in the analysis, and again point estimates were slightly attenuated or minimally changed, although the CIs narrowed due to the larger number of observations and the pooled estimates for all four categories of contact hours were statistically significant. Finally, to calculate the SD of change scores for trials that reported only baseline and followup means and SDs, we estimated the correlation between baseline and followup weight measures to be 0.50, which we judged to be a fairly conservative (i.e., low) estimate. We also ran sensitivity analyses assuming a higher correlation of 0.80, as would likely be seen in an adult population, and predictably found that this approach resulted in larger effect sizes.

Important subpopulations (KQ4c). Subgroup analysis of our pre-specified subpopulations of interest (i.e., age, race/ethnicity, sex, degree of excess weight, socioeconomic status) was sparse in the included trials, leading us to draw no conclusion about differential effectiveness on weight outcomes. Analyses of the effect of behavior-based treatments in subpopulations were generally limited by small study sizes and the absence of statistical interaction testing in several trials.

Five trials reported results separately for boys and girls, but no clear pattern emerged to suggest that weight management interventions are differentially effective.[113,124,133,149,157] Only a few trials reported subgroup analysis by severity of obesity,[133,140] age (among young children: 4 to 5 years vs. 6 to 7 years[113] and 2 to 4 years vs. 5 to 7 years[157]), parental education,[113,157] race/ethnicity,[157] and income.[157] Subgroup analyses showed no differential effectiveness based on age or race/ethnicity.

One of the trials, which examined whether the effects were similar across two levels of obesity severity in Swedish adolescents with an average baseline BMI of 34.5 kg/m^2 and an estimated 16 hours of contact, found that the subgroup below the median zBMI for their study showed a statistically significant reduction in excess weight while those above the median had minimal

change.[140] The other trial with a subgroup analysis by baseline obesity severity found no beneficial effect in any of the subgroups of adolescents they examined (BMI percentiles of 85 to 95, 95 to 99, and above 99).[133] However, this trial of adolescents conducted in a school-based health center with an estimated 2.5 hours of contact did have an imbalance between intervention and control participants in that control participants had substantially higher athletic participation, which may have attenuated the effects of the intervention.

Two trials examining socioeconomic factors had contradictory findings.[113,157] The primary care-based study in 2- to 6-year-olds in the United States reported that lower-income families showed a greater benefit than higher-income families did, but found no subgroup differences by age, parental education, or race/ethnicity.[157] An Italian trial found greater benefit in families with higher than lower maternal education (interaction p=0.008).[113]

Among studies that were limited to important subgroups, contact hours still appeared to be the primary factor that predicted success. We saw no evidence that age group of participants was an important driver of effect size (**Appendix D Figure 1** for results grouped by age category). In four trials of young children, two trials with 30 to 36 hours of contact showed large beneficial effects[153,154] and the two brief (2 to 3 hours), primary care-based studies revealed very small and statistically nonsignificant effects.[157,160] Both trials with the largest effects among those providing 26 to 51 estimated hours of contact both targeted young children.[153,154] Small absolute weight changes can have a large impact on excess adiposity for very young children (**Table 1**), which suggests that slightly less intensive programs may be beneficial in young children. Both of these trials were very small studies, however, and need to be replicated. These interventions involved individual and group activities as well as home visits, instruction in behavior change principles, and general parenting instruction.

In the six studies targeting adolescents, the only one that showed a statistically significant benefit had the highest estimated contact hours (37 hours). This trial was limited to girls (average BMI of 32 kg/m^2) recruited through a primary care setting for a 5-month intervention that included visits with the primary care provider as well as separate group sessions for the girls and their parents.[120] This study had a fairly small effect, with zBMI dropping from 2.00 to 1.88 in the intervention group and from 2.00 to 1.94 in the control group at 6 months, but the benefits were fully retained at the 12 month followup. In terms of pounds, at 12 months intervention group youth gained an average of 4.9 pounds (1 SD range, -31.2 to +41 pounds) compared with an average gain of 7.1 pounds in the control group (1 SD range, -28.9 to +43.1 pounds).

Four trials were limited to or primarily comprised of Latino youth.[111,130,133,141] All involved relatively brief interventions (2.5 to 11 estimated hours of contact), and none demonstrated a benefit of treatment. However, two of the highest intensity trials included samples in which more than 60 percent of participants were Black or Latino[149,150] and both showed relatively large benefit with 78 to 82 hours of contact.

Five trials were limited to youths with severe obesity (at or above the 97^{th} or 98^{th} percentile for the norms used by the study).[114,126,143,147,164] The interventions with more than 52 contact hours showed beneficial effects,[143,164] whereas the intervention with fewer than 26 hours did not.[114] The two interventions with mid-range contact hours had mixed results.[126,147] At the other end of

the spectrum, four additional trials were limited to children and adolescents who were overweight and either did not have obesity[113,151,155,160] All of these were brief interventions (1 to 4 hours), but two of these had a beneficial effect, despite the short contact time.[113,155]

Other Behavior-Based Interventions

We also included one small trial (n=61) of weight maintenance in adolescents who had participated in a 4-month weight loss intervention.[119] The maintenance portion of the intervention involved eight group sessions, involving four motivational calls to the adolescents, and up to four parent sessions over the course of 8 months. Compared to a newsletters-only control group, the active maintenance group did not show improved weight, body composition, glucose/insulin indices, or lipid levels immediately after the intervention finished. Detailed results were not provided for most outcomes, but group differences were not statistically significant (**Appendix D Table 9**).

We also included two small pilot trials (n<50) that used fundamentally different approaches to weight management. Rather than provide information and structure regarding change in diet and physical activity, one trial tested a "Regulation of Cues" (ROC) intervention that involved appetite awareness and cue exposure training.[112] This 14-session intervention for 8- to 12-year-olds focused on increasing awareness of overeating in relation to the environment and used behavioral approaches to reduce overeating. The other trial used both individual and group-based interpersonal therapy for adolescent girls, assuming that overeating was related to poor social functioning and the consequent negative mood.[156] This trial focused on improving interpersonal skills as a way to reduce overeating. Neither of these trials showed group differences in mean BMI or zBMI with the intervention (with no zBMI reductions >0.10 in either group).

Pharmacotherapy Interventions

Study Characteristics

Eleven trials compared pharmacotherapy for weight loss with a placebo pill. Eight of these trials used metformin[117,122,129,134,152,165-167] and three used orlistat[102,116,135] (**Table 6**). These trials were generally small, ranging from 28 to 155 participants in metformin trials and from 40 to 539 participants in orlistat trials. Overall, 616 participants were randomized for metformin trials and 779 for orlistat trials. Most (64%) were conducted in the United States,[102,122,134,166,167] and others were held in the United Kingdom,[129] Canada,[117] Australia,[152] and Germany and Switzerland.[165] No trials were conducted in primary care; 18 percent were conducted in pediatric obesity centers,[116,165] another 18 percent in pediatric endocrine clinics,[129,152] and the remainder in other types of clinical research centers. Participants in 27 percent of trials were selected from populations referred to pediatric obesity centers[165] or pediatric endocrine centers.[129,152] One study recruited volunteers only,[122] and others used heath care based-recruitment, often by using several strategies such as clinician referral in combination with advertisement. Four studies were partially or wholly funded by industry.[102,116,122,165]

Two studies included placebo run-in periods to enrich population compliance[166] or confirm eligibility.[116] One study of metformin had a cross-over design with a 2-week washout in between

periods.[152] Eight trials were 6 months long and three were 1 year long. One trial continued participant monitoring for 48 weeks after drug discontinuation following a 1-year randomized phase.[166]

Populations

Fifty-four percent of trials were conducted exclusively with adolescents,[102,116,122,134,135,166] and the remainder of trials included younger children as well. The mean age of participants in metformin and orlistat trials was 13.7 and 14.0 years, respectively. All three orlistat trials were limited to adolescents.[102,116,135] One metformin trial enrolled children as young as 6 years.[167] Participants in pharmacotherapy trials had a higher BMI than those in behavior-based interventions (36.0 kg/m^2 for metformin trials and 37.4 kg/m^2 for orlistat trials). Among trials reporting weight, mean baseline values ranged from 172 to 241 pounds in the metformin trials and 213 to 248 pounds in the orlistat trials. All trials included both boys and girls. About two-thirds of the participants were female. Among trials reporting percentage of white participants, the range of percent white was 25 to 89 percent. Two trials were conducted in a majority Hispanic population[134,135] and four trials included at least 33 percent of children who were black.[102,122,134,167]

For inclusion, six of eight (75%)[122,129,134,152,165,167] metformin trials required abnormalities of insulin or glucose metabolism, such as hyperinsulinemia, insulin resistance, or impaired glucose tolerance; one trial explicitly excluded participants with elevated fasting or 2-hour glucose or HbA1c.[117] Three metformin trials also had selection criteria regarding a family history of diabetes or the presence of acanthosis nigricans.[122,134,152] One metformin trial restricted inclusion to participants with a previous unsuccessful lifestyle intervention, defined as BMI change less than 2 kg/m^2 over 6 months and persistent insulin resistance.[165]

With the exception of one orlistat study that required the presence of one or more obesity-related comorbidity (including type 2 diabetes, among others),[102] studies typically excluded individuals with diabetes. Metformin trials screened out patients with contraindications to the drug (mainly renal or hepatic dysfunction which can increase the risk of lactic acidosis, a rare but serious potential side effect).[218]

Interventions

To examine the incremental effect of the drug, trials were selected to have the same background lifestyle intervention in each group plus the pharmacotherapy or placebo pill. Interventions from pharmacotherapy trials are described in **Table 12**. All but one drug trial provided a background lifestyle intervention, and this was a study of metformin.[122] Two trials provided minimal standardized diet and exercise advice with an estimated contact time of 15 minutes,[129,152] and five trials provided advice on behavioral management in addition to advice on diet and exercise advice with estimated contact time ranging from 2.25 to 9.5 hours.[116,134,135,166,167] Three studies also offered group exercise sessions in addition to diet and exercise advice and behavioral management; these studies had estimated contact time of 15 to 86 hours.[102,117,165]

Interventions were delivered individually for most included trials. Sessions were attended by both parents and children in four of the trials,[117,165-167] and apparently by only the child in the

remainder of studies; no trial included a parent-only component. Primary care providers were not involved in delivering interventions for any of these included trials.

Adherence to pharmacotherapy was typically assessed through use of pill counts[116,117,135,152,165,167] but also through prescription dispensing[134] and asking participants about missed doses.[166] Adherence metrics were inconsistent across studies. The lowest adherence level occurred in a trial reporting that 60 and 75 percent of the metformin and control groups, respectively, filled four prescriptions over 6 months, equating to a maximum dose for 2 months.[134] Adherence was greatest in a trial where 93.2 and 92.2 percent of pills were taken in the metformin and placebo groups, respectively.[167] Adherence in orlistat trials was 72 to 73 in one trial,[116] greater than 80 percent for the overall population in one trial,[135] and not reported in the other.[102]

Adherence to lifestyle intervention components in these pharmacotherapy trials was less commonly reported. Where reported, it was variable. The lowest rate of attendance occurred in a 1-year trial, in which participants attended an average of 6.3 and 6.7 out of a possible 19 sessions in the intervention and placebo groups, respectively.[166] The highest rate occurred in a 6-month trial where 88 and 92 percent of the intervention and placebo groups, respectively, attended clinical visits and education sessions but only 61 and 70 percent, respectively, attended at least one group exercise session per week.[165] The trial with the most intensive lifestyle intervention — 86 estimated contact hours—reported adherence to sessions over time and showed that attendance decreased as the intervention progressed.[117] At 3 to 6 months, attendance at fitness and nutrition/social work sessions was 57 to 76 percent and 64 to 71 percent, respectively, and 40 to 63 percent and 53 to 79 percent, respectively, at 7 to 12 months.

The total daily metformin dose ranged from 1,000 to 2,000 mg.[166] Doses were typically up-titrated over several weeks to reduce side effects; participants were generally allowed to reduce the dose if side effects occurred. All orlistat trials administered a total daily dose of 360 mg. Participants in all orlistat trials[102,116,135] were instructed to take a multivitamin, consistent with FDA label information that this agent can reduce the absorption of some fat-soluble vitamins and beta-carotene.[219] Similarly, participants in two metformin trials[166,167] were advised to take a multivitamin due to possible metformin interference with B_{12} absorption.[218]

Quality Assessment

We gave one study a good rating,[167] excluded one for poor quality,[220] and rated the remaining 10 trials as fair.[102,116,117,122,129,134,135,152,165,166] Among the fair-quality trials, several reported generally good methods but attrition greater than 25 percent.[116,117,129,134,165,166] Concerns in other fair-quality studies also included missing information on the randomization procedure, allocation concealment, or weight measurement methods; lack of reporting regarding adherence to behavioral intervention components; unclear analysis methods; and differential attrition of approximately 10 percent. Results of one fair-quality trial were published only on ClinicalTrials.gov[102] and as a conference abstract;[171] quality rating was performed based on information available only through these sources. Methods in the poor-quality trial were sparsely described and information about several quality domains, including the number of participants followed-up, was not reported.[220]

Metformin

Summary. Metformin was associated with a small but statistically significant weight reduction with minimal statistical heterogeneity in trials of 6 to 12 months' duration. In pooled analyses, metformin reduced zBMI by -0.10 ([95% CI -0.17 to -0.03]; k=6; I^2=13.1%) and BMI by -0.86 ([95% CI, -1.44 to -0.29]; k=6; I^2=0%) (**Figures 13** and **14**). Results of trials that could not be pooled for any or select outcomes were generally consistent with pooled results.[122,134,152] When individual trials adjusted for characteristics such as baseline weight, age, sex, or race/ethnicity, several trials became statistically significant which were not in our unadjusted analyses.[129,166,167] Dose did not appear to modify the weight effect of metformin, but our analysis was limited by confounding across the studies. Limited data are available about the persistence of metformin effect after discontinuation. Metformin was associated with no statistically significant benefit for fasting glucose, lipid or blood pressure outcomes; where outcomes could be pooled, confidence intervals were wide and statistical heterogeneity was high for some outcomes (**Table 13**).

Weight. Six of eight metformin trials reported sufficient data for a meta-analysis of zBMI change (**Appendix D Table 10**). These pooled results showed a zBMI net reduction of -0.10 ([95% CI -0.17 to -0.03]; k=6; I^2=13.1%) among those taking metformin compared with those taking a placebo (**Figure 13**), with almost identical results using the more conservative PL pooling method to account for the very small number of trials being pooled (-0.10 [95% CI, -0.19 to -0.03; k=5; I^2=0%). Despite differences in metformin dose and background therapy between trials, statistical heterogeneity was very low. As with the behavioral trials, the relatively large SDs suggested a wide range of effects within trials (**Appendix D Tables 11** and **12**).

The largest between-group difference in zBMI change occurred in a small fair-quality trial of 6 months that offered no adjunct diet or activity advice or behavioral component (this trial was also the only one with exclusively volunteer recruitment). Participants in the metformin group had a statistically significantly higher BMI at baseline than those in the placebo group, without adjustment of results.[122] Intervention group participants achieved the second greatest mean zBMI reduction across trials at -0.12 (SD 0.30), but placebo group participants had the largest zBMI increase at 0.23 (SD 0.39). The trial with the most intensive lifestyle background therapy, with an estimated 86 contact hours, showed a sizeable net difference in zBMI between the intervention and placebo groups that neared statistical significance at 12 months (-0.22 [95% CI, -0.46 to 0.02]);[117] despite the intensive lifestyle intervention in both groups, mean zBMI increased by 0.05 (SD 0.40) in the placebo group. Six month outcomes in this trial showed a smaller and nonsignificant zBMI net difference of -0.10 (95% CI, -0.31 to 0.11), where the metformin group had a zBMI reduction that was similar to that at 12 months [-0.14 (SD 0.44)], but the placebo group had a 6 month zBMI reduction of -0.04 (SD 0.38) that turned into zBMI increase at 12 months. The one trial that restricted inclusion to participants with a previous unsuccessful lifestyle intervention, defined as BMI change less than 2 kg/m^2 and persistent insulin resistance, showed no difference in zBMI between the metformin and placebo groups.[165] The remaining trials had similar very small and statistically nonsignificant unadjusted between-group zBMI reductions, which ranged from -0.06 to -0.08.[129,166,167] However, study-reported results adjusted for baseline zBMI[129] or age, sex, and race[167] were statistically significant in two trials. For the latter (the one good-quality trial of metformin), this equated to a 1.5-kg weight

gain in participants taking metformin and a 4.8-kg gain in those taking placebo.[167] An additional trial reporting zBMI could not be included in the meta-analysis because no measure of dispersion was reported; instead, it reported a metformin treatment effect that was generally consistent with other trials: -0.12 ($p<0.005$).[152]

Of the of eight metformin trials, six could be pooled to evaluate BMI change. These six trials showed a reduction of -0.86 with very low statistical heterogeneity ([95% CI, -1.44 to -0.29]; k=6; I^2=0%) (**Figure 14**), again with almost identical results in the PL analysis (-0.86 [95% CI, -1.45 to -0.28]; k=6; I^2=0%). In unadjusted analyses, the difference in BMI between intervention and control groups ranged from -1.86 to 0.38. In adjusted analyses, three trials rendered statistically significant results.[129,166,167] Two small, fair-quality trials could not be pooled owing to no reported measures of dispersion. Both trials reported somewhat larger metformin treatment effects on BMI than were shown in other pooled trials, -1.4 ($p<0.02$)[122] and -1.26 ($p=0.002$).[152] Five of the metformin trials were conducted with participants with a wide age range,[117,129,152,165,167] so analyses of zBMI may be preferred to analyses of BMI since many participants were still growing.

Very limited evidence is available regarding the persistence of metformin effects on weight after drug discontinuation. One study had a randomized phase of 52 weeks and then followed participants for an additional 48 weeks after drug discontinuation.[166] This study showed a significant BMI improvement after 52 weeks of metformin treatment in adjusted analyses. The improvement persisted for 12 to 24 weeks after cessation of drug treatment, but retention was only 49 percent at the end of the monitoring period.

In qualitative analyses, we found no evidence that dose modified the effect of metformin. However, study-level analyses are confounded by differences in recruitment, quality, and level of medication adherence.

Fasting plasma glucose level. Most studies reported small or no reduction in fasting glucose level with the use of metformin (ranging from -1.62 to 0.6 mg/dL), and small increases with placebo (ranging from 0.18 to 3.47 mg/dL) (**Figure 15**). Pooled analyses showed a between-group difference in fasting glucose of -3.7 with wide confidence intervals ([95% CI, -9.9 to 2.5]; k=5; I^2=64.0%) (**Table 13**). One outlier study showed a statistically significant difference of -17.90 mg/dL (95% CI, -27.91 to -7.89) between the metformin and placebo groups.[122] A small fair-quality study without lifestyle modification components, this trial also exhibited the largest metformin effect on zBMI. However, this trial had a statistically significant BMI imbalance between groups at baseline and questionable fasting glucose balance between groups that was not adjusted for. Between-group change in fasting glucose in other studies was small and generally nonsignificant in unadjusted analyses (range, -0.90 to -4.35 mg/dL).[117,129,152,165,167] Change in one of these trials was statistically significant upon adjustment but retained the same magnitude of change.[167] This pattern of results was generally similar for other glucose and insulin-related outcomes (**Figure 15**; **Appendix D Table 13**).

Lipid and blood pressure levels. Six of eight metformin trials reported measures of various lipids (total cholesterol, low-density lipoprotein, high-density lipoprotein, and triglycerides). None of the trials reported statistically significant differences in any lipid outcome and pooled

estimates were similarly non-significant with low statistical heterogeneity (**Figure 16**; **Table 13**; **Appendix D Table 14**).[117,122,129,165-167] Similarly, neither of three reporting trials showed differences in blood pressure.[117,129,165]

Important subpopulations. Four of eight metformin trials commented on results for sex or race/ethnicity subpopulations.[122,134,166,167] Analyses of the effect of metformin in subpopulations were limited by small study sizes, lack of prespecified subgroup analyses in individual trials, and the absence of statistical interaction testing in several trials. In the one trial with explicitly prespecified subgroup analyses and interaction testing, neither sex nor race/ethnicity modified the effect of metformin on BMI ($p>0.20$).[166] Another study found that BMI decreased less in non-Hispanic blacks than in non-Hispanic or Hispanic whites; however, the p-value for the interaction test was 0.064.[167] A study of 85 adolescents showed that females were twice as likely as males to decrease BMI by at least 5 percent, which was not explained by metformin adherence; however, interaction testing was not performed and prespecification of the analysis was not reported.[134]

Orlistat

Summary. In a small body of evidence (three trials), orlistat was associated with small between-group reductions in BMI ranging from -0.94 (95% CI, -1.58 to -0.30) to -0.50 (95% CI, -7.62 to 6.62) and weight ranging from -3.90 (-25.54 to 17.74) to -2.61 (95% CI, not reported, $p<0.001$). Results were significant in the two larger trials. Two of three trials reported changes in cardiometabolic risk factors and results were generally statistically nonsignificant, except for DBP reduction in a large trial (mean between-group difference, -1.81 mm Hg [CI not reported], $p=0.04$). None of the studies followed weight change after medication use ended.

Weight. Orlistat trials reported small between-group BMI differences ranging from -0.94 (95% CI, -1.58 to -0.30) to -0.50 (95% CI, -7.62 to 6.62) (**Appendix D Table 10**).[102,116,135] Intervention groups reduced BMI between -1.44 (95% CI, -1.96 to -0.9) to -0.55 (95% CI, not reported) whereas control groups had BMI changes ranging from -0.8 (95% CI, -7.47 to 5.87) to 0.31 (95% CI, not reported). BMI reduction was statistically significant in the two larger trials (n=539 and n=200)[102,116] but was not in the smaller trial (n=40).[135] Baseline BMIs in orlistat trials ranged from 35.6 to 41.7 kg/m^2. In the largest trial, 19.0 percent of participants who had been given orlistat but 11.7 percent who had been given placebo achieved weight loss of ≥5 percent ($p=0.03$).[116] Weight reduction in both groups peaked at about 12 weeks. Weight change (kg) ranged from -5.5 (95% CI, -18.24 to 7.2) to 0.53 (95% CI, not reported) among orlistat participants and -1.6 (95% CI, -21.19 to 17.99) to 3.14 (95% CI, not reported) among participants given a placebo. Between-group differences in weight were similar among trials and ranged from -3.90 (-25.54 to 17.74) to -2.61 (95% CI, not reported, $p<0.001$); again, results were statistically significant in only the two larger trials. The one trial reporting zBMI showed a between-group difference of -0.06 (95% CI, -0.12 to 0.00) favoring orlistat.[102]

Cardiometabolic outcomes. Two of three orlistat trials reported cardiometabolic outcomes.[116,135] Changes in glucose, insulin, and lipid levels were statistically nonsignificant in both reporting trials. In the one trial that reported blood pressure, the orlistat group achieved a greater DBP reduction (mean between-group difference, -1.81 mm Hg [CI not reported],

p=0.04); changes in SBP were not statistically significant (mean between-group difference, -0.22 [CI not reported], p=0.84).[116]

Important subpopulations. Two of three orlistat trials commented on potential effect modification by sex and noted that there appeared to be no effect modification by this characteristic.[116,135] Two of three trials commented on race/ethnicity.[102,116] In the larger trial (n=539) in which 16.9 percent of the population was black, authors reported no effect modification by race/ethnicity; analyses were not explicitly prespecified and did not include interaction testing.[116] In the smaller trial (n=200) in which 62 percent of the population was black, non-Hispanic whites in the orlistat group lost more weight than non-Hispanic blacks, but confidence intervals overlapped (weight loss in kg of -3.7 [CI, -5.8 to -1.7] and -2.1 [-3.7 to -0.5], respectively).[102] Non-Hispanic white children in the placebo group did better than Non-Hispanic blacks, but confidence intervals again overlapped (weight loss in kg of -1.6 [CI, -3.6 to 0.4] and 0.4 [CI, -1.2 to 2.0], respectively). No interaction testing was performed; specification of the analysis was unclear, but recruitment was limited to non-Hispanic whites and non-Hispanic blacks. In trials reporting power, power was not calculated for analyses of subpopulations.[116,135]

Key Question 5. Do Weight Management Interventions for Children and Adolescents Have Adverse Effects?

Lifestyle-Based Weight Loss Interventions

Three of the lifestyle-based weight loss intervention trials reported that there were no adverse events of the intervention,[118,145,147] and two additional trials (published in the same article) reported that there were no serious adverse events.[142] Five trials similarly found no group differences on measures of disordered eating or body dissatisfaction, measures that could potentially show a benefit or harm of the interventions.[120,136,148,162,163] For example, the good-quality trial with adolescent girls reported the proportion in the intervention and control groups with disordered eating.[120] The proportion of girls who reported disordered eating declined in both the intervention and control groups: at baseline 13 girls in each group reported disordered eating, and at 12-month followup one girl in the control group and none of the girls in the intervention group reported such pathology.

Pharmacotherapy Interventions

Fourteen trials were included for the evaluation of adverse effects associated with pharmacotherapy. In addition to the 11 trials included for efficacy analyses,[102,116,117,122,129,134,135,152,165-167] an additional three metformin trials with durations of less than 6 months were eligible for consideration of harm.[115,121,128] These three additional trials were small fair-quality trials of 2 to 4 months duration with 24 to 34 participants.

Metformin

Summary. Gastrointestinal side effects were common but not serious in participants taking metformin. Side effects were frequently reported by those on placebo. Discontinuations due to

adverse effects, however, were relatively rare (<5%) and occurred in relatively similar proportions between groups. Reporting trials generally showed no differences in liver or kidney function, and there were no reported cases of lactic acidosis.[115,121,122,129,152,166,167]

Side effects. Side effects were reported inconsistently across studies, but were generally common and gastrointestinal in nature. Two studies of metformin reported overall gastrointestinal symptoms and showed high prevalence in both metformin and placebo groups. In one trial the prevalence of symptoms in the metformin and placebo groups was 29 and 19 percent, respectively,[134] and in the other trial the prevalence was 14 and 26 percent, respectively.[165] Nausea was common in the two studies reporting this outcome (23% and 42% among those taking metformin);[128,166] just one of these trials reported nausea for placebo participants (8%). Liquid or loose stools were reported by 17 to 42 percent of metformin participants in two reporting trials;[128,167] in the trial reporting this outcome for placebo participants, it occurred in 17 percent (p=0.01 compared with 42% in metformin participants). Vomiting was reported by 15 to 42 percent of those on metformin in two trials and by 3 and 21 percent of control group participants, respectively.[166,167] In one of the 12 month trials, one participant in the metformin group discontinued the drug for 2 weeks due to persistent diarrhea; this was unchanged and metformin was resumed.[117]

Trial protocols generally allowed for a reduction in dose when participants presented with side effects. Five trials reported the proportion of participants reducing dose. Among trials using a dose of 2,000 mg/day, between 7 and 17 percent of intervention group participants reduced dose to alleviate side effects, whereas dose reductions in placebo participants ranged from 2 to 8 percent.[117,152,166,167] A 3-month trial using a dose of 1,500 mg/day reported that no participants required a reduction in dose.[115] Seven percent of metformin participants in a 6-month trial using a dose of 1,000 mg/day required dose reduction, but the proportions in control groups were not reported.[122] In a trial that reported side effects by month, symptoms were most prevalent at 1 month and decreased over time such that there were no differences between the metformin and placebo groups by the end of the 6-month trial.[167]

Discontinuation due to adverse effects. Five of the 11 metformin trials reported the number of participants (for both intervention and control groups) discontinuing the trial due to adverse effects.[121,134,165-167] Two trials of short duration reported that there were no discontinuations due to adverse effects among participants receiving metformin and did not report discontinuations in placebo groups.[115,128] A 12 month trial reported one discontinuation in the metformin group but did not report discontinuations in the placebo group.[117] Summed across trials, the proportion of participants discontinuing due to adverse effects was 3.8 percent (10 of 263) for metformin participants and 3.2 percent for placebo participants (seven of 221) (**Table 12**).

Liver function, kidney function, and lactic acidosis. Eight of 11 metformin trials reported measures of liver function (alanine aminotransferase, aspartate aminotransferase), kidney function (serum creatinine), or lactate levels.[115,117,121,122,129,152,166,167] In five of these trials, authors reported either no difference between groups in these measures[115,129,152] or that no participant achieved abnormal levels.[122,167] In one trial, two participants in the metformin group and one in the placebo group had elevated alanine aminotransferase levels and discontinued therapy.[166] In another trial, one participant in the placebo group withdrew due to increased liver

transaminase level at 1 month; this participant had fatty liver secondary to obesity which was detected by ultrasonography.[121] In one of the 12 month trials, one participant in the metformin group experienced transient elevation of transaminases which resolved 1 month after discontinuation.[117] Cumulatively, there were three cases of elevated liver enzymes among metformin participants and two cases among placebo participants. There were no reported cases of lactic acidosis in the included trials.

Vitamin and hemoglobin levels. The two trials reporting B_{12} levels showed no adverse effects related to this vitamin.[115,167] The two trials reporting hemoglobin levels exhibited no metformin-associated differences in this outcome.[122,167]

Orlistat

Summary. Gastrointestinal side effects were very common among patients taking orlistat. Discontinuations due to adverse effects were relatively rare (<5%) and were about twice as common in orlistat participants than in those taking placebo.

Side effects. Side effects were reported inconsistently across the three included trials but were primarily gastrointestinal and were very common among patients taking orlistat. Fatty or oily stools were reported by 50 to 70 percent of orlistat participants and 0 to 8 percent of those on placebo.[102,116,135] Abdominal pain or cramps were reported by 16 to 65 percent and 11 to 26 percent of those on orlistat and placebo, respectively. Flatus with discharge was reported by 20 to 43 percent of those on orlistat and 3 to 11 percent of those on placebo. In two trials, fecal incontinence was reported in 9 to 10 percent of orlistat participants and 0 to 1 percent of placebo participants.[116,135] In the other trial, 60 versus 11 percent of orlistat and placebo participants, respectively, reported uncontrolled passage of stool or oil.[102] One trial reported adverse effects over time.[135] The prevalence of some, but not all, adverse effects decreased over time among those taking orlistat. Cramps, for example, decreased from 65 percent reporting at 1 month to 13 percent at 6 months. Fatty or oily stools, cramps, flatus with discharge, and fecal incontinence improved more over time among those on orlistat than on placebo.

Discontinuation due to adverse effects. All three orlistat groups reported discontinuations due to adverse effects. Cumulatively, 3.2 percent of orlistat participants (15 of 472) and 1.7 percent of placebo participants (five of 301) withdrew due to adverse effects. In the largest orlistat trial, there were 11 serious adverse events in the orlistat group and five in the placebo group.[116] In the orlistat group, only one serious adverse event was thought to be possibly study-related—asymptomatic cholelithiasis leading to cholecystectomy in a 15-year-old female who had lost 15.8 kg by the time of the event. In the smaller trial, one suicide occurred in the orlistat group in a patient who was under a psychiatrist's care.[135] No deaths occurred in the placebo group. In the other orlistat trial, no serious adverse events occurred in the intervention group, but two occurred in the placebo group—these were one episode of hypoglycemia due to a pharmacy error in preparing insulin and the other an overnight hospital admission for lower left quadrant pain and vomiting.[102]

Vitamin levels, growth, and hormones. Two of three orlistat trials measured vitamin A, D, and E levels and reported no differences between groups.[116,135] All orlistat trials, however,

provided multivitamin supplementation for all participants. No between-group differences in growth, bone mineral density, or sexual maturation were reported in the one trial reporting these outcomes.[8] This trial reported a decrease from baseline in estradiol among girls taking orlistat and a slight increase in those taking placebo (p=0.05).

Chapter 4. Discussion

Given the many factors that influence weight and the many ways our current environment conspires to make weight management difficult[46,48] even for those without genetic predisposition for obesity, unprecedented levels of self-discipline are required to maintain a healthy weight, and even more so to lose excess weight.[51,52] Environmental challenges are strongest in economically disadvantaged communities, where safe play spaces are scarcest and access to healthy and delicious food is often limited due to a lack of availability, relatively high cost, and time required to prepare meals from scratch.[221] The need to support children and families in their efforts to reduce excess weight in children is great, as evidenced by the large number of children resorting to ineffective and unhealthy methods to control their weight.[93,94]

Summary of Evidence

A fairly large and recent body of literature on lifestyle-based weight loss programs with at least 26 hours of contact consistently demonstrated small average reductions in excess weight compared to usual care or other control groups in children and adolescents who were overweight or had obesity (**Table 15**). The literature also revealed no evidence of these programs causing harm. Relative reductions in zBMI of 0.20 or more were typical, but the absolute amount of weight loss was highly variable within studies, suggesting a wide possible range of benefit. Those with the most contact hours (targeting children ages 6 to 16 years, collectively) also demonstrated approximately 6- to 9-point reductions in SBP relative to the control groups, smaller reductions in DBP, some improvement in insulin and glucose parameters, but typically no improvements in fasting plasma glucose or lipid parameters. Behavior-based interventions with fewer hours of contact rarely demonstrated benefit, although very limited evidence suggested that briefer interventions may be effective in children who are overweight but do not have obesity. Hours of contact was the only study or intervention characteristic that was clearly related to effect size, with larger effects seen in trials with more contact hours. Use of metformin and orlistat were associated with very small reductions in excess weight in youth. Medications provided small or no benefit for intermediate cardiometabolic outcomes, including fasting glucose level. Evidence of metformin was primarily limited to youth with abnormalities of insulin or glucose metabolism, most of whom met adult criteria for severe obesity. The evidence base was small for metformin and even smaller for orlistat, with only three trials. Pooled metformin results showed very small effect sizes, so those results are vulnerable to change in statistical significance if newly published studies find no benefit. We found no direct evidence on the benefits or harms of screening children and adolescents for excess weight.

Clinical Significance

The clinical importance of these changes in weight is difficult to understand. A German expert panel considers a zBMI reduction of 0.2 to be associated with clinically significant improvement,[222] but we found no data to support any particular cutoff. The German group, using German norms, noted that a reduction of 0.2 zBMI units typically corresponds to a weight

reduction of 5 percent.[223] Several small prospective studies of children who had obesity have reported larger improvements in cardiometabolic measures among those who reduced their zBMI over time—and reported statistically significant linear trends in some cases—across four levels of zBMI improvement (i.e., zBMI increase, zBMI decrease of 0 to 0.25, zBMI decrease of 0.25 to 0.50, zBMI decrease >0.50). However, no clear or consistent threshold or a clearly increasing benefit with increased zBMI change category was apparent over the chosen zBMI change categories.[224-226] Similarly, a study showing greater improvement in insulin sensitivity with an 8 percent reduction in BMI did not provide compelling data showing this level of BMI change to be an important threshold (e.g., compared with 6% or 10%) nor whether the amount of improvement in insulin sensitivity reported was clinically significant.[227] Analysis of subjects who completed a short-term, family-based behavioral weight management program showed that the average 0.15 zBMI reduction achieved in the intervention group was associated with statistically significant improvements in lipid and insulin measures in linear regression analyses as well as normalization of blood pressure, total cholesterol, and LDL-cholesterol in a significant portion of participants with initially abnormal levels of these measures.[228] While it may be useful to know, for example, that an 8 percent reduction in BMI is associated with a statistically detectable change in insulin sensitivity, statistical significance was the determinant of benefit in all of these studies, and is partially a function of sample size and may not reflect clinically meaningful change. However, setting aside the issue of degree of excess weight needed to improve cardiometabolic health, in many trials children in the control groups were more likely to show a continued trajectory of increasing excess weight, on average, so simply arresting the gain in excess weight likely constitutes a clinically important benefit for many of the these interventions.

In the literature on adult obesity, weight loss amounts of both 5 percent and 10 percent or more of baseline weight are commonly cited as thresholds of clinical significance to confer cardiovascular benefit. As in the pediatric literature, we found no direct evidence to justify any specific threshold. Older obesity guidelines and commercial weight loss programs claim that 10 percent weight loss is sufficient to significantly decrease the severity of obesity-related risk factors[229] and improve several markers of overall health.[230] Some literature targeted at consumers cite lower thresholds of 5 to 10 percent.[231,232] To guide industry about developing products for weight management, the FDA set efficacy benchmarks of mean weight loss of 5 percent or more, subsequently citing the Diabetes Prevention Program (DPP) and a narrative review of obesity epidemiology.[233-236] In contrast, a systematic review of long-term (≥2 years) dietary-focused interventions for weight loss found that weight loss of at least 5 percent was not consistently associated with significant improvements in cardiovascular risk factors in an unselected adult population that was overweight or had obesity.[237] Instead, substantial changes in risk factors occurred principally in those at increased cardiovascular risk, such as participants with impaired glucose tolerance.[235,238,239]

DPP, which included nondiabetic overweight adults with elevated glucose, set a weight loss goal of 7 percent in their lifestyle intervention group.[235] About half of this intervention group achieved this weight loss goal at 24 weeks, although weight regain was steady after this point (but still remained below baseline). Despite some weight regain, the incidence of type 2 diabetes was reduced by 58 percent with lifestyle intervention over an average followup of 2.8 years (95% CI, 48 to 66). The DPP intervention was highly intensive and likely involved more than 26

hours of contact: 16 individual sessions over the first 24 weeks, followed by subsequent monthly individual and group sessions, twice-weekly optional supervised physical activity sessions, and optional 4- to 6-week maintenance courses. This level of intensity, access to trained interventionists, and focus in a high-risk population limit applicability to unselected overweight adults or adults with obesity, let alone children and adolescents, in real-world practice.

Regardless of the lack of direct evidence for any specific threshold for clinical significance, there is strong evidence of a relationship between adiposity, intermediate risk factors, and long-term health outcomes. An individual patient data meta-analysis of nearly 900,000 adults showed a continuous positive association between BMI and overall and cause-specific mortality at BMIs greater than 22.5.[240] On average, overall mortality in the individual patient data meta-analysis was about 30 percent higher for every 5 kg/m^2 increment of BMI above 22.5, and proportional increases in risk were slightly larger at progressively younger age strata after an average of 13 years of followup. However, controversy remains about the ill-effects of overweight in the absence of obesity, since some large prospective studies have not shown increased mortality risk below a BMI of 25.[241,242] Smaller analyses suggested that the associations between adiposity and mortality are established in adolescence.[243,244] The relationship between adiposity and health outcomes, the close tracking of childhood and adolescent obesity into adulthood, and the difficulty of achieving and sustaining weight loss all underscore the importance of obesity prevention.

Behavior-Based Lifestyle Interventions

The results of the current review were consistent with a recent review commissioned by the Canadian Task Force on Preventive Health Care (CTFPHC), which included a different but overlapping body of evidence, including trials with no connection to a health care setting and limiting their evidence to RCT studies.[245] These reviewers found that behavioral interventions aimed at weight management were associated with a small but robust average reduction in BMI (pooled mean difference [MD], -1.15 [95% CI, -1.59 to -0.72]) as well as small improvements in blood pressure (SBP pooled MD, -4.64 [95% CI, -7.46 to -1.82]; DBP pooled MD, -4.08 [95% CI, -6.07 to -2.09]) and quality of life (pooled MD, 2.05 [95% CI, -0.31 to 4.40]). These pooled effect sizes are entirely consistent with the results in the trials included in our review. In addition, we primarily examined zBMI rather than BMI because of the relatively consistent interpretability of zBMI across ages. Differences in BMI change in our review were typically greater than 1.0 for interventions with 26 or more hours of contact and most commonly less than 1.0 with fewer hours of contact. Other reviews have similarly reported favorable effects of lifestyle-based weight management interventions, particularly comprehensive programs involving parents and at least a moderate level of intervention intensity.[246-248]

Due to the wide range of ages in the included studies and the large variability in effects, even when ages were more restricted, it is difficult to characterize the amount of weight loss children and adolescents are likely to experience from participating in lifestyle-based weight loss interventions. Nine of the 13 trials with lifestyle-based weight loss interventions of 26 or more contact hours showed average zBMI reductions of 0.20 or more, and seven of the 13 reported reductions of 0.30 or more (**Appendix D Table 4**). Typically, most intervention groups

maintained their average baseline weight within approximately 5 pounds while growing in height (**Appendix D Table 5**). These reductions were generally compared with small average increases in zBMI or reductions of 0.10 or less in control groups, or 5- to 17-pound average increases in weight. However, it is unknown how many children in control groups sought out formal weight loss programs and resources from their communities. Given the wide range of effects in the control groups (as in the intervention groups) some families may have received formal help. Few of the less intensive interventions reported zBMI reductions of 0.20 or more.

We were unable to identify specific characteristics or components that showed a clear association with effect size. As mentioned above, most successful interventions included sessions that targeted both the parent and child (separately, together, or both); offered individual family sessions as well as group sessions; provided information about healthy lifestyle choices; encouraged the use of stimulus control (e.g., limiting access to tempting foods, limiting screening time), goal-setting, self-monitoring, contingent rewards, and problem-solving; and included some supervised physical activity sessions. Parents were frequently asked to modify their behavior and were sometimes actively engaged in weight loss interventions themselves. These are typical of components of family-based behavioral treatment as described by Altman and Wilfley.[249] They describe four target areas: dietary modification (reducing caloric intake), energy expenditure modification (increasing energy expenditure), behavior change techniques (goal setting, self-monitoring, reward systems, stimulus control), and family involvement and support (shaping the home environment, modeling healthy eating and activity, parenting skills, and lifestyle goals for both parents and children) and provide specific strategies or goals for each area. For example, to shape the home environment, families are encouraged to "make the healthy choice the easy choice" by limiting availability of unhealthy foods in the house. Another review of child obesity treatment interventions noted the importance parental involvement.[250] A review focused on interventions in primary care found evidence to support training health professionals before intervention delivery; offering behavior change options; using a combination of counselling, education, written resources, support, and motivation; and tailoring intensity according to whether behavioral, anthropometric, or metabolic changes are the priority.[251] One study examining interventionist characteristics found that adherence to the protocol showed the strongest association with greater weight loss.[252]

It is always questionable whether results reported in clinical trials will be comparable to those in in real-world settings. For comparison, one study of 3,135 children who had attended a certified German pediatric obesity treatment center and had 2 years of continuous followup data found results fairly comparable to those seen in the higher-intensity trials in our review. That study reported that 47 percent of the children had reduced zBMI by 0.2 units or more after 2 years.[223] The 23 percent of the children who showed both initial weight loss success in the first 6 months (average zBMI reduction, 0.46) and continued improvement through 2 years, wound up with a final average zBMI of 1.79, down from an average of 2.4. Boys and children younger than age 12 years were most likely to show this pattern of success. However, 53 percent of the children either did not maintain initial loss of excess weight or never showed substantial improvement in zBMI scores.

The included evidence was limited to followup of 1 to 2 years. Epstein and colleagues published 10-year followup results from children who completing several versions of a family-based

comprehensive weight management intervention, a program that the interventions of several included trials were modeled after.[253] Children from four trials were combined for long-term followup; the interventions differed slightly across the four studies, but all involved an estimated 30 or more hours of contact with the families. Epstein reported that 52.5 percent of the children undergoing these interventions met criteria for obesity at 10-year followup. Children were 8 to 12 years old at study entry (average age, 10.4 years) and were on average 49.9 ± 17.2 percent overweight; almost all participants likely met the criteria for obesity at baseline. Naturalistic longitudinal studies generally show higher rates of obesity at comparable followup, typically 64 to 87 percent, with U.S.-based studies falling in the higher end of the spectrum,[13,14,254,255] suggesting that family-based weight management programs improve the likelihood of avoiding future obesity, at least during early adulthood.

We found no harms associated with behavior-based weight management interventions in the included studies. However, in the United States, stigma against persons who are overweight or have obesity can be pronounced and are associated with prejudice and discrimination—including by health care providers[256-258]—in multiple domains of life.[259] Obesity is usually blamed on the individual, and bullying, shaming, and discrimination are not uncommon. Encountering these events in the healthcare setting may lead persons with excess weight to avoid health care and delay preventive care.[256] Further, a longitudinal study of 2,944 adults aged 50 years and older found that perceived weight discrimination was associated with relative increases in weight (+1.66 kg, $p<0.001$) and waist circumference (+1.12 cm, $p=0.046$).[260] Whether similar effects occur in children and adolescents is unknown.

Even so, based on measures related to acceptability of weight loss programs, evidence from 17 of the included trials suggests that participants did not feel stigmatized or shamed (**Appendix E**). On various satisfaction questionnaires, both parents and children rated their satisfaction with the weight management interventions highly. In most trials, 80 percent or more of participants had high satisfaction or acceptability ratings, and continuous satisfaction scores typically were above four on a five-point scale.[112,123,124,130,141,154,157,158] The interventions were also rated high in quality and value; for example, all the parents of one fair-quality study rated the Positive Parenting Program (Triple P) as good to excellent.[124] The participants of four included studies reported that the intervention met their particular weight loss needs.[120,124,141,160] Primary care providers also found the interventions to be of high quality,[137,160] helpful,[163] and relevant.[136]

Pharmacotherapy Interventions

Our systematic review of two pharmacotherapies found that these agents offer a small incremental benefit over background lifestyle therapy; between-group BMI reductions were of the magnitude of -0.86 kg/m^2 for metformin and at most -0.94 kg/m^2 for orlistat. In the context of high baseline BMI in included trials (36.0 kg/m^2 for metformin and 37.4 for orlistat), these values represent a BMI reduction of only about 2 percent. The largest zBMI reduction seen in any intervention arm of a pharmacotherapy trial was 0.17,[117] although only one orlistat trial reported zBMI and only six of the eight metformin trials did. These drugs generally showed little to no benefit for glucose, lipid, or blood pressure outcomes. Side effects for both metformin and orlistat were primarily gastrointestinal in nature and common, but not serious, and

discontinuations due to adverse effects were relatively rare (less than 5%). For metformin, our results for BMI change were generally similar but smaller in magnitude than those reported in a recent systematic review which showed a pooled BMI reduction of -1.16 kg/m^2 (95% CI, -1.60 to -0.73).[261] That review included trials that we excluded based on duration for efficacy analyses,[115,121,128] setting,[262] no use of a placebo pill in control groups,[263,264] quality,[220] and study aim other than weight loss.[265] Regardless, that review reached similar conclusions, namely that the magnitude of BMI change was small compared with the reductions needed for long-term health benefits.[261] Our results were also similar to those of a recent trial of metformin added to insulin in 140 adolescents who were overweight or had obesity with type 1 diabetes: similar between-group zBMI reduction of -0.1 (95% CI, -0.2 to -0.1) and no statistically significant improvements in glycemic control, blood pressure, or lipid levels with metformin at 6 months.[266]

Most metformin trials (75%)[122,129,134,152,165,167] were conducted in populations with hyperinsulinemia, insulin resistance, or impaired glucose tolerance, thereby limiting applicability of the results to the general pediatric population with obesity. The two metformin trials that did not require abnormalities of insulin or glucose metabolism for inclusion were fair-quality trials of about 70 participants each with children ranging from 10 to 18 years old with obesity; both trials showed statistically significant reductions in BMI of -1.1 kg/m^2 and -1.86 kg/m^2, respectively, at 1 year.[117,166] The body of evidence for pharmacotherapy was further limited by small trials of limited duration. Moreover, only one drug trial evaluated the effects after discontinuation: it showed that the effect of metformin disappears after 12 to 24 weeks off treatment.[166] The benefits of pharmacological treatment for the general population of patients with obesity may also be hindered by lower adherence by patients than that experienced in trials, particularly given the general challenges of adherence in adolescent populations.[267]

Metformin reduces hepatic glucose production and plasma insulin, inhibits fat cell lipogenesis, and may increase peripheral insulin sensitivity and reduce appetite by raising levels of glucagon-like peptide-1.[268] Its precise mechanism of action for weight reduction, however, is not completely understood.[269-272] Due to extremely wide variation in glucose and insulin outcomes, our data did not confirm nor rule out improvements in these outcomes as having a mediating effect on BMI. Metformin is FDA-approved for the treatment of type 2 diabetes for children 10 years or older, but not for children (or adults) for weight management. Data on the use of metformin for obesity in pediatric populations is limited and its use for this indication in the United States is unknown. An analysis of a large U.K. primary care database spanning 2000 to 2010 showed that among adolescents prescribed metformin, most had a diagnosis of diabetes. Only 8 percent of adolescents on this medication were prescribed metformin for obesity alone.[273]

Orlistat inhibits intestinal lipases and reduces the gastrointestinal absorption of fat by 30 percent.[268] Orlistat is FDA-approved for weight management in patients 12 years or older and is available over the counter (as Alli) in adults 18 or older. Use of orlistat in the United States peaked in 2000 (the year after it was approved by the FDA) and has seen a dramatic decline since, with about 23,000 projected users in 2011, of whom 0.6 percent were 16 or younger.[274] Just about half of orlistat users discontinue the medication after 30 days. A U.K. primary care database spanning 1999 to 2006 found a similar rate of orlistat discontinuation among individuals less than 18 years of age.[275] Reasons for discontinuation could include side effects or a perceived lack of effectiveness.[274]

The use of pharmacotherapy for obesity treatment is an active area of research, as evidenced by four newly included metformin studies in this updated review and one ongoing trial,[276] one newly included orlistat trial,[102] and additional literature on various agents for adult populations. Since the last systematic review for the USPSTF, sibutramine was removed from the market because of concerns about cardiovascular safety[277] and the following drugs were FDA-approved for chronic weight management in adults: lorcaserin, phentermine-topiramate, bupropion-naltrexone, and liraglutide.[278-280]

However, investigation of these and other pharmacologic agents for general pediatric populations with obesity is very limited. Exenatide, a glucagon-like peptide-1 receptor (GLP-1) agonist used to improve glycemic control in adults with diabetes, demonstrated a statistically significant BMI reduction of -1.13 kg/m^2 in a placebo-controlled 3-month randomized trial of 26 adolescents.[281] GLP-1 agonists enhance satiety by slowing gastric emptying, and activation of GLP-1 receptors suppresses appetite.[270,281] This agent is administered via injection twice per day, which may limit its acceptability. Bupropion is a norepinephrine and dopamine reuptake inhibitor that can improve appetite regulation and decrease food cravings;[272] its combination with naltrexone is FDA-approved for weight management in adults.[279] Evidence for the use of bupropion in children and adolescents is limited. A 2016 study evaluating the efficacy of bupropion for smoking cessation in adolescents found that adolescents randomized to 300 mg/day had a small statistically significant reduction in zBMI at 6 weeks (-0.16 [95% CI, -0.29 to -0.04]) that was not maintained at 6 months when compared with adolescents randomized to placebo or 150 mg/day.[282]

Studies designed to evaluate the efficacy and tolerability of the antiepileptic medications topiramate and zonisamide have demonstrated weight loss, but these studies were conducted with children and adolescents with epilepsy or otherwise non-generalizable clinical history (i.e., treatment for brain tumor).[270,283-285] Adverse effects of topiramate included impacts on language, attention, memory and psychomotor speed and somnolence, vomiting, and diarrhea for zonisamide.

The Expert Committee guidelines consider pharmacotherapy an intensive tertiary-care intervention that can be offered through a comprehensive multidisciplinary intervention to some youth who have severe obesity and have previously attempted weight control.[1] This 2007 guideline addressed only orlistat and sibutramine, the latter of which has since been withdrawn from the market. A 2008 guideline from the Endocrine Society similarly suggested that pharmacotherapy should be considered in children who have obesity only after failure to lose weight with an intensive lifestyle modification program and considered only in children who are overweight if they have significant, severe comorbidities who have not responded to lifestyle intervention.[269] Direct evidence for this recommended stepped-care approach to pharmacotherapy is limited to one RCT of metformin (70 adolescents with insulin resistance), which restricted inclusion to participants with a previous unsuccessful lifestyle intervention, defined as BMI change less than 2 kg/m^2 and persistent insulin resistance; this study showed no difference in BMI or zBMI change between groups.[165] The CTFPHC, which evaluated only orlistat, recently authored a weak recommendation based on moderate-quality evidence that practitioners not routinely offer this drug for youth aged 12 to 17 years (and strongly recommended against offering orlistat in younger children).[286] No guidelines explicitly

recommend the use of metformin, mainly due to lack of regulatory approval for treatment of pediatric obesity.[269,286]

Role of Primary Care

Given the tremendous effort required to change a family's dietary and activity patterns, some children and adolescents will cycle through weight management programs more than once before successfully and substantially reducing excess weight. Because weight management will likely be a lifelong struggle for many of these children, and because families' energy and commitment to weight management likely varies over time, these children will need varying levels of support at different stages and will have times when they are more—or less—successful. Having access to multiple sources of support of varying levels of intensity over the course of many years would likely be ideal. Primary care providers are limited in the degree to which they can provide direct instruction and support for weight loss, but they could collaborate with their patients to determine the level of care needed at different points in their weight management journey, help connect them with appropriate resources, and provide a supportive "home base" throughout the process. A chronic care model envisioned by the 2007 Expert Committee remains an aspirational paradigm in which practices are linked to community resources that can provide more intensive support; have clinical information systems; and have in-house capability to support patient self-management, monitor patient and clinician adherence to evidence-based care pathways, and remind providers about routine tests and treatment. The Expert Committee noted that with regard to the obesity epidemic at large, "health care-centered efforts alone cannot effect change, but they can complement and potentially enhance evolving public health efforts, such as school wellness policies, parks and recreation programs, and shifts in child-targeted food advertisements."[1]

Limitations of the Review

This review identified several limitations to the evidence base, including no evidence related to benefits or harms of screening for obesity. In the trials of treatment for excess weight, limitations included minimal long-term followup, many studies with small numbers of participants, methodologic limitations, and somewhat sparse reporting of health outcomes. In addition, it is difficult to interpret average effects in the presence of high within-study variability in results, and the results rarely allowed us to determine the proportion of children falling below obesity and overweight thresholds after participating in the interventions. The degree to which control group children participated in formal weight management programs is unknown but could attenuate the apparent benefit of the intervention. In addition, heterogeneity in population, study, and intervention characteristics along with inconsistent reporting made it impossible to understand how most of these characteristics affected the study results. The evidence base for pharmacologic studies was small, particularly for orlistat. Most pharmacotherapy trials only followed children for 6 months, and only one had planned followup after the medication was discontinued.

Estimated hours of intervention contact did show a clear relationship with effect size, although

our measure of this was imperfect. First, not all studies reported a detailed description that included hours of contact and we had to estimate session duration in many cases. In addition, we estimated planned hours of intervention but generally did not have access to actual hours received by participants. In addition, we divided the continuous variable into categories *post hoc*, on the basis of maintaining methods of the previous review, extending similar logic, and the distributional properties of the included studies, and not on clear differences in effectiveness at specific cut-points. Thus, it is not apparent that a 25-hour intervention would be substantially less effective than a 26-hour intervention. However, the evidence did seem to demonstrate that a 60-hour intervention is much more likely than a 5-hour intervention to show an average treatment benefit.

Another concern regards the quality of life and intermediate cardiometabolic outcomes. Because trials were only included if they reported a weight outcome, it is possible that there may be additional trials the focused only on quality of life or cardiometabolic outcomes without reporting weight change, and were not included in this review.

Some bodies of literature not included in this review may provide relevant information. We limited our review to trials in which either the intervention or recruitment occurred in a health care setting, thereby increasing applicability to primary care, but interventions in some of the excluded studies were likely very similar to the included studies and at least somewhat applicable. Similarly, multi-level trials, such as those that involve school- and community-level interventions, may also include individually-targeted components in health care settings but were not included. These trials might highlight the ability of healthcare-based interventions to potentiate other initiatives. Also, we did not systematically search for observational evidence of harms of behavior-based interventions, although we believe these interventions are unlikely to be harmful. We did not include comparative effectiveness studies, which might have enabled us to better identify specific components that are associated with effectiveness. Many recent trials only included active comparators. Many researchers already believe evidence supports treatment benefit, so they may consider it unethical to withhold treatment from the control group, and instead focus their research on questions related to treatment response in special populations, adaptations to improve treatment response, and generalization to other settings and providers.

Future Research Needs

A number of future research needs were identified in our review. Trials of benefit and harms of screening children and adolescents for obesity are needed. For example, a trial that implements a systematic screening program in one set of clinics or providers but continues with usual care in another set of clinics/providers would be valuable. Replication of existing successful treatment programs and full trials of small feasibility studies is a logical next step for many interventions, and indeed some such studies are under way (**Appendix F**). Specifically, examination of the stepped-care approach recommended by the Expert Panel would be valuable. More long-term followup is needed, particularly into adulthood, to determine the degree to which reductions in excess weight persist. Also, evidence is needed about what constitutes clinically important health benefits and, ultimately, the amount of weight loss that is associated with such benefits. Also, although the quality of methods and reporting in more recent studies was generally much better

than that of earlier literature, this field would benefit from greater consistency in reporting. In addition, individual patient meta-analysis could be very helpful in this field (with such large within-study differences in results) to start to understand the differences between patients who lose excess weight and those who do not. Finally given the high level of stigma associated with excess weight, including prejudice or discrimination by health care clinicians, direct assessment of experiences of participation in weight management interventions would be desirable.

Douketis and colleagues proposed a standardized framework for reporting weight loss intervention studies with adults, and much of this framework applies to studies with children and adolescents also.[237] This group proposed reporting body weight (in kilograms), BMI, waist circumference (in centimeters), and clinical cardiovascular risk factors (e.g., blood pressure) at baseline and followup, to which we would add zBMI for children, with the norms on which zBMI is based being reported. They also recommend reporting the effects of weight loss on cardiovascular risk factors according to the amount of weight lost, which also would be beneficial for children and adolescents. Other outcomes pertinent to children are the number and percentage that fall below the 85th percentile for age and sex, between the 85th and 95th percentile, and above the 95th percentile. Douketis and colleagues also recommended reporting outcomes in high-risk groups, such as those with impaired glucose tolerance, because benefits may differ in those who are experiencing deleterious health effects and those who are not; this recommendation would also apply to adolescents and potentially to younger children as well. They further recommend followup of 4 years or more, followup in 80 percent or more of participants, reporting of the number and reason for participants leaving a study, and strenuous efforts to contact all participants at the final followup.

Conclusion

We found no direct evidence on benefits or harms of screening children and adolescents for excess weight. However, lifestyle-based weight management interventions with 26 or more hours of intervention contact generally increased weight reduction with no apparent harms, and some cardiometabolic measures were improved with 52 or more hours of contact. Less-intensive programs are unlikely to improve weight status, except perhaps for children who are overweight but do not yet have obesity. The clinical significance of the small benefits seen with the use of metformin and orlistat is unclear. The degree to which changes in excess weight are maintained in the long term, particularly into adulthood, are unknown.

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Figure 1. Prevalence of Obesity Among Children and Adolescents Aged 2 to 19 Years, United States[10,287,288]

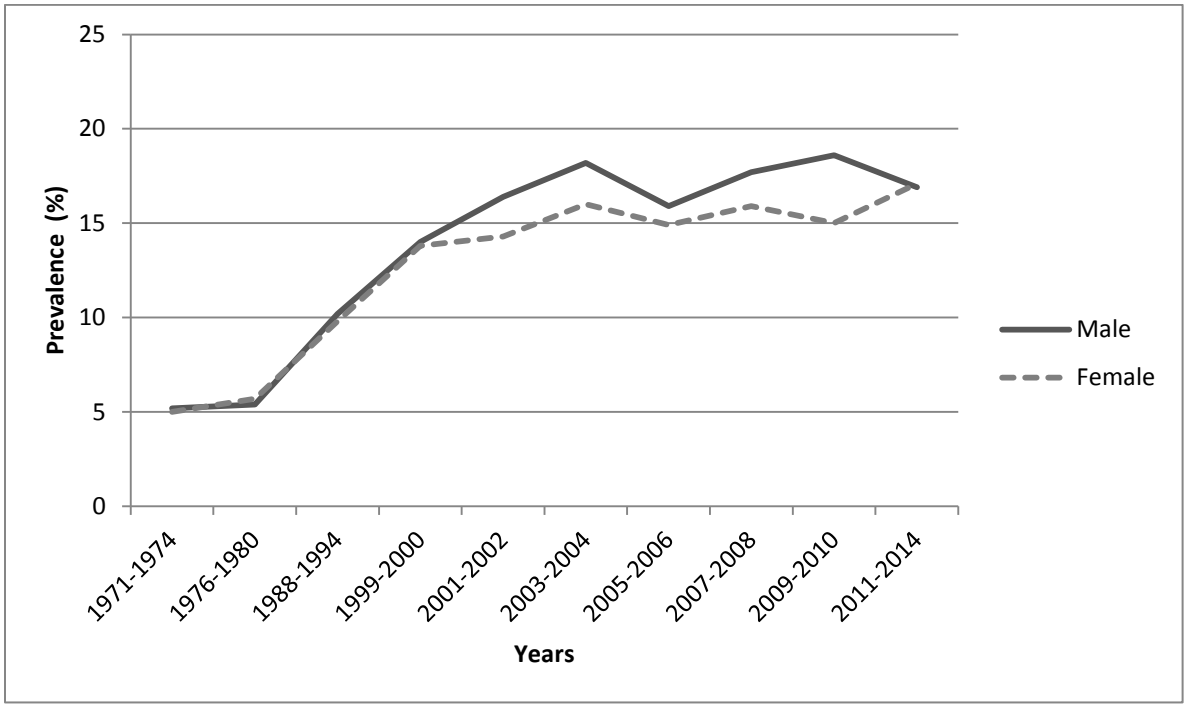


Figure 2. Prevalence of Obesity Among Youth Aged 2 to 19 Years Based on BMI Percentile for Age and Sex, by Sex and Race/Hispanic Origin, United States, 2011–2014[288]

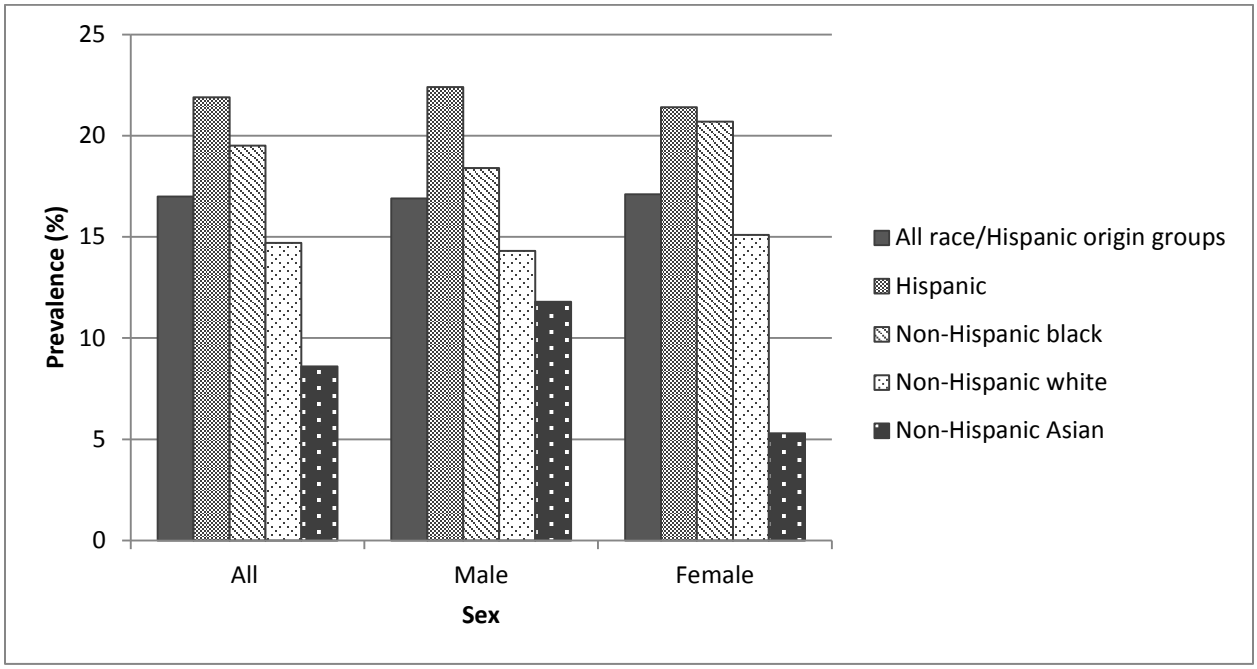
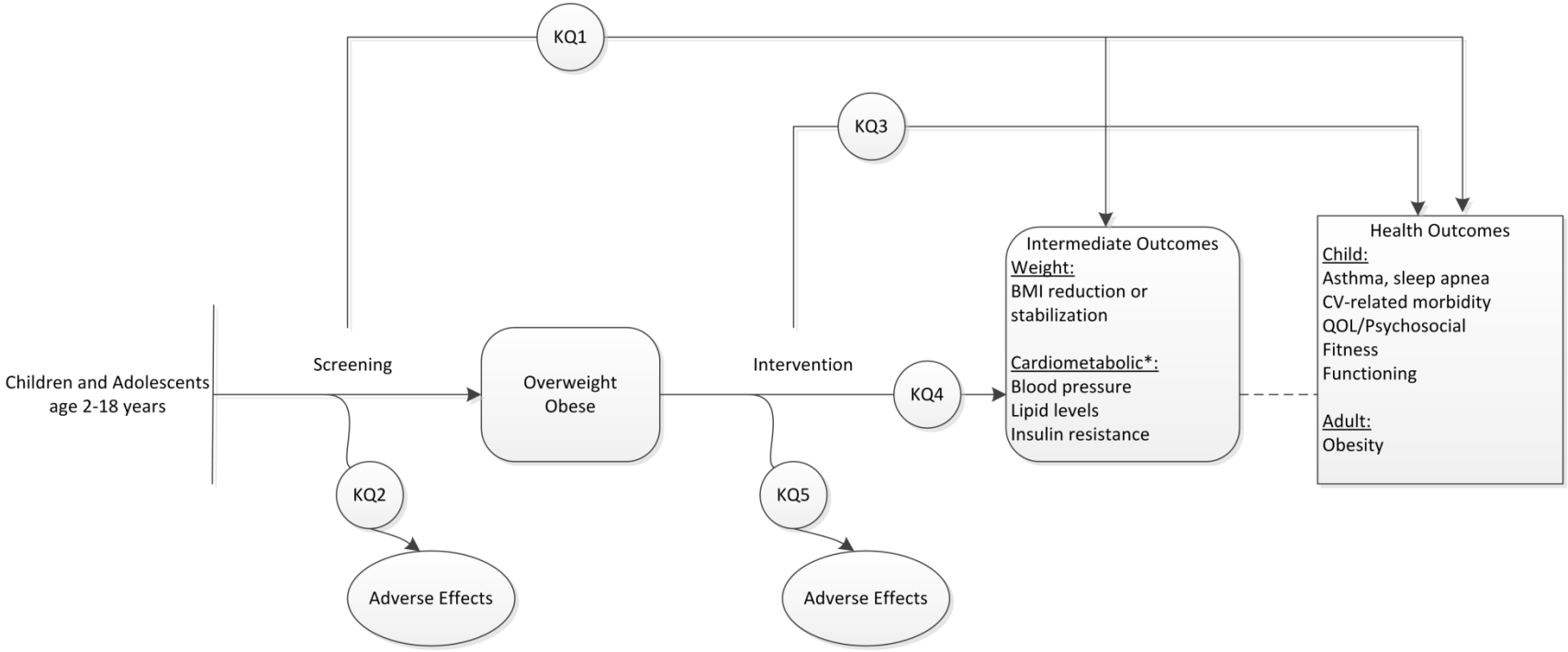


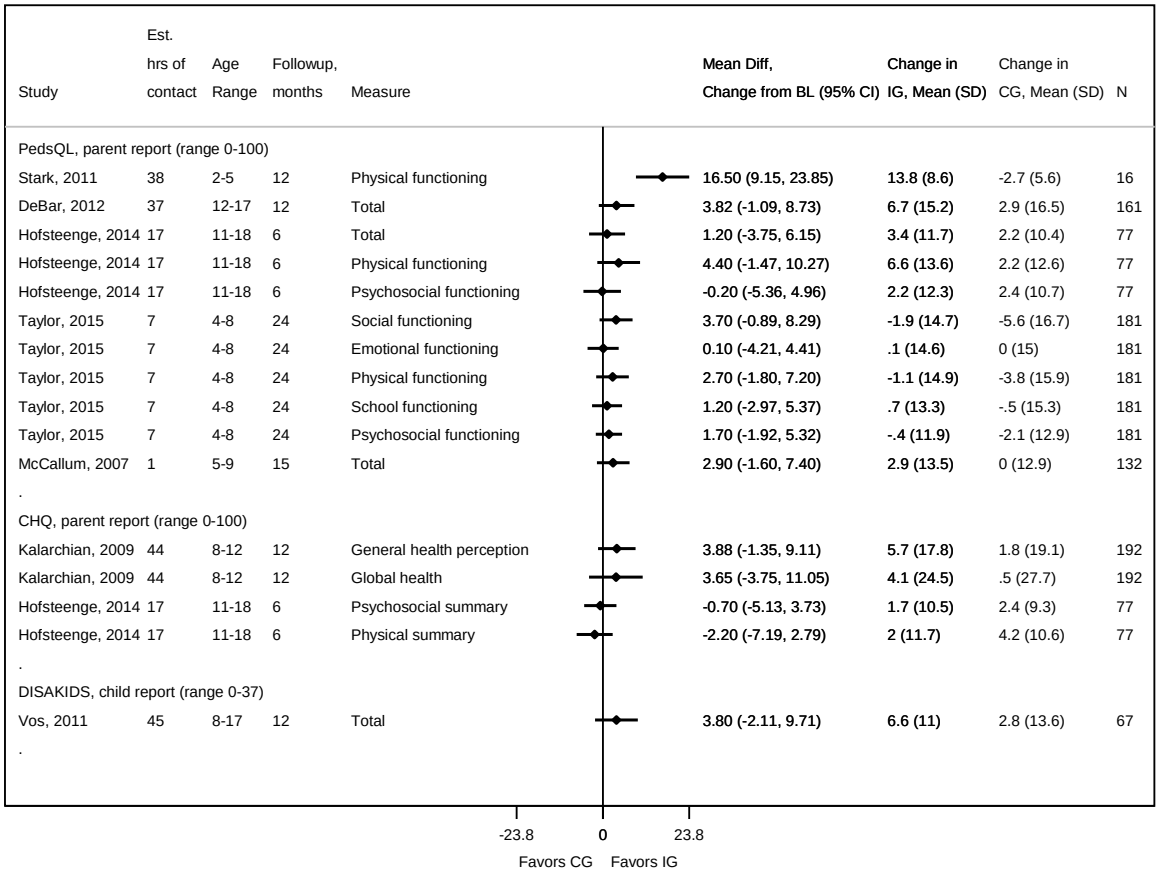
Figure 3. Analytic Framework



*****Blood pressure, lipid levels, and insulin resistance are secondary outcomes when reported with weight.

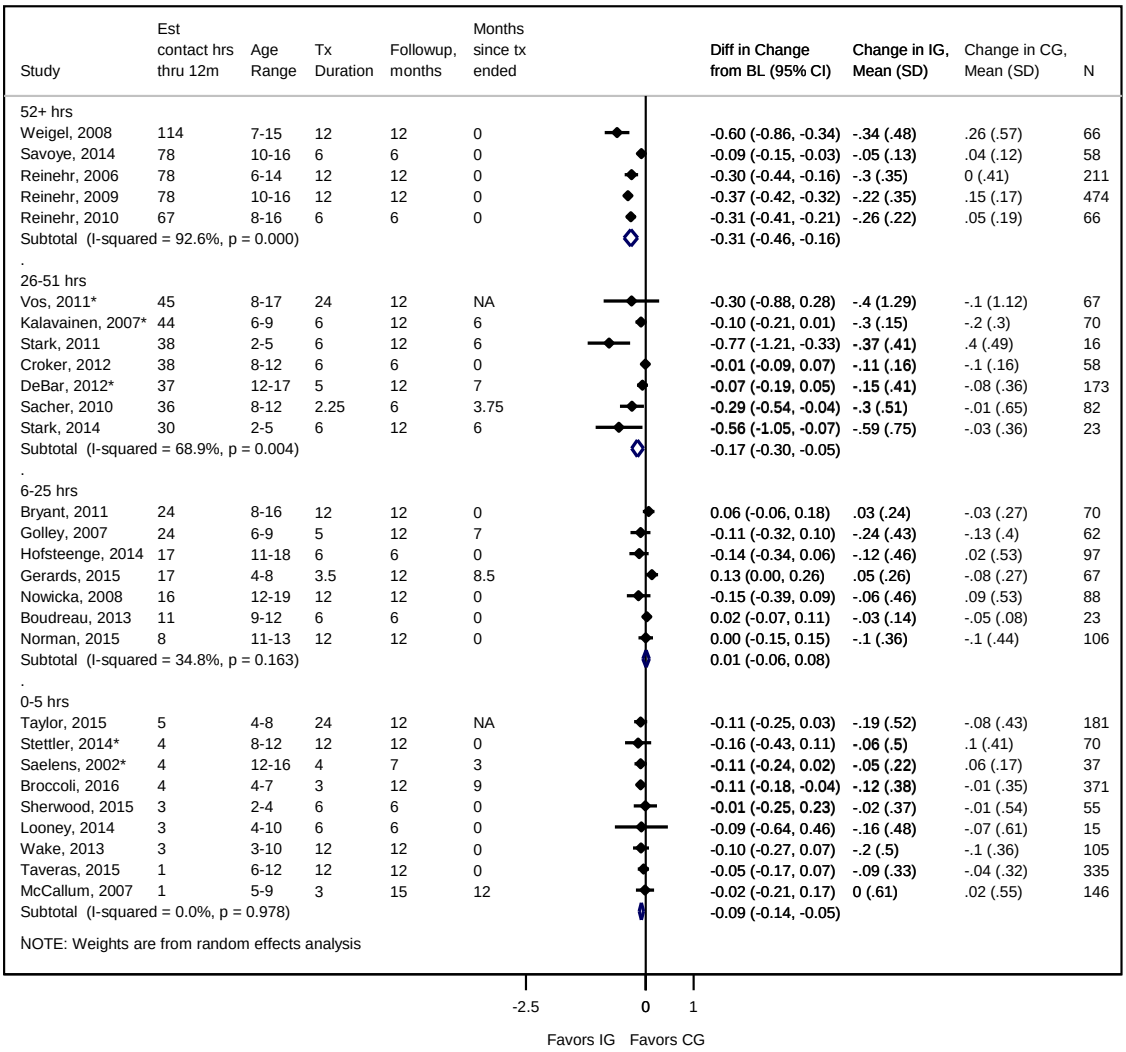
Abbreviations: BMI = body mass index; CV = cardiovascular; KQ = Key Question; QOL = quality of life.

Figure 4. Forest Plot of Change in Quality of Life and Functioning in Behavior-Based Intervention Trials (Key Question 3)



Abbreviations: BL = baseline; CG = control group; CHQ = Child Health Questionnaire; CI = confidence interval; diff = difference; est = estimated; hrs = hours; IG = intervention group; PEDsQL = Pediatric Quality of Life; tx = treatment.

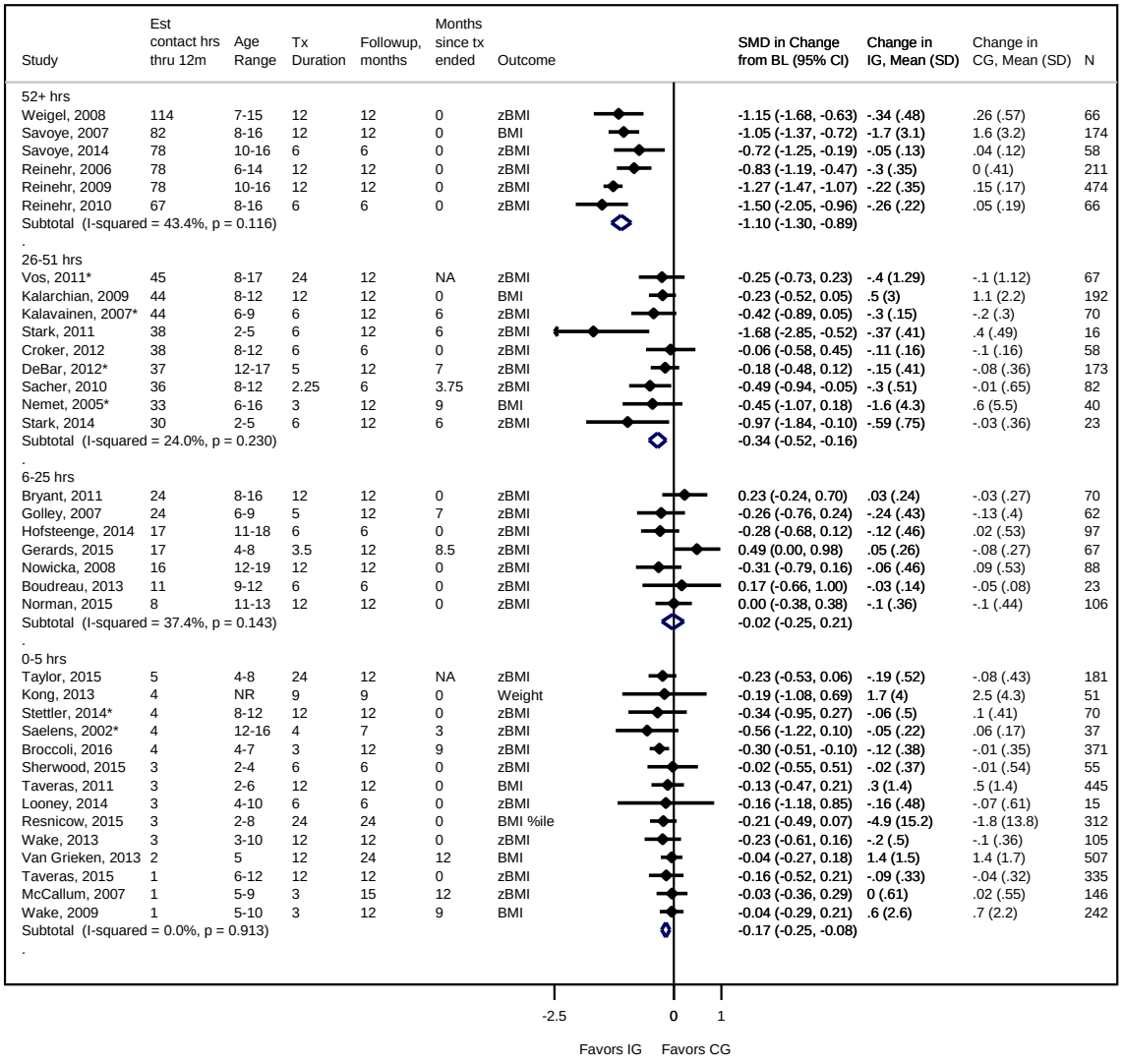
Figure 5. Forest Plot of zBMI in Behavior-Based Weight Loss Intervention Trials (Key Question 4)



*Study-reported repeated measures or adjusted analysis demonstrated a statistically significant benefit.

Abbreviations: BL =baseline; CG = control group; CI = confidence; diff = difference; interval; est = estimated; hrs = hours; IG = intervention group; m = month(s); SD = standard deviation; tx = treatment; zBMI = body mass index z-score.

Figure 6. Forest Plot of Change in Weight (zBMI, BMI, Weight in Kilograms, or BMI Percentile) in Behavior-Based Weight Loss Intervention Trials, by Estimated Hours of Contact, Showing DerSimonian & Laird Pooled Estimates (Key Question 4)

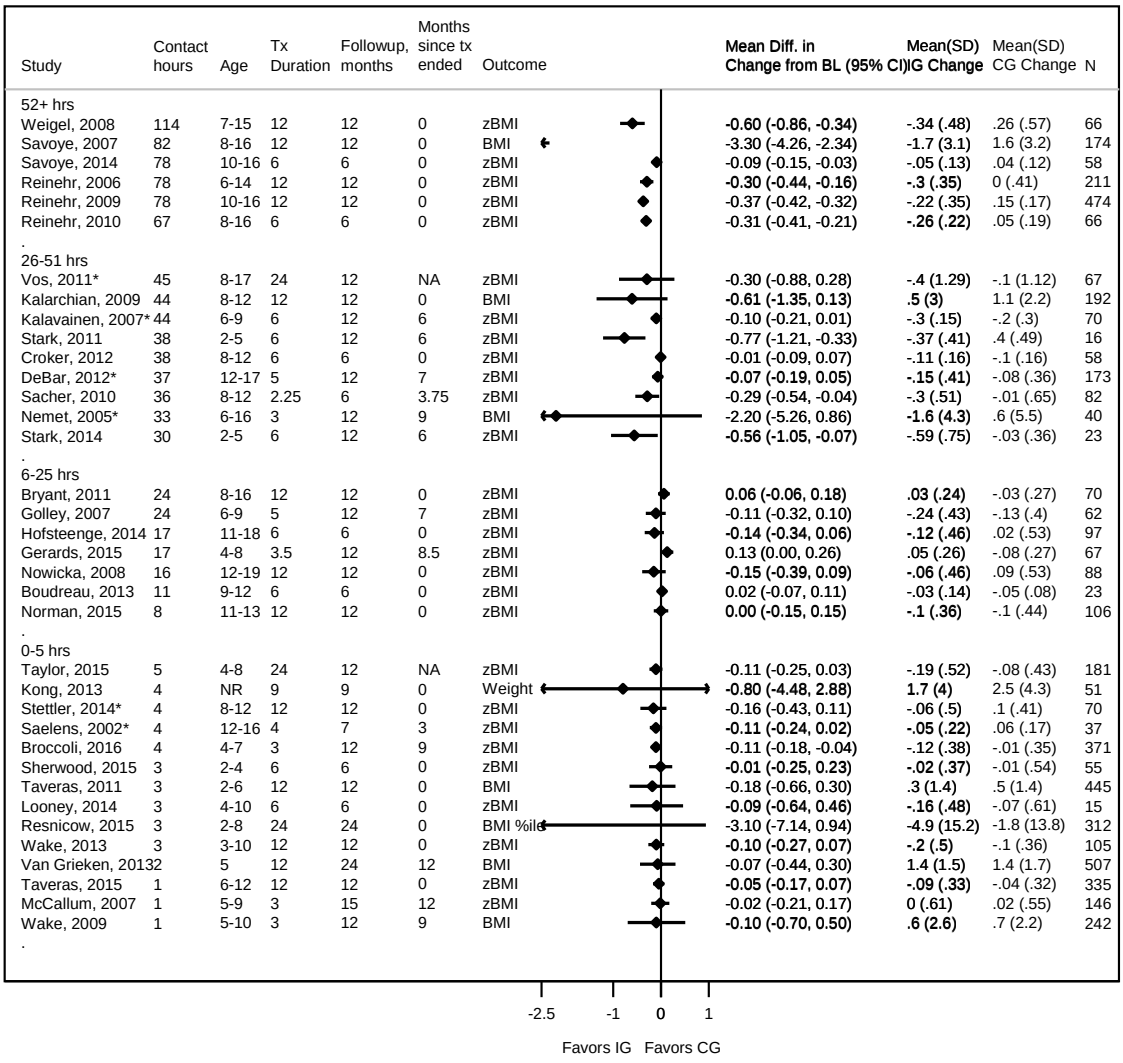


Study	Est contact hrs thru 12m	Age Range	Tx Duration	Followup, months	Months since tx ended	Outcome	SMD in Change from BL (95% CI)	Change in IG, Mean (SD)	Change in CG, Mean (SD)	N
52+ hrs										
Weigel, 2008	114	7-15	12	12	0	zBMI	-1.15 (-1.68, -0.63)	-.34 (.48)	.26 (.57)	66
Savoye, 2007	82	8-16	12	12	0	BMI	-1.05 (-1.37, -0.72)	-1.7 (3.1)	1.6 (3.2)	174
Savoye, 2014	78	10-16	6	6	0	zBMI	-0.72 (-1.25, -0.19)	-.05 (.13)	.04 (.12)	58
Reinehr, 2006	78	6-14	12	12	0	zBMI	-0.83 (-1.19, -0.47)	-.3 (.35)	0 (.41)	211
Reinehr, 2009	78	10-16	12	12	0	zBMI	-1.27 (-1.47, -1.07)	-.22 (.35)	.15 (.17)	474
Reinehr, 2010	67	8-16	6	6	0	zBMI	-1.50 (-2.05, -0.96)	-.26 (.22)	.05 (.19)	66
Subtotal (I-squared = 43.4%, p = 0.116)							-1.10 (-1.30, -0.89)			
.										
26-51 hrs										
Vos, 2011*	45	8-17	24	12	NA	zBMI	-0.25 (-0.73, 0.23)	-.4 (1.29)	-.1 (1.12)	67
Kalarchian, 2009	44	8-12	12	12	0	BMI	-0.23 (-0.52, 0.05)	.5 (3)	1.1 (2.2)	192
Kalavainen, 2007*	44	6-9	6	12	6	zBMI	-0.42 (-0.89, 0.05)	-.3 (.15)	-.2 (.3)	70
Stark, 2011	38	2-5	6	12	6	zBMI	-1.68 (-2.85, -0.52)	-.37 (.41)	.4 (.49)	16
Croker, 2012	38	8-12	6	6	0	zBMI	-0.06 (-0.58, 0.45)	-.11 (.16)	-.1 (.16)	58
DeBar, 2012*	37	12-17	5	12	7	zBMI	-0.18 (-0.48, 0.12)	-.15 (.41)	-.08 (.36)	173
Sacher, 2010	36	8-12	2.25	6	3.75	zBMI	-0.49 (-0.94, -0.05)	-.3 (.51)	-.01 (.65)	82
Nemet, 2005*	33	6-16	3	12	9	BMI	-0.45 (-1.07, 0.18)	-1.6 (4.3)	.6 (5.5)	40
Stark, 2014	30	2-5	6	12	6	zBMI	-0.97 (-1.84, -0.10)	-.59 (.75)	-.03 (.36)	23
Subtotal (I-squared = 24.0%, p = 0.230)							-0.34 (-0.52, -0.16)			
.										
6-25 hrs										
Bryant, 2011	24	8-16	12	12	0	zBMI	0.23 (-0.24, 0.70)	.03 (.24)	-.03 (.27)	70
Golley, 2007	24	6-9	5	12	7	zBMI	-0.26 (-0.76, 0.24)	-.24 (.43)	-.13 (.4)	62
Hofsteenge, 2014	17	11-18	6	6	0	zBMI	-0.28 (-0.68, 0.12)	-.12 (.46)	.02 (.53)	97
Gerards, 2015	17	4-8	3.5	12	8.5	zBMI	0.49 (0.00, 0.98)	.05 (.26)	-.08 (.27)	67
Nowicka, 2008	16	12-19	12	12	0	zBMI	-0.31 (-0.79, 0.16)	-.06 (.46)	.09 (.53)	88
Boudreau, 2013	11	9-12	6	6	0	zBMI	0.17 (-0.66, 1.00)	-.03 (.14)	-.05 (.08)	23
Norman, 2015	8	11-13	12	12	0	zBMI	0.00 (-0.38, 0.38)	-.1 (.36)	-.1 (.44)	106
Subtotal (I-squared = 37.4%, p = 0.143)							-0.02 (-0.25, 0.21)			
.										
0-5 hrs										
Taylor, 2015	5	4-8	24	12	NA	zBMI	-0.23 (-0.53, 0.06)	-.19 (.52)	-.08 (.43)	181
Kong, 2013	4	NR	9	9	0	Weight	-0.19 (-1.08, 0.69)	1.7 (4)	2.5 (4.3)	51
Stettler, 2014*	4	8-12	12	12	0	zBMI	-0.34 (-0.95, 0.27)	-.06 (.5)	.1 (.41)	70
Saelens, 2002*	4	12-16	4	7	3	zBMI	-0.56 (-1.22, 0.10)	-.05 (.22)	.06 (.17)	37
Broccoli, 2016	4	4-7	3	12	9	zBMI	-0.30 (-0.51, -0.10)	-.12 (.38)	-.01 (.35)	371
Sherwood, 2015	3	2-4	6	6	0	zBMI	-0.02 (-0.55, 0.51)	-.02 (.37)	-.01 (.54)	55
Taveras, 2011	3	2-6	12	12	0	BMI	-0.13 (-0.47, 0.21)	.3 (1.4)	.5 (1.4)	445
Looney, 2014	3	4-10	6	6	0	zBMI	-0.16 (-1.18, 0.85)	-.16 (.48)	-.07 (.61)	15
Resnicow, 2015	3	2-8	24	24	0	BMI %ile	-0.21 (-0.49, 0.07)	-4.9 (15.2)	-1.8 (13.8)	312
Wake, 2013	3	3-10	12	12	0	zBMI	-0.23 (-0.61, 0.16)	-.2 (.5)	-.1 (.36)	105
Van Grieken, 2013	2	5	12	24	12	BMI	-0.04 (-0.27, 0.18)	1.4 (1.5)	1.4 (1.7)	507
Taveras, 2015	1	6-12	12	12	0	zBMI	-0.16 (-0.52, 0.21)	-.09 (.33)	-.04 (.32)	335
McCallum, 2007	1	5-9	3	15	12	zBMI	-0.03 (-0.36, 0.29)	0 (.61)	.02 (.55)	146
Wake, 2009	1	5-10	3	12	9	BMI	-0.04 (-0.29, 0.21)	.6 (2.6)	.7 (2.2)	242
Subtotal (I-squared = 0.0%, p = 0.913)							-0.17 (-0.25, -0.08)			
.										

*Study-reported repeated measures or adjusted analysis demonstrated a statistically significant benefit.

Abbreviations: BL =baseline; BMI = body mass index; CG = control group; CI = confidence interval; est = estimated; hrs = hours; IG = intervention group; m = month(s); SD = standard deviation; SMD = standardized mean difference; tx = treatment; zBMI = body mass index z-score.

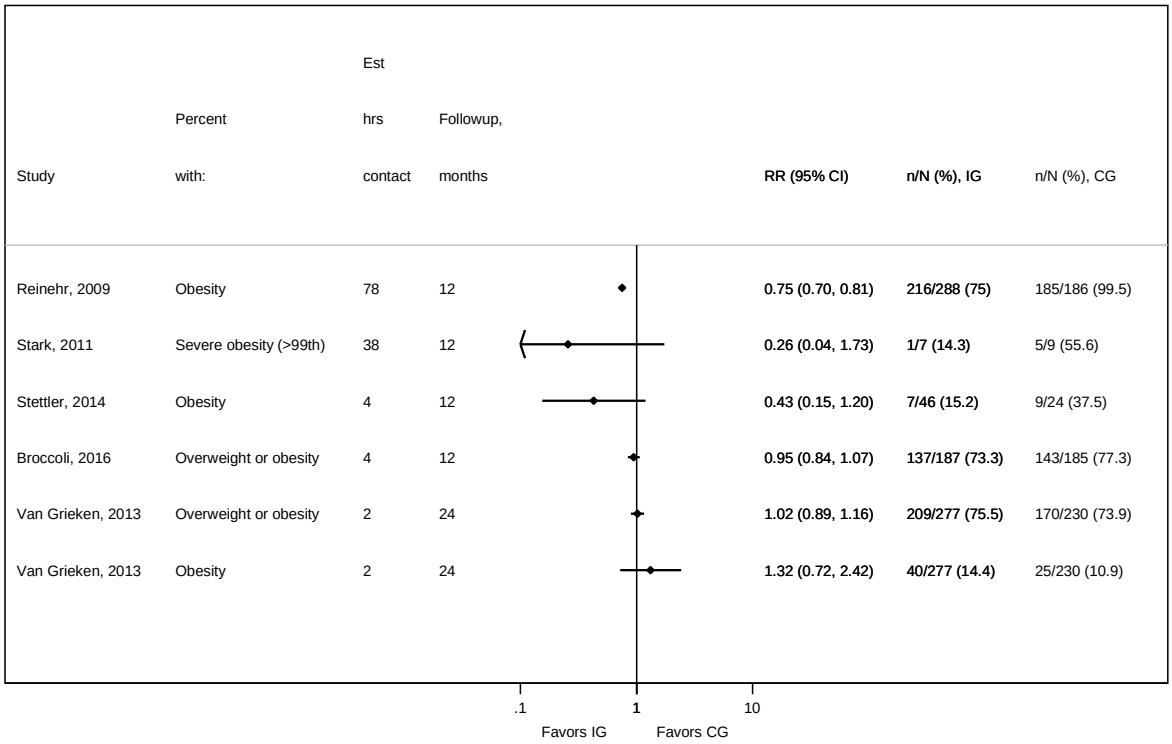
Figure 7. Forest Plot of Change in Weight (zBMI, BMI, Weight in Kilograms, or BMI Percentile) in Behavior-Based Weight Loss Intervention Trials, Showing Native Units, Without Pooling (Key Question 4)



*Study-reported repeated measures or adjusted analysis demonstrated a statistically significant benefit.

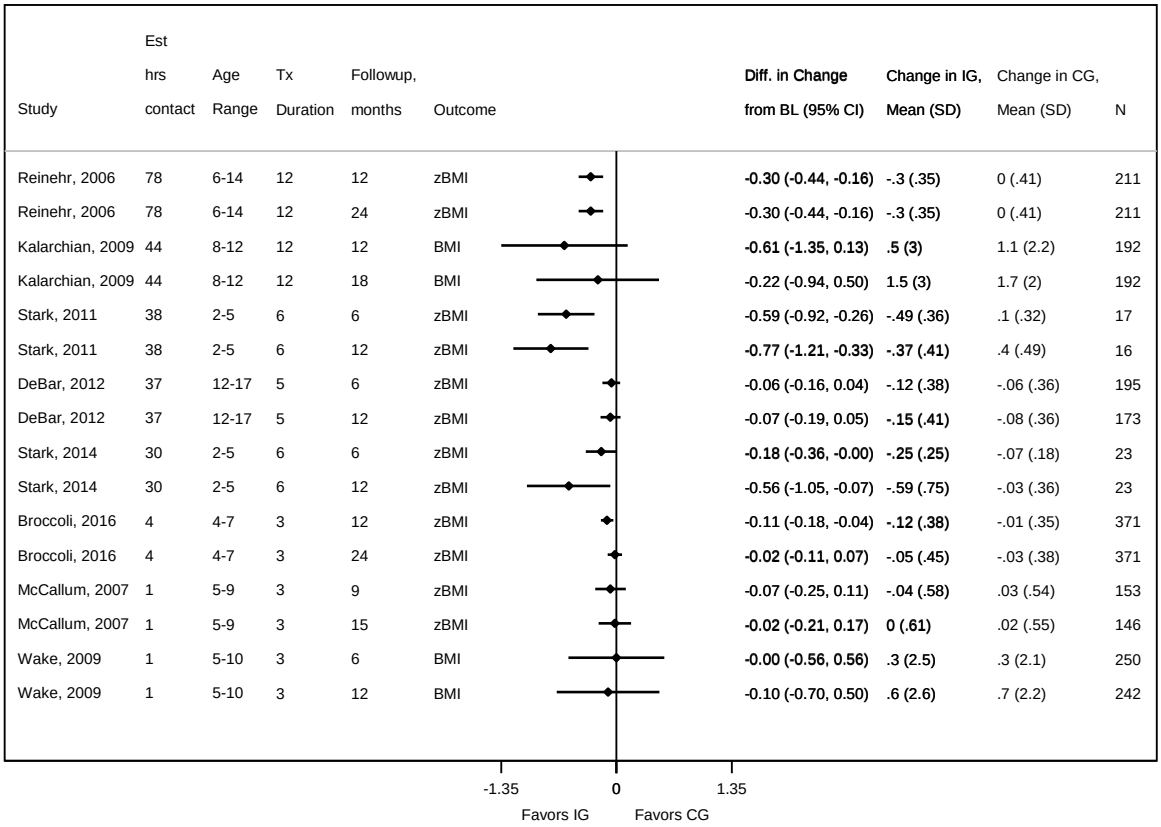
Abbreviations: BL =baseline; BMI = body mass index; CG = control group; CI = confidence interval; est = estimated; hrs = hours; IG = intervention group; m = month(s); SD = standard deviation; SMD = standardized mean difference; tx = treatment; zBMI = body mass index z-score.

Figure 8. Forest Plot of Dichotomous Weight Status Outcomes of Behavior-Based Weight Loss Intervention Trials (Key Question 4)



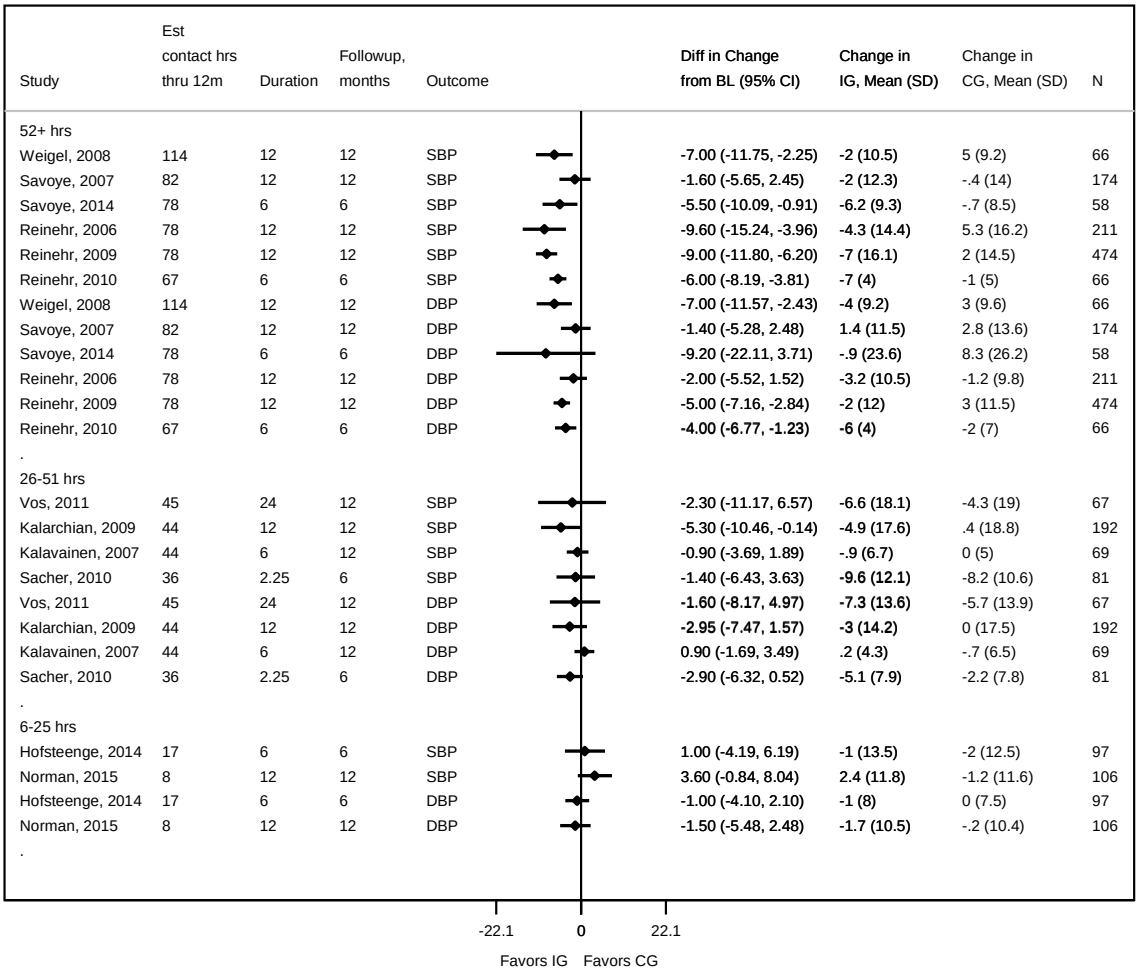
Abbreviations: CG = control group; CI = confidence interval; est = estimated; hrs = hours; IG = intervention group; RR = relative risk.

Figure 9. Forest Plot of Change in Weight (zBMI, BMI, Weight in Kilograms, or BMI Percentile) in Behavior-Based Weight Loss Intervention Trials With Multiple Post-Treatment Followups, by Estimated Hours of Contact, Showing DerSimonian & Laird Pooled Estimates (Key Question 4)



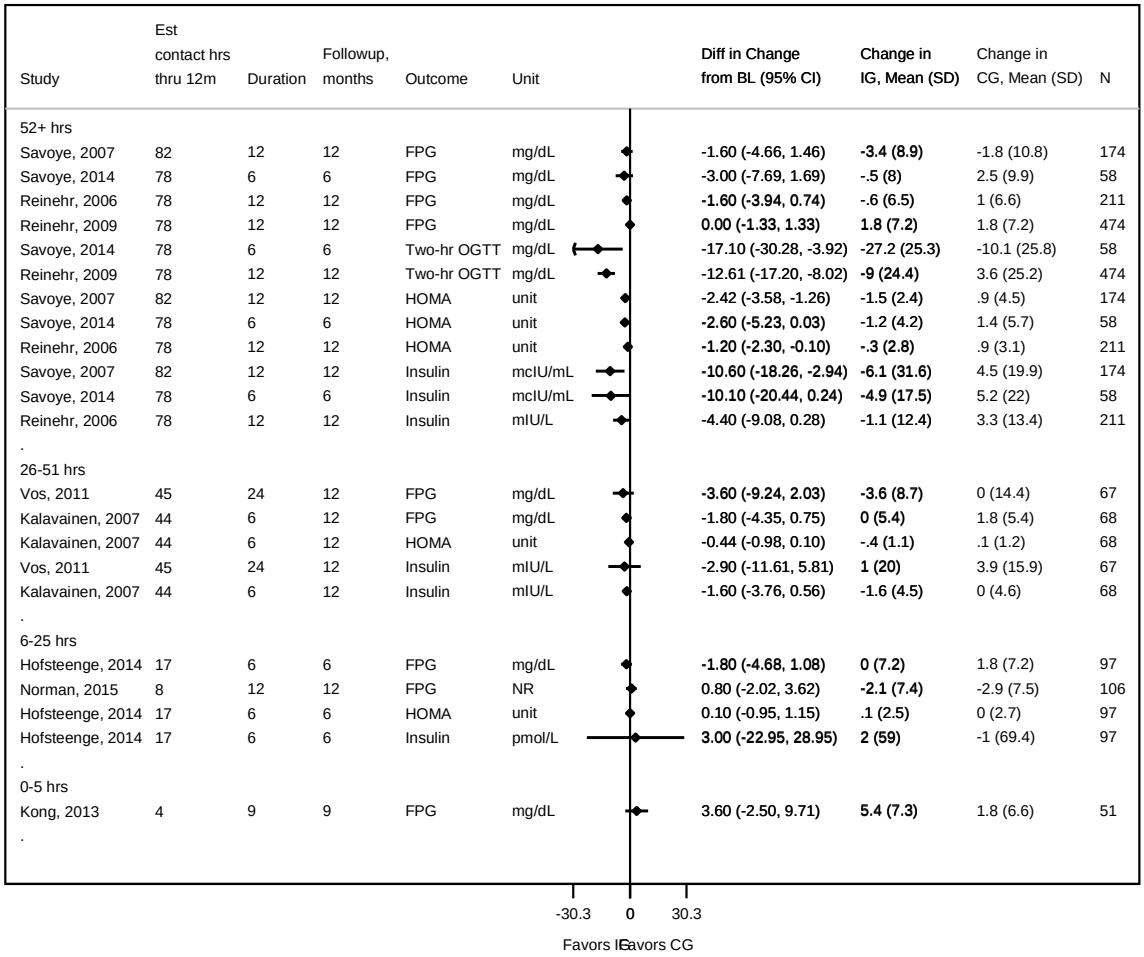
Abbreviations: BL =baseline; CG = control group; CI = confidence; diff = difference; interval; est = estimated; hrs = hours; IG = intervention group; m = month(s); SD = standard deviation; tx = treatment; zBMI = body mass index z-score.

Figure 10. Forest Plot of Blood Pressure in Behavior-Based Weight Loss Intervention Trials (Key Question 4)



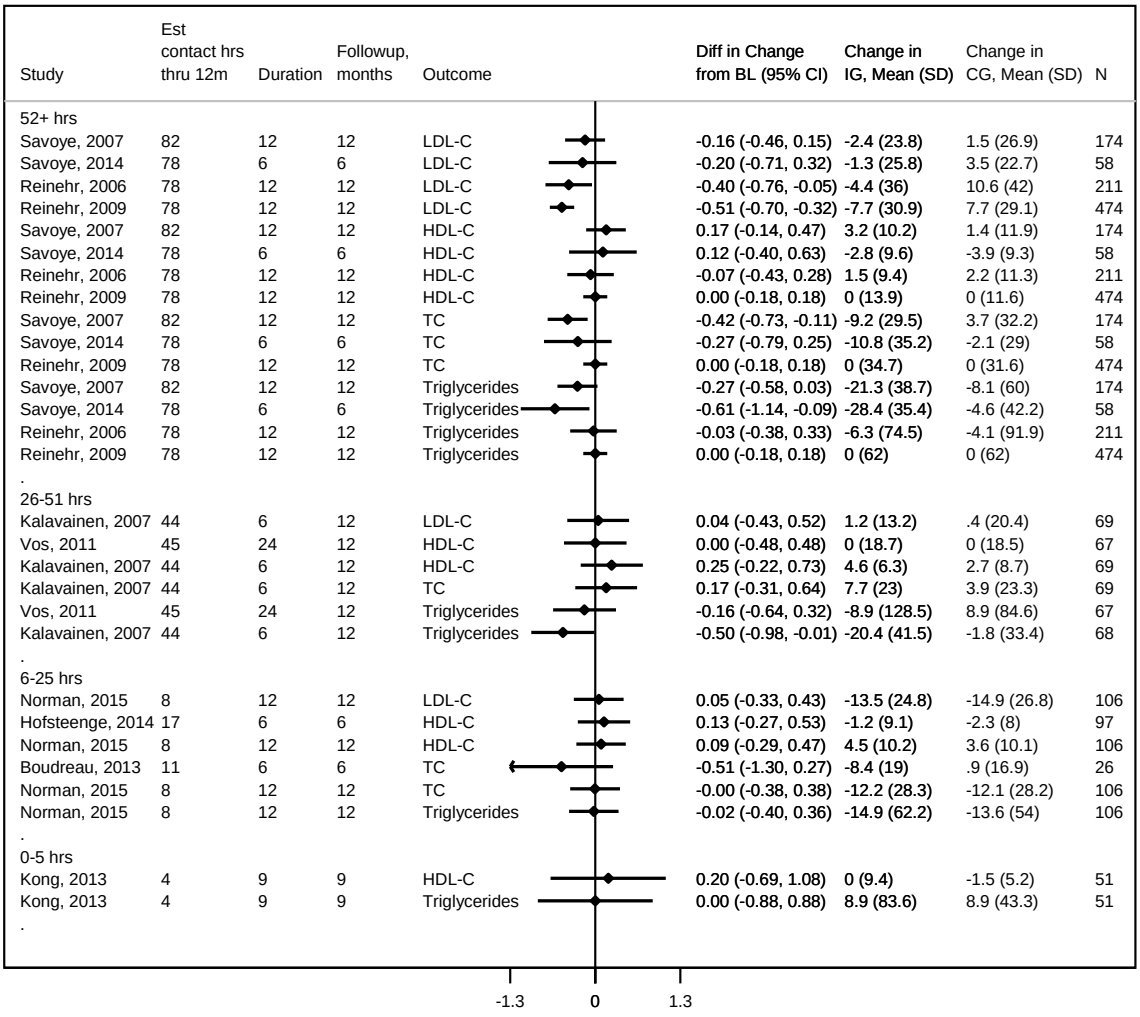
Abbreviations: BL =baseline; CG = control group; CI = confidence interval; DBP = diastolic blood pressure; est = estimated; hrs = hours; IG = intervention group; m = month(s); SBP = systolic blood pressure; tx = treatment; WMD = weighted mean difference.

Figure 11. Forest Plot of Glucose Outcomes in Behavior-Based Weight Loss Intervention Trials (Key Question 4)



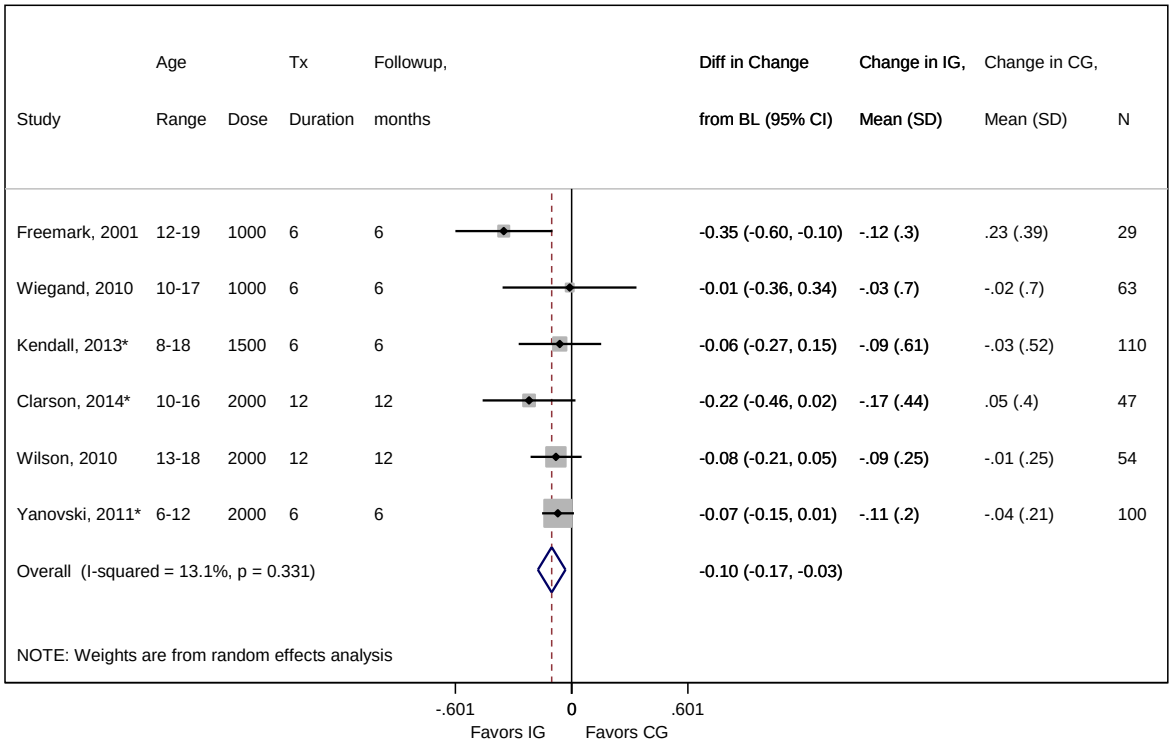
Abbreviations: BL =baseline; CG = control group; CI = confidence interval; dL = deciliter(s); est = estimated; FPG = fasting plasma glucose; HOMA = homeostatic model assessment; hrs = hours; IG = intervention group; IU = international unit(s); m = month(s); mc = micro; mg = milligrams(s); mL = milliter(s); OGTT = oral glucose tolerance test; pmol = picomole(s); SD = standard deviation; tx = treatment; WMD = weighted mean difference.

Figure 12. Forest Plot of Lipids in Behavior-Based Weight Loss Intervention Trials (Key Question 4)



Abbreviations: BL = baseline; CG = control group; CI = confidence interval; DBP = diastolic blood pressure; est = estimated; HDL-C = high-density lipoprotein cholesterol; hrs = hours; IG = intervention group; LDL-C = low-density lipoprotein cholesterol; m = month(s); SBP = systolic blood pressure; TC = total cholesterol; tx = treatment.

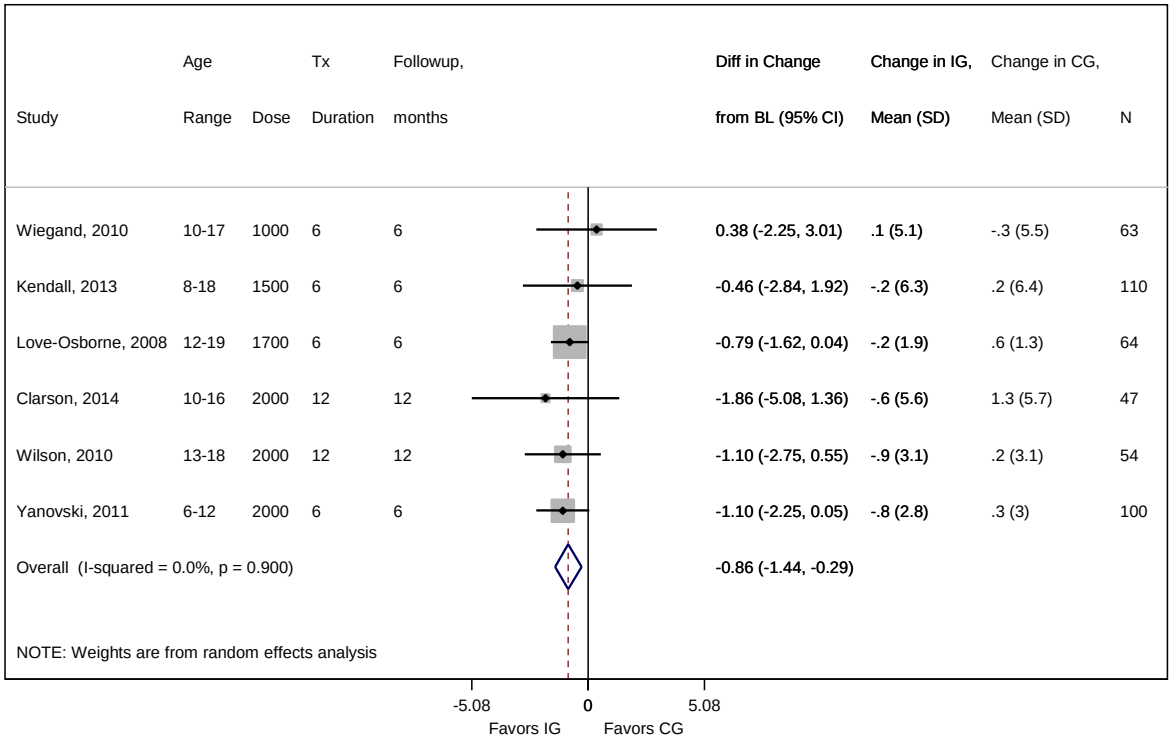
Figure 13. Forest Plot of Change in zBMI in Metformin Trials (Key Question 4)



*Study-reported repeated measures or adjusted analysis demonstrated a statistically significant benefit.
Note: dose in milligrams per day.

Abbreviations: BL = baseline; CG = control group; CI = confidence interval; IG = intervention group; SD = standard deviation; WMD =weighted mean difference; Tx – treatment.

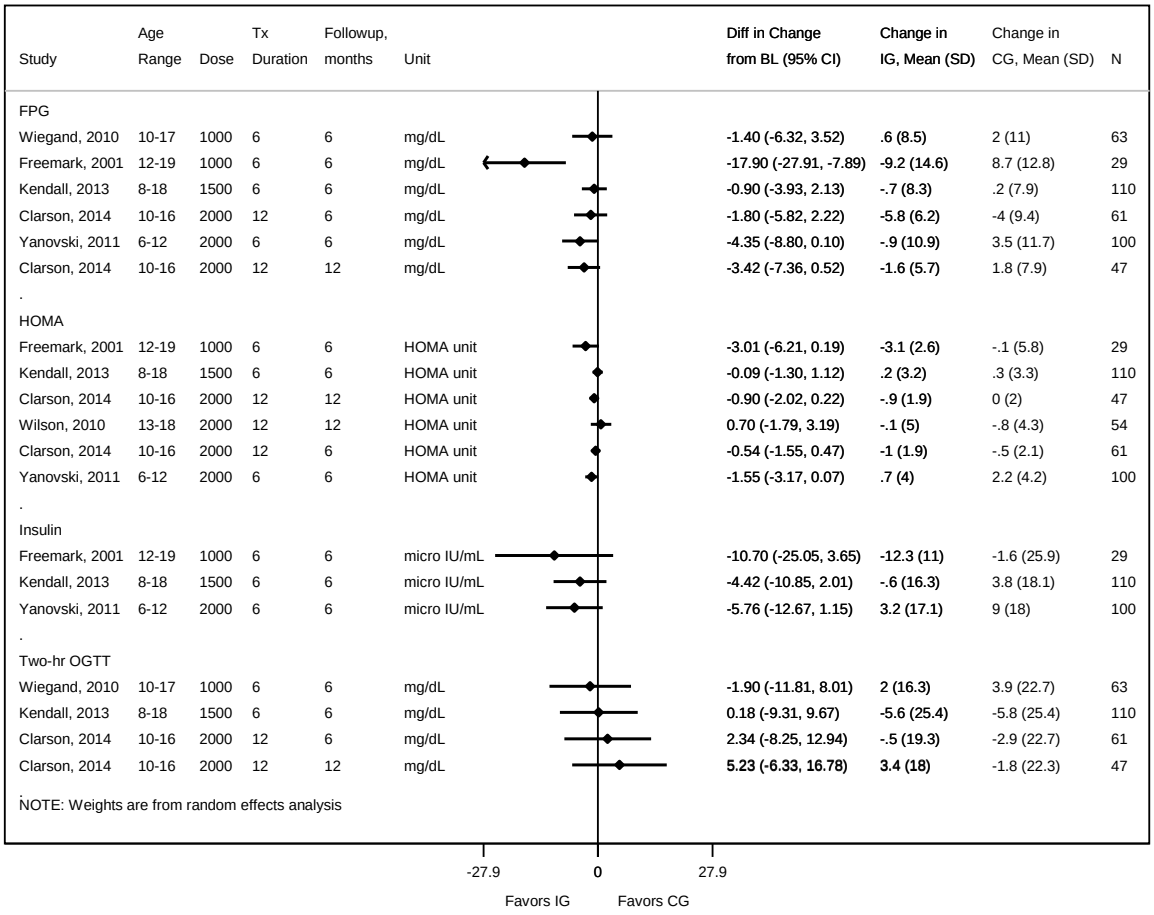
Figure 14. Forest Plot of Change in BMI in Metformin Trials (Key Question 4)



*Study-reported repeated measures or adjusted analysis demonstrated a statistically significant benefit.
Note: dose in milligrams per day.

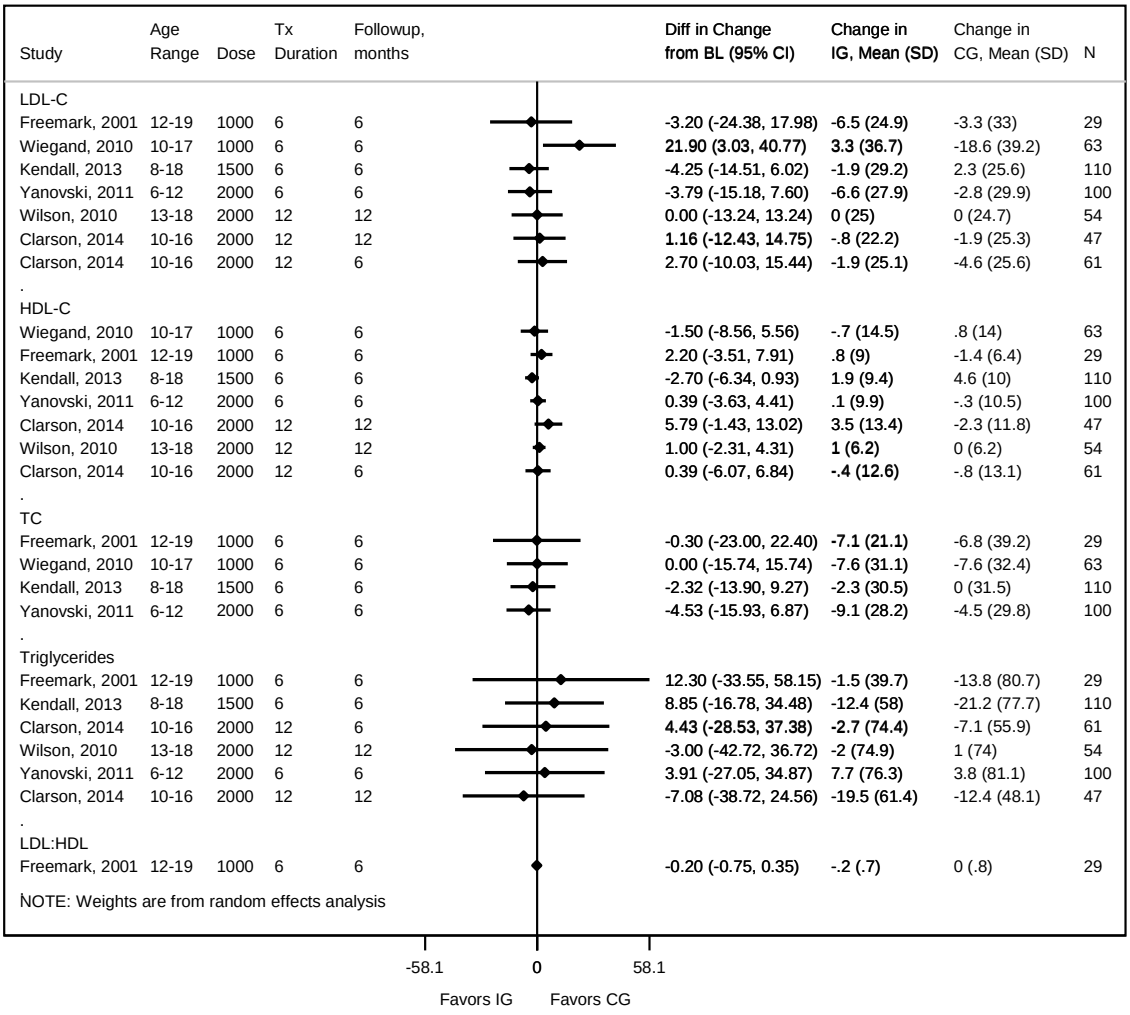
Abbreviations: BL = baseline; CG = control group; CI = confidence interval; IG = intervention group; SD = standard deviation; WMD =weighted mean difference; Tx = treatment.

Figure 15. Forest Plot of Change in Insulin and Glucose Outcomes in Metformin Trials (Key Question 4)



Abbreviations: BL = baseline; CI = confidence interval; dL = deciliter(s); FPG = Fasting plasma glucose; HOMA = Homeostasis Model Assessment; hr = hour; IU = international unit; mg = milligram(s); ml = milliliter; OGTT = oral glucose tolerance test; SD = standard deviation; SMD =standardized mean difference.

Figure 16. Forest Plot of Change in Lipid Outcomes (mg/dL*) in Metformin Trials (Key Question 4)



*Except for LDL:HDL, which is a ratio.

Abbreviations: BL = baseline; CG = control group; CI = confidence interval; HDL = high density lipoprotein cholesterol; IG = intervention group; LDL-C = low density lipoprotein cholesterol; SD = standard deviation; TC = total cholesterol.

Table 1. Illustrative Weight 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; lb = pound(s); zBMI = body mass index z-score; y = year(s).

Table 2. Proportion of Adults Who Have Obesity, Among Persons With or Without Overweight or Obesity in Childhood or Adolescence in Three British Cohorts[15]

Overweight or had Obesity in Childhood (Age 7 Years)	Overweight or had Obesity in Adolescence (Age 15-16 Years)	Proportion with Obesity in Adulthood (Age 34-43 Years)
Yes	Yes	62.3%
Yes	No	25.8%
No	Yes	49.4%
No	No	11.8%

Table 3. Expert Committee Stages of Obesity Treatment

Stage	Brief Description
Stage 1: Prevention Plus	Prevention counseling message, but with weight management goal Include motivational interviewing techniques Primary care office setting Counseling provided by physician, advanced practice nurse, physician assistant, or office nurses, with appropriate training Family and provider work together to identify appropriate behavioral target. Followup frequency tailored to individual family Increase to Stage 2 if lack appropriate improvement after 3-6 months
Stage 2: Structured Weight Management	More support and structure provided than Stage 1, with specific eating and activity goals, monitoring, and planned reinforcement Office staff with training in motivational interviewing, monitoring, and reinforcement techniques establish goals, see families for followup care, and may provide group sessions Counseling by dietitian or clinician with training in creating eating plan Other specialty providers involved as needed (e.g., family therapist, physical/exercise therapist) Usually monthly followup Increase to Stage 3 if have not met goals after 3-6 months
Stage 3: Comprehensive Multidisciplinary Intervention	Structured program with behavior modification (at least food monitoring, goal-setting, contingency management) Multidisciplinary team with expertise in childhood obesity, including behavior specialist, registered dietitian, exercise specialist, primary care provider Usually weekly visits for 8-12 weeks, then monthly Generally not possible in primary care setting Only increase to Stage 4 after considering patient's maturity and ability to understand risks, willingness to maintain physical activity and appropriate diet and behavioral monitoring
Stage 4: Tertiary Care Intervention	For youth with severe obesity Include medications, very low-calorie diet, or weight control surgery Should occur in pediatric weight management centers Multidisciplinary team with standard clinical assessment protocols

Table 4. Childhood Obesity Screening and Intervention Recommendations and Guidelines by Major Health Organizations

Organization Date	Recommendation
Canadian Task Force on Preventive Health[286] 2015	Growth monitoring: For all children and youth aged 17 years and younger who present to primary care, recommend growth monitoring (measurement of height or length, weight, and BMI calculation or weight-for-length according to age) is recommended at all appropriate primary care visits using the 2014 WHO Growth Charts for Canada. (Strong recommendation; very low-quality evidence) Prevention of overweight and obesity in healthy-weight children: For all children and youth aged 17 years and younger who have a healthy weight (i.e., who maintain a healthy BMI trajectory according to the WHO Growth Charts for Canada), it does not apply to children and youth with eating disorders, or who are underweight, overweight or obese, recommend that primary care practitioners not routinely offer structured interventions aimed at preventing overweight and obesity in healthy-weight children and youth aged 17 years and younger. (Weak recommendation; very low-quality evidence) Management of overweight and obesity: • For children and youth 2 to 17 years of age who are overweight or obese, children and youth with health conditions for which weight management is inappropriate are excluded; recommend that primary care practitioners offer or refer to structured behavioural interventions aimed at healthy weight management. Structured behavioral interventions are intensive behavioural modification programs that involve several sessions that take place over weeks to months, follow a comprehensive approach delivered by a specialized interdisciplinary team, involve group sessions, and incorporate family and parent involvement. Interventions examined included behaviourally based prevention interventions focused on diet, increasing exercise, making lifestyle changes or any combination of these. These can be delivered by a primary care team in the office or through a referral to a formal program within or outside of primary care, such as hospital-based, school-based or community programs. (Weak recommendation; moderate quality evidence) • Recommend that primary care practitioners not offer orlistat aimed at healthy weight management for children aged 2 to 11 years. (Strong recommendation; very low-quality evidence) • Recommend that primary care practitioners not routinely offer orlistat aimed at healthy weight management for youth aged 12 to 17 years. (Weak recommendation; moderate-quality evidence) • Recommend that primary care practitioners not routinely refer for surgical interventions. (Strong recommendation; very low-quality evidence)
National Association of Pediatric Nurse Practitioners (NAPNAP)[289] 2015	Identification of childhood overweight/obesity through accurate measurement and documentation of height and weight parameters including height/weight ratio in children younger than 2 years and height and weight parameters and BMI in children 2 years and older and blood pressure beginning at age 3. Pediatric health care providers should obtain a comprehensive health and medical history, including family history and risk for comorbid conditions, family eating and physical activity patterns, home and neighborhood environments, and community resources. Interventions should be culturally sensitive, family-centered interventions that focus on health and lifestyle modifications, not weight, when working with children who are overweight and obese. Patient-centered practices, such as motivational interviewing, should be used when partnering with children and families to identify goals for lifestyle and health behavior changes that are targeted, realistic, and attainable. Pediatric health care providers should incorporate clinical practicum experiences related to prevention of pediatric overweight and obesity in educational programs for pediatric health care providers who care for children and families. They should recognize and utilize current, evidence-based, and evolving platforms such as social media and mobile technology to identify, prevent, and manage childhood overweight and obesity.
American Association of Family Physicians (AAFP)[290] 2010	[Endorsement of USPSTF Recommendation] Clinicians should screen children aged 6 years and older for obesity and offer or refer them to comprehensive, intensive behavioral interventions to promote improvement in weight status. (Grade: B recommendation)

Table 4. Childhood Obesity Screening and Intervention Recommendations and Guidelines by Major Health Organizations

Organization Date	Recommendation
Institute for Clinical Systems Improvement (ICSI)[291] 2013	BMI should be calculated and documented in the medical record of all children ages 2-8 at least annually and CDC growth charts should be used for children ages 2-18. Assessment of diet, physical activity, and sedentary behaviors should be done annually and used to target appropriate messages to each family.
Community Preventive Services Task Force[292] 2013	The Community Guide has issued a series of recommendations related to provider-level interventions for obesity prevention and control. Specifically, they found insufficient evidence 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 • Multicomponent provider-oriented strategies • Combination of multicomponent provider-oriented interventions
National Heart, Lung and Blood Institute (NHLBI) Expert Panel[79] 2011	Panel recommended identifying children and adolescents aged 2-21 years at high risk for obesity (based on parental obesity, excessive gain in BMI, and change in physical activity) (Grade B). The guidelines concluded that "there is good evidence for the effectiveness of combined weight loss programs that included behavior change counseling, negative energy balance through diet, and increased physical activity in addressing obesity in children older than age 6 years with a BMI at or greater than 95th percentile and no comorbidities (Grade A). However, such programs have primarily been shown to be effective in a comprehensive weight loss program or research settings, with only a small number shown to be effective in primary care settings."
Institute of Medicine (IOM)[293] 2011	Recommended that health care providers measure weight and length or height in a standardized way, plotted on WHO growth charts (ages 0-23 months) or CDC growth charts (ages 24-59 months), as part of every well-child visit. They also recommend that health care professionals consider children's attained weight-for-length or BMI ≥ 85th percentile, rate of weight gain, and parental weight status as risk factors in assessing which young children are at highest risk of later obesity and its adverse consequences.
The Expert Committee[1] 2007 (convened by American Medical Association, Health Resources and Services Administration, and Centers for Disease Control and Prevention, endorsed by the American Academy of Pediatricians)	Primary care providers should universally assess children for obesity risk to improve early identification of elevated BMI, medical risks, and unhealthy eating and physical activity habits. Providers can provide obesity prevention messages for most children and suggest weight control interventions for those with excess weight. The writing groups also recommend changing office systems so that they support efforts to address the problem. BMI should be calculated and plotted at least annually, and the classification should be integrated with other information such as growth pattern, familial obesity, and medical risks to assess the child's obesity risk.

Abbreviations: BMI = body mass index; CDC = Centers for Disease Control and Prevention; USPSTF = U.S. Preventive Services Task Force; WHO = World Health Organization.

Table 5. Population-Based Guidelines and Policies for Childhood Obesity Prevention, Screening, and Treatment

Organization	Recommendation
Medicaid[294]	Diagnostic and Treatment (Early Pediatric Screening, Diagnostic and Treatment) benefit covers all medically necessary obesity-related services, including screening.
Affordable Care Act[295]	The Affordable Care Act requires health plans to cover childhood obesity screening and counseling
Community Preventive Services Task Force[292]	The Community Guide found insufficient evidence to recommend school-based obesity prevention and control programs and mass media campaigns to reduce screen time or change weight-related behaviors and outcomes.
Center for Disease Control and Prevention[296]	Recommends 26 community strategies to prevent obesity in the United States, many of which directly affect children and adolescents. Recommendations include strategies to: promote availability of affordable healthy food and beverages, promote healthy food and beverage choices, encourage breastfeeding, encourage physical activity among children and youth, create safe communities that support physical activity, and encourage communities to organize for change.

Table 6. Summary of Treatment Studies, Grouped by Intervention Type, Sorted by Descending Estimated Intervention Contact Hours (Key Questions 3–5)

Author, Year and Quality	Design	Setting	N Rand	Months F/U (% F/U 12 Months or Closest)	Population	Intervention	Est Hours Contact (Sessions)	Control	Key Question 1	2	3	4	5
Lifestyle-based weight loss interventions (includes minimizing weight gain with growth in height)													
Lison, 2012[131] Fair	RCT	Spain Health Care	110	6 (76.4)	6 to 16 year old Caucasians who are overweight or have obesity (≥85th percentile but zBMI ≤2.5 for age and sex [IOTF])	Hospital-based group exercise	122 (122)	Lifestyle instruction during regular visits				X	
Weigel, 2008[164] Fair	RCT	Germany Other	73	6; 12 (90.4)	7 to 15 year olds with obesity (>97th percentile [German norms])	Sea Lion Club	114.1 (104)	Brief advice				X	
Savoye, 2007[150, 194, 195] Fair	RCT	United States Health Care	209	6; 12 (68.4)	8 to 16 year olds with obesity (BMI > 95th percentile [CDC])	Bright Bodies	82.33 (64)	Semi-annual individual counseling				X	
Savoye, 2014[149, 193] Fair	RCT	United States Health Care	75	6 (77.3)	10 to 16 year olds with obesity (BMI > 95th percentile [CDC])	Bright Bodies	78 (52)	General advice + brief psychosocial counseling				X	
Reinehr, 2006[143, 189] Fair	CCT	Germany Health Care	240	12; 24 (87.9)	6 to 14 year olds with obesity (BMI ≥ 97th percentile [German norms])	Obeldicks	77.5 (52)	Distance control				X	
Reinehr, 2009[144] Fair	CCT	Germany Health Care	474	12 (100)	10 to 16 year olds with obesity (minimum BMI NR [German norms])	Obeldicks	77.5 (52)	Distance control				X	
Reinehr, 2010[145, 188] Fair	RCT	Germany Health Care	71	6 (84.5)	8 to 16 year olds who are overweight (BMI 90-97th percentile [German norms])	Obeldicks light	67 (37)	Waitlist				X	X
Vos, 2011[161, 204, 205] Fair	RCT	Netherlands Health Care	81	12 (82.7)	8 to 17 year olds with obesity (IOTF)	Family-based multidisciplinary lifestyle intervention	46.25 (19)	Waitlist			X	X	
Kalarchian, 2009[126, 209] Fair	RCT	United States Health Care	192	6;12;18 (72.4)	8 to 12 year olds with severe obesity (BMI ≥ 97th percentile [CDC])	Family-based lifestyle intervention	43.75 (26)	Nutrition consultation			X	X	

Table 6. Summary of Treatment Studies, Grouped by Intervention Type, Sorted by Descending Estimated Intervention Contact Hours (Key Questions 3–5)

Author, Year and Quality	Design	Setting	N Rand	Months F/U (% F/U 12 Months or Closest)	Population	Intervention	Est Hours Contact (Sessions)	Control	Key Question				
									1	2	3	4	5
Kalavainen, 2007[127,184,185] Fair	RCT	Finland Health Care	70	12 (98.6)	7 to 9 year olds with obesity (weight for height 120-200% of median [UK norms])	Health-promoting lifestyle	43.5 (15)	Brief education + booklets				X	
Stark, 2011[154] Fair	RCT	United States Primary Care and Home	18	6; 12 (88.9)	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])	LAUNCH	38.25 (18)	Enhanced standard of care			X	X	
Croker, 2012[118] Fair	RCT	United Kingdom Health Care	72	6 (68.1)	8 to 12 year olds who are overweight or have obesity (IOTF)	Family-based behavioral therapy	37.5 (15)	Waitlist				X	X
DeBar, 2012[120] Good	RCT	United States Health Care	208	6; 12 (83.2)	12 to 17 year old females who are overweight or have obesity (BMI ≥ 90th percentile [CDC])	Multi-component behavioral intervention	36.5 (18)	PCP Meeting + materials			X	X	X
Sacher, 2010[147] Fair	RCT	United Kingdom Other	116	6 (70.7)	8 to 12 year olds with obesity (BMI ≥ 98th percentile [UK 1990 reference norms])	MEND	36 (18)	Waitlist			X	X	X
Nemet, 2005[138] Fair	RCT	Israel Health Care	54	12 (74.1)	6 to 16 year olds with obesity (definition NR)	Dietitian + PA sessions	32.5 (34)	Nutrition referral				X	
Stark, 2014[153, 201] Fair	RCT	United States Health Care	27	6; 12 (85.2)	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])	LAUNCH-clinic	30 (10)	Enhanced standard of care				X	
Bryant, 2011[114, 191] Fair	RCT	United Kingdom Other	70	12 (75.7)	8 to 16 year olds with obesity (BMI > 98th percentile, [NR])	WATCH IT	24 (16)	Waitlist				X	
Mellin, 1987[137] Fair	RCT	United States Health Care	66	6 (95.5)	12 to 18 year olds with obesity (definition NR)	SHAPEDOWN	24 (16)	Waitlist				X	

Table 6. Summary of Treatment Studies, Grouped by Intervention Type, Sorted by Descending Estimated Intervention Contact Hours (Key Questions 3–5)

Author, Year and Quality	Design	Setting	N Rand	Months F/U (% F/U 12 Months or Closest)	Population	Intervention	Est Hours Contact (Sessions)	Control	Key Question				
									1	2	3	4	5
Golley, 2007[124,178-180, 192] Fair	RCT	Australia Health Care	111	12 (82.0)	6 to 9 year olds who are overweight or have obesity, but zBMI≤3.5 (IOTF)	Triple P + healthy lifestyle group	23.75 (18)	Waitlist				X	
Hofsteenge, 2014[125, 181, 182, 208] Fair	RCT	Netherlands Health Care	122	6 (79.5)	11 to 18 year olds who are overweight or have obesity (Dutch norms)	Go4it	16.5 (11)	Usual care			X	X	
Gerards, 2015[123, 176] Fair	RCT	Netherlands Primary Care	86	12 (77.9)	4 to 8 year olds who are overweight or have obesity (IOTF)	Lifestyle Triple P	16.5 (14)	Control				X	
Nowicka, 2008[140] Fair	CCT	Sweden Health Care	95	12 (92.6)	12 to 19 year olds with obesity (IOTF)	Family Weight School	16 (4)	Waitlist				X	
Boudreau, 2013[111] Fair	RCT	United States Primary Care	41	6 (63.4)	9 to 12 year old Latinos who are overweight or had obesity (BMI ≥ 85th percentile [CDC])	PowerUp + coaching	10.5 (12)	Waitlist			X	X	
Norman, 2015[139] Fair	RCT	United States Primary Care	106	8; 12 (80.2)	11 to 13 year olds with obesity (BMI ≥ 95 percentile for age and gender [CDC])	Stepped-down care	8.25 (27)	Enhanced usual care				X	
Taylor, 2015[159, 200] Good	RCT	New Zealand University and home	206	12; 24 (87.9)	4 to 8 years old who are overweight or have obesity (BMI ≥ 85th percentile [CDC])	Tailored lifestyle support	7.2 (14)	Brief feedback and advice			X	X	
Raynor, 2012a[142] Fair	RCT	United States Other	101	6; 12 (89.1)	4 to 9 year olds who are overweight or have obesity (≥ 85th BMI percentile [CDC])	DECREASE + Growth Monitoring	6 (8)	Monthly newsletters + growth monitoring				X	X
Raynor, 2012b[142] Fair	RCT	United States Other	81	6; 12 (91.4)	4 to 9 year olds who are overweight or have obesity (≥ 85th BMI percentile [CDC])	TRADITIONAL + Growth Monitoring	6 (8)	Monthly newsletters + growth monitoring				X	X

Table 6. Summary of Treatment Studies, Grouped by Intervention Type, Sorted by Descending Estimated Intervention Contact Hours (Key Questions 3–5)

Author, Year and Quality	Design	Setting	N Rand	Months F/U (% F/U 12 Months or Closest)	Population	Intervention	Est Hours Contact (Sessions)	Control	Key Question				
									1	2	3	4	5
Kong, 2013[130] Fair	SG-CRCT	United States Primary Care	60	6 (85.0)	Students in 9th - 11th grades who are overweight or have obesity (BMI ≥ 85th percentile [CDC])	ACTION	4.25 (16)	Single PCP visit + booklet				X	
Stettler, 2014[155] Fair	Cluster RCT	United States Primary Care	173	6;12;24 (69.9)	8 to 12 year olds who are overweight (75th-95th percentile [CDC]) and consuming average of ≥ 4 ounces of sugar sweetened beverages/day	Multiple-behavior change	4 (12)	Attention control (bullying prevention)				X	
Saelens, 2002[148] Fair	RCT	United States Primary Care	44	7 (84.1)	12 to 16 year olds who are overweight or have obesity (20% to 100% above median for BMI [NHANES])	Healthy Habits Intervention	3.75 (13)	Single pediatrician session				X	X
Broccoli, 2016[113, 172] Good	RCT	Italy Primary Care	372	12 (95.4)	4 to 7 year olds who are overweight (85th-95th BMI percentile [CDC])	Motivational Interviewing	3.75 (5)	Obesity prevention booklet				X	
O'Connor, 2013[141] Fair	RCT	United States Primary Care	40	7 (85)	5 to 8 year olds who are overweight or have obesity (BMI 85th-98th percentile [CDC])	Helping HAND	3.5 (12)	Waitlist				X	
Sherwood, 2015[151] Fair	RCT	United States Primary Care	60	6 (91.7)	2 to 4 year olds who are at risk for obesity (50th-85th BMI percentile [CDC 2000] with one parent who is overweight) or who is overweight (85th-95th BMI percentile [CDC 2000])	Busy Bodies / Better Bites	3.32 (9)	Attention control (safety education)				X	
Taveras, 2011[157, 196, 197, 211] Good	Cluster RCT	United States Primary Care	475	12; 24 (93.7)	2 to 6 year olds who are overweight (≥ 85th percentile [CDC]) and have an overweight parent (BMI ≥ 25), or are obese (≥ 95th percentile)	MI + enhanced EMR and training	2.67 (8)	Usual care				X	
Love-Osborne, 2014[133, 174] Fair	RCT	United States Primary Care	165	8 (90.3)	Middle and high school students at schools with high percentages of underserved, largely ethnic minority students who are overweight or have obesity (BMI ≥ 85th percentile [norms NR])	Health educator visits	2.5 (5)	Physical exam and lab screening if due, followup as needed				X	

Table 6. Summary of Treatment Studies, Grouped by Intervention Type, Sorted by Descending Estimated Intervention Contact Hours (Key Questions 3–5)

Author, Year and Quality	Design	Setting	N Rand	Months F/U (% F/U 12 Months or Closest)	Population	Intervention	Est Hours Contact (Sessions)	Control	Key Question				
									1	2	3	4	5
Looney, 2014[132] Fair	RCT	United States Primary Care	22	6 (95)	4 to 10 year olds who are overweight or have obesity (≥ 85th percentile [CDC])	Newsletters + Growth Monitoring + Family-based Behavioral Counseling	2.5 (6)	Newsletters				X	
Resnicow, 2015[146, 190] Fair	Cluster RCT	United States Primary Care	645	24 (70.9)	2 to 8 year olds who are overweight or have obesity (BMI 85-97th percentile [CDC])	PCP + RD MI	2.5 (10)	Usual care				X	
Wake, 2013[163, 207] Good	RCT	Australia Health Care	118	12 (90.7)	3 to 10 year olds with obesity (≥95th percentile [CDC])	HopSCOTCH	2.5 (6)	Usual care			X	X	X
Van Grieken, 2013[160, 202, 203] Fair	Cluster RCT	Netherlands Primary Care	637	24 (79.6)	5 year olds who are overweight but do not have obesity (IOTF)	Be Active Eat Right	2 (4)	Usual care				X	
Taveras, 2015[158, 198, 199] Good	Cluster RCT	United States Primary Care	549	12 (94.4)	6 to 12 years olds with obesity (≥ 95th percentile [CDC])	CDS + coaching	1.25 (5)	Usual care				X	
McCallum, 2007[136, 186, 206] Good	RCT	Australia Primary Care	163	9.1; 15.0 (89.6)	5 to 9 year olds who are overweight or have mild obesity (IOTF [but zBMI <3.0])	LEAP	1 (4)	Usual care			X	X	X
Wake, 2009[162, 183, 186] Good	RCT	Australia Primary Care	258	6; 12 (95.0)	5 to 10 year olds who are overweight or have obesity but zBMI <3.0 (IOTF and UK norms)	LEAP-2	1 (4)	Usual care			X	X	X

Table 6. Summary of Treatment Studies, Grouped by Intervention Type, Sorted by Descending Estimated Intervention Contact Hours (Key Questions 3–5)

Author, Year and Quality	Design	Setting	N Rand	Months F/U (% F/U 12 Months or Closest)	Population	Intervention	Est Hours Contact (Sessions)	Control	Key Question 1	2	3	4	5
Lifestyle-based maintenance after weight loss interventions													
Davis, 2012[119] Fair	RCT	United States Other	61	8 (86.9)	Adolescent African Americans or Latinos in grades 9 to 12 who had completed initial 4-month weight loss intervention and are overweight or have obesity (≥85th percentile [CDC])	Maintenance (Group classes)	16 (14)	Newsletters				X	
Non-lifestyle behavior-based interventions													
Boutelle, 2014[112] Fair	RCT	United States Other	44	8 (88.6)	8 to 12 year olds meeting criteria for eating in the absence of hunger who are overweight or had obesity (≥ 85th percentile [CDC])	Regulation of Cues (ROC) program	28 (14)	Waitlist				X	
Tanofsky-Kraff, 2010 [156, 173, 177] Fair	RCT	United States Other	38	6; 12 (92.1)	Adolescent girls who are overweight or have obesity (BMI 75-97th percentile [norms NR])	IPT-Weight Gain Prevention	17.9 (13)	Attention control (health education)				X	X
Pharmacotherapy													
Clarson, 2014[117] Fair	RCT	Canada Health Care	69	6; 12; 24 (68.1)	10 to 16 year olds with obesity (BMI >95th percentile for age and sex [CDC])	Metformin + compre-hensive lifestyle	86 (106)	Placebo + comprehensive lifestyle				X	X
Wiegand, 2010[165] Fair	RCT	Germany and Switzerland Health Care	70	6 (90)	10 to 17 year olds with obesity (>97th percentile [German norms]) at risk of developing type 2 diabetes with previous unsuccessful lifestyle intervention	Metformin + family-based lifestyle intervention	40.8 (58)	Placebo + lifestyle intervention				X	X
Wilson, 2010[166] Fair	RCT	United States Health Care	77	12 (70.1)	13 to 18 year olds with obesity (BMI ≥95th percentile [CDC]) but weight <136 kg	Metformin + lifestyle intervention	9.5 (19)	Placebo + lifestyle intervention				X	X
Yanovski, 2011[167, 168] Good	RCT	United States Health Care	100	6 (85)	6 to 12 year olds with insulin resistance and obesity (BMI ≥95th percentile [CDC])	Metformin + lifestyle intervention	3 (6)	Placebo + lifestyle intervention				X	X

Table 6. Summary of Treatment Studies, Grouped by Intervention Type, Sorted by Descending Estimated Intervention Contact Hours (Key Questions 3–5)

Author, Year and Quality	Design	Setting	N Rand	Months F/U (% F/U 12 Months or Closest)	Population	Intervention	Est Hours Contact (Sessions)	Control	Key Question				
									1	2	3	4	5
Love-Osborne, 2008[134] Fair	RCT	United States Other	85	6 (75.3)	12 to 19 year olds with insulin resistance or presence of acanthosis nigricans and obesity (BMI >95 percentile [norms NR])	Metformin + goal setting	2.25 (6)	Placebo + goal setting				X	X
Kay, 2001[128] Fair	RCT	United States NR	24	2 (NR)	Adolescents with obesity (BMI >30 [NR])	Metformin + calorie-controlled diet	0.5 (1)	Placebo + calorie-controlled diet					X
Evia-Viscarra 2012[121] Fair	RCT	Mexico Health Care	31	3 (83.9)	9 to 18 year olds with insulin resistance and obesity (BMI >95th percentile for age and sex [CDC])	Metformin + lifestyle recommendations	0.25 (1)	Placebo + lifestyle recommendations					X
Kendall, 2013[129] Fair	RCT	United Kingdom Health Care	155	6 (71.0)	8 to 18 year olds with IGT or hyperinsulinemia and obesity (BMI >98th percentile [UK norms])	Metformin + 1 individual session	0.25 (1)	Placebo + 1 individual session				X	X
Srinivasan, 2006[152] Fair	RCT	Australia Health Care	28	6 (78.6)	9 to 18 year olds with clinical suspicion of insulin resistance or presence of acanthosis nigricans and obesity (IOTF)	Metformin + 1 individual session	0.25 (1)	Placebo				X	X
Burgert, 2008[115] Fair	RCT	United States Health Care	34	4 (82.4)	13 to 18 years old with insulin resistance and obesity [NR]	Metformin + lifestyle recommendations	0.25 (1)	Placebo + lifestyle recommendations					X
Freemark, 2001[122, 175] Fair	RCT	United States Health Care	32	6 (90.6)	12 to 19 year olds with fasting hyperinsulnemia and family history of type II DM and obesity (BMI >30)	Metformin	0 (0)	Placebo				X	X
Yanovski, 2012[102, 171] Fair	RCT	United States Health Care	200	6 (85.5)	12 to 17 year old African Americans and Caucasians with severe obesity (BMI and triceps skinfold >95th percentile [NHANES]) and ≥1 obesity-related comorbidity	Orlistat + behavioral weight loss	15 (15)	Placebo + behavioral weight loss				X	X
Chanoine, 2005[116, 169] Fair	RCT	United States and Canada Health Care	539	12 (64.7)	12 to 16 year olds with obesity (≥2 BMI units above US mean for 95th percentile, and BMI<44)	Orlistat + Diet, PA, and Behavior Therapy	9 (18)	Placebo + Diet, PA, and Behavior Therapy				X	X

Table 6. Summary of Treatment Studies, Grouped by Intervention Type, Sorted by Descending Estimated Intervention Contact Hours (Key Questions 3–5)

Author, Year and Quality	Design	Setting	N Rand	Months F/U (% F/U 12 Months or Closest)	Population	Intervention	Est Hours Contact (Sessions)	Control	Key Question				
									1	2	3	4	5
Maahs, 2006[135] Fair	RCT	United States Other	40	6 (85)	14 to 18 year olds who are overweight or have obesity (BMI >85th percentile [norms NR])	Orlistat + dietitian counseling	3.5 (7)	Placebo + dietitian counseling			X	X	X

Abbreviations: BMI = body mass index; CCT = controlled clinical trial; CDC = Centers for Disease Control and Prevention; CDS = clinical decision support; EMR = electronic medical record; est = estimated; IGT = impaired glucose tolerance; IOTF = International Obesity Task Force; IPT = interpersonal therapy; KQ = Key Question; MI = motivational interviewing; NHANES = National Health and Nutrition Examination Survey; NR = not reported; PA = physical activity; PCP = primary care physician; RCT = randomized controlled trial; RD = registered dietitian; SG-CRCT = single group cluster randomized controlled trial; UK = United Kingdom; zBMI = body mass index z-score.

Table 7. Population Characteristics of Treatment Studies, Grouped by Intervention Type, Sorted by Descending Estimated Intervention Contact Hours (Key Questions 3–5)

Author, Year and Quality	Recruitment	Age range (mean)	Mean Baseline BMI and zBMI	% Female	% Race/Ethnicity
Behavior-based interventions					
Lison, 2012[131] Fair	NR	6-16 (11.9)	29.1 2.13	49.1	Black: NR Latino: NR Native Amer: NR White: 100
Weigel, 2008[164] Fair	Mixed	7-15 (11.2)	28.6 2.36	54.8	Black: NR Latino: NR Native Amer: NR White: NR
Savoye, 2007[150] Fair	NR	8-16 (12.1)	36.0 NR	60.9	Black: 38.5 Latino: 24.7 Native Amer: NR White: 36.8
Savoye, 2014[149] Fair	Clinician referral	10-16 (12.9)	33.3 2.2	65.3	Black: 28 Latino: 36 Native Amer: NR White: 20
Reinehr, 2006[143] Fair	Other	6-14 (10.4)	26.9 2.4	46.7	Black: NR Latino: NR Native Amer: NR White: NR
Reinehr, 2009[144] Fair	Not reported	10-16 (12.6)	NR 2.46	56.1	Black: NR Latino: NR Native Amer: NR White: NR
Reinehr, 2010[145] Fair	Mixed	8-16 (11.5)	23.8 1.66	60.6	Black: NR Latino: NR Native Amer: NR White: NR
Vos, 2011[161] Fair	Clinician referral	8-17 (13.2)	32.5 4.3	53.2	Black: NR Latino: NR Native Amer: NR White: NR
Kalarchian, 2009[126] Fair	NR	8-12 (10.19)	32.12 NR	56.8	Black: 26 Latino: 1 Native Amer: 0 White: 73.4
Kalavainen, 2007[127] Fair	Mixed	6-9 (8.1)	23.2 2.6	60	Black: NR Latino: NR Native Amer: NR White: NR

Table 7. Population Characteristics of Treatment Studies, Grouped by Intervention Type, Sorted by Descending Estimated Intervention Contact Hours (Key Questions 3–5)

Author, Year and Quality	Recruitment	Age range (mean)	Mean Baseline BMI and zBMI	% Female	% Race/Ethnicity
Stark, 2011[154] Fair	Screening (population-based)	2-5 (4.1)	NR NR	33.3	Black: NR Latino: 16.7 Native Amer: NR White: 83.3
Croker, 2012[118] Fair	Clinician referral	8-12 (10.3)	30.6 3.2	69.4	Black: 19.4 Latino: NR Native Amer: NR White: 56.9
DeBar, 2012[120] Good	Clinician referral	12-17 (14.1)	31.9 2.00	100	Black: NR Latino: NR Native Amer: NR White: 72.1
Sacher, 2010[147] Fair	Mixed	8-12 (10.3)	27.2 2.77	54.3	Black: NR Latino: NR Native Amer: NR White: 50
Nemet, 2005[138] Fair	Volunteer	6-16 (11.1)	28.2 NR	43.5	Black: NR Latino: NR Native Amer: NR White: NR
Stark, 2014[153] Fair	Screening (population-based)	2-5 (4.5)	NR 2.4	65.2	Black: NR Latino: NR Native Amer: NR White: 82.6
Bryant, 2011[114] Fair	Mixed	8-16 (11.4)	NR 2.99	64.3	Black: 4.3 Latino: NR Native Amer: NR White: 87.1
Mellin, 1987[137] Fair	Mixed	12-18 (15.6)	NR NR	78.8	Black: 3 Latino: 7.6 Native Amer: NR White: 88
Golley, 2007[124] Fair	Other	6-9 (8.2)	24.3 2.75	63.1	Black: NR Latino: NR Native Amer: NR White: 98
Hofsteenge, 2014[125] Fair	Clinician referral	11-18 (14.5)	33.4 2.93	55.7	Black: NR Latino: NR Native Amer: NR White: NR

Table 7. Population Characteristics of Treatment Studies, Grouped by Intervention Type, Sorted by Descending Estimated Intervention Contact Hours (Key Questions 3–5)

Author, Year and Quality	Recruitment	Age range (mean)	Mean Baseline BMI and zBMI	% Female	% Race/Ethnicity
Gerards, 2015[123] Fair	Mixed	4-8 (7.21)	20.5 1.84	55.8	Black: NR Latino: NR Native Amer: NR White: NR
Nowicka, 2008[140] Fair	Clinician referral	12-19 (14.7)	34.5 3.25	50	Black: NR Latino: NR Native Amer: NR White: NR
Boudreau, 2013[111] Fair	Clinician referral	9-12 (10.3)	NR 2.1	61.5	Black: NR Latino: 100 Native Amer: NR White: NR
Norman, 2015[139] Fair	Mixed	11-13 (11.9)	29.3 2.1	50.9	Black: 3.8 Latino: 82.1 Native Amer: NR White: 7.5
Taylor, 2015[159] Good	Screening (population-based)	4-8 (6.5)	19.4 1.63	55.3	Black: NR Latino: NR Native Amer: NR White: NR
Raynor, 2012a[142] Fair	Mixed	4-9 (7.2)	NR 2.32	61.4	Black: NR Latino: 18.8 Native Amer: NR White: 86.1
Raynor, 2012b[142] Fair	Mixed	4-9 (7.1)	NR 2.27	60.5	Black: NR Latino: 11.1 Native Amer: NR White: 90.1
Kong, 2013[130] Fair	Volunteer	NR (14.8)	NR NR	58.8	Black: NR Latino: 68.6 Native Amer: 5.9 White: NR
Stettler, 2014[155] Fair	Screening (population-based)	8-12 (10.8)	21.6 1.24	52.3	Black: 42.4 Latino: 6.4 Native Amer: NR White: 52.9
Saelens, 2002[148] Fair	Mixed	12-16 (14.2)	30.7 2.07	40.9	Black: 4.5 Latino: 15.9 Native Amer: NR White: 70.5

Table 7. Population Characteristics of Treatment Studies, Grouped by Intervention Type, Sorted by Descending Estimated Intervention Contact Hours (Key Questions 3–5)

Author, Year and Quality	Recruitment	Age range (mean)	Mean Baseline BMI and zBMI	% Female	% Race/Ethnicity
Broccoli, 2016[113] Good	Screening (population-based)	4-7 (6.6)	18.25 1.35	61.6	Black: NR Latino: NR Native Amer: NR White: NR
O'Connor, 2013[141] Fair	Mixed	5-8 (6.8)	NR NR	80	Black: 12.5 Latino: 82.5 Native Amer: NR White: 5
Sherwood, 2015[151] Fair	Clinician referral	2-4 (2.75)	NR 0.94	45	Black: NR Latino: 7 Native Amer: NR White: 80
Taveras, 2011[157] Good	Screening (population-based)	2-6 (4.9)	19.2 1.85	48.3	Black: 18.9 Latino: 16.6 Native Amer: NR White: 56.6
Love-Osborne, 2014[133] Fair	NR	12-18 (15.9)	31.7 1.90	52.1	Black: NR Latino: 88.5 Native Amer: NR White: NR
Looney, 2014[132] Fair	Mixed	4-10 (8.0)	NR 2.34	68.2	Black: 4.5 Latino: 9.1 Native Amer: NR White: 72.7
Resnicow, 2015[146] Fair	Clinician referral	2-8 (5.1)	NR NR	57.1	Black: 6.6 Latino: 21.6 Native Amer: NR White: 60.0
Wake, 2013[163] Good	Screening (population-based)	3-10 (7.3)	22.5 2.2	54.2	Black: NR Latino: NR Native Amer: NR White: NR
Van Grieken, 2013[160] Fair	Screening (population-based)	5 (5.8)	18.13 NR	61.9	Black: NR Latino: NR Native Amer: NR White: NR
Taveras, 2015[158] Good	Screening (population-based)	6-12 (9.8)	25.8 2.06	46.8	Black: 21.1 Latino: 14 Native Amer: NR White: 51.2

Table 7. Population Characteristics of Treatment Studies, Grouped by Intervention Type, Sorted by Descending Estimated Intervention Contact Hours (Key Questions 3–5)

Author, Year and Quality	Recruitment	Age range (mean)	Mean Baseline BMI and zBMI	% Female	% Race/Ethnicity
McCallum, 2007[136] Good	Screening (population-based)	5-9 (7.4)	20.3 1.9	51.5	Black: NR Latino: NR Native Amer: NR White: NR
Wake, 2009[162] Good	Screening (population-based)	5-10 (7.5)	20.2 1.9	60.5	Black: NR Latino: NR Native Amer: NR White: NR
Davis, 2012[119] Fair	Volunteer	NR (15.7)	34.9 2.2	54.7	Black: NR Latino: NR Native Amer: NR White: NR
Boutelle, 2014[112] Fair	Volunteer	8-12 (10.2)	27.3 2.10	50	Black: NR Latino: NR Native Amer: NR White: 69.1
Tanofsky-Kraff, 2010[156] Fair	Mixed	NR (15.1)	25.4 1.3	100	Black: 47.4 Latino: 5.3 Native Amer: NR White: 36.8
Pharmacotherapy					
Clarson, 2014[117] Fair	Mixed	10-16 (13.7)	32.5 2.17	58	Black: 2.9 Latino: NR Native Amer: 4.3 White: 76.8
Wiegand, 2010[165] Fair	Screening (population-based)	10-17 (15.0)	34.88 NR	67.1	Black: NR Latino: NR Native Amer: NR White: 88.6
Wilson, 2010[166] Fair	NR	13-18 (14.9)	35.9 2.29	66.2	Black: 18.2 Latino: 23.4 Native Amer: NR White: 63.6
Yanovski, 2011[167] Good	Mixed	6-12 (10.2)	34.4 2.57	60	Black: 40 Latino: 11 Native Amer: NR White: 45
Love-Osborne, 2008[134] Fair	Mixed	12-19 (15.7)	39.7 NR	71	Black: 34 Latino: 58 Native Amer: NR White: NR

Table 7. Population Characteristics of Treatment Studies, Grouped by Intervention Type, Sorted by Descending Estimated Intervention Contact Hours (Key Questions 3–5)

Author, Year and Quality	Recruitment	Age range (mean)	Mean Baseline BMI and zBMI	% Female	% Race/Ethnicity
Kay, 2001[128] Fair	NR	NR (15.6)	41.0 NR	62.5	Black: NR Latino: NR Native Amer: NR White: 100
Evia-Viscarra, 2012[121] Fair	NR	10.1-16.6 (13.4)	33.1 NR	65.4	Black: NR Latino: NR Native Amer: NR White: NR
Kendall, 2013[129] Fair	Screening (population-based)	8-18 (13.7)	36.5 3.4	67.5	Black: 1.3 Latino: NR Native Amer: NR White: 76.2
Srinivasan, 2006[152] Fair	Screening (population-based)	9-18 (12.5)	35.2 2.43	53.6	Black: NR Latino: NR Native Amer: NR White: 25
Burgert, 2008[115] Fair	Other	13-18 (15)	40.5 NR	67.9	Black: 25 Latino: 17.9 Native Amer: NR White: 57.1
Freemark, 2001[122] Fair	Volunteer	12-19 (14.9)	40.0 NR	62.1	Black: 44.8 Latino: NR Native Amer: NR White: 55.2
Yanovski, 2012[102] Fair	NR	12-17 (14.59)	41.7 NR	65.5	Black: 61.5 Latino: 0 Native Amer: 0 White: 38.5
Chanoine, 2005[116] Fair	Mixed	12-16 (13.6)	35.6 NR	67	Black: 16.9 Latino: NR Native Amer: NR White: 76
Maahs, 2006[135] Fair	Mixed	14-18 (15.8)	40.4 NR	67.5	Black: NR Latino: 62.5 Native Amer: NR White: NR

Abbreviations: Amer = American; BMI = body mass index; NR = not reported; zBMI = body mass index z-score.

Table 8. Intervention Characteristics of Behavior-Based Trials Included for Treatment Benefit (Key Questions 3–5)

Author, Year Quality Age Group	Intervention	Description	Delivery	Format	Target	# Sessions and Session Length (min)	Duration (months)	Est hours	Provider	Role of PCP
Lison, 2012[131] Fair Wide range	Hospital-based group exercise (IG1)	2 1-hr parent/child lifestyle education sessions with behavior change strategies; 120 1-hr group PA sessions (offered 5 times/week, families encouraged to attend at least 3 sessions/week)	In Person	Group PA sessions	Child, Family	122	6	122	Pediatrician (education sessions), PE instructor (exercise sessions)	No role
	Home-based exercise (IG2)	2 1-hr parent/child lifestyle education sessions with behavior change strategies and Mediterranean diet focus; detailed home-based PA plan with demonstration, written instructions, and log	In Person, Print	Individual PA sessions	Child, Family	2 60	6	2	Pediatrician (education sessions), PE instructor (assumed, exercise demonstration)	No role
Weigel, 2008[164] Fair Wide range	Sea Lion Club	Twice weekly 45- to 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	In Person	Group PA sessions	Parent, Child, Family	104 45-60 (child), 120 (parent)	12	114.1	Dietitians, psychologists, sports coaches	No role
Savoye, 2007[150] Fair Wide range	Bright Bodies	26 weekly nutrition education and behavioral management sessions using Smart Moves Workbook, twice-weekly physical activity sessions tapering to twice-monthly after 6 months	In Person, Print	Group PA sessions	Parent, Child, Family	64 40 (diet + behavioral), 50 (PA, 1st 6m), 100 (PA, 2nd 6m)	12	82.33	Dietitian or social worker; exercise physiologists	No role
Savoye, 2014[149] Fair Wide range	Bright Bodies	26 weekly nutrition education and behavioral management sessions using Smart Moves Workbook; twice-weekly physical activity sessions tapering to twice-monthly after 6 months; 26 parent support sessions	In Person	Group PA sessions	Parent, Child, Family	52 50 (exercise), 40 (therapy)	6	78	Dietitian, physical therapist	No role

Table 8. Intervention Characteristics of Behavior-Based Trials Included for Treatment Benefit (Key Questions 3–5)

Author, Year Quality Age Group	Intervention	Description	Delivery	Format	Target	# Sessions and Session Length (min)	Duration (months)	Est hours	Provider	Role of PCP
Reinehr, 2006[143] Fair Wide range	Obeldicks	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)	In Person	Group, Individual PA sessions	Parent, Child, Family	52 90 (group sessions), 30 (individual family), 60 (PA)	12	77.5	Pediatrician, dietitian, psychologist, exercise physiologist	No role
Reinehr, 2009[144] Fair Wide range	Obeldicks	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)	In Person	Group, Individual PA sessions	Parent, Child, Family	52 90 (group sessions), 30 (family), 60 (PA)	12	77.5	Pediatricians, diet assistants, psychologists, and exercise physiologists	No role
Reinehr, 2010[145] Fair Wide range	Obeldicks light	37 child sessions, 6 parent sessions, 5 child+parent sessions; PA training, nutrition education, and behavior counseling performed in group sessions with individual counseling for child and family	In Person	Group, Individual PA sessions	Parent, Child, Family	37 PA: 90; parent: 90; individual child/parent counseling: 30	6	67	Pediatricians, diet assistants, psychologists, exercise physiologists	No role
Vos, 2011[161] Fair Wide range	Family-based multi-disciplinary lifestyle intervention	2 individual family assessment and advice visits followed by 7 2.5-hr group comprehensive behavioral lifestyle meetings, parents and children usually separate, plus 2 to 3 booster group sessions yearly	In Person	Group, Individual PA sessions	Parent, Child, Family	19 150 (group) 180-270 (individual)	24	46.25	Dietician, child physiotherapist, child psychologist, social worker	No role
Kalarchian, 2009[126] Fair Elementary	Family-based lifestyle intervention	20 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)	In Person, Phone	Group, Individual	Parent, Child, Family	26 60	12	43.75	Lifestyle coach	No role

Table 8. Intervention Characteristics of Behavior-Based Trials Included for Treatment Benefit (Key Questions 3–5)

Author, Year Quality Age Group	Intervention	Description	Delivery	Format	Target	# Sessions and Session Length (min)	Duration (months)	Est hours	Provider	Role of PCP
Kalavainen, 2007[127] Fair Elementary	Health-promoting lifestyle	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	In Person, Print	Group PA sessions	Parent, Child, Family	15 90	6	43.5	Dietitian (parent sessions); advanced clinical nutrition students (child sessions)	No role
Stark, 2011[154] Fair Preschool	LAUNCH	9 clinic-based 90-min comprehensive behavioral lifestyle group sessions for parents and children separately plus 9 home visits; vegetable taste tests, pedometers, parents received 2 weeks worth of vegetables, child sessions included 15-min PA	In Person	Group, Individual	Parent, Child, Family	18 90 (clinic), 60-90 (in-home)	6	38.25	Licensed clinical psychologist, post doc and research coordinator	No role
Croker, 2012[118] Fair Elementary	Family-based behavioral therapy	15 90-min comprehensive multicomponent family-based behavioral therapy group sessions, parents and children meeting separately for 10 sessions and together for 5 sessions	In Person	Group	Parent, Child, Family	15 90	6	37.5	Psychologist, family therapist, dietitian	No role
DeBar, 2012[120] Good Adolescent	Multi-component behavioral intervention	16 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	In Person, Phone	Group, Individual PA sessions	Parent, Child	18 90 (group), NR, est 15 min (PCP)	5	36.5	Nutritionists, health educators and clinical psychologists; primary care physicians	Participated in intervention

Table 8. Intervention Characteristics of Behavior-Based Trials Included for Treatment Benefit (Key Questions 3–5)

Author, Year Quality Age Group	Intervention	Description	Delivery	Format	Target	# Sessions and Session Length (min)	Duration (months)	Est hours	Provider	Role of PCP
Sacher, 2010[147] Fair Elementary	MEND	18 2-hr family-based multicomponent behavioral healthy lifestyle group sessions targeting education, skills training, and motivational enhancement; included 1-hr PA sessions in 16 of the sessions; free access to community pool	In Person, Print	Group PA sessions	Child, Family	18 120	2.25	36	MEND leaders, assistant	No role
Nemet, 2005[138] Fair Wide range	Dietitian + PA sessions	4 evening lectures for parents, 6 dietician meetings, and twice-weekly PA sessions for 3 months	In Person, Print	Group, Individual PA sessions	Parent, Child, Family	34 45 (dietician), 60 (exercise + lectures)	3	32.5	Physicians, dieticians, youth coaches	Participated in intervention
Stark, 2014[153] Fair Preschool	LAUNCH-clinic	10 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	In Person	Group, Individual	Parent, Child	10 90	6	30	Clinical psychologist, pediatric psychologist, research coordinator	No role
Bryant, 2011[114] Fair Wide range	WATCH IT	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	In Person	Group, Individual PA sessions	Child, Family	16 30 (individual, parent), 60 (group PA)	12	24	Nonprofessional health trainers, support and supervision by nurse, dietician, psychologist, + pediatrician	No role
Mellin, 1987[137] Fair Adolescent	SHAPEDOWN	14 90-minute weekly group adolescent sessions and 2 90-minute parent sessions plus separate workbooks for parent and adolescent; focus on successive, sustainable, small lifestyle modifications	In Person, Print	Group PA sessions	Parent, Child	16 90	3	24	Nutritionists	No role

Table 8. Intervention Characteristics of Behavior-Based Trials Included for Treatment Benefit (Key Questions 3–5)

Author, Year Quality Age Group	Intervention	Description	Delivery	Format	Target	# Sessions and Session Length (min)	Duration (months)	Est hours	Provider	Role of PCP
Golley, 2007[124] Fair Elementary	Triple P + healthy lifestyle group (IG1)	4 2-hr group sessions and 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	In Person, Phone, Print	Group, Individual PA sessions	Parent, Child	18 2 hours (group parenting), 15-20 minutes (calls)	5	23.75	Dietitian	No role
	Triple P (IG2)	4 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	In Person, Phone, Print	Group, Individual	Parent	11 2 hours (group), 15-20 minutes (phone)	5	9.75	Dietitian	No role
Hofsteenge, 2014[125] Fair Wide range	Go4it	7 90-min group sessions plus 2 booster sessions covering diet, PA, and cognitive behavior therapy for adolescents; 2 separate parent sessions	In Person, Print	Group	Parent, Child	11 90	6	16.5	Dietician, pediatrician/ endocrinologist, psychologist	No role
Gerards, 2015[123] Fair Elementary	Lifestyle Triple P	10 90-minute group sessions and 4 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	In Person, Phone, Print	Group, Individual	Parent	14 90 (group), 15-30 (telephone)	3.5	16.5	Health professionals (not further specified)	No role
Nowicka, 2008[140] Fair Adolescent	Family Weight School	4 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	In Person	Group, Individual	Parent, Child, Family	4 240 (including 10-min individual PCP session)	12	16	Pediatrician, dietician/sports trainer, pediatric nurse, family therapist	Participated in intervention

Table 8. Intervention Characteristics of Behavior-Based Trials Included for Treatment Benefit (Key Questions 3–5)

Author, Year Quality Age Group	Intervention	Description	Delivery	Format	Target	# Sessions and Session Length (min)	Duration (months)	Est hours	Provider	Role of PCP
Boudreau, 2013[111] Fair Elementary	PowerUp + coaching	6 90-minute PowerUp classes (separate, interactive group sessions for children and caregivers) covering nutrition, PA, and stress management, plus 6 monthly individual culturally-sensitive health coaching sessions	In Person, Phone	Group, Individual PA sessions	Parent, Child, Family	12 90	6	10.5	Health educator, physical therapist, nutritionist, and primary care pediatrician	Participated in intervention
Norman, 2015[139] Fair Wide range	Stepped-down Care	Stepped-down care: tailored to progress of individual participants in achieving weight loss goals	In Person, Phone, Print	Individual	Parent, Child	27 NR	13	8.25	Physician, health education counselor	Participated in intervention
Taylor, 2015[159] Good Elementary	Tailored lifestyle support	1 individual 1- to 2-hour multidisciplinary session with parents followed by 16 brief contacts for tailored behavioral lifestyle change support	In Person, Phone	Individual	Parent	14 60-120 (multi-disciplinary consult), 30-40 (in-person visits), 5-10 (phone calls)	24	7.2	Mentor, nutritionist/ dietician, exercise specialist/trainer, clinical psychologist	No role
Raynor, 2012a[142] Fair Elementary	DECREASE + Growth Monitoring (IG1)	8 45-min parent group sessions covering behavioral strategies to decrease high-calorie non-nutrient dense foods; growth assessed at 0, 3, and 6 months with accompanying letter providing anthropometric information and interpretation	In Person	Group	Parent	8 45	6	6	Research-staff therapist (master or doctoral-level with expertise in nutrition or exercise and behavior modification)	No role
	INCREASE + Growth Monitoring (IG2)	8 45-min parent group sessions covering behavioral strategies to increase healthy food intake; growth assessed at 0, 3, and 6 months with accompanying letter providing anthropometric information and interpretation	In Person	Group	Parent	8 45	6	6	Research-staff therapist (master or doctoral-level with expertise in nutrition or exercise and behavior modification)	No role

Table 8. Intervention Characteristics of Behavior-Based Trials Included for Treatment Benefit (Key Questions 3–5)

Author, Year Quality Age Group	Intervention	Description	Delivery	Format	Target	# Sessions and Session Length (min)	Duration (months)	Est hours	Provider	Role of PCP
Raynor, 2012b[142] Fair Elementary	TRADITIONAL + Growth Monitoring (IG1)	8 45-minute parent group sessions covering behavioral strategies to increase PA and reduce sugar-sweetened beverage consumption; growth assessed at 0, 3, and 6 months with accompanying letter providing anthropometric information and interpretation	In Person	Group	Parent	8 45	6	6	Research-staff therapist (master or doctoral-level with expertise in nutrition or exercise and behavior modification)	No role
	SUBSTITUTES + Growth Monitoring (IG2)	8 45-minute parent group sessions covering behavioral strategies to increase low-fat milk and decrease TV as substitute behaviors; growth assessed at 0, 3, and 6 months with accompanying letter providing anthropometric information and interpretation	In Person	Group	Parent	8 45	6	6	Research-staff therapist (master or doctoral-level with expertise in nutrition or exercise and behavior modification)	No role
Kong, 2013[130] Fair Adolescent	ACTION	Initial MI visit with PCP and student to review medical history/lab results, assess diet and PA, receive DVD; 7 followup MI visits with PCP to discuss DVD and work toward healthy lifestyle goals; newsletter and 8 post-visit MI calls to parents/caregivers	In Person, Phone, Electronic, Print	Individual	Parent, Child	16 47 (mean, 1st session), 24 (mean, subsequent sessions)	9	4.25	School-based health center clinician (family medicine nurse practitioner)	Participated in intervention
Stettler, 2014[155] Fair Elementary	Multiple-behavior change (IG1)	12 15- to 25-min sessions targeting healthy beverages, increased PA, and reduced sedentary activity, incorporating behavior change techniques	In Person	Individual	Family	12 15-25	12	4	Trained primary care clinician	Participated in intervention

Table 8. Intervention Characteristics of Behavior-Based Trials Included for Treatment Benefit (Key Questions 3–5)

Author, Year Quality Age Group	Intervention	Description	Delivery	Format	Target	# Sessions and Session Length (min)	Duration (months)	Est hours	Provider	Role of PCP
	Combined (IG2)	12 15-25 min sessions incorporating behavior change techniques targeting healthy beverages, increased PA, and reduced sedentary activity (IG2), or targeting health beverage consumption only (IG3)	In Person	Individual	Family	12 15-25	12	4	Trained primary care physician	Participated in intervention
	Beverage-only intervention (IG3)	12 15-25 min sessions to reduce intake of sugary drinks and increase intake of water and milk, incorporating behavior change techniques	In Person	Individual	Family	12 15-25	12	4	Trained primary care clinician	Participated in intervention
Saelens, 2002[148] Fair Adolescent	Healthy Habits Intervention	Computer assessment with 1 pediatrician session to discuss results with family; 11 phone counseling calls, 3 mailings	In Person, Phone, Electronic, Print	Individual	Child, Family	13 Computer + pediatrician sessions NR; phone sessions 10-20 mins (average length 16.4 mins)	4	3.75	Pediatrician; phone counselors	Participated in intervention
Broccoli, 2016[113] Good Elementary	Motivational Interviewing	5 individual motivational interviewing sessions with parent and child and pediatrician; families decided on goals, progress discussed at subsequent meetings	In Person	Individual	Parent, Child, Family	5 30-60	3	3.75	Family pediatrician	Participated in intervention
O'Connor, 2013[141] Fair Elementary	Helping HAND	6 monthly individual family sessions with health advisors with follow-up phone call after each session; set monthly child-behavior goals with implementation plan and behavior-specific parenting practice goals	In Person, Phone	Individual	Family	12 NR	7	3.5	Trained allied health staff "health advisors"	No role

Table 8. Intervention Characteristics of Behavior-Based Trials Included for Treatment Benefit (Key Questions 3–5)

Author, Year Quality Age Group	Intervention	Description	Delivery	Format	Target	# Sessions and Session Length (min)	Duration (months)	Est hours	Provider	Role of PCP
Sherwood, 2015[151] Fair Preschool	Busy Bodies / Better Bites	1 brief primary care session followed by 8 15- to 30-min phone coaching sessions for goal setting and MI	In Person, Phone, Print	Individual	Parent, Child, Family	9 NR (in-person), 15-30, average 23 (phone)	6	3.32	Pediatric primary care provider; experienced interventionists	1-time brief message/ Endorse-ment
Taveras, 2011[157] Good Preschool	MI + enhanced EMR and training	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.	In Person, Phone, Electronic, Print	Individual	Family	8 15-25	12	2.67	Nurse practitioner (primary interventionist), pediatrician	Participated in intervention
Love-Osborne, 2014[133] Fair Adolescent	Health educator visits	Average of 5 visits with health educator using motivational interviewing, goal-setting, self-monitoring, with or without supporting text messages; participants linked to existing resources and facilitated applications for free recreation memberships	In Person, Electronic	Individual	Child	5 NR	8	2.5	Health educator	No role
Looney, 2014[132] Fair Elementary	Newsletters + Growth Monitoring + Family-based Bx Counseling (IG1)	6 20- to 30-min in-person or phone sessions for growth monitoring/feedback and caretaker behavioral counseling; 6 monthly educational newsletters on nutrition and activity; usual care from the pediatrician	In Person, Phone, Print	Individual	Parent, Child, Family	6 30 (in-person), 20 (telephone)	6	2.5	Trained interventionist + pediatrician	No role
	Newsletters + Growth Monitoring (IG2)	6 10- to 15-min in-person or phone growth monitoring sessions with standardized feedback; 6 monthly educational newsletters on nutrition and leisure-lime activity; usual care from the pediatrician	In Person, Phone, Print	Individual	Child, Family	6 15 (in-person), 10 (telephone)	6	1.25	Trained interventionist + pediatrician	No role

Table 8. Intervention Characteristics of Behavior-Based Trials Included for Treatment Benefit (Key Questions 3–5)

Author, Year Quality Age Group	Intervention	Description	Delivery	Format	Target	# Sessions and Session Length (min)	Duration (months)	Est hours	Provider	Role of PCP
Resnicow, 2015[146] Fair Elementary	PCP + RD MI (IG1)	4 brief MI counseling sessions by PCP + 6 MI counseling sessions from RD conducted over 2 years, targeting diet and activity behaviors	In Person, Phone, Print	Individual	Parent	10 NR	24	2.5	PCP (pediatrician and NPs) and RD	Participated in intervention
	PCP MI (IG2)	4 brief MI counseling sessions over 2 years conducted by PCP, targeting diet and activity behaviors	In Person, Print	Individual	Parent	4 NR	24	1	PCP (pediatrician and NPs)	Participated in intervention
Wake, 2013[163] Good Elementary	HopSCOTCH	1 hour-long family visit with obesity specialist team to develop plan and goals, followed by GP visits every 4 to 8 weeks using brief solution-focused techniques; web-based software (HopSCOTCH) used to track progress and link specialist team with GP	In Person	Individual	Family	6 60 (specialist), 20-40 (long GP), 6-20 (standard GP)	12	2.5	General practitioner, obesity specialist team (pediatrician and dietician)	Participated in intervention
Van Grieken, 2013[160] Fair Preschool	Be Active Eat Right	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.	In Person, Print	Individual	Family	4 NR, average duration of 1st additional session, 24.76 (range, 0-60)	12	2	Youth Health Care Team (pediatrician, nurse, assistant)	Participated in intervention
Taveras, 2015[158] Good Elementary	CDS+ coaching (IG1)	Computerized clinical decision support system with point of care prompts at well-child visit, motivational interview, patient materials + 4 phone MI sessions by health coach and optional text message program	In Person, Phone, Electronic, Print	Individual	Parent, Family	5 75	12	1.25	Pediatrician, health coach	Participated in intervention
	CDS (IG2)	Computerized clinical decision support system with point of care prompts at well-child visit, motivational interview, patient materials	In Person, Electronic, Print	Individual	Family	1 15	12	0.25	Pediatrician	Participated in intervention

Table 8. Intervention Characteristics of Behavior-Based Trials Included for Treatment Benefit (Key Questions 3–5)

Author, Year Quality Age Group	Intervention	Description	Delivery	Format	Target	# Sessions and Session Length (min)	Duration (months)	Est hours	Provider	Role of PCP
McCallum, 2007[136] Good Elementary	LEAP	4 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	In Person, Print	Individual	Family	4 "Brief"	3	1	General practitioner	Participated in intervention
Wake, 2009[162] Good Elementary	LEAP-2	4 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	In Person, Print	Individual	Family	4 "Brief"	3	1	General practitioner	Participated in intervention
Davis, 2012[119] Fair Adolescent	Maintenance (Group classes)	8 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	In Person, Phone	Group, Individual PA sessions	Parent, Child	14 15 (phone), 90 (group)	8	16	Trained research staff	No role
Boutelle, 2014[112] Fair Elementary	Regulation of Cues (ROC) program	14 group session behavioral counseling based on appetite awareness and cue exposure treatment; core components included psychoeducation, parenting skills, coping skills, self-monitoring of hunger and cravings, and experiential learning	In Person, Print	Group	Parent, Child, Family	14 45 (separate child and parent groups); 30 (joint child and parent)	4	28	Doctoral-level psychologists assisted by masters-level cotherapists and undergraduate volunteers	No role
Tanofsky-Kraff, 2010[156] Fair Adolescent	IPT-Weight Gain Prevention	12 75- to 90-min interpersonal psychotherapy (IPT) group meetings + individual 1.5-hr pre-group meeting; overeating and loss-of-control eating linked to interpersonal functioning	In Person	Group, Individual	Child	13 1.5 hours (individual), 75-90 (group)	3	17.9	Psychologist, graduate student	No role

Abbreviations: CDS = clinical decision support; DVD = digital video disc; est = estimated; GP = general practitioner; HD = healthful diet; hr = hour(s); IG = intervention group;

Table 8. Intervention Characteristics of Behavior-Based Trials Included for Treatment Benefit (Key Questions 3–5)

indiv = individual; IPT = interpersonal therapy; m = month(s); MI = motivational interviewing; min = minute(s); msg = message; NP = nurse practitioner; NR = not reported; PA = physical activity; PCP = primary care physician; PE = physical education; pt = participant; RD = registered dietitian; TV = television.

Table 9. Summary of Meta-Analyses of Weight Change in Lifestyle-Based Weight Loss Interventions Compared to Control Groups (Key Question 4)

Estimated Hours of Contact	Outcome	Analysis	SMD	95% CI	k	I^2 (%)
52+	Best weight outcome	Primary*	-1.10	-1.30 to -0.89	6	43.4
		REML model with Knapp-Hartung	-1.10	-1.37 to -0.83	6	43.4
		Including poor-quality studies	-0.97	-1.31 to -0.64	7	86.0
		Higher correlation between baseline and followup (0.80)	-1.24	-1.46 to -1.02	6	48.2
	zBMI only	Primary*	-1.10	-1.37 to -0.84	5	52.8
		REML model with Knapp-Hartung	-1.10	-1.48 to -0.73	5	52.8
		Including poor-quality studies	-0.96	-1.36 to -0.56	6	88.1
		Higher correlation between baseline and followup (0.80)	-1.30	-1.56 to -1.04	5	50.0
26-51	Best weight outcome	Primary*	-0.34	-0.52 to -0.16	9	24.0
		REML model with Knapp-Hartung	-0.31	-0.51 to -0.11	9	24.0
		Including poor-quality studies	-0.31	-0.47 to -0.14	10	19.5
		Higher correlation between baseline and followup (0.80)	-0.43	-0.64 to -0.22	9	41.9
	zBMI only	Primary*	-0.38	-0.64 to -0.13	7	40.0
		REML model with Knapp-Hartung	-0.34	-0.63 to -0.41	7	40.0
		Including poor-quality studies	-0.38	-0.64 to -0.13	7	40.0
		Higher correlation between baseline and followup (0.80)	-0.47	-0.74 to -0.19	7	48.8
6-25	Best weight outcome	Primary*	-0.02	-0.25 to 0.21	7	37.4
		REML model with Knapp-Hartung	-0.02	-0.31 to 0.27	7	37.4
		Including poor-quality studies	-0.16	-0.33 to 0.01	14	34.5
		Higher correlation between baseline and followup (0.80)	-0.06	-0.34 to 0.21	7	56.0
	zBMI only	Primary*	-0.02	-0.25 to 0.21	7	37.4
		REML model with Knapp-Hartung	-0.02	-0.31 to 0.27	7	37.4
		Including poor-quality studies	-0.13	-0.33 to 0.06	12	42.1
		Higher correlation between baseline and followup (0.80)	-0.06	-0.34 to 0.21	7	56.0
0-5	Best weight outcome	Primary*	-0.16	-0.25 to -0.08	14	0.0
		REML model with Knapp-Hartung	-0.17	-0.26 to -0.07	14	0.0
		Including poor-quality studies	-0.15	-0.22 to -0.07	14	0.0
		Higher correlation between baseline and followup (0.80)	-0.20	-0.28 to -0.11	14	0.0
	zBMI only	Primary*	-0.22	-0.34 to -0.10	9	0.0
		REML model with Knapp-Hartung	-0.22	-0.37 to -0.08	9	0.0
		Including poor-quality studies	-0.21	-0.33 to -0.09	9	0.0
		Higher correlation between baseline and followup (0.80)	-0.27	-0.39 to -0.15	9	0.0

*Primary analysis included all fair- and good-quality trials with sufficient data for meta-analysis, assuming a correlation of 0.50 between baseline and followup measures for calculating standard deviation of the change score when not reported, using the Dersimonian & Laird method for pooling.

Abbreviations: CI = confidence interval; k = number of studies; REML = restricted maximum likelihood; SMD = standardized mean difference; zBMI = body mass index z-score.

Table 10. Weight Outcomes of Included Behavior-Based Weight Loss Intervention Trials That Were Not Included in the Meta-Analysis (Key Question 4)

Author, Year Quality	Population	# of Sessions	Months Followup	Outcome	IG Mean Change (SD)	CG Mean Change (SD)	Between Group P-Value
Lison, 2012[131] Fair	Wide age range	122	6	zBMI	-0.16 (NR)	-0.01 (NR)	0.002
Mellin, 1987[137] Fair	Adolescents	24	6	Weight (kg)	-1.40 (NR)	-1.05 (NR)	NSD
Raynor, 2012a[142] Fair	Elementary age	6	6	zBMI	-0.08 (NR)	-0.11 (NR)	NSD
			12	zBMI	-0.10 (NR)	-0.13 (NR)	NSD
Raynor, 2012b[142] Fair	Elementary age	6	6	zBMI	-0.16 (NR)	-0.07 (NR)	NSD
			12	zBMI	-0.22 (NR)	-0.22 (NR)	NSD
O'Connor, 2013[141] Fair	Elementary age	3.5	7	zBMI	1.77 (0.05)*	1.75 (0.06)*	0.86
Love-Osborne, 2014[133] Fair	Adolescents	2.5	8	zBMI	NR (NR)	NR (NR)	NSD

*O'Connor, 2013[141] reported mean (SE) zBMI at followup but BMI percentile at baseline.

Abbreviations: CG = control group; IG = intervention group; kg = kilogram(s); NR = not reported; NSD = no significant difference; SD = standard deviation; zBMI = body mass index.

Table 11. Pooled Results for Continuous Intermediate Cardiometabolic Outcomes of Included Behavior-Based Weight Loss Intervention Trials With ≥52 Estimated Hours of Contact (Key Question 4)

Outcome	Unit	Pooled mean difference in change between groups (95% CI)	# trials	I^2	Model	Report Figure
SBP	mm Hg	-6.4 (-8.6 to -4.2)*	6	51.3	DL	10
DBP	mm Hg	-4.0 (-5.6 to -2.5)†	6	17.3	DL	10
FPG	mg/dL	-0.7 (-2.6 to 0.4)	4	0	PL	11
LDL	mg/dL	-10.0 (-21.1 to 1.1)	4	56.6	REML	12
HDL	mg/dL	0.4 (-1.2 to 2.2)	4	0	PL	12
Triglycerides	mg/dL	-9.1 (-27.8 to 9.6)	4	36.9	REML	12

*REML estimate, -6.4 (95% CI, -9.3 to -3.5).
†REML estimate, -4.1 (95% CI, -6.1 to -2.0).

Abbreviations: DBP = diastolic blood pressure; dL = deciliter(s); DL = Dersimonian & Laird; FPG = fasting plasma glucose; HDL = high density lipoprotein; LDL = low density lipoprotein; mg = milligram(s); mm Hg = millimeters of mercury; PL = profile likelihood; REML = restricted maximum likelihood with Knapp-Hartung modification; SBP = systolic blood pressure.

Table 12. Intervention Characteristics of Pharmacotherapy Trials Included for Treatment Benefit (Key Questions 3, 4)

Author, Year Quality Age group	Intervention	Description	Components	Delivery	Format	Target	# Sessions (session length)	Duration (months)	Est hours	Provider	Role of PCP
Metformin											
Clarson, 2014[117]* Fair Wide range	Metformin + comprehensive lifestyle	Metformin 2000 mg QD + lifestyle intervention consisting of the following sessions over 12 months: 66 group exercise, 12 dietitian, 12 social worker, 4 group family and 12 group child behavior change sessions, for a total of 86 hours of direct contact	HD advice PA advice PA sessions Behavioral Drug	In Person	Group, Individual	Child, Family	106 (Social worker 30 mins, dietitian 30 mins, group family 120 mins, group behavior 20 mins, exercise 60 mins)	12	86	Exercise specialist, social worker, dietitian	No role
Wiegand, 2010[165]* Fair Wide range	Metformin + family-based lifestyle intervention	Metformin 500 mg bid + multi-professional family-based lifestyle program consisting of individual goal setting, reinforcement sessions and structured interview with basic education and 2 45-min PA classes per week	HD advice PA advice PA sessions Behavioral Drug	In Person	Group, Individual	Family	58 (sport sessions 45 minutes; other NR)	6	40.8	Multi-professional (not further described)	No role
Wilson, 2010[166]* Fair Adolescent	Metformin + lifestyle intervention	Metformin 500 mg qid + 19 session lifestyle cognitive-behavioral therapy program	HD advice PA advice Behavioral Drug	In Person	Individual	Family	19 (NR)	12	9.5	Trained health specialist	No role

Table 12. Intervention Characteristics of Pharmacotherapy Trials Included for Treatment Benefit (Key Questions 3, 4)

Author, Year Quality Age group	Intervention	Description	Components	Delivery	Format	Target	# Sessions (session length)	Duration (months)	Est hours	Provider	Role of PCP
Yanovski, 2011[167]* Good Wide range	Metformin + lifestyle intervention	Metformin 1 g bid + lifestyle intervention consisting of 6 monthly family meetings with dietitian and self-monitoring of food and activity using pedometer	HD advice PA advice Behavioral Drug	In Person	Individual	Family	6 (NR)	6	3	Dietitian	No role
Love-Osborne, 2008[134] Fair Adolescent	Metformin + goal setting	Metformin 850 mg bid + 6 monthly individual goal-setting sessions; initial session included written material and video	HD advice PA advice Behavioral Drug	In Person, Electronic, Print	Individual	Child	6 (NR)	6	2.25	Dietitian or study investigator and research assistant	No role
Kendall, 2013[129]* Fair Wide range	Metformin + 1 individual session	Metformin 1.5 g/day and 1 standardized individual healthy lifestyle advice session	HD advice PA advice Drug	In Person, Print	Individual	Child	1 (NR)	6	0.25	NR	No role
Srinivasan, 2006[152] Fair Wide range	Metformin + 1 individual session	Metformin 1 g bid + standardized information on healthy eating and exercise	HD advice PA advice Drug	In Person	Individual	Child	1 (NR)	6	0.25	NR	No role
Freemark, 2001[122] Fair Adolescent	Metformin	Metformin 500 mg bid; no dietary change attempted	Drug	NA	NA	Child	0 (NR)	NA	0	NA	No role

Table 12. Intervention Characteristics of Pharmacotherapy Trials Included for Treatment Benefit (Key Questions 3, 4)

Author, Year Quality Age group	Intervention	Description	Components	Delivery	Format	Target	# Sessions (session length)	Duration (months)	Est hours	Provider	Role of PCP
Orlistat											
Yanovski, 2012[102]* Fair Adolescent	Orlistat + behavioral weight loss	Orlistat 120 mg TID for 6 months plus 12-week behavioral weight loss program	HD advice PA advice PA sessions Behavioral Drug	In Person	Group	Child	15 (NR)	6	15	Registered dietitian	NR
Chanoine, 2005[116] Fair Adolescent	Orlistat + Diet, PA, and Behavior Therapy	Orlistat 120 mg 3 times/day + hypocaloric diet, exercise and behavioral therapy; 18 individual meetings with dietitian and behavioral psychologist	HD advice PA advice Behavioral Drug	In Person	Individual	Child	18 (NR)	12	9	Dietitian, behavioral psychologist	No role
Maahs, 2006[135] Fair Adolescent	Orlistat + dietitian counseling	Orlistat 120 mg 3 times/day + 7 monthly diet and exercise counseling sessions with dietitian	HD advice PA advice Behavioral Drug	In Person, Print	Individual	Child	7 (NR)	6	3.5	Dietitian	No role

*New studies since previous review.

Abbreviations: bid = twice daily; HD = healthy diet; est = estimated; g = gram(s); mg = milligram(s); NA = not applicable; NR = not reported; qid = four times daily; PA = physical activity.

Table 13. Pooled Results for Continuous Intermediate Cardiometabolic Outcomes of Included Metformin Trials (Key Question 4)

Outcome	Unit	Pooled mean difference in change between groups (95% CI)	# trials	I^2	Model	Report Figure
FPG	mg/dL	-3.7 (-9.9 to 2.5)	5	64.0	REML	15
TC	mg/dL	-2.5 (-13.7 to 8.7)	4	0.0	REML	16
LDL	mg/dL	-0.3 (-8.4 to 7.8)	6	21.4	REML	16
HDL	mg/dL	0.2 (-2.4 to 2.8)	6	11.9	REML	16
Triglycerides	mg/dL	3.1 (-17.6 to 23.8)	5	0.0	REML	16

Abbreviations: CI = confidence interval; DBP = diastolic blood pressure; dL = deciliter(s); DL = Dersimonian & Laird; FPG = fasting plasma glucose; HDL = high density lipoprotein; LDL = low density lipoprotein; mg = milligram(s); mm Hg = millimeters of mercury; PL = profile likelihood; REML = restricted maximum likelihood with Knapp-Hartung modification; SBP = systolic blood pressure.

Table 14. Discontinuation Rates in Pharmacotherapy Trials Included for Harms of Treatment (Key Question 5)

Study, Year Quality	Timepoint, months	Drug: N Discontinuing due to AE	Drug: N Analyzed	Drug: % Discontinuing due to AE	Placebo: N Discontinuing due to AE	Placebo: N Analyzed	Placebo: % Discontinuing due to AE
Metformin							
Kay, 2001[128] Fair	2	0	12	0	NR*	12	NR*
Evia-Viscarra, 2012[121] Fair	3	2	15	13.3	2	16	12.5
Burgert, 2008[115] Fair	4	0	15	0	NR*	13	NR*
Love-Osborne, 2008[134] Fair	6	2	60	3.3	1	25	4
Wiegand, 2010[165] Fair	6	1	36	2.8	3	34	8.8
Yanovski, 2011[167] Good	6	1	53	1.9	0	47	0
Clarson, 2014[117] Fair	12	1	33	3.0	NR*	36	NR*
Wilson, 2010[166] Fair	12	3	39	7.7	1	38	2.6
Metformin Total		**10**	**263**	**3.8%**	**7**	**221**	**3.2%**
Orlistat							
Maahs, 2006[135] Fair	6	2	20	10	0	20	0
Yanovski, 2012[102] Fair	6	1	100	1	2	100	2
Chanoine, 2005[116] Fair	12	12	352	3.4	3	181	1.7
Orlistat Total		**15**	**472**	**3.2%**	**5**	**301**	**1.7%**

*NR counted as 0 in totals.

Abbreviations: AE = adverse effect; NR = not reported.

Table 15. Summary of Evidence

Key Question Topic	# of Studies	# of Participants	Study Design	Summary of Findings	Consistency/ Precision	Limitations (Includes Reporting Bias)	Overall Study Quality	Applicability
Key Question 1, 1a, 1b, 1c: Benefits of screening	0	NA	NA	NA	NA	NA	NA	NA
Key Question 2: Harms of screening	0	NA	NA	NA	NA	NA	NA	NA
Key Question 3: Health benefits treatment *Behavior-based interventions*	11	1523	RCTs	11 trials reported generally small statistically nonsignificant relative increases in health-related quality of life or functioning scores, using a variety of specific measures, except 1 trial in young children that reported improved physical functioning with a larger effect size. Trials reported high variability in effects, suggesting a wide range of benefit to individuals within trials. In addition, 5 trials reported measures related to self-esteem and 5 of body satisfaction, with most finding no group differences. 1 trial reported no differences in percent screening positive for depression.	Consistency: Quality of life/functioning results reasonably consistent, other outcomes either inconsistent or had insufficient data to rate consistency for other outcomes Precision: Quality of life/functioning results imprecise, primarily due to confidence intervals that straddle 1.0 and wide variety of specific measures; other outcomes imprecise due to inconsistency or insufficient data to rate precision for other outcomes	Wide variety of measures and specific outcomes reported, raising concerns about reporting bias; however, since most results were not statistically significant this concern is mitigated.	Fair to good (5 good-quality trials, 6 fair-quality trials)	5 trials conducted in the United States, 3 involved primary care
Key Questions 3a (common components of efficacious interventions) and 3b (differences in efficacy by subpopulation) *Behavior-based interventions*	11	1523	RCTs	Data were insufficient to examine variability in effects due to treatment components or differences in effect for important subpopulations.	Consistency: NA Precision: NA	Same as KQ3, and only 1 trial reporting clear benefit, with insufficient variability in effect size to examine further	Fair to good (5 good-quality trials, 6 fair-quality trials)	5 trials conducted in the United States, 3 involved primary care

Table 15. Summary of Evidence

Key Question Topic	# of Studies	# of Participants	Study Design	Summary of Findings	Consistency/ Precision	Limitations (Includes Reporting Bias)	Overall Study Quality	Applicability
Key Questions 3, 3a, 3b Health benefits of treatment *Pharmacologic interventions*	1 (Orlistat)	40	RCT	No difference in quality of life between users of orlistat and placebo. Insufficient data to examine common components of efficacious interventions or differences in efficacy by subpopulation.	Consistency: NA Precision: Imprecise	Single small study, short (6 month) followup	Fair	Conducted in the United States, but not in primary care.
Key Question 4, 4a: Benefits of behavior-based interventions on weight and cardiometabolic outcomes *Lifestyle-based weight loss interventions*	42	6956	3 CCTs, 39 RCTs	Interventions with ≥26 hours of contact generally reported small average reductions in excess weight, with larger effects seen in trials with greater contact hours. Intervention groups receiving ≥26 hours of contact generally reported zBMI reductions of 0.10 to 0.77 while control group youth showed reductions of ≤0.20, or increased zBMI at followup. Trials reported high variability in effects, suggesting a wide range of benefit to individuals within trials. In trials with ≥52 hours of estimated contact, improvements were seen in SBP (-6.4, 95% CI -8.6 to -4.2) and DBP (-4.0, 95% CI -5.6 to -2.5) and some insulin/glucose parameters in some trials, but benefits were rare and cardiometabolic outcomes were sparsely reported in trials of lower-contact interventions.	Consistency: Reasonably consistent for weight outcomes, reasonably consistent for blood pressure and lipids, inconsistent for insulin/glucose measures Precision: Imprecise	No evidence of reporting bias was identified, but many included trials were limited by small sample sizes (n<40 per treatment arm) and fairly high (20%-40%) attrition. 16 trials were excluded for poor quality. For cardiometabolic outcomes, reporting bias was not apparent because most of the highest-contact trials reported these outcomes. Reporting was most spare in trials with <52 contact hours, where benefits were rarely found.	Fair to good (8 good-quality, 34 fair-quality)	Almost half of the trials were conducted in the United States, and over one-third were conducted in primary care settings, but trials with the highest contact hours and largest effects were not conducted in primary care, and access to similar programs is likely limited.
Key Question 4: Benefits of behavior-based interventions on weight *Other weight loss interventions*	2	82	RCTs	Small feasibility trials of interpersonal therapy and a regulation of cues intervention to limit overeating did not show group differences in BMI or zBMI change.	Consistency: NA Precision: Imprecise	Very limited data	Fair (both fair-quality)	Both trials conducted in the United States, one with substantial representation of black and Latino youth.

Table 15. Summary of Evidence

Key Question Topic	# of Studies	# of Participants	Study Design	Summary of Findings	Consistency/ Precision	Limitations (Includes Reporting Bias)	Overall Study Quality	Applicability
Key Question 4: Benefits of behavior-based interventions on weight *Weight loss maintenance interventions*	1	61	RCT	Small pilot study found that the addition of a maintenance group intervention after completing a weight loss intervention did not improve weight maintenance.	Consistency: NA Precision: Imprecise	Single very small trial.	Fair	Trials conducted in the United States, sample limited to black and Latino youth
Key Question 4, 4a: Benefits of pharmacologic interventions on weight and cardiometabolic outcomes *Metformin*	8	616	RCTs	Metformin was associated with a small statistically significant weight reduction with very low statistical heterogeneity despite differences in dose and background therapy. In pooled analyses, metformin reduced zBMI by -0.10 (95% CI, -0.17 to -0.03; k=6; I^2=13.1) and BMI by -0.86 (95% CI, -1.44 to -0.29; k=6; I^2=0). Results of trials that could not be pooled were generally consistent with pooled results. Metformin was associated with no statistically significant benefit for fasting glucose, lipid or blood pressure outcomes; where outcomes could be pooled, confidence intervals were wide and statistical heterogeneity was high for some outcomes.	Consistency: Reasonably consistent Precision: Imprecise	Small studies with wide confidence intervals; short trials primarily of 6 month duration; limited data about persistence of effect after discontinuation	Fair (1 good-quality, 7 fair-quality)	Most trials conducted in the United States, but none in primary care. 75% of trials required abnormalities of insulin or glucose for inclusion and mean baseline BMI of 36.0 kg/m^2; reasonable representation of black and Hispanic youth

Table 15. Summary of Evidence

Key Question Topic	# of Studies	# of Participants	Study Design	Summary of Findings	Consistency/ Precision	Limitations (Includes Reporting Bias)	Overall Study Quality	Applicability
Key Question 4, 4a: Benefits of pharmacologic interventions on weight and cardiometabolic outcomes *Orlistat*	3	779	RCTs	Orlistat was associated with small between-group reductions in BMI ranging from -0.94 (95% CI, -1.58 to -0.30) to -0.50 (95% CI, -7.62 to 6.62) and weight ranging from -3.90 (-25.54 to 17.74) to -2.61 (95% CI, not reported, p<0.001) kg. The 1 trial reporting zBMI showed a between-group difference of -0.06 (95% CI, -0.12 to 0.00) favoring orlistat. Results were statistically significant only in the 2 larger trials. Where reported, changes in cardiometabolic risk factors were generally statistically nonsignificant, except for a diastolic blood pressure reduction in 1 large trial (mean between-group difference, -1.81 mm Hg [CI not reported], p=0.04).	Consistency: Reasonably consistent Precision: Imprecise	Small body of evidence (3 studies). 1 of 3 studies was small (n=40); 2 of 3 trials had short 6-month duration. No study followed weight change after medication use ended.	Fair (all fair-quality)	All trials conducted in the United States, but none in primary care. Mean baseline BMI of 37.4 kg/m^2; reasonable representation of black and Hispanic youth.
Key Question 4b: Common components of efficacious interventions *Lifestyle-based weight loss interventions*	42	6956	3 CCTs, 39 RCTs	Hours of contact was the only treatment characteristic clearly associated with effect size. Most successful interventions took place outside of the primary care setting, targeted both the parent and child, provided didactic information, helped parents and children engage in stimulus control (e.g., limiting access to tempting foods, limiting screening time), identified or helped participants identify specific goals, and encouraged self-monitoring and problem-solving to help achieve the goals, and included supervised physical activity sessions.	Consistency: Apparent dose-response effect for hours of contact, could not determine for other components Precision: NA	Interventions were highly variable and impact of specific components could not be evaluated.	Fair to good (8 good quality, 34 fair quality)	Almost ½ of the trials were conducted in the United States, and >1/3 were conducted in primary care settings, but trials with the highest contact hours and largest effects were not conducted in primary care, and access to similar programs is likely limited.

Table 15. Summary of Evidence

Key Question Topic	# of Studies	# of Participants	Study Design	Summary of Findings	Consistency/ Precision	Limitations (Includes Reporting Bias)	Overall Study Quality	Applicability
Key Question 4c: Differences in efficacy by key patient subgroups *Lifestyle-based weight loss interventions*	42	6956	3 CCTs, 39 RCTs	Only 6 trials reported subgroup analyses, and neither these analyses nor evidence in trials limited to important subpopulations suggested that lifestyle-based weight loss interventions were more or less effective in subpopulations defined by age, race/ethnicity, sex, degree of excess weight, or socioeconomic status	Consistency: Inconsistent Precision: Imprecise	Only 6 trials included subgroups analyses, definitions of subpopulations varied across studies; many subgroups involved small sample sizes; statistical interaction testing was missing in several trials	Fair to good (8 good-quality, 34 fair-quality)	Almost half of the trials were conducted in the United States, and over one-third were conducted in primary care settings, but trials with the highest contact hours and largest effects were not conducted in primary care, and access to similar programs is likely limited.
Key Question 5: Harms of treatment *Behavior-based interventions*	10	1232	RCT	Among 10 trials reporting something related to adverse effects, 5 reported no adverse or serious adverse effects associated with the interventions; others reported no group differences on eating disorder pathology or body dissatisfaction.	Consistency: Consistent Precision: Imprecise	Sparsely and inconsistently reported.	Fair to good (4 good-quality,6 fair - quality)	4 U.S.-based trials, 3 conducted in primary care, covering elementary age children and adolescents
Key Question 5: Harms of pharmacologic interventions *Metformin*	11	705	RCTs	Gastrointestinal side effects were common but not serious in participants taking metformin. Side effects were also frequently reported by those on placebo. Discontinuation due to adverse effects was relatively rare (<5%) and occurred in relatively similar proportions in metformin and placebo groups.	Consistency: Despite difference in how side effects were reported, results reasonably consistent Precision: Imprecise	Inconsistent definitions of side effects across studies.	10 fair, 1 good	Most trials conducted in the United States, but none in primary care.

Table 15. Summary of Evidence

Key Question Topic	# of Studies	# of Participants	Study Design	Summary of Findings	Consistency/ Precision	Limitations (Includes Reporting Bias)	Overall Study Quality	Applicability
Key Question 5: Harms of pharmacologic interventions *Orlistat*	3	779	RCTs	Gastrointestinal side effects were very common among patients taking orlistat. Discontinuation due to adverse effects was relatively rare (<5%), and about twice as common in orlistat participants compared with those taking placebo.	Consistency: Despite difference in how side effects were reported, results reasonably consistent Precision: Imprecise	Evidence limited to 3 studies, 1 of which was small (n=40).	Fair (all fair-quality)	All trials conducted in the United States, but none in primary care.

Abbreviations: BMI = body mass index; CCT = controlled clinical trial; CI = confidence interval; KQ = Key Question; NA = not applicable; RCT = randomized controlled trial; SBP = systolic blood pressure; zBMI = body mass index z-score.

Appendix A. Association Between Childhood Weight Loss and Adult Obesity (Contextual Question 1)

Concerns about child and adolescent obesity are due in large part to the potential link to adult obesity and associated morbidity. We did not identify any studies that provided direct evidence on the effect of improvements in child weight outcomes on the likelihood of adult obesity. However, an association between childhood weight loss and lower risk of adult obesity is suggested by ten-year outcomes for 176 children with obesity in four randomized family-based obesity treatment studies.[253, 297] Study participants were 6 to 12 years of age at baseline (mean, 10.4 years), so the average age at followup was 20 years. At baseline, children were 49.9 (SD 17.2) percent overweight on average, with an average zBMI of 2.8 (SD 1.1). Based on these statistics, we estimate that almost all youth in these studies would have been above the 95th percentile for BMI, with approximately 85 percent meeting obesity criteria as a conservative low-end estimate. At 12 months after baseline, 39.1 percent of children achieved a BMI value below the 95th BMI percentile, and 23.7 percent were below the 85th BMI percentile. At 10-year followup, 47.5 percent and 22.2 percent of children were below the 95th and 85th BMI percentile, respectively. The magnitude of zBMI changes shows similar long-term success of treatment. At 12 months, 73.7 percent and 46.5 percent of children achieved at least a 0.5 and 1.0 zBMI unit reduction, respectively. At 10-year followup, 66.7 percent and 44.4 percent of children achieved at least a 0.5 and 1.0 zBMI unit reduction, respectively.

Table 1. Percentage of Children Who Met Success Criteria at 12 and 120 Months, Among Participants in Four Family-Based Obesity Intervention Programs[253]

Outcome	12 months	120 months
<95th BMI percentile	39.1%	47.5%
<85th BMI percentile	23.7%	22.2%
>0.5 zBMI unit change	73.7%	66.7%
>1 zBMI unit change	46.5%	44.4%

Abbreviations: BMI = body mass index; zBMI = body mass index z-score.

There is also substantial evidence from cohort studies presented in several systematic reviews that childhood obesity typically persists into adulthood. A 2005 systematic review evaluated 19 longitudinal cohort studies (retrospective or prospective) that reported on weight measurements in childhood and adulthood.[13] The review found correlations between child (ages 6 to 11 years) and adult (up to age 37 years) BMI measures ranging from 0.36 to 0.73 in white males and from 0.21 to 0.63 in white females. Correlations between child and adult measures ranged from 0.28 to 0.68 for black males and from 0.28 to 0.65 in black females. Childhood BMI showed stronger tracking into adulthood in children who were older than 8 years, were more overweight, or had one or more parents with obesity. Correlations between adolescent (ages 12 to 18 years) and adult BMI measures were generally higher than for childhood measures, ranging from 0.58 to 0.81 in white males aged 17 to 18 years, from 0.63 to 0.81 in white females aged 17 to 18 years, and from 0.37 to 0.72 in black males and females aged 13 to 17 years. Data on tracking of BMI in children aged 2 to 5 years were limited, but generally showed that tracking into adulthood was minimal. Sex differences in tracking were not consistent across ages. The probability of having obesity as an adult (ages 18 to 37 years) was about 50 percent for children and adolescents (ages 5 to 17 years) between the 85th and 94th BMI percentile, and about 70 percent for those at or above the 95th BMI percentile.

A 2008 systematic review examined the evidence on the persistence of childhood overweight from 18 prospective or retrospective longitudinal studies with anthropometric measurements during childhood or adolescence (ranging from birth to age 19 years) and adulthood (ranging

from age 18 to 54 years).[298] All the included studies reported that youths who were overweight or had obesity were at increased risk of becoming overweight or having obesity in adulthood. When limited to only high-quality studies, the relative risk of overweight children becoming overweight or having obesity in adulthood ranged from 1.9 to 10.1. For children with obesity, the odds ratio ranged from 1.3 to 22.3. The percentage of overweight adolescents who became overweight or developed obesity in adulthood ranged between 22 percent and 58 percent, and the percentage of adolescents with obesity who became overweight or developed obesity in adulthood ranged between 24 percent and 90 percent.

A 2011 meta-regression analysis on BMI tracking included data on 55,072 individuals from 48 articles with BMI measurements in the same persons at two or more time points.[50] Correlations between BMI measured in children under age 10 and BMI measured 10, 20, and 30 years later were 0.67, 0.50, and 0.27, respectively. For BMI measurements in children aged 10 to 14 years, correlations were 0.75, 0.60, and 0.40. Correlations for adolescent (age 14 to 18 years) BMI measurements were 0.73, 0.58, and 0.38.

A 2012 systematic review included 24 studies that investigated the association between early (≤5 years) childhood obesity and adult overweight or obesity.[299] Almost all studies reported a significant association between childhood obesity and adult overweight or obesity. The review concluded that early childhood obesity (especially after age two) persists into adulthood, so early childhood obesity is a probable early predictor of adult obesity.

A 2015 systematic review and meta-analysis investigated how accurately simple measures of childhood obesity (e.g., BMI) predict obesity in adolescence and adulthood.[14] The review included prospective, longitudinal studies with a sample of at least 1,000 children that measured obesity in childhood and again at least 5 years later. Included studies were limited to those reporting data needed to calculate test accuracy; therefore, studies that provided only correlations between obesity measures at different time points were excluded. Twenty-three studies from 16 cohorts were included in the review, and all used BMI to measure childhood obesity. Followup for the studies ranged from 6 to 42 years, with 11 of the 23 studies having followup of at least 20 years. Meta-analyses of twenty studies showed a strong association between childhood obesity and adult obesity, with children with obesity being about five times more likely to have obesity in adulthood than children without obesity (pooled RR, 5.21 [95% CI, 4.50 to 6.02]). The review presents data on the sensitivity, specificity, and PPV for each study to investigate the diagnostic performance of using obesity in children, according to age of BMI measurement, to predict obesity in adults. The review found that children with obesity, and particularly adolescents with obesity, are likely to still have obesity in adulthood. The PPVs for predicting adult obesity from childhood obesity showed that close to 80 percent of adolescents with obesity go on to have obesity as adults, or approximately 70 percent, when adult BMI was measured at age 30 years or older. Approximately 64 percent of pre-adolescents who had obesity also had obesity in adulthood. However, the review demonstrated that childhood BMI is a poor predictor of adult obesity. Sensitivity was less than 40 percent in all but one study, so most adults with obesity did not have obesity in childhood.

In an effort to explain the childhood determinants of adult obesity, a 2011 systematic review examined the evidence on tracking of physical activity and diet between childhood and

adulthood.[300] The review included five studies with data on diet tracking and 16 studies with data on physical activity tracking. There was evidence for tracking of both of these behaviors, with similar estimates of strength of tracking, lending support to the need for interventions aimed at modifying diet and physical activity behaviors in overweight children. Based on correlation coefficients, the strength of tracking of physical activity into adulthood was stronger for males (range, -0.1 to 0.47; $p<0.001$ for frequency of activity over 8 years) than females (range, -0.04 to 0.37; $p<0.001$ over 6 years), increased with age at which the baseline measurements were made, and declined with duration of followup. Correlation coefficients for tracking of food intake were positive in all cohorts and ranged from 0.009 to 0.66.

Although the data reported in the reviews described above are highly variable due to heterogeneity across studies in sample sizes, study design, cutoffs to define overweight and obesity, and the age at which child and adult weight were measured, the results consistently provide support for the persistence of obesity from childhood into adulthood. The long-term data from four childhood obesity treatment studies suggest that weight loss in children with obesity may reduce the likelihood of adult obesity, reinforcing the importance of effective interventions to manage childhood obesity.

Literature Search Strategies

CENTRAL

Issue 1 of 12, January 2015

#1 (obese or obesity or overweight or "over weight"):ti,ab,kw
#2 screen*:ti,ab,kw
#3 (body next mass next ind*):ti,ab,kw
#4 (body next mass next abdominal next ind*):ti,ab,kw
#5 (body next adiposity next ind*):ti,ab,kw
#6 (bmi or bmai):ti,ab,kw
#7 (skinfold or "skin fold"):ti,ab,kw
#8 (waist next circumference*):ti,ab,kw
#9 (waist near/3 ratio*):ti,ab,kw
#10 "weight for height":ti,ab,kw
#11 "weight for age":ti,ab,kw
#12 "weight stature":ti,ab,kw
#13 (adipos* near/2 measur*):ti,ab,kw
#14 anthropometr*:ti,ab,kw
#15 (#2-`#14)
#16 (child* or teen or teens or teenage* or adolescen* or youth or youths or young people or (young next adult*) or pediatric* or paediatric* or schoolchildren or school children or preschool* or (pre next school*) or toddler*):ti,ab,kw
#17 #1 and #15 and #16 Publication Year from 2005 to 2015, in Trials
#18 (obese or obesity or overweight or "over weight"):ti,ab,kw
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#20 (weight next change*):ti,ab,kw
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#68 metformin:ti,ab,kw
#69 Glucophage:ti,ab,kw
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#71 dimethylguanylguanidine:ti,ab,kw
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#73 (or #64-#72)
#74 #41 or #47 or #53 or #63 or #73
#75 #16 and #25 and #74 Publication Year from 2010 to 2015, in Trials
#76 #17 or #75

ERIC

#	Query	Limiters/Expanders
S17	S5 AND S16	Limiters - Date Published: 20050101-20151231 Search modes - Find all my search terms
S16	(S6 OR S7 OR S8 OR S9 OR S10 OR S11 OR S12 OR S13 OR S14 OR S15)	
S15	TI child* OR TI student* OR TI school*	
S14	DE "Nutrition Instruction"	
S13	DE "Child Caregivers" OR DE "Child Development Specialists" OR DE "Caregiver Role"	
S12	DE "Interdisciplinary Approach"	
S11	DE "Lesson Plans" OR DE "Integrated Curriculum" OR DE "Curriculum Implementation"	
S10	DE "School Policy" OR DE "School Role" OR DE "School Community Relationship" OR DE "School Involvement" OR DE "School Responsibility" OR DE "Teacher Role" OR DE "Teacher Responsibility"	
S9	DE "High School Freshmen" OR DE "High School Seniors" OR DE "High School Students" OR DE "High Schools" OR DE "Secondary School Teachers" OR DE "Secondary Schools"	
S8	DE "Middle School Students" OR DE "Middle School Teachers" OR DE "Middle Schools"	
S7	DE "Primary Education" OR DE "Kindergarten" OR DE "Grade 1" OR DE "Grade 2" OR DE "Grade 3" OR OR DE "Grade 4" OR DE "Grade 5" OR DE "Grade 6" OR DE "Grade 7" OR DE "Grade 8" OR DE "Grade 9" OR DE "Grade 10" OR DE "Grade 11" OR DE "Grade 12"	
S6	DE "Elementary School Students" OR DE "Elementary School Teachers" OR DE "Elementary Schools" OR DE "Elementary Secondary Education" OR DE "Elementary School Curriculum"	
S5	S1 OR S2 OR S3 OR S4	
S4	TI obesity OR TI obese OR TI overweight OR TI over weight	
S3	DE "Body Weight"	
S2	DE "Body Composition"	
S1	DE "Obesity"	

Ovid Medline

Screening

Database: Ovid MEDLINE(R) <1946 to February Week 1 2015>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <February 09, 2015>, Ovid MEDLINE(R) Daily Update <February 09, 2015>

Search Strategy:

---

1 Obesity/
2 Obesity, Morbid/
3 Obesity, Abdominal/
4 Overweight/
5 Weight Gain/
6 obesity.ti,ab.
7 obese.ti,ab.
8 overweight.ti,ab.
9 over weight.ti,ab.
10 or/1-9
11 Child/ or Child, Preschool/ or Adolescent/ or Young Adult/
12 (child$ or teen or teens or teenage$ or adolescen$ or youth or youths or young people or young adult$ or pediatric$ or paediatric$ or schoolchildren or school children or preschool$ or pre school$ or toddler$).ti.
13 (child$ or teen or teens or teenage$ or adolescen$ or youth or youths or young people or young adult$ or pediatric$ or paediatric$ or schoolchildren or school children or preschool$ or pre school$ or toddler$).ti,ab.
14 limit 13 to ("in data review" or in process or "pubmed not medline")
15 10 and (11 or 12 or 14)
16 Pediatric Obesity/
17 15 or 16
18 Mass screening/
19 Body constitution/
20 "Body Weights and Measures"/
21 Body Fat Distribution/
22 Adiposity/
23 Body Mass Index/
24 Skinfold thickness/
25 Body height/ and Body weight/
26 Waist circumference/
27 Waist-height ratio/
28 Anthropometry/
29 screen$.ti,ab.
30 body mass index$.ti,ab.
31 body mass indices.ti,ab.
32 bmi.ti,ab.
33 body mass abdominal index$.ti,ab.
34 body mass abdominal indices.ti,ab.
35 bmai.ti,ab.

36 body adiposity index$.ti,ab.
37 body adiposity indices.ti,ab.
38 (skinfold or skin fold).ti,ab.
39 waist circumference$.ti,ab.
40 waist to height ratio$.ti,ab.
41 waist height ratio$.ti,ab.
42 waist to hip ratio$.ti,ab.
43 waist hip ratio$.ti,ab.
44 weight for height.ti,ab.
45 height for weight.ti,ab.
46 weight for age.ti,ab.
47 weight stature.ti,ab.
48 (adiposity adj2 measur$).ti,ab.
49 anthropometr$.ti,ab.
50 or/18-49
51 17 and 50
52 Pediatric Obesity/di [Diagnosis]
53 Obesity/di
54 Obesity, Morbid/di
55 Obesity, Abdominal/di
56 Overweight/di
57 53 or 54 or 55 or 56
58 57 and (11 or 12 or 14)
59 51 or 52 or 58
60 clinical trials as topic/ or controlled clinical trials as topic/ or randomized controlled trials as topic/ or meta-analysis as topic/
61 (clinical trial or controlled clinical trial or meta analysis or randomized controlled trial).pt.
62 Random$.ti,ab.
63 control groups/ or double-blind method/ or single-blind method/
64 clinical trial$.ti,ab.
65 controlled trial$.ti,ab.
66 meta analy$.ti,ab.
67 or/60-66
68 59 and 67
69 limit 68 to (english language and yr="2005 -Current")
70 remove duplicates from 69

Ovid Medline
Treatment trials

Database: Ovid MEDLINE(R) <1946 to February Week 1 2015>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <February 09, 2015>, Ovid MEDLINE(R) Daily Update <February 09, 2015>
Search Strategy:
---
1 Obesity/
2 Obesity, Morbid/
3 Obesity, Abdominal/
4 Overweight/
5 Weight Gain/
6 Weight Loss/
7 obesity.ti,ab.
8 obese.ti,ab.
9 overweight.ti,ab.
10 over weight.ti,ab.
11 (weight gain$ or weight loss$).ti,ab.
12 weight change$.ti,ab.
13 ((bmi or body mass ind$) adj2 (gain$ or loss$ or change$)).ti,ab.
14 weight maintenance.ti,ab.
15 weight control.ti,ab.
16 weight manag$.ti,ab.
17 or/1-16
18 Child/ or Child, Preschool/ or Adolescent/ or Young Adult/
19 (child$ or teen or teens or teenage$ or adolescen$ or youth or youths or young people or young adult$ or pediatric$ or paediatric$ or schoolchildren or school children or preschool$ or pre school$ or toddler$).ti.
20 (child$ or teen or teens or teenage$ or adolescen$ or youth or youths or young people or young adult$ or pediatric$ or paediatric$ or schoolchildren or school children or preschool$ or pre school$ or toddler$).ti,ab.
21 limit 20 to ("in data review" or in process or "pubmed not medline")
22 17 and (18 or 19 or 21)
23 Pediatric Obesity/ (
24 22 or 23
25 Counseling/
26 Directive Counseling/
27 Behavior therapy/
28 Aversive therapy/
29 Biofeedback, Psychology/
30 Feedback, Psychological/
31 Cognitive therapy/
32 "Acceptance and commitment therapy"/
33 Mindfulness/
34 Desensitization, psychologic/

35 Relaxation therapy/
36 Meditation/
37 Social Support/
38 Psychotherapy, Group/
39 Family Therapy/
40 Persuasive Communication/
41 Risk Reduction Behavior/
42 Health Education/
43 Health Promotion/
44 Patient Education as Topic/
45 "Early Intervention (Education)"/
46 ((psychological or behavio?r$) adj (therap$ or modif$ or chang$ or strateg$ or intervention$)).ti,ab.
47 (group therap$ or family therap$ or cognitive therap$).ti,ab.
48 cbt.ti,ab.
49 ((lifestyle or life style) adj (chang$ or interven$ or modif$)).ti,ab.
50 counsel?ing.ti,ab.
51 social$ support$.ti,ab.
52 (peer$ adj2 support$).ti,ab.
53 ((child$ adj3 parent$) and therap$).ti,ab.
54 (family intervention$ or parent$ intervention$).ti,ab.
55 (parent$ adj2 (behavio?r$ or involv$ or control$ or attitude$ or educat$)).ti,ab.
56 health education.ti,ab.
57 health promotion.ti,ab.
58 patient education.ti,ab.
59 nonpharmacologic intervention$.ti,ab.
60 non pharmacologic intervention$.ti,ab.
61 self regulat$.ti,ab.
62 (school$ adj5 (intervention$ or program$)).ti,ab.
63 or/25-62
64 Exercise/
65 Physical Conditioning, Human/
66 (exercise or physical activity).ti.
67 aerobic$.ti.
68 (fitness adj (class$ or regime$ or program$)).ti.
69 (physical training or physical education).ti.
70 (sedentary behavio?r$ adj3 reduc$).ti,ab.
71 ((exercise or physical activity) adj5 (intervention$ or promot$)).ti,ab.
72 or/64-71
73 Diet-Fat-Restricted/
74 Diet-Reducing/
75 Diet, Carbohydrate-Restricted/
76 Diet-Therapy/
77 Caloric Restriction/
78 Food Habits/
79 (diet or diets or dieting or dietary).ti.

80 (diet$ adj (modif$ or therap$ or intervention$ or strateg$)).ti,ab.
81 (low calorie or calorie control$ or healthy eating).ti,ab.
82 formula diet$.ti,ab.
83 (weightwatcher$ or weight watcher$).ti,ab.
84 or/73-83
85 Case management/
86 Patient care team/
87 Cooperative behavior/
88 Interprofessional Relations/
89 Continuity of patient care/
90 Patient-centered care/
91 Patient care management/
92 Delivery of Health Care, Integrated/
93 collaborat$.ti,ab.
94 (interdisciplinary or inter disciplinary).ti,ab.
95 (multidisciplinary or multi disciplinary).ti,ab.
96 (integrated adj5 (healthcare or care)).ti,ab.
97 care manag$.ti,ab.
98 case manag$.ti,ab.
99 cooperative care.ti,ab.
100 coordinated care.ti,ab.
101 patient centered care.ti,ab.
102 stepped care.ti,ab.
103 or/85-102
104 Anti-Obesity Agents/
105 Metformin/
106 Lactones/
107 Orlistat.ti,ab.
108 tetrahydrolipstatin.ti,ab.
109 Xenical.ti,ab.
110 Alli.ti,ab.
111 metformin.ti,ab.
112 Glucophage.ti,ab.
113 dimethylbiguanidine.ti,ab.
114 dimethylguanylguanidine.ti,ab.
115 (dimethylbiguanide or dimethyl-biguanide).ti,ab.
116 or/104-115
117 Weight Reduction Programs/
118 ((weight loss or weight reduction) adj3 (intervention$ or promot$)).ti,ab.
119 24 and (63 or 72 or 84 or 103 or 116 or 117 or 118)
120 Pediatric Obesity/dh, dt, pc, rh, th [Diet Therapy, Drug Therapy, Prevention & Control, Rehabilitation, Therapy]
121 Obesity/dh, dt, pc, rh, th
122 Obesity, Morbid/dh, dt, pc, rh, th
123 Obesity, Abdominal/dh, dt, pc, rh, th
124 Overweight/dh, dt, pc, rh, th

125 or/121-124
126 125 and (18 or 19 or 21)
127 119 or 120 or 126
128 clinical trials as topic/ or controlled clinical trials as topic/ or randomized controlled trials as topic/ or meta-analysis as topic/
129 (clinical trial or controlled clinical trial or meta analysis or randomized controlled trial).pt.
130 Random$.ti,ab.
131 control groups/ or double-blind method/ or single-blind method/
132 clinical trial$.ti,ab.
133 controlled trial$.ti,ab.
134 meta analy$.ti,ab.
135 or/128-134
136 127 and 135
137 limit 136 to (english language and yr="2010 -Current")
138 remove duplicates from 137

Ovid Medline
Drug Treatment Harms

Database: Ovid MEDLINE(R) <1946 to February Week 1 2015>, Ovid MEDLINE(R) In-Process & Other Non-Indexed Citations <February 09, 2015>, Ovid MEDLINE(R) Daily Update <February 09, 2015>
Search Strategy:
---

1 Obesity/
2 Obesity, Morbid/
3 Obesity, Abdominal/
4 Overweight/
5 Weight Gain/
6 Weight Loss/
7 obesity.ti,ab.
8 obese.ti,ab.
9 overweight.ti,ab.
10 over weight.ti,ab.
11 (weight gain$ or weight loss$).ti,ab.
12 weight change$.ti,ab.
13 ((bmi or body mass ind$) adj2 (gain$ or loss$ or change$)).ti,ab.
14 weight maintenance.ti,ab.
15 weight control.ti,ab.
16 weight manag$.ti,ab.
17 or/1-16
18 Child/ or Child, Preschool/ or Adolescent/ or Young Adult/
19 (child$ or teen or teens or teenage$ or adolescen$ or youth or youths or young people or young adult$ or pediatric$ or paediatric$ or schoolchildren or school children or preschool$ or pre school$ or toddler$).ti.

20 (child$ or teen or teens or teenage$ or adolescen$ or youth or youths or young people or young adult$ or pediatric$ or paediatric$ or schoolchildren or school children or preschool$ or pre school$ or toddler$).ti,ab.
21 limit 20 to ("in data review" or in process or "pubmed not medline")
22 17 and (18 or 19 or 21)
23 Pediatric Obesity/
24 22 or 23
25 Anti-Obesity Agents/
26 Metformin/
27 Lactones/
28 Orlistat.ti,ab.
29 tetrahydrolipstatin.ti,ab.
30 Xenical.ti,ab.
31 Alli.ti,ab.
32 metformin.ti,ab.
33 Glucophage.ti,ab.
34 dimethylbiguanidine.ti,ab.
35 dimethylguanylguanidine.ti,ab.
36 (dimethylbiguanide or dimethyl-biguanide).ti,ab.
37 or/25-36
38 24 and 37
39 Pediatric Obesity/dt
40 Obesity/dt
41 Obesity, Morbid/dt
42 Obesity, Abdominal/dt
43 Overweight/dt
44 40 or 41 or 42 or 43
45 44 and (18 or 19 or 21)
46 38 or 39 or 45
47 "Drug-Related Side Effects and Adverse Reactions"/
48 safety.ti,ab.
49 harm$.ti,ab.
50 mortality.ti,ab.
51 toxicity.ti,ab.
52 complication$.ti,ab.
53 (death or deaths).ti,ab.
54 (adverse adj2 (interaction$ or response$ or effect$ or event$ or reaction$ or outcome$)).ti,ab.
55 adverse effects.fs.
56 toxicity.fs.
57 mortality.fs.
58 poisoning.fs.
59 quality of life/
60 depression/
61 depressive disorder
62 (depression or depressed).ti,ab.

63 stress, psychological/
64 adaptation, psychological/
65 anxiety/
66 (anxiety or anxious).ti,ab.
67 suicide/
68 (suicide$ or suicidal).ti,ab.
69 self concept/
70 self esteem.ti,ab.
71 body image/
72 social isolation/
73 False Positive Reactions/
74 Social stigma/
75 stigma$.ti,ab.
76 (label or labeled or labeling).ti,ab.
77 Patient Compliance/
78 Patient Acceptance of Health Care/
79 Patient Participation/
80 Treatment Refusal/
81 Patient Dropouts/
82 Eating Disorders/
83 Anorexia/
84 Anorexia Nervosa/
85 Bulimia/
86 Bulimia Nervosa/
87 eating disorder$.ti,ab.
88 disordered eating.ti,ab.
89 (anorexic or anorexia).ti,ab.
90 (bulimic or bulimia).ti,ab.
91 weight cycling.ti,ab.
92 weight fluctuat$.ti,ab.
93 fasting/
94 laxative$.ti,ab.
95 (overweight adj4 concern$).ti,ab.
96 (weight adj4 concern$).ti,ab.
97 ((stunt$ or suppress$) adj2 growth).ti,ab.
98 Nausea/
99 Vomiting/
100 (nausea$ or nauseous or vomit$).ti,ab.
101 Diarrhea/
102 diarrh?ea.ti,ab.
103 Malnutrition/
104 (malnourished or malnutrition).ti,ab.
105 nutritional defici$.ti,ab.
106 or/47-105
107 46 and 106
108 limit 107 to (english language and yr="2010 -Current")

109 remove duplicates from 108

PsycInfo
Screening
Database: PsycINFO <1806 to February Week 1 2015>
Search Strategy:
---
1 Obesity/
2 Overweight/
3 Weight gain/
4 obesity.ti,ab,id.
5 obese.ti,ab,id.
6 overweight.ti,ab,id.
7 over weight.ti,ab,id.
8 weight gain.ti,ab,id.
9 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8
10 limit 9 to (100 childhood <birth to age 12 yrs> or 160 preschool age <age 2 to 5 yrs> or 180 school age <age 6 to 12 yrs> or 200 adolescence <age 13 to 17 yrs>)
11 (child$ or teen or teens or teenage$ or adolescen$ or youth or youths or young people or young adult$ or pediatric$ or paediatric$ or schoolchildren or school children or preschool$ or pre school$ or toddler$).ti,ab,id.
12 9 and 11
13 10 or 12
14 Screening/
15 Health screening/
16 Body mass index/
17 Body fat/
18 Body weight/
19 Anthropometry/
20 screen$.ti,ab,id.
21 body mass index$.ti,ab,id.
22 body mass indices.ti,ab,id.
23 bmi.ti,ab,id.
24 body mass abdominal index$.ti,ab,id.
25 body mass abdominal indices.ti,ab,id.
26 bmai.ti,ab,id.
27 body adiposity index$.ti,ab,id.
28 body adiposity indices.ti,ab,id.
29 (skinfold or skin fold).ti,ab,id.
30 waist circumference$.ti,ab,id.
31 waist to height ratio$.ti,ab,id.
32 waist height ratio$.ti,ab,id.
33 waist to hip ratio$.ti,ab,id.
34 waist hip ratio$.ti,ab,id.
35 weight for height.ti,ab,id.
36 height for weight.ti,ab,id.

37 weight for age.ti,ab,id.
38 weight stature.ti,ab,id.
39 (adiposity adj2 measur$).ti,ab,id.
40 anthropometr$.ti,ab,id.
41 or/14-40
42 13 and 41
43 random$.ti,ab,id,hw.
44 placebo$.ti,ab,hw,id.
45 controlled trial$.ti,ab,id,hw.
46 clinical trial$.ti,ab,id,hw.
47 meta analy$.ti,ab,hw,id.
48 treatment outcome clinical trial.md.
49 43 or 44 or 45 or 46 or 47 or 48
50 42 and 49
51 limit 50 to (english language and yr="2005 -Current")

PsycInfo
Treatment
Database: PsycINFO <1806 to February Week 1 2015>
Search Strategy:
---

1 Obesity/
2 Overweight/
3 Weight gain/
4 Weight Control/
5 Weight Loss/
6 obesity.ti,ab,id.
7 obese.ti,ab,id.
8 overweight.ti,ab,id.
9 over weight.ti,ab,id.
10 weight gain.ti,ab,id.
11 weight loss.ti,ab,id.
12 weight maintenance.ti,ab,id.
13 weight control.ti,ab,id.
14 (weight adj3 manag$).ti,ab,id.
15 weight change$.ti,ab,id.
16 ((bmi or body mass ind$) adj2 (gain$ or loss$ or change$)).ti,ab,id.
17 or/1-16
18 limit 17 to (100 childhood <birth to age 12 yrs> or 160 preschool age <age 2 to 5 yrs> or 180 school age <age 6 to 12 yrs> or 200 adolescence <age 13 to 17 yrs>)
19 (child$ or teen or teens or teenage$ or adolescen$ or youth or youths or young people or young adult$ or pediatric$ or paediatric$ or schoolchildren or school children or preschool$ or pre school$ or toddler$).ti,ab,id.
20 17 and 19
21 18 or 20
22 Counseling/

23 Behavior Therapy/
24 Cognitive Behavior Therapy/
25 Cognitive Therapy/
26 Cognitive Techniques/
27 Behavior Modification/
28 Behavior Change/
29 Lifestyle Changes/
30 Lifestyle/
31 School Counseling/
32 Psychotherapeutic Counseling/
33 Peer Counseling/
34 Group Counseling/
35 Community Counseling/
36 School Counseling/
37 Motivational Interviewing/
38 Feedback/
39 Biofeedback/
40 Health Education/
41 Health Promotion/
42 Client Education/
43 Self Regulation/
44 Intervention/
45 School Based Intervention/
46 Family Intervention/
47 Early Intervention/
48 ((psychological or behavio?r$) adj (therap$ or modif$ or chang$ or strateg$ or intervention$)).ti,ab,id.
49 (group therap$ or family therap$ or cognitive therap$).ti,ab,id.
50 cbt.ti,ab,id.
51 ((lifestyle or life style) adj (chang$ or interven$ or modifi$)).ti,ab,id.
52 counsel$.ti,ab,id.
53 social$ support$.ti,ab,id.
54 (peer adj2 support).ti,ab,id.
55 ((child$ adj3 parent$) and therapy).ti,ab,id.
56 (family intervention$ or parent$ intervention$).ti,ab,id.
57 (parent$ adj2 (behavio?r$ or involv$ or control$ or attitude$ or educat$)).ti,ab.
58 health education.ti,ab,id.
59 health promotion.ti,ab,id.
60 patient education.ti,ab,id.
61 nonpharmacologic intervention$.ti,ab,id.
62 non pharmacologic intervention$.ti,ab,id.
63 self regulat$.ti,ab,id.
64 (school$ adj5 (intervention$ or program$)).ti,ab,id.
65 or/22-64
66 Physical Activity/
67 Physical Fitness/

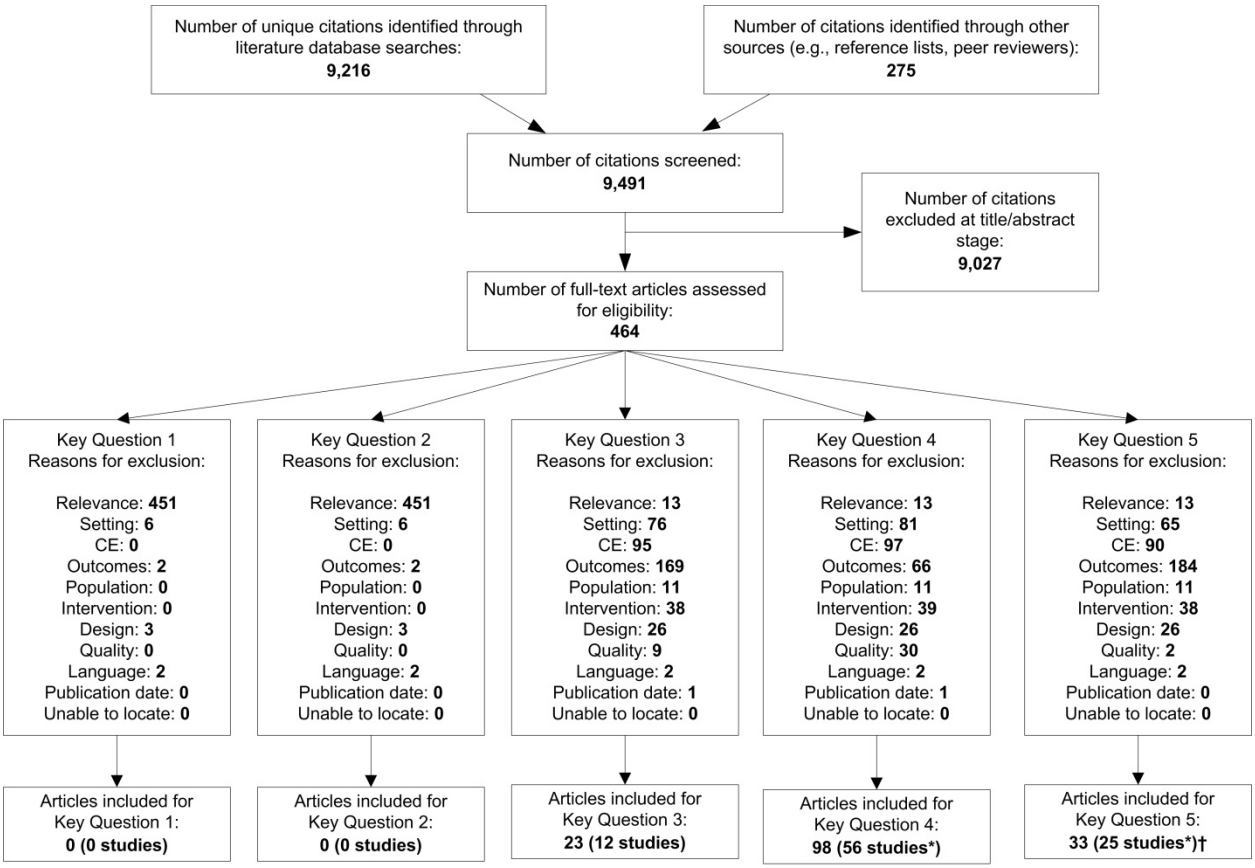
68 Exercise/
69 Aerobic Exercise/
70 Active Living/
71 (exercise or physical activity).ti.
72 aerobic$.ti.
73 (fitness adj (class$ or regime$ or program$)).ti.
74 (physical training or physical education).ti.
75 (sedentary behavio?r$ adj3 reduc$).ti,ab,id.
76 ((exercise or physical activity) adj5 (intervention$ or promot$)).ti,ab,id.
77 or/66-76
78 Diets/
79 Dietary Restraint/
80 Food Intake/
81 Eating Behavior/
82 (diet or diets or dieting or dietary).ti.
83 (diet$ adj (modif$ or therapy or intervention$ or strateg$)).ti,ab,id.
84 (low calorie or calorie control$ or healthy eating).ti,ab,id.
85 formula diet$.ti,ab,id.
86 (weightwatcher$ or weight watcher$).ti,ab,id.
87 or/78-86
88 Interdisciplinary Treatment Approach/
89 Collaboration/
90 Cooperation/
91 Case Management/
92 Work Teams/
93 Community Mental Health Services/
94 Health Care Delivery/
95 Community Psychology/
96 Community Psychiatry/
97 collaborat$.ti,ab,id.
98 (interdisciplinary or inter disciplinary).ti,ab,id.
99 (multidisciplinary or multi disciplinary).ti,ab,id.
100 (integrated adj5 (healthcare or care)).ti,ab,id.
101 care manag$.ti,ab,id.
102 case manag$.ti,ab,id.
103 cooperative care.ti,ab,id.
104 coordinated care.ti,ab,id.
105 patient centered care.ti,ab,id.
106 or/88-105
107 ((weight loss or weight reduction or weight control or weight maintenance or weight managment) adj3 (intervention$ or promot$)).ti,ab,id.
108 21 and (65 or 77 or 87 or 106 or 107)
109 random$.ti,ab,id,hw.
110 placebo$.ti,ab,hw,id.
111 controlled trial$.ti,ab,id,hw.
112 clinical trial$.ti,ab,id,hw.

113 meta analy$.ti,ab,hw,id.
114 treatment outcome clinical trial.md.
115 or/109-114
116 108 and 115
117 Orlistat.ti,ab,id.
118 tetrahydrolipstatin.ti,ab,id.
119 Xenical.ti,ab,id.
120 Alli.ti,ab,id.
121 metformin.ti,ab,id.
122 Glucophage.ti,ab,id.
123 dimethylbiguanidine.ti,ab,id.
124 dimethylguanylguanidine.ti,ab,id.
125 (dimethylbiguanide or dimethyl-biguanide).ti,ab,id.
126 or/117-125
127 21 and 126
128 116 or 127
129 limit 128 to (english language and yr="2010 -Current")

Pubmed, publisher-supplied

Search	Query
#7	#4 OR #6
#6	#1 AND #2 AND #5 AND publisher[sb] AND English[Language]) AND ("2010"[Date - Publication] : "3000"[Date - Publication]))
#5	Orlistat[tiab] OR tetrahydrolipstatin[tiab] OR Xenical[tiab] OR Alli[tiab] OR metformin[tiab] OR Glucophage[tiab] OR dimethylbiguanidine[tiab] OR dimethylguanylguanidine[tiab] OR dimethylbiguanide[tiab] OR dimethyl-biguanide[tiab]
#4	#1 AND #2 AND #3 AND publisher[sb] AND English[Language] AND ("2005"[Date - Publication] : "3000"[Date - Publication])
#3	(random*[tiab] OR trial*[tiab])
#2	(child*[title] OR adolescen*[title] OR teen*[title] OR boy*[title] OR girl*[title] OR youth*[title] OR young[title] OR school*[title] preschool*[title] OR OR pediatric*[title] OR paediatric*[title] OR toddler*[title])
#1	obese[title] OR obesity[title] OR overweight[title] OR weight[title] OR bmi[title] OR body mass index[title]

Appendix B Figure 1. Literature Flow Diagram



Abbreviation: CE = comparative effectiveness.

Appendix B Table 1. Inclusion and Exclusion Criteria

Category	Include	Exclude
Condition definition	Studies identifying children who are overweight or have obesity using methods such as BMI, BMI percentile, BMI z-score, percent overweight, waist circumference, or a similar measure	
Aim	**KQs 1, 2 (screening):** Studies of programs that systematically screen children and adolescents to identify those who are overweight or have obesity **KQs 3–5 (interventions):** Studies with a primary aim of weight management (including weight loss and weight gain prevention)	**KQs 1, 2 (screening):** Intervention programs for diet or physical activity without a weight-related measure **KQs 3–5 (interventions):** healthy lifestyle counseling with no weight-related aim
Population	**All KQs:** Children and adolescents ages 2 to 18 years. Studies that substantially overlap this age range (e.g., ages 14–65 years) will be included if results for younger participants are reported separately. **KQs 1, 2 (screening):** General primary care or comparable populations **KQs 3–5 (interventions):** Either: • The entire sample has an age- and sex-specific BMI ≥85th percentile or meets other similar criteria for overweight based on ideal body weight • The entire sample previously had excess weight and is now engaged in maintenance of weight loss/improved weight trajectory **or** • ≥50% of the sample has an age- and sex-specific BMI ≥85th percentile and ≥80% have 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)	• Studies with an average age younger than 2 or older than 18 years • Populations limited exclusively to youth who: o Have an eating disorder o Are pregnant or postpartum o Are overweight or have obesity secondary to a genetic or medical condition, such as polycystic ovarian syndrome, hypothyroidism, Cushing's syndrome, growth hormone deficiency, insulinoma, hypothalamic disorders (e.g., Froelich syndrome, Bardet-Biedl syndrome, Prader-Willi syndrome), or medication use (e.g., antipsychotics) o Are in college
Intervention	**KQs 1, 2 (screening):** Screening involving BMI or other primary care–feasible anthropometric measure; may also involve treatment or referral after screening **KQs 3–5 (interventions):** • Designed to promote weight reduction or stabilization, or maintenance of previous weight reduction or stabilizabtion • May include the following, alone or in combination: o Behavioral-based interventions o Pharmacological (i.e., orlistat, metformin) interventions o Health system–level interventions (e.g., stepped care, collaborative care) • Must be either conducted in a primary care setting, or feasible in "usual" primary care, or referable from primary care. Must at least involve the health care system in some way (may be limited to recruitment)	**KQs 3–5 (interventions):** • Primary prevention in children who are normal weight • Surgical interventions • Studies that include elements that cannot be implemented in the health care setting (e.g., changes in the physical/built environment, legislation) • Complementary and alternative medicine approaches (e.g., herbal supplements, acupuncture, Chinese medicine, yoga) • Studies that provide all or most of participants' food

Appendix B Table 1. Inclusion and Exclusion Criteria

Category	Include	Exclude
Comparator	**KQs 1, 2 (screening):** Usual care, no obesity screening **KQs 3–5 (interventions):** Control groups with no intervention (e.g., wait-list control, usual care), minimal intervention (e.g., pamphlets, single annual session presenting information similar to what intervention groups receive through usual care in a primary care setting), or attention control (e.g., similar format and intensity of intervention on a different content area)	Comparative effectiveness studies; the following components are too intensive to be considered usual care, so would be considered active comparators, including: • Personalized prescription for weight loss and exercise based on standardized dietary assessment • Homework, such as study-provided self-help workbooks • More than a single annual brief intervention contact (unless content not related to weight loss) Comparator cannot be focused on healthy lifestyle, as this is too similar to intervention programs for weight loss
Outcomes	**Child health outcomes:** • Reduced asthma or sleep apnea • Decreased morbidity from diabetes mellitus or hypertension • Improved depression or quality of life (including psychosocial distress and functioning) • Physical fitness capacity or performance (not behavioral) • Physical functioning (scores on physical subscales of quality of life measures) • Disability (global measures of disability, such as activities of daily living) **Adult health outcomes:** Obesity **Intermediate outcomes:** • Reduction or appropriate maintenance of weight or adiposity (required outcome). Acceptable measures include weight (kilograms or pounds), age- and sex-normative weight (BMI percentile or z-score for age and sex), relative weight (BMI, percent overweight), total adiposity (e.g., dual-energy x-ray absorptiometry, underwater weight, or comparable), other similar measures, or change in any of these measures • Weight maintenance after an intervention has ended • Cardiometabolic measures (only when weight-related measures are also reported): insulin resistance/blood glucose/diabetes, blood pressure/hypertension, lipid levels/dyslipidemia, metabolic syndrome, and polycystic ovarian syndrome • Liver dysfunction/nonalcoholic fatty liver disease **Adverse effects:** • Labeling • Stigma or increased body image concerns • Eating disorder • Suppressed growth • Exercise-induced injury • Serious treatment-related harms at any time after initiation of intervention (i.e., death, medical issue requiring hospitalization or urgent medical treatment) or other treatment-related harms reported in trials meeting inclusion criteria for intermediate or health outcomes	Behavioral outcomes (diet, physical activity)

Appendix B Table 1. Inclusion and Exclusion Criteria

Category	Include	Exclude
Timing of outcome assessment	**All KQs (except serious harms of pharmacotherapy):** ≥6 months after baseline **KQ 5 (serious harms of pharmacotherapy):** No minimum followup. Serious harms are events resulting in death, hospitalization, or the need for urgent medical treatment	
Setting	**All KQs:** Primary care settings (e.g., pediatrics, internal medicine, family medicine, obstetrics/gynecology, family planning, military health clinics) **KQs 3–5 (interventions):** • Other outpatient health care settings • Phone, mobile, or virtual settings (e.g., online intervention, if there is some connection to a health setting, such as recruitment from a health care setting) • Community or research settings, if there is some connection to a health setting (e.g., recruitment from a health care setting)	• Community/university research laboratories or other nonmedical centers • College settings • Mental health clinics (unless recruitment is through primary care screening) • Correctional facilities • School classrooms • Worksites • Inpatient/residential facilities • Emergency departments
Study design	**All KQs:** Randomized, controlled trials; controlled clinical trials **KQ 5 (harms of weight loss medications):** Large comparative cohort or case-control studies with appropriate comparison group; large case-series; large event monitoring studies	All other study designs
Country	Economically developed countries (i.e., countries that are a member of the Organisation for Economic Co-Operation and Development): Australia, Austria, Belgium, Canada, Chile, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, The Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, and United States	Countries that are not a member of the Organisation for Economic Co-Operation and Development
Language	English	Languages other than English
Study quality	Fair or good	Poor, according to design-specific USPSTF criteria

Abbreviations: BMI = body mass index; KQ = Key Question; USPSTF = U.S. Preventive Services Task Force.

Appendix B Table 2. Quality Assessment

Study Design	Adapted Quality Criteria
Randomized and non-randomized controlled trials, adapted from the U.S. Preventive Services Task Force methods[104]	• Valid random assignment? (NA for non-randomized controlled trials) • Was allocation concealed? • Was eligibility criteria specified? • Were groups similar at baseline? • Were outcome assessors blinded? • Were measurements equal, valid and reliable? • Was there intervention fidelity? • Was there adequate adherence to the intervention? • Were the statistical methods acceptable? • Was the handling of missing data appropriate? • Was there acceptable followup? • Was there evidence of selective reporting of outcomes? • Was there risk of contamination?

Good quality studies generally meet all quality criteria. Fair quality studies do not meet all the criteria but do not have critical limitations that could invalidate study findings. Poor quality studies have a single fatal flaw or multiple important limitations that could invalidate study findings. Critical appraisal of studies using *a priori* quality criteria are conducted independently by at least two reviewers. Disagreements in final quality assessment are resolved by consensus, and, if needed, consultation with a third independent reviewer.

Appendix C. Excluded Studies

E1. Study Relevance **a.** Not a trial of childhood overweight screening or treatment **b.** Other
E2. Setting: Community/university research laboratories or other nonmedical centers; college setting; mental health clinics (unless recruitment is through primary care); correctional facilities; school classrooms; worksites; inpatient/residential facilities; emergency departments. **a.** Countries that are not a member of the OECD
E3. Comparative Effectiveness (multiple active interventions, no control condition, including pharmacogenetic studies and other studies looking at treatment matching)
E4. No relevant outcomes: Behavioral outcomes only (diet, physical activity) **b.** Timing of outcome assessment (KQ 1-4) <6 months after baseline
E5. Population **a.** Limited to average age younger than 2 or older than 18 years **b.** Limited exclusively to youth who: have an eating disorder, are pregnant or postpartum, are overweight or have obesity secondary to a genetic or medical condition, are in college
E6. Intervention (KQ3-5) **a.** Primary prevention in children who are normal weight **b.** Surgical interventions **c.** Studies that include elements that cannot be implemented in a health care setting (e.g., changes to the physical/built environment, legislation) **d.** Complementary and alternative medicine approaches **e.** Studies that provide all or most of participants' food
E7. Study Design: Not an RCT or CCT (KQ1-4) or comparative observational design, large case series, large event monitoring studies (KQ5 harms of weight loss medications only)
E8. Study Quality **a.** High or differential attrition **b.** Other quality issue or not enough information to assess quality
E9. Non-English
E10. Published in 1966 or earlier
E11. Unable to locate article

1. Adeyemo MA, McDuffie JR, Kozlosky M, et al. Effects of metformin on energy intake and satiety in obese children. Diabetes Obes Metab. 2015;17(4):363-70. PMID: 25483291. **KQ1E1, KQ2E1, KQ3E4.**
2. Aguilera A, Torre A, Kaiser L. Changes in food consumption patterns of mexican-heritage children during a nutrition intervention. Exp Biol. 2015;29(1). PMID: None. **KQ1E1, KQ2E1, KQ3E6a, KQ4E6a, KQ5E6a.**
3. Alexy U, Reinehr T, Sichert-Hellert W, et al. Positive changes of dietary habits after an outpatient training program for overweight children. Nutr Res. 2006;26(5):202-8. PMID: None. **KQ1E1, KQ2E1, KQ3E7, KQ4E7, KQ5E7.**
4. Altman M, Cahill Holland J, Lundeen D, et al. Reduction in food away from home is associated with improved child relative weight and body composition outcomes and this relation is mediated by changes in diet quality. J Acad Nutr Diet. 2015;115(9):1400-7. PMID: 25963602. **KQ1E1, KQ2E1, KQ3E2b, KQ4E2b, KQ5E4.**
5. Amador M, Ramos LT, Morono M, et al. Growth rate reduction during energy restriction in obese adolescents. Exp Clin Endocrinol. 1990;96(1):73-82. PMID: 2279528. **KQ1E1, KQ2E1, KQ3E2a, KQ4E2a, KQ5E2a.**
6. Anderson JD, Newby R, Kehm R, et al. Taking Steps Together: a family- and community-based obesity intervention for urban, multiethnic children. Health Educ Behav. 2015;42(2):194-201. PMID: None. **KQ1E1, KQ2E1, KQ3E7, KQ4E7, KQ5E7.**
7. Andre N, Beguier S. Using motivational interviewing as a supplement to physical activity program in obese adolescents: a RCT study. Eat Weight Disord. 2015;20(4):519-23. PMID: None. **KQ1E1, KQ2E1, KQ3E4b, KQ4E4b, KQ5E4b.**
8. Antal H, Buckloh L, Lochrie A, et al. Family-based intervention for overweight youth: Effects on health-related quality of life and measurements of physical health. 2010. PMID: None. **KQ1E1, KQ2E1, KQ3E2b, KQ4E2b, KQ5E4.**

9. Armstrong B, Lim CS, Janicke DM. Park density impacts weight change in a behavioral intervention for overweight rural youth. Behav Med. 2015;41(3):123-30. PMID: 26332930. **KQ1E1, KQ2E1, KQ3E2b, KQ4E2b, KQ5E2b.**
10. Atabek ME, Pirgon O. Use of metformin in obese adolescents with hyperinsulinemia: a 6-month, randomized, double-blind, placebo-controlled clinical trial. J Pediatr Endocrinol Metab. 2008;21(4):339-48. PMID: 18556965. **KQ1E1, KQ2E1, KQ3E4, KQ4E8b, KQ5E8b.**
11. Azad A, Gharakhanlou R, Niknam A, et al. Effects of aerobic exercise on lung function in overweight and obese students. Tanaffos. 2011;10(3):24-31. PMID: 25191372. **KQ1E2a, KQ2E2a, KQ3E2a, KQ4E2a, KQ5E2a.**
12. Backlund C, Sundelin G, Larsson C. Effect of a 1-year lifestyle intervention on physical activity in overweight and obese children. Adv Physiother. 2011;13(3):87-96. PMID: None. **KQ1E1, KQ2E1, KQ3E4, KQ4E8b, KQ5E4.**
13. Backlund C, Sundelin G, Larsson C. Effects of a 2-year lifestyle intervention on physical activity in overweight and obese children. Adv Physiother. 2011;13(3):97-109. PMID: None. **KQ1E1, KQ2E1, KQ3E4, KQ4E8b, KQ5E4.**
14. Backlund C, Sundelin G, Larsson C. Evaluation of a 2-year family-based lifestyle intervention regarding physical activity among children with overweight and obesity. Physiotherapy (United Kingdom). 2011;97:eS94-eS5. PMID: None. **KQ1E1, KQ2E1, KQ3E4, KQ4E8b, KQ5E4.**
15. Balagopal P, Bayne E, Sager B, et al. Effect of lifestyle changes on whole-body protein turnover in obese adolescents. Int J Obes Relat Metab Disord. 2003;27(10):1250-7. PMID: 14513074. **KQ1E1, KQ2E1, KQ3E4b, KQ4E4b, KQ5E4b.**
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17. Ball GD, Mackenzie-Rife KA, Newton MS, et al. One-on-one lifestyle coaching for managing adolescent obesity: Findings from a pilot, randomized controlled trial in a real-world, clinical setting. Paediatr child health. 2011;16(6):345-50. PMID: 22654546. **KQ1E1, KQ2E1, KQ3E4b, KQ4E4b, KQ5E4b.**
18. Barkin SL, Gesell SB, Poe EK, et al. Changing overweight Latino preadolescent body mass index: the effect of the parent-child dyad. Clin Pediatr (Phila). 2011;50(1):29-36. PMID: 20837625. **KQ1E1, KQ2E1, KQ3E4, KQ4E8b, KQ5E4.**
19. Bauer S, de Niet J, Timman R, et al. Enhancement of care through self-monitoring and tailored feedback via text messaging and their use in the treatment of childhood overweight. Patient Educ Couns. 2010;79(3):315-9. PMID: 20418046. **KQ1E1, KQ2E1, KQ3E3, KQ4E3, KQ5E3.**
20. Bean MK, Mazzeo SE, Stern M, et al. A values-based Motivational Interviewing (MI) intervention for pediatric obesity: study design and methods for MI Values. Contemp Clin Trials. 2011;32(5):667-74. PMID: 21554994. **KQ1E1, KQ2E1, KQ3E3, KQ4E3, KQ5E3.**
21. Bean MK, Powell P, Quinoy A, et al. Motivational interviewing targeting diet and physical activity improves adherence to paediatric obesity treatment: results from the MI Values randomized controlled trial. Pediatr Obes. 2014. PMID: 24729537. **KQ1E1, KQ2E1, KQ3E3, KQ4E3, KQ5E3.**
22. Bean MK, Wilson DB, Thornton LM, et al. Dietary intake in a randomized-controlled pilot of NOURISH: a parent intervention for overweight children. Prev Med. 2012;55(3):224-7. PMID: 22735041. **KQ1E1, KQ2E1, KQ3E4, KQ4E4, KQ5E4.**
23. Becque MD, Katch VL, Rocchini AP, et al. Coronary risk incidence of obese adolescents: reduction by exercise plus diet intervention. Pediatrics. 1988;81(5):605-12. PMID: 3357722. **KQ1E1, KQ2E1, KQ3E4b, KQ4E4b, KQ5E4b.**

24. Berkowitz RI, Fujioka K, Daniels SR, et al. Effects of sibutramine treatment in obese adolescents: a randomized trial. Ann Intern Med. 2006;145(2):81-90. PMID: 16847290. **KQ1E1, KQ2E1, KQ3E6f, KQ4E6f, KQ5E6f.**
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26. Berkowitz RI, Wadden TA, Tershakovec AM, et al. Behavior therapy and sibutramine for the treatment of adolescent obesity: a randomized controlled trial. JAMA. 2003;289(14):1805-12. PMID: 12684359. **KQ1E1, KQ2E1, KQ3E6f, KQ4E6f, KQ5E6f.**
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29. Berry D, Savoye M, Melkus G, et al. An intervention for multiethnic obese parents and overweight children. Appl Nurs Res. 2007;20(2):63-71. PMID: 17481469. **KQ1E1, KQ2E1, KQ3E3, KQ4E3, KQ5E3.**
30. Berry DC, McMurray R, Schwartz TA, et al. Rationale, design, methodology and sample characteristics for the family partners for health study: a cluster randomized controlled study. BMC Public Health. 2012;12:250. PMID: 22463125. **KQ1E2, KQ2E2, KQ3E2, KQ4E2, KQ5E2.**
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32. Best JR, Goldschmidt AB, Mockus-Valenzuela DS, et al. Shared weight and dietary changes in parent-child dyads following family-based obesity treatment. Health Psychol. 2016;35(1):92-5. PMID: 26192385. **KQ1E1, KQ2E1, KQ3E2b, KQ4E2b, KQ5E4.**
33. Bloom T, Sharpe L, Mullan B, et al. A pilot evaluation of appetite-awareness training in the treatment of childhood overweight and obesity: a preliminary investigation. Int J Eat Disord. 2013;46(1):47-51. PMID: 22826019. **KQ1E1, KQ2E1, KQ3E4b, KQ4E4b, KQ5E4b.**
34. Bluher S, Panagiotou G, Petroff D, et al. Effects of a 1-year exercise and lifestyle intervention on irisin, adipokines, and inflammatory markers in obese children. Obesity (Silver Spring). 2014;22(7):1701-8. PMID: 24644099. **KQ1E1, KQ2E1, KQ3E7, KQ4E7, KQ5E7.**
35. Bocca G, Corpeleijn E, Stolk RP, et al. Results of a multidisciplinary treatment program in 3-year-old to 5-year-old overweight or obese children: a randomized controlled clinical trial. Arch Pediatr Adolesc Med. 2012;166(12):1109-15. PMID: 23108941. **KQ1E1, KQ2E1, KQ3E3, KQ4E3, KQ5E4.**
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37. Bocca G, Corpeleijn E, van den Heuvel ER, et al. Three-year follow-up of 3-year-old to 5-year-old children after participation in a multidisciplinary or a usual-care obesity treatment program. Clin Nutr. 2014;33(6):1095-100. PMID: 24377413. **KQ1E1, KQ2E1, KQ3E4, KQ4E3, KQ5E4.**
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49. Braet C, Van Winckel M, Van Leeuwen K. Follow-up results of different treatment programs for obese children. Acta Paediatr. 1997;86(4):397-402. PMID: 9174227. **KQ1E1, KQ2E1, KQ3E7, KQ4E7, KQ5E7.**
50. Brennan L, Walkley J, Fraser SF, et al. Motivational interviewing and cognitive behaviour therapy in the treatment of adolescent overweight and obesity: study design and methodology. Contemp Clin Trials. 2008;29(3):359-75. PMID: 17950046. **KQ1E1, KQ2E1, KQ3E8a, KQ4E8a, KQ5E4.**
51. Brennan L, Walkley J, Wilks R. Parent- and adolescent-reported barriers to participation in an adolescent overweight and obesity intervention. Obesity (Silver Spring). 2012;20(6):1319-24. PMID: 22193923. **KQ1E1, KQ2E1, KQ3E8a, KQ4E8a, KQ5E4.**
52. Brennan L, Walkley J, Wilks R, et al. Physiological and behavioural outcomes of a randomised controlled trial of a cognitive behavioural lifestyle intervention for overweight and obese adolescents. Obes Res Clin Pract. 2013;7(1):e23-41. PMID: 24331680. **KQ1E1, KQ2E1, KQ3E8a, KQ4E8a, KQ5E4.**
53. Brennan L, Wilks R, Walkley J, et al. Treatment acceptability and psychosocial outcomes of a randomised controlled trial of a cognitive behavioural lifestyle intervention for overweight and obese adolescents. Behav Change. 2012;29(1):36-62. PMID: 24331680. **KQ1E1, KQ2E1, KQ3E8a, KQ4E8a, KQ5E4.**
54. Broccoli S, Davoli AM, Bonvicini L, et al. Motivational interviewing to treat overweight children: 24-month follow-up of a randomized controlled trial. Pediatrics. 2016;137(1):1-10. PMID: 26702030. **KQ1E1, KQ2E1, KQ3E4, KQ5E4.**

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62. Burgert TS, Duran EJ, Goldberg-Gell R, et al. Short-term metabolic and cardiovascular effects of metformin in markedly obese adolescents with normal glucose tolerance. Pediatr Diabetes. 2008;9(6):567-76. **KQ1E1, KQ2E1, KQ3E4b, KQ4E4b.**
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Appendix D Table 1. Health Outcomes in Included Behavior-Based Weight Loss Intervention Trials (Key Question 3)

Author, Year & Quality	Est hrs of contact	Followup (months since tx ended)	Outcome (unit)	IG mean difference (SD)	IG n	CG mean difference (SD)	CG n	Between group p-value	Adjustment details
Vos, 2011[161] Fair	45	12 (**)	DISAKIDS, child, total score	6.6 (11.0)	32	2.8 (13.6)	35	NR	
Kalarchian, 2009[126] Fair	44	6 (**)	Child Health Questionnaire (CHQ), general health perception	6.88 (15.16)	97	0.46 (16.67)	95	0.006	
		12 (0)		5.71 (17.82)	97	1.83 (19.10)	95	0.15	
		6 (**)	Child Health Questionnaire (CHQ), global health	6.55 (20.68)	97	-0.28 (23.29)	95	0.32	
		12 (0)		4.13 (24.52)	97	0.48 (27.68)	95	0.33	
Stark, 2011[154] Fair	38	6 (0)	PedsQL, parent/caregiver, physical functioning	9.5 (13)	7	-1.7 (6.5)	10	0.042	
		12 (6)		13.8 (8.6)	7	-2.7 (5.6)	9	0.001	
DeBar, 2012[120] Good	37	6 (1)	PedsQL, parent/caregiver, total score	6.51 (15.06)	104	5.09 (15.68)	102	0.189	
		12 (7)		6.68 (15.15)	85	2.86 (16.47)	76	0.189	
		6 (1)	Body Satisfaction Scale, total score	0.33 (0.70)	104	0.21 (7.08)	102	0.026	
		12 (7)		0.43 (0.65)	85	0.2 (0.71)	76	0.026	
		6 (1)	Rosenburg Self-Esteem Scale, total score	0.01 (0.25)	104	-0.02 (0.26)	102	0.275	
		12 (7)		0.06 (0.26)	85	-0.01 (0.26)	76	0.275	
		6 (1)	Patient Health Questionnaire-Adolescents (PHQ-A), % mood disorder	5 (4.49)	104	6 (6.02)	102	0.362	
		12 (7)		6 (7.32)	85	4)5.26)	76	0.362	
Sacher, 2010[147] Fair	36	6 (3.75)	Harter Scale, total score	0.4 (0.6)	37	0.1 (0.7)	44	0.04	Baseline
Hofsteenge, 2014[125] Fair	17	6 (0)	PedsQL, parent/caregiver, physical functioning	6.60 (13.55)	44	2.20 (12.6)	33	NSD	Age, sex, ethnicity
		6 (0)	PedsQL, parent/caregiver, psychosocial functioning	2.20 (12.31)	44	2.40 (10.73)	33	NSD	Age, sex, ethnicity
		6 (0)	PedsQL, parent/caregiver, total score	3.40 (11.73)	44	2.20 (10.37)	33	NSD	Age, sex, ethnicity
		6 (0)	Body Esteem Scale, weight satisfaction	0.1 (0.7)	44	0.1 (0.7)	33	NSD	Age, sex, ethnicity
		6 (0)	Child Health Questionnaire (CHQ), physical summary	2 (11.68)	44	4.20 (10.55)	33	NSD	Age, sex, ethnicity
		6 (0)	Child Health Questionnaire (CHQ), psychosocial summary	1.70 (10.52)	44	2.40 (9.27)	33	NSD	Age, sex, ethnicity
Boudreau, 2013[111] Fair	11	6 (0)	PedsQL, parent/caregiver, total score	8.30 (NR)	NR	7.10 (NR)	NR	0.16	Maternal BMI and caregiver education
			PedsQL, child, total score	5.80 (NR)	NR	0.60 (NR)	NR	0.33	Primary household language and child's sex

Appendix D Table 1. Health Outcomes in Included Behavior-Based Weight Loss Intervention Trials (Key Question 3)

Author, Year & Quality	Est hrs of contact	Followup (months since tx ended)	Outcome (unit)	IG mean difference (SD)	IG n	CG mean difference (SD)	CG n	Between group p-value	Adjustment details
Taylor, 2015[159] Good	7	24 (-12)	PedsQL, parent/caregiver, emotional functioning	0.10 (14.62)	89	0 (14.97)	92	NR, NS	Baseline value, age, sex, feedback condition, and interactions btwn time and feedback condition and time and intervention
		24 (-12)	PedsQL, parent/caregiver, physical functioning	-1.1 (14.93)	89	-3.8 (15.94)	92	NR, NS	Baseline value, age, sex, feedback condition, and interactions btwn time and feedback condition and time and intervention
		24 (-12)	PedsQL, parent/caregiver, psychosocial functioning	-0.4 (11.93)	89	-2.1 (12.90)	92	NR, NS	Baseline value, age, sex, feedback condition, and interactions btwn time and feedback condition and time and intervention
		24 (-12)	PedsQL, parent/caregiver, social functioning	-1.90 (14.73)	89	-5.60 (16.71)	92	NR, NS	Baseline value, age, sex, feedback condition, and interactions btwn time and feedback condition and time and intervention
		24 (-12)	PedsQL, parent/caregiver, school functioning	0.70 (13.25)	89	-0.5 (15.32)	92	NR, NS	Baseline value, age, sex, feedback condition, and interactions btwn time and feedback condition and time and intervention
Wake, 2013[163] Good	3	12 (0)	Harter Scale, total score	NR (NR)	NR	NR (NR)	NR	>0.9	Children's sex and age at randomization, neighborhood socioeconomic disadvantage score, raw baseline BMI, and baseline value of outcome measures where available
		12 (0)	PedsQL, child, total score	NR (NR)	NR	NR (NR)	NR	0.5	Children's sex and age at randomization, neighborhood socioeconomic disadvantage score, raw baseline BMI, and baseline value of outcome measures where available

Appendix D Table 1. Health Outcomes in Included Behavior-Based Weight Loss Intervention Trials (Key Question 3)

Author, Year & Quality	Est hrs of contact	Followup (months since tx ended)	Outcome (unit)	IG mean difference (SD)	IG n	CG mean difference (SD)	CG n	Between group p-value	Adjustment details
		12 (0)	Body Satisfaction Scale, total score	NR (NR)	NR	NR (NR)	NR	0.3	Children's sex and age at randomization, neighborhood socioeconomic disadvantage score, raw baseline BMI, and baseline value of outcome measures where available
McCallum, 2007[136] Good	1	9 (6)	PedsQL, parent/caregiver, total score	3.90 (12.35)	58	3.80 (12.56)	67	0.23	SES, age, sex, baseline BMI
		15 (12)		2.90 (13.45)	63	0 (12.85)	69	0.91	SES, age, sex, baseline BMI
		9 (6)	Harter Scale, total score	NR (NR)	73	NR (NR)	80	0.65	SES, age, sex, baseline BMI
		15 (12)		NR (NR)	72	NR (NR)	74	0.64	SES, age, sex, baseline BMI
		9 (6)	PedsQL, child, total score	NR (NR)	73	NR (NR)	80	0.7	SES, age, sex, baseline BMI
		15 (12)		NR (NR)	72	NR (NR)	74	0.19	SES, age, sex, baseline BMI
		9 (6)	Collins Body Figure Perception Scale, total score	NR (NR)	73	NR (NR)	80	0.58	SES, age, sex, baseline BMI
		15 (12)			72		74	0.3	SES, age, sex, baseline BMI
Wake, 2009[162] Good	1	6 (3)	PedsQL, child, physical functioning	NR (NR)	NR	NR (NR)	NR	0.7	Social disadvantage index, age at randomization, sex
		12 (9)		NR (NR)	NR	NR (NR)	NR	0.1	Social disadvantage index, age at randomization, sex
		6 (3)	PedsQL, child, psychosocial functioning	NR (NR)	NR	NR (NR)	NR	0.3	Social disadvantage index, age at randomization, sex
		12 (9)		NR (NR)	NR	NR (NR)	NR	0.5	Social disadvantage index, age at randomization, sex
		6 (3)	PedsQL, child, total score	NR (NR)	NR	NR (NR)	NR	0.4	Social disadvantage index, age at randomization, sex
		12 (9)		NR (NR)	NR	NR (NR)	NR	0.3	Social disadvantage index, age at randomization, sex
		6 (3)	Collins Body Figure Perception Scale	NR (NR)	130	NR (NR)	115	0.5	Social disadvantage index, age, sex, raw BMI at BL
		12 (9)		NR (NR)	125	NR (NR)	112	0.6	Social disadvantage index, age, sex, BL score for outcome, raw BMI at BL

Appendix D Table 1. Health Outcomes in Included Behavior-Based Weight Loss Intervention Trials (Key Question 3)

Author, Year & Quality	Est hrs of contact	Followup (months since tx ended)	Outcome (unit)	IG mean difference (SD)	IG n	CG mean difference (SD)	CG n	Between group p-value	Adjustment details
		6 (3)	Positive vs negative appearance/self-worth, number of participants	91 (70.1)	130	80 (69.6)	115	0.5	Social disadvantage index, age, sex, raw BMI at BL
		12 (9)		96 (76.4)	125	83 (73.8)	112	0.4	Social disadvantage index, age, sex, BL score for outcome, raw BMI at BL

Abbreviations: BL = baseline; BMI = body mass index; CG = control group; est = estimatedhrs = hours; IG = intervention group; kg = kilogram(s); m = meter(s); NR = not reported; NS = not significant; NSD = no significant difference; SD = standard deviation; SES = socioeconomic status.

Appendix D Table 2. Detailed Intervention Descriptions of Included Behavior-Based Intervention Trials, Alphabetical Order (Key Questions 3–5)

Author, Year & Quality	Intervention Group	Intervention Description	Control Group	Control Group Description
Boudreau, 2013[111] Fair	IG1: PowerUp + coaching	Five weekly (with a sixth, 3 months later) 90-minute PowerUp classes educated children and caregivers about nutrition, activity, and stress management. Classes separated children and caregivers who participated in interactive activities; topics included portion control, healthy snacking, label reading, dangers of liquid calories, goal setting, TV viewing, family changes, stress and overeating, stress reduction, and physical activity; classes ended with physical activity component. Lessons reinforced at home via journals, assignments, and giveaway items. Concurrent monthly culturally-sensitive coaching for 6 months to empower families to incorporate learned behavior and address family and social barriers to lifestyle changes (based on ESFT Model); coaching occurred in-person at the health center, at the families' home, or by phone. Families met with coach in-person at least once with subsequent in-person or phone meetings determined by family preferences and needs (with monthly contact ideal); home visits offered.	Waitlist	Control participants waited 6 months from baseline to begin the intervention, immediately following the 6-month assessment.
Boutelle, 2014[112] Fair	IG1: Regulation of Cues (ROC) program	Weekly 45-minute group sessions for 12 weeks and biweekly for an additional two visits. Parents and children had separate but simultaneous meetings (content similar, delivery targeted for children). After group session, parents and children participated in an additional 30-min experiential exercise together. Components included psychoeducation (10 sessions) to increase awareness of overeating in relation to environment, parenting skills, coping skills (e.g., behavioral alternatives, relaxation, attentional focus, motivation to resist cues), self-monitoring of hunger and craving, experiential learning (cue exposure treatment, appetite awareness training). Included workbooks and handouts for parents and children. Individual followup provided when a meeting was missed.	Waitlist	No intervention during the 4 months of treatment. At posttreatment assessment, participants were given a binder for the program including at-home version of the curriculum with handouts and a brief 5-min orientation to the program. No other information provided to control group. Assessments provided at BL, 4 months and 8 months.
Bryant, 2011[114] Fair	IG1: WATCH IT	Encourage lifestyle changes by taking motivational enhancement and solution focused approach. Included 16 weekly 30-min individual appointments for child and parent together for encouragement, support and motivational counseling using HELP manual. Session included healthy diet and physical activity information as well as discussions on the degree to which behavior change is important to the individual, their confidence in their ability to achieve behavior change, the degree to which change is a priority; views the patient as the expert in "what works" for them. Activities make links between thoughts and emotional responses that contribute to overeating. 16 1-hr weekly group physical activity sessions. Optional further 4 or 8 months of continuing sessions offered. Group parenting sessions mentioned in source article (number NR, may be part of optional additional 4 to 8 months' treatment, unclear if offered in current study).	Waitlist	12 month waitlist control

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Author, Year & Quality	Intervention Group	Intervention Description	Control Group	Control Group Description
Croker, 2012[118] Fair	IG1: Family-based behavioral therapy	Family-based behavioral treatment consisting of 15 90-minute group sessions over 6 months (10 weekly, 3 fortnightly, 2 monthly) with parents and children meeting separately but concurrently for 10 sessions and 5 joint parent-child sessions. Behavior modification techniques included: self-monitoring, goal setting, positive reinforcement, stimulus control, and relapse prevention. Advice provided on managing teasing and general problem-solving. Parents taught behavior management principles to assist child's behavior change and modify home environment for family-wide lifestyle change. Specific dietary targets included regular eating patterns, reduced snacks (≤2 times/day), balanced diet (as described in 'eatwell plate' and 'Traffic Light' system). Specific physical activity targets included reducing sedentary behavior and 60 mins/day lifestyle or structured activity. Baseline assessment included "motivational assessment" including children and parents' independent rating of motivation for making lifestyle changes as well as perceived benefits of and barriers to change.	Waitlist	6-month waitlist control. Baseline assessment included "motivational assessment" including children and parents' independent rating of motivation for making lifestyle changes as well as perceived benefits of and barriers to change.
Davis, 2012[119] Fair	IG1: Maintenance (Group classes)	Prior to randomization, participant completed either nutrition only (N) or nutrition + strength training (N+ST) classes that included a cooking component, a snack, nutrition lesson (focused on reducing sugar and increasing fiber intake), and a 45-minute strength training session (for those in N +ST) led by a certified personal trainer. Participants were encouraged to eat healthy and do strength training on their own at home throughout the entire program. All participants received a variety of cooking utensils and gadgets (cutting boards, apple cutters, etc.) throughout the program. Participants in the N+ST group also received resistance bands and an instructional video of exercises to do with the bands. Parents and children had separate classes. For current study, randomized adolescents attended 8 monthly 90-minute weight loss maintenance group classes, similar to those received during the 4-month intervention preceding this maintenance trial. Participants also received 4 motivational interviewing sessions over the phone and lasting approximately 15 minutes designed to help participants resolve ambivalence and engage in healthier eating and strength training in their own home. Parents were also offered separate monthly classes, which were held simultaneously with the teen group classes with the same curriculum that the youth were receiving. Parents were asked to attend a minimum of 2 classes.	Newsletters	8 monthly newsletters that matched previous 4-month intervention group assignment (nutrition or nutrition plus strength training). Newsletters included dietary tips and recipes, information about benefits of strength training and sample exercises, and information on community resources. Participants were called twice to make sure newsletters were received and to verify contact information; no lifestyle content was delivered. Anthropomorthic measurements taken before and after maintenance phase.
Broccoli, 2016[113] Good	IG1: Motivational Interviewing	Family pediatrician-led MI consisting of 5 individual meetings based on transtheoretical model of addiction and behavior change; child and parents always had to leave the meeting having agreed on two objectives (1 food, 1 physical activity); during each subsequent interview, degree of achievement of the objectives set at previous meeting assessed; objectives reinforced or redefined and recorded. Pediatricians attended 20-hr training course on motivational interviewing prior to study start.	Obesity prevention booklet	Received a booklet with the main information on obesity prevention, then usual care currently offered by pediatricians (i.e., opportunistic advice if the pediatrician is seeing the child for other reasons).

Appendix D Table 2. Detailed Intervention Descriptions of Included Behavior-Based Intervention Trials, Alphabetical Order (Key Questions 3–5)

Author, Year & Quality	Intervention Group	Intervention Description	Control Group	Control Group Description
DeBar, 2012[120] Good	IG1: Multicomponent behavioral intervention	16 90-minute group meetings; weekly for 3 months than biweekly during months 4 and 5 where teens were weighed, revised dietary and physical activity self-monitoring records. Telephone sessions offered if unable to attened sessions. Multicomponent intervention included change in dietary intake and eating patterns (e.g., decreasing portion sizes, limiting energy-dense foods, consume lower energy-dense foods); increasing physical activity by using developmentally tailored forms of exercise (e.g., exergaming equipment, yoga, strength training, pedometers, developing goal of 30-60 minutes at least 5 days per week, limiting screen time to 2 hours per day); addressing issues associated w/ obesity in adolescent girls (mood regulation, body image, self esteem, media education, sleep); and training the primary care physician to support behavioral weight management goals. Each sessions reviewed goals, problem solving to overcome barriers and challenges in increased activity. Specific behavioral and cognitive tools for coping included regular self monitoring of dietary intake, physical activity and screen time; stimulus control and environmental changes, stepwise goal-setting and problem solving; setting goals for increasing pleasant activities; and cognitive restructuring techniques to combat negative self-talk. Parents invited to separate weekly group meetings in first 3 months where they learned to support their daughter and address potential barriers to success; encourage appropriate teen autonomy and improve understanding of how parents' own attitudes, eating behavior, monitoring and comments may affect daughters. Adolescents met w/ their PCPs who were trained in motivational enhancement techniques at BL and 6 months where they received a health status summary and targeted areas of improvement (e.g., physical activity); PCPs encouraged to help pt select 1-2 of these targets.	PCP Meeting + materials	Received a packet of materials, including approaches to weight management, a parents' guide to help teens make healthy lifestyle changes, local resources for weight management and healthy activity, and suggested books and online materials on healthy lifestyle change. Met with PCP at study onset to encourage healthy lifestyle changes.
Gerards, 2015[123] Fair	IG1: Lifestyle Triple P	14 week parent-only program with 10 90-minute group sessions and four individual 15-30 minute phone sessions. Aimed at changing parenting practices and general parenting styles; used active skills training methods based on self-regulation. Parents individually formulated goals in the first session and were instructed in the following strategies: positive parenting skills, modeling, stimulus control, shopping and cooking, behavior charts/monitoring, managing behavior and using rewards. Telephone sessions provided parents individualized support in implementing strategies at home. Materials included a parent workbook, recipes, and active games booklet.	Control	2 brochures (1 on healthy nutrition and PA and 1 on positive parenting) and a short internet-based knowledge quiz (sent via email) including tailored advice and suggestions for active exercises at home.

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Author, Year & Quality	Intervention Group	Intervention Description	Control Group	Control Group Description
Golley, 2007[124] Fair	IG1: Triple P + healthy lifestyle group	Positive Parenting Program (Triple P) (4 weekly 2-hour group sessions with 7 15-20 minute individual followup calls) followed by 7 group lifestyle support sessions for parents and concurrent child PA sessions. Lifestyle sessions focused on knowledge and skills including family-focused healthy eating including specific food recommendations, monitoring, label reading, snacks, modifying recipes, being active, and roles and responsibilities about eating, managing appetite, self-esteem and teasing. While parents attended group sessions, children attended supervised PA sessions focused on fun aerobic games designed for play and easily replicated at home; PA sessions were diversional rather than interventional. Triple P parenting component aimed at changing parenting practices and general parenting styles; used active skills training methods based on self-regulation. Core parenting skills included: parent-child relationship enhancement, encouraging desirable behavior, teaching new skills and behaviors, managing misbehavior, preventing problems in high-risk situations, self-regulation, mood management and coping, partner support and communication. Telephone sessions provided parents individualized support in implementing strategies at home. Materials included standard Triple P resources (workbook and video) and a healthy lifestyle pamphlet.	Waitlist	Waitlist control for 12 months; healthy-lifestyle pamphlet and 3-4 telephone calls for retention purposes (content not specified)
	IG2: Triple P	Positive Parenting Program (Triple P): 4 weekly 2-hour group sessions with 7 15-20 minute individual followup calls. Aimed at changing parenting practices and general parenting styles; used active skills training methods based on self-regulation. Core parenting skills included: parent-child relationship enhancement, encouraging desirable behavior, teaching new skills and behaviors, managing misbehavior, preventing problems in high-risk situations, self-regulation, mood management and coping, partner support and communication. Lifestyle-specific strategies not addressed. Telephone sessions provided parents individualized support in implementing strategies at home. Materials included standard Triple P resources (workbook and video shown during session) and a healthy lifestyle pamphlet.	Waitlist	Waitlist control for 12 months; healthy-lifestyle pamphlet and 3-4 telephone calls for retention purposes (content not specified)
Hofsteenge, 2014[125] Fair	IG1: Go4it	Seven 90-min group sessions every 2-3 weeks over 3 months followed by 2 maintenance booster sessions. Sessions consisted of education on healthy dietary, sedentary, and PA behavior and CBT for lifestyle improvement and maintenance of energy balance; sessions were interactive and included homework. Behavior change strategies included: self-monitoring of diet and activity (via pedometers), setting personal goals, and techniques for coping with difficult situations and teasing. Participants remained in same group throughout intervention (8-12 in a group). Two separate parent sessions covered education on health risks of overweight, healthy behavior, and how to support their children. Materials included an information book, workbook, and dietary and PA diaries. [Due to high attrition for 18-month outcomes, only 6-month outcomes used and included in intervention description and intensity calculations].	Usual care	Regular care in the Netherlands; consisted of referral to a dietician in the home care setting. Teens had to make the appointment themselves.

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Author, Year & Quality	Intervention Group	Intervention Description	Control Group	Control Group Description
Kalarchian, 2009[126] Fair	IG1: Family-based lifestyle intervention	20 60-min group sessions during first 6 months; adult and child groups met separately and presented with complementary material. Before or after these sessions, adult and child jointly met with lifestyle coach to review self-monitoring records and set weekly goals. 6 booster sessions (3 group, 3 telephone calls) between 6 and 12 months with no further contact after 12 months. Intervention adapted from Epstein and included modified Stoplight Eating Plan with daily energy range, and goal to increase PA and decrease PA to less than 15 hours/week. Behavior change techniques included: self-monitoring, environmental changes, step-wise goal setting, stimulus control, and positive reinforcement. Instruction provided in setting realistic expectations, promoting body image, minimizing emotional eating, and coping with teasing. Adults instructed to set goals and model behavior change; overweight adults encouraged to lose weight.	Nutrition consultation	Adults and children offered 2 nutrition consultation sessions to develop an individual nutrition plan based on the Stoplight Eating Plan; offered intervention after completion of 18-month assessment. This group intended as usual care in patients with severe obesity.
Kalavainen, 2007[127] Fair	IG1: Health-promoting lifestyle	15 90-minute group sessions; 14 held separately for parents and children and one session held together (10 weekly sessions, and 5 every 2 weeks). Program focused on healthy lifestyle as opposed to weight management and parents were targeted as the main agents of change; lifestyle changes intended for entire family and overweight parents who desired to lose weight were encouraged. Parent sessions included education on healthy lifestyle, parenting skills, and behavior change techniques (pros and cons, goal-setting, self-monitoring, stimulus control and cue elimination, action planning, problem-solving, and relapse prevention). Child sessions involved functional activities and non-competitive PA. Parents given treatment manuals and children given workbooks; materials based on Magnificent Kids and Magnificent Teens and "Think Good-Feel Good" CBT workbook. Homework assigned to parents and children; the importance of regular weighing at home emphasized.	Brief education + booklets	Booklets for families and 2 30-min individual sessions for each child with school nurse. Booklets contained information about weight management, eating habits and PA. Appointments intended for child only but parents allowed if willing. Themes of sessions were self-knowledge and PA; weight and height measured at each session. Children completed workbooks with school nurse and at home with parents. Booklets and workbooks based on Magnificent Kids material and "Think Good-Feel Good" CBT workbook.

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Kong, 2013[130] Fair	IG1: ACTION	Transtheoretical model based-intervention consisting of 8 motivational interviews with PCP and student over the academic year (1 session every 2-3 weeks), DVD and print materials from a toolkit, and 8 motivational interview followup calls with caregivers. At 1st visit, patient received DVD player and DVD (content included adolescent motivation for change, strategies targeting energy balance and nutritional quality, physical aerobic dance and strength training) and summary of medical results; this visit dedicated to reviewing medical history, assessing diet and PA and stage of change, and feedback about status relative to recommendations. Participants asked to review DVD and followup with topics they would like to discuss at next session. Subsequent visits tailored to stage of change with intention of moving toward goal setting for healthier eating and PA. Print materials included: weight loss guidelines for clinicians, MI for clinicians, newsletter for caregivers, clinic displays, and adolescent session tools (goal setting, activity/food journal).	Single PCP visit + booklet	1 PCP clinic visit at beginning of trial for assesment of diet and PA, review of medical results, and feedback about status relative to national recommendations. Provided AAP "Balance for a Healthy Life" booklet.
Lison, 2012[131] Fair	IG1: Hospital-based group exercise	Two 1-hour parent/child group education sessions and 120 group PA sessions (5 1-hour supervised sessions per week for 6 months). Education sessions covered importance of weight loss and maintenance, therapeutic nutritional approach to childhood obesity, and role of PA in cardiovascular fitness. Dietary focus was Mediterranean diet. Behavior change strategies included stimulus control, pre-planning, problem solving, and skills for shopping and interpreting food labels. Encouraged to reduce sedentary behavior. 60-minute group exercise sessions included stretching, moderate aerobic activity, and resistance training tailored to each participant with increasing intensity throughout program; parents were allowed to remain present for PA sessions. 5 sessions offered per week with minimum attendance at 3 per week strongly advised. Group sessions aimed to foster positive feeling and attitude toward PA. Participants and parents asked to practice PA during the weekend.	Lifestyle instruction during regular visits	Instructed about diet and other lifestyle changes during regular visits to the hospital, but did not receive the education or PA sessions. Maintained usual levels of of daily activity with no additional exercise components.
	IG2: Home-based exercise	Two 1-hour parent/child education sessions and detailed plan for 120 sessions of home-based exercise (5 1-hour sessions per week for 6 months). Education sessions covered importance of weight loss and maintenance, therapeutic nutritional approach to childhood obesity, and role of PA in cardiovascular fitness. Dietary focus was Mediterranean diet. Behavior change strategies included stimulus control, pre-planning, problem solving, and skills for shopping and interpreting food labels. Encouraged to reduce sedentary behavior. Home-based exercise program included demonstration of how to perform exercises, daily exercise log book, and detailed plan for home exercise sessions which included resistance and aerobic training with progressively increasing duration throughout program. Exercise plan was for 5 1-hr sessions per week for 6 months with minimum participation of 3 per week strongly advised.	Lifestyle instruction during regular visits	Instructed about diet and other lifestyle changes during regular visits to the hospital, but did not receive the education or PA sessions. Maintained usual levels of daily activity with no additional exercise components.

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Looney, 2014[132] Fair	IG1: Newsletters + Growth Monitoring + Family-based Behavioral Counseling	6 monthly sessions (3 30-min in-person and 3 20-minute calls); half of session time was used for growth monitoring and standardized feedback and half of session time for behavioral counseling for the caretaker. A family-based approach was used where both the caretaker and child were encouraged to change and monitor eating and activity behaviors. Behavioral strategies included: self-monitoring, modeling, stimulus control, and positive reinforcement. Child behavioral goals included: <3 sugar-sweetened beverages/week, ≥1.5 cups vegetables/day, ≥1 cup fruit/day, ≥60 minutes/day of exercise, <2 hours/day TV; children asked to achieve 3 of 5 goals each day. Caretaker goals included <3 sugar-sweetened beverages/week, ≥2.5 cups vegetables/day, ≥1.5 cups fruit/day, ≥150 minutes exercise/week, <10 hours TV viewing/week. Level of goals increased incrementally until full program goal reached by month 4. Caretakers and children asked to monitor sugar-sweetened beverages, fruit, vegetables, activity and TV time; weekly picture-based diaries provided. 6 monthly mailed educational newsletters on nutrition and leisure-lime activity topics with recommendations to assist with child overweight and obesity plus usual care from the pediatrician (e.g., well-child visits, sick visits).	Newsletters	6 monthly educational newsletters on nutrition and leisure-lime activity topics with recommendations to assist with child overweight and obesity plus usual care from the pediatrician (e.g., well-child visits, sick visits).
	IG2: Newsletters + Growth Monitoring	6 monthly growth monitoring sessions with standardized feedback (3 15-min in-person appointments and 3 10-minute calls) with tools provided: scale, BMI wheel, wall growth chart, BMI-for-age growth chart, plotting tool, and growth self-monitoring diary. 6 monthly educational newsletters on nutrition and leisure-lime activity topics with recommendations to assist with child overweight and obesity plus usual care from the pediatrician (e.g., well-child visits, sick visits).	Newsletters	6 monthly educational newsletters on nutrition and leisure-lime activity topics with recommendations to assist with child overweight and obesity plus usual care from the pediatrician (e.g., well-child visits, sick visits).
Love-Osborne, 2014[133] Fair	IG1: Health educator visits	Initial visit with health educator (HE) consisted of feedback from diet and PA assessment using motivational interviewing to support change and goal-setting. Goals reviewed and modified at each subsequent visit. HE encouraged participants to choose 1 nutrition and 1 PA goal. Frequency of HE visits directed by participant (mean 5, range 1-8 visits). HE linked patients to existing resources for healthy eating and PA, including facilitating applications for free parks and recreation memberships. Self-monitoring of weight and lifestyle behaviors encouraged and incentives provided for returning log sheets. IG further randomized to 2 weekly text messages (1 individualized goal-related and one log sheet reminder) or no text messages during the first semester. Physical examination and laboratory screening as needed by physician.	Physical exam and lab screening if due, followup as needed	If physical exam and lab screening for comorbidities of obesity had not been done in previous 2 years, considered standard of care in the organization, a visit was scheduled in the school-based health center. Abnormal lab testing evaluated by physician investigators and addressed within school-based health center with referral for specialty care as needed.

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McCallum, 2007[136] Good	IG1: LEAP	Four GP consultations of brief solution-focused family therapy to support healthy lifestyle goals. 20-page family folder included 7 topic sheets targeting areas of behavioral change (sedentary time, physical activity, water consumption, eating habits and lower fat food options). Topic sheets summarized supporting evidence for the target behavior, modelled solutions to common challenges, and provided suggestions for reaching the goal. Materials included wall chart, reward stickers, and shopping tips. Parents encouraged to offer family meals, engage in shared parent-child activities, use praise and non-food rewards, and use contracting for behavior change. Before first appointment, GPs received intervention materials, summary of parent's responses from baseline questionnaire regarding nutrition, physical activity and weight status concern, and child's BMI. GP also provided brief encouragement during non-counseling visits.	Usual care	Usual care. Control families notified of control status via letter and never identified to GPs. Medical records of CG children audited to assess possible contamination (i.e., discussion of weight at a medical visit).
Mellin, 1987[137] Fair	IG1: SHAPEDOWN	14 90-minute weekly group sessions for adolescents and 2 90-minute parent sessions using SHAPEDOWN materials (a Leader's Guide, parent workbook and adolescent workbook). Focus of the program was successive, sustainable, small modifications in diet, exercise, relationships, lifestyle, communication and attitudes; very-low calorie or restrictive diets avoided. Each session included voluntary weigh-in, leader-facilitated group interaction and exercise period. Parents instructed on strategies to support adolescents' weight loss efforts including altering family diet and activity and improving parenting and communication skills. Techniques included: problem-solving, parenting skills (limit-setting and nurturing), cognitive therapy, stress management, body image therapy, and instruction in eating regular meals and eating in response to hunger and satiety. Content integrated ethnic, cultural, and economic differences and used examples of a broad range of family types.	Waitlist	Subjects received no treatment initially and were informed they could enroll in the next program that would commence after 6 months.
Nemet, 2005[138] Fair	IG1: Dietitian + PA sessions	Four evening lectures w/ parents on childhood obesity, general nutrition, therapeutic nutritional approach for childhood obesity, physical activity and childhood obesity). Met w/ dietician 6 times and differed based on age of participant; if 6-8 years, parent only during first 2 sessions then child joined; if 8 year - pubertal, parent and child for all meetings; if adolescent, alternated child-only and parent-only meetings after joint 1st meeting. First session 45-60 minutes, all other sesssions 30-45 minutes. Instructed on nutritional education (e.g., food pyramid), food choices, dietary/cooking habits, and motivation for weight loss. Received a balanced hypocaloric diet (5021-8368 kg depending on age and weight), a caloric deficit of 30% from reported intake and intake 15% less than estimated daily required intake. Exercise program consisted of twice-weekly 1-hour training sessions, pts encouraged to add extra 30-45 minutes of walking or weight-bearing sports activities at least once per week. Encouraged to reduce sedentary activities.	Nutrition referral	Control subjects were referred to an ambulatory nutritional consultation at least once and were instructed to perform physical activity 3 times per week on their own.

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Norman, 2015[139] Fair	IG1: Stepped-down Care	Based on a combination of the chronic care model and social cognitive theory; followed recommendations from AAP about treatment of childhood obesity. Consisted of 3 4-month steps with a goal of 4lb weight loss every 4 months. If the participant did not meet the goal, the step was repeated. If the 4-lb weight loss was achieved, the participant 'stepped down' to the next level of reduced intensity. At the start of the program, the physician provided brief counseling on health diet and PA behaviors. If progress is not made, a follow-up physician visit occurred at month 8 and focused on weight management strategies. Face-to-face health educator visits occurred monthly in step 1 and bi-monthly in step 2, and included discussion of weight management concepts, identification of barriers to healthy eating and PA, and brainstorming problem-solving strategies to overcome barriers. These meetings were available to child and parent, but parents were not required to attend. Phone calls (biweekly in steps 1 and 2, monthly in step 3) were used to review progress, help set new goals and discuss barriers and solutions, speak to parents to reinforce parental involvement and emphasize importance of healthy changes in the home environment to encourage goal attainment. Diet and PA education materials were distributed at health education visits at pediatric clinics. Adolescent and parents asked to keep self-monitoring logs for steps and weight that could be shared with health counselor for feedback. Pedometers were distributed at the initial visit to monitor PA and help participants set PA goals.	Enhanced Usual Care	Received an initial counselling visit by physician, one visit with a health educator, materials on how to improve weight-related behaviors, and monthly follow-up mailings on weight-related issues. Labelled "enhanced" because participants received more than the current standard of practice in the Children's Primary Care Medical Group for adolescents with obesity with no medical comorbidities. Participants also received pedometer at initial health educator visit
Nowicka, 2008[140] Fair	IG1: Family Weight School	Based on systemic family and solution-focused therapies, using a systemic interactional method. Therapist aimed to reinforce family resources and create optimal emotional climate to help the child with obesity emphasizing parent cooperation, communication skills, mutual support, consistency and establishment of appropriate limits. 4 group meetings (up to 12 families) for 4 hours, including 10 minute individual family meetings w/ pediatric nurse or pediatrician with feedback (e.g., on child's strengths) at each session. Intervention toolbox included nutrition (regular family meal planning, adequate portion sizes, limited intake of nutrient-poor foods, increased intake of F/V, water over SSBs), physical activity (≥60 minutes per day), decreasing sedentary time (max 2 hours per day), and lifestyle modifications (select 1-2 changes for subsequent visits). Child and parents met together for at least 1 hour at all meetings, separately for 1.5 hours during meeting 2 and 3 only.	Waitlist	Once the treatment condition was filled, additionally referred children were placed on the waiting list for treatment. This group served as the control group. The control group did not receive any treatment during the 1 year study period.

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O'Connor, 2013[141] Fair	IG1: Helping HAND	6 monthly individual family sessions with health advisors with followup phone call 2 weeks after each session. Behavior change strategies included: collaborative goal setting for children and parents, action planning, behavioral contract, self-monitoring of goal-specific behavior, and problem solving. Child behavior goals selected from menu of goals about healthy diet, PA, and TV time; goals were for 1-month period with option to work on the goal for an additional month. Parent goals included behavior-specific parenting practices (responsiveness, structure and nondirected control for diet; logistic support and modeling for PA; and mediation and social coviewing for TV). Worksheets used during sessions to facilitate goal-setting and problem-solving.	Waitlist	Asked to see doctor as regularly scheduled and follow doctor's advice and treatment plans. Recontacted after 7 months for post-intervention data collection and to start intervention; asked to avoid participation in other obesity prevention or treatment programmes during this time.
Raynor, 2012a[142] Fair	IG1: DECREASE + Growth Monitoring	8 45-minute parent-only group behavioral sessions (biweekly for 2 months and monthly for months 3-6). Behavior change strategies included: self-monitoring, pre-planning, problem-solving, shaping, setting goals, positive reinforcement, stimulus control, and parental modeling. Children and parents self-monitored targeted behaviors and submitted logs at meetings. Used a restrictive approach to reduce intake of non-nutrient-dense, energy-dense foods. Goal was to reduce intake of sweet and salty snacks to ≤3 servings/week and sugar-sweetened beverages to ≤3 servings/week. Growth assessed at 0, 3, and 6 months. Letters providing changes in height, weight, BMI, BMI percentile, and % overweight and interpretation of changes were sent to families and the child's PCP after each growth assessment.	Monthly newsletters + growth monitoring	Monthly newsletter with information about healthy eating and leisure-time behaviors; growth assessed at 0, 3, + 6 months. Letters providing changes in height, weight, BMI, BMI percentile, and % overweight and interpretation of changes were sent to families and the child's PCP after each growth assessment. Families provided with research staff contact information and encouraged to contact staff with any questions about information in the letter.
	IG2: INCREASE + Growth Monitoring	Eight 45-minute parent-only group behavioral sessions (biweekly for 2 months and monthly for months 3-6). Behavior change strategies included: self-monitoring, pre-planning, problem-solving, shaping, setting goals, positive reinforcement, stimulus control, and parental modeling. Children and parents self-monitored targeted behaviors and submitted logs at meetings. Increase healthy food intake to shape food preference for these foods and lower energy density of the diet. Goal was to consume 2 servings/day of whole fruit, 3 servings/day of vegetables, and 2 servings/day of low-fat dairy products. Growth assessed at 0, 3, and 6 months. Letters providing changes in height, weight, BMI, BMI percentile, and % overweight and interpretation of changes were sent to families and the child's PCP after each growth assessment.	Monthly newsletters + growth monitoring	Monthly newsletter with information about healthy eating and leisure-time behaviors; growth assessed at 0, 3, + 6 months. Letters providing changes in height, weight, BMI, BMI percentile, and % overweight and interpretation of changes were sent to families and the child's PCP after each growth assessment. Families provided with research staff contact information and encouraged to contact staff with any questions about information in the letter.

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Raynor, 2012b[142] Fair	IG1: TRADITIONAL + Growth Monitoring	Eight 45-minute parent-only group behavioral sessions (biweekly for 2 months and monthly for months 3-6). Behavior change strategies included: self-monitoring, pre-planning, problem-solving, shaping, setting goals, positive reinforcement, stimulus control, and parental modeling. Children and parents self-monitored targeted behaviors and submitted logs at meetings. Focused on two typically targeted behaviors in pediatric weight management programs, decreasing sugar-sweetened beverages and increasing PA. Goals were 60 minutes/day of moderate-intensity PA (30 minutes/day for parents) most days of the week and for children and parents to consume ≤3 servings of sugar-sweetened beverages/week. Growth assessed at 0, 3, and 6 months. Letters providing changes in height, weight, BMI, BMI percentile, and % overweight and interpretation of changes were sent to families and the child's PCP after each growth assessment.	Monthly newsletters + growth monitoring	Monthly newsletter with information about healthy eating and leisure-time behaviors; growth assessed at 0, 3, + 6 months. Letters providing changes in height, weight, BMI, BMI percentile, and % overweight and interpretation of changes were sent to families and the child's PCP after each growth assessment. Families provided with research staff contact information and encouraged to contact staff with any questions about information in the letter.
	IG2: SUBSTITUTES + Growth Monitoring	Eight 45-minute parent-only group behavioral sessions (biweekly for 2 months and monthly for months 3-6). Behavior change strategies included: self-monitoring, pre-planning, problem-solving, shaping, setting goals, positive reinforcement, stimulus control, and parental modeling. Children and parents self-monitored targeted behaviors and submitted logs at meetings. Used behavioral economics approach to enhance the feeling of choice for engaging in and liking the targeted behaviors in order to increase long-term adherence. Goals were to watch ≤2 hours of TV per day (as a substitute for PA) and consume 2 servings of low-fat milk per day (as a substitute for sugar-sweetened beverages). Growth assessed at 0, 3, and 6 months. Letters providing changes in height, weight, BMI, BMI percentile, and % overweight and interpretation of changes were sent to families and the child's PCP after each growth assessment.	Monthly newsletters + growth monitoring	Monthly newsletter with information about healthy eating and leisure-time behaviors; growth assessed at 0, 3, + 6 months. Letters providing changes in height, weight, BMI, BMI percentile, and % overweight and interpretation of changes were sent to families and the child's PCP after each growth assessment. Families provided with research staff contact information and encouraged to contact staff with any questions about information in the letter.

Appendix D Table 2. Detailed Intervention Descriptions of Included Behavior-Based Intervention Trials, Alphabetical Order (Key Questions 3–5)

Author, Year & Quality	Intervention Group	Intervention Description	Control Group	Control Group Description
Reinehr, 2006[143] Fair	IG1: Obeldicks	Covered physical exercise, nutrition education and behavioral therapy including individual psychological care of child and family. Intensive phase (3 months): nutritional education (traffic light system, target 30% fat, 15% protein, 55% carbohydrates) and behavior therapy groups (6 group sessions, 1.5 hours each); concurrent parent sessions; weekly PA sessions. Establishing phase (6 months): 3 parent group "talk rounds" sessions, solution-focused individual family therapy (30 min/month), weekly PA sessions. Followup phase (3 months): further individual psychogical care as needed, weekly PA sessions. PA sessions included ballgames, jogging, trampoline jumping, instruction in PA as part of daily life, instruction to reduce sedentary time. Behavioral course included behavior contracts, booster systems, self-reflecting curves, impulse control techniques, self instruction, cognitive restructuring, development of problem-solving strategies, training in social competences, model learning via parents, and relapse prevention.	Distance control	Control group comprised of children who met eligibility criteria but whose families lived too far away to travel regularly to the obesity clinic.
Reinehr, 2009[144] Fair	IG1: Obeldicks	Covered physical exercise, nutrition education and behavioral therapy including individual psychological care of child and family. Intensive phase (3 months): nutritional education (traffic light system, target 30% fat, 15% protein, 55% carbohydrates) and behavior therapy groups (6 group sessions, 1.5 hours each); concurrent parent sessions; weekly PA sessions. Establishing phase (6 months): 3 parent group "talk rounds" sessions, solution-focused individual family therapy (30 min/month), weekly PA sessions. Followup phase (3 months): further individual psychogical care as needed, weekly PA sessions. PA sessions included ballgames, jogging, trampoline jumping, instruction in PA as part of daily life, instruction to reduce sedentary time. Behavioral course included behavior contracts, booster systems, self-reflecting curves, impulse control techniques, self instruction, cognitive restructuring, development of problem-solving strategies, training in social competences, model learning via parents, and relapse prevention.	Distance control	The control group was made up of children with 1 year of follow up available who were not treated with the lifestyle intervention because they lived too far away and had no means of transportation. Children and their families were advised in a 15 minute consultation about healthy diet and necessary physical exercise and behaviors. Written information on nutrition with recipes was provided.
Reinehr, 2010[145] Fair	IG1: Obeldicks light	Intervention included PA training, nutrition education, and behavior counseling and was performed in group sessions with individual counseling for child and family. Children divided into groups based on sex and age. PA training involved weekly 1.5 hour sessions for 6 months with exercise activities and instruction in PA and reduction in TV and computer game time. Nutrition course based on “Optimized Mixed Diet” which was fat and sugar reduced and contained 30% of energy from fat, 15% energy from protein, and 55% energy from carbohydrates. Children followed traffic light system. During intensive phase of first 3 months, 6-1.5 hour group sessions for kids about nutrition and eating behavior and 6-1.5 hour parent sessions which included nutrition, PA and behavior education, 1 30-min individual nutrition counseling session. During "establishing phase" (next 3 months) 4 30-minute individual child/parent counselling sessions were held (2 nutrition-focused), plus continuation of weekly PA sessions.	Waitlist	Waitlist control for 6 months

Appendix D Table 2. Detailed Intervention Descriptions of Included Behavior-Based Intervention Trials, Alphabetical Order (Key Questions 3–5)

Author, Year & Quality	Intervention Group	Intervention Description	Control Group	Control Group Description
Resnicow, 2015[146] Fair	IG1: PCP + RD MI	Same as IG2 + 6 additional motivational interviewing counseling sessions conducted by RD over 2 years. RDs given flexibility in scheduling counseling sessions, though encouraged to provide more visits toward the beginning of the intervention. RD sessions delivered in-person or by phone.	Usual care	Measurements at BL, 1- + 2-year F/U and provided routine care by PCP, as well as standard educational materials for parents that addressed healthy eating and exercise. Usual care PCPs attended a half-day orientation session that included current treatment guidelines.
	IG2: PCP MI	3 brief PCP-delivered MI counseling sessions with parents in year 1 and 1 additional "booster" visit in year 2 (flexibility allowed in session scheduling). Techniques include reflective listening, autonomy support, shared decision-making, and eliciting change talk (e.g. building discrepancy through values clarification, importance/confidence rulers). Targeted dietary and activity behaviors included: snack foods, sweetened beverages, eating in restaurants, fruits, vegetables, TV/screen time, video and computer games and PA/exercise. Target behaviors identified by a brief screener. PCPs asked to provide positive feedback on "green" behaviors and collaboratively identify with the parent "red" or "yellow" behaviors they would be willing to discuss and possibly modify. Provided materials were tailored to the chosen targeted behavior. Self-monitoring logs offered.	Usual care	Measurements at BL, 1- + 2-year F/U and provided routine care by PCP, as well as standard educational materials for parents that addressed healthy eating and exercise. Usual care PCPs attended a half-day orientation session that included current treatment guidelines.
Sacher, 2010[147] Fair	IG1: MEND	Multicomponent group healthy lifestyle program based on nutritional and sports science plus from psychology, learning and social cognitive theories. Engages family in process of weight management by addressing education, skills training and motivational enhancement. 18 group (8-15 children w/ parents or carers and siblings) sessions over 9 weeks (2-hour health twice a week in early evening) by two MEND leaders and one assistant. Sessions included 1 introduction, 8 behavior change (apply techniques to change such as stimulus control, goal setting, reinforcement, and response prevention), 8 nutrition education (healthy eating, weekly achievable diet targets, label reading, supermarket tour, recipes and food preparation, food samples, discouraged weighing in favor of increasing healthy habits), 16 PA sessions (1 hour exercise) for children, and a closing session. Free access to community swimming pool for 12 weeks.	Waitlist	Received intervention after 6 months wait period
Saelens, 2002[148] Fair	IG1: Healthy Habits Intervention	Healthy habits intervention: 1 computerized assessment followed by 1 meeting with pediatrician to discuss assessment results, develop action plan; 11 10-20 min counseling calls; mailed participant manual in 3 different mailings (part of manual mailed each time, included information sheet for parents); encouraged self-monitoring of food intake and PA; single session to discuss intervention and self-monitoring with child and parents	Single pediatrician session	Meeting with pediatrician assessing motivation and providing (non-tailored) information on healthy eating and PA

Appendix D Table 2. Detailed Intervention Descriptions of Included Behavior-Based Intervention Trials, Alphabetical Order (Key Questions 3–5)

Author, Year & Quality	Intervention Group	Intervention Description	Control Group	Control Group Description
Savoye, 2007[150] Fair	IG1: Bright Bodies	Family group sessions twice per week for 6 months, then twice monthly for 6 months. First 6 months: two 50-min exercise sessions/week (parents and children together), 1 weekly weigh-in (both parents and children), and 1 weekly 40-min class covering nutrition (parents and children together) and behavior modification (parents and children in separate groups). Encouraged to exercise 3 additional days/week. Used motivational tools to increase attendance, such as a game accumulating points for participation in group activities and exercise. Dietician led the nutrition portion of the class using the Smart Moves workbook and emphasized a non-diet approach to healthy eating. Behavior modification portion was facilitated by dietician or social worker, and included self-awareness, goal setting, stimulus control, coping skills training, cognitive behavior strategies, and contingency management. Exercise consisted of warm-up, high-intensity and cool-down; once per month special exercise activities planned (e.g., Zumba class). During behavioral modification portion parents attended a separate coping skills training class that emphasized the important of parent as role model, led by psychologist or dietician.	Semi-annual individual counseling	Seen in pediatric obesity clinic every 6 months; Diet (decrease intake of juice, switching to diet produts, bringing lunch to school) and exercise (decrease sedentary activities) counseling by RD and physician, and brief psychological counseling with social worker; caregiver involved in nutrition an activity goal-setting
Savoye, 2014[149] Fair	IG1: Bright Bodies	Group family sessions twice per week for 6 months at two separate locations (one w/ Spanish bilingual instructors); two 50-min exercise sessions/week, 1 weekly weigh-in, and 1 weekly 40-min nutrition and behavior modification class. Encouraged to exercise 3 additional days/week. Earned tickets for monthly raffle for weight maintenance or loss and, in some cases, for turning in exercise logs. Dietician led the nutrition and behavioral modification class using the Smart Moves workbook. Nutrition component emphasized a non-diet approach to healthy eating. Behavior modification included self-awareness, goal setting, stimulus control, coping skills training, cognitive behavior strategies, and contingency management. Exercise consisted of warm-up, high-intensity and cool-down; once per month special exercise activities planned (e.g., Zumba class). During behavioral modification portion parents attended a support class with solution-focused brief therapy elements and tool (e.g., strength cards, so help parent identify their own and their child's strengths), led by psychologist or dietician.	General advice + brief psychosocial counseling	Followed in the clinic every 6 months and received general diet and exercise counseling by dieticians and physicians along with brief psychosocial counseling by a social worker.

Appendix D Table 2. Detailed Intervention Descriptions of Included Behavior-Based Intervention Trials, Alphabetical Order (Key Questions 3–5)

Author, Year & Quality	Intervention Group	Intervention Description	Control Group	Control Group Description
Sherwood, 2015[151] Fair	IG1: Busy Bodies/Better Bites	Brief pediatric primary care component (including the use of a flipchart and pamphlet) regarding obesity and injury prevention in addition to eight biweekly (15-30 min) phone coaching sessions focusing on healthy eating and physical activity and received a bag of relevant activities and workbooks (Busy Bodies / Better Bites). Phone sessions including goal setting and MI to reduce screen time, increase physical activity, decrease SSBs, increase availability of healthy foods. Each phone session reviewed behavior changes with a discussion of challenges and successes.	Attention control (injury prevention)	Brief pediatric primary care component (including use of a flipchart and pamphlet) regarding obesity and injury prevention plus 8 biweekly (15-30 min) phone coaching sessions focusing on safety and injury prevention and received a bag of relevant activities and workbooks (Healthy Tots/Safe Spots). Phone sessions including goal setting and MI to reduce distracted driving, prevent falls, fire safety, poison control, and sun protection. Each phone session reviewed behavior changes with a discussion of challenges and successes.
Stark, 2011[154] Fair	IG1: LAUNCH	Phase 1 (intensive intervention), 12 weekly sessions that alternated btwn group-based clinic session (parent and child concurrent groups) and individual home visits; Phase 2 (maintenance), 6 sessions (every other week over 12 weeks) alternating btwn group clinic-base sessions and home sessions. Parent clinic-based sessions (90 minutes) addressed dietary education (snacks/beverages, breakfast/lunch, dinner) and kept dietary diaries for child (caloric goal 1000-1200/day); decreasing screen time (<2 hours/day) and increasing physical activity (60 minutes/day). Both parent and child provided w/ pedometers (goal 5000-10000 steps/day). Parents taught by license clinical psychologist to use child bx management skills including praise and attention to increase healthy bx, ignoring and timeouts to manage tantrums, contingency management and modeling; taught stimulus control; provided w/ 14 day supply of vegetables for taste-testing w/ child. Children received nutrition education, tried new foods during structured meals, and complete 15 minutes of moderate-to-vigorous exercise in a group format conducted by a pediatric psychology postdoc and research coordinator. In-home sessions (60-90 minutes) to support generalization of clinic-taught skills as well as clean-outs of pantry (high-calorie/low-nutrient foods) and assisted parents w/ setting a safe place in home for active play. During maintenance stage, session focused on helping families continue or maintain changes by identifying barriers and problem-solving; diet diary recording reduced to 3 days/week and pedometers worn but not longer recorded.	Enhanced standard of care	Each family met with a pediatrican for 1 45-minute session to review child's growth chart and to explain BMI, BMI percentiles, and the child's current BMI percentile. Recommendations were made in accordance with "Prevention Plus" for preschool children with obesity: amount of screen time, amount of active play time, amount of soda and juice , amount of fruits and vegetables, limiting eating out, and appropriate portion sizes. Received 1-page healthy food and activity brochure.

Appendix D Table 2. Detailed Intervention Descriptions of Included Behavior-Based Intervention Trials, Alphabetical Order (Key Questions 3–5)

Author, Year & Quality	Intervention Group	Intervention Description	Control Group	Control Group Description
Stark, 2014[153] Fair	IG1: LAUNCH-clinic	10-session manualized intervention to produce small decreases or stabilize rate of child weight gain consistent w/current obesity treatment recommendations. Parent-group clinic sessions (90 min) concurrent w/child group sessions (90 min). Parent sessions (90 min) addressed dietary education (snacks/beverages, breakfast/lunch, dinner) and kept dietary diaries for child (caloric goal 1000-1200/day); decreasing screen time (<2 hours/day) and increasing physical activity (60 min/day), emphasized parental modeling of health lifestyle behaviors. Both parent and child provided w/pedometers (goal 5000-10000 steps/day). Children received nutrition education, tried new foods during structured meals, and complete 15 min of moderate-to-vigorous exercise in a group format conducted by a pediatric psychology postdoc and research coordinator. Parents taught by license clinical psychologist to use child bx management skills including praise and attention to increase healthy bx, ignoring and timeouts to manage tantrums, contingency management and modeling; taught stimulus control. At each sessions, parents provided w/vegetables for daily taste tests (14 days worth of food) and kept food diaries. Also received a home clean-out box to use on their own to eliminate high-calorie, low-nutrient foods from home. Sessions conducted every other week during first 3 months, then monthly during next 3 months for 10 treatment sessions	Enhanced standard of care	Pediatrician met with each family to explain BMI, BMI percentiles, and to review the child's growth chart in a single 45-minute meeting. Modeled on AAP "Prevention Plus" guideline--Pediatrician made recommendations regarding daily screen time, active play, eliminating soda, fruit and vegetable servings, limiting eating out, and appropriate portion sizes for preschoolers. Received 1 page healthy food and activity brochure.

Appendix D Table 2. Detailed Intervention Descriptions of Included Behavior-Based Intervention Trials, Alphabetical Order (Key Questions 3–5)

Author, Year & Quality	Intervention Group	Intervention Description	Control Group	Control Group Description
Stettler, 2014[155] Fair	IG1: Multiple-behavior change	12 15-25 min weekly (1-4 sessions), biweekly (5, 6), monthly (7, 8) and bimonthy (9-12) with child, parent/guardian and clinician. Bx goals to reduce intake of "Whoa" sugary drinks (e.g., soda, lemonade), increase intake of "Go" drinks (water, milk), increase pedometer to 15000 steps/day, and reduce screen time ≤ 2 hours/day. Increase knowledge of serving sizes, benefits of water intake, detrimental effects of sugary drinks, importance of parent modeling behavior, healthy eating, screen time, and physical activity. Skill-building of self-monitoring and stimulus control. Point-system used with children for positive reinforcement for both session attendance and behavioral change, behavioral contract signed by parent, child and clinician. Role-playing and other activities (e.g., grocery receipt review, measure target HR, identify alternatives to sedentary bx).	Attention control (bullying prevention)	12 15-25-minute clinician, child, and parent sessions. Bullying prevention attention control condition to aid children in developing strategies for improving friendship making skills and anger management abilities. Children received cartoons of different social situations and discussed them with the clinician. Homework assignments included similar cartoons and other creative assignments including drawing places where bullying might happen, drawing what different emotions look like, and strategies for handling negative social situations. Point-system used with children for positive reinforcement for positive social behaviors and handling friendship-making problems but no behavioral contract. Sessions occurred on same schedule and for same length of time as IG conditions.

Appendix D Table 2. Detailed Intervention Descriptions of Included Behavior-Based Intervention Trials, Alphabetical Order (Key Questions 3–5)

Author, Year & Quality	Intervention Group	Intervention Description	Control Group	Control Group Description
	IG2: Combined	Combined participants from IG2 and IG3	Attention control (bullying prevention)	12 15-25 min clinician, child, and parent sessions. Bullying prevention attention control condition to aid children in developing strategies for improving friendship making skills and anger management abilities. Children received cartoons of different social situations and discussed them with the clinician. Homework assignments included similar cartoons and other creative assignments including drawing places where bullying might happen, drawing what different emotions look like, and strategies for handling negative social situations. Point-system used with children for positive reinforcement for positive social behaviors and handling friendship-making problems, but no behavioral contract. Sessions occurred on same schedule and for same length of time as IG conditions.

Appendix D Table 2. Detailed Intervention Descriptions of Included Behavior-Based Intervention Trials, Alphabetical Order (Key Questions 3–5)

Author, Year & Quality	Intervention Group	Intervention Description	Control Group	Control Group Description
	IG3: Beverage-only intervention	12 15-25 min weekly (1-4 sessions), biweekly (5, 6), monthly (7, 8) and bimonthy (9-12) sessions with child, parent/guardian and clinician. Bx goals to reduce intake of "Whoa" sugary drinks (e.g., soda, lemonade), increase intake of "Go" drinks (water, milk). Increase Knowledge of serving sizes, benefits of water intake, detrimental effects of sugary drinks, and importance of parent modeling bx. Skill-building of self-monitoring and stimulus control. Point-system used with children for positive reinforcement for both session attendance and behavioral change, behavioral contract signed by parent, child and clinician. Role-playing and other activities (e.g., label reading, tooth brushing).	Attention control (bullying prevention)	12 15-25 min clinician, child, and parent sessions. Bullying prevention attention control condition to aid children in developing strategies for improving friendship making skills and anger management abilities. Children received cartoons of different social situations and discussed them with the clinician. Homework assignments included similar cartoons and other creative assignments including drawing places where bullying might happen, drawing what different emotions look like, and strategies for handling negative social situations. Point-system used with children for positive reinforcement for positive social behaviors and handling friendship-making problems, but no behavioral contract. Sessions occurred on same schedule and for same length of time as IG conditions.
Tanofsky-Kraff, 2010[156] Fair	IG1: IPT-Weight Gain Prevention	One individual 90-minute pre-group session and 12 75-90 minute weekly group sessions for the adolescents of interpersonal psychotherapy (IPT-WG) for the prevention of excessive weight gain. IPT is based on the assumption that binge eating occurs in response to poor social functioning and consequent negative mood and focused on improving interpersonal difficulties and social deficits. Group sessions offered psychoeducation and general skill-building that could be applied to different relationships within the framework of interpersonal problem areas; episodes of overeating and loss-of-control eating were linked to interpersonal functioning.	Attention control (health education)	12 group health education sessions as attention control. Curriculum topics included: avoiding alcohol, drug, and tobacco use, identifying signs of depression and suicide, nonviolent conflict resolution, sun safety, domestic violence, and very basic information on nutrition, body image, and exercise. Information provided in didactic manner.

Appendix D Table 2. Detailed Intervention Descriptions of Included Behavior-Based Intervention Trials, Alphabetical Order (Key Questions 3–5)

Author, Year & Quality	Intervention Group	Intervention Description	Control Group	Control Group Description
Taveras, 2011[157] Good	IG1: MI + enhanced EMR and training	Chronic Care Model-based intervention where all practice team members were trained and electronic medical record enhanced to assist clinicians with decision support, patient tracking, followup, scheduling, and billing. 4 25-min face-to-face + 3 15-min phone motivational interviewing sessions with NP, which used tailored educational modules targeting TV viewing and fast food and SSB intake. Included printed and electronic behavior monitoring tools, lists of resources for PA, and interactive website. Focus on de-emphasizing labeling, giving the parent responsibility for identifying which behaviors are problematic, encouraging parents to clarify and resolve ambivalence about behavior change, and settings goals to initiate change process. Pediatricians trained to use brief, focused negotiation (based on motivational interviewing) in routine well-child exams to endorse family behavior change. Posters in waiting rooms highlighted targeted behaviors. Behavioral goals were <1 hr/ day TV or video viewing, no TV where child sleeps, ≤1 serving/week fast food, and ≤1 serving/day SSB. 1 year intervention period followed by less intensive maintenance period (not further described).	Usual care	Current standard of care offered by the pediatric practice. This included well-child care visits and follow-up appointments for weight checks with their pediatrician or a specialist (e.g., nutritionist). Families in the UC group visited the practice for the baseline and annual well-child appointment.

Appendix D Table 2. Detailed Intervention Descriptions of Included Behavior-Based Intervention Trials, Alphabetical Order (Key Questions 3–5)

Author, Year & Quality	Intervention Group	Intervention Description	Control Group	Control Group Description
Taveras, 2015[158] Good	IG1: CDS + coaching	Modified existing electronic health record to deploy a computerized, point-of-care CDS alert to pediatric clinicians at time of well-child visit for child with a BMI at ≥95th percentile. Alert contained links to growth charts, evidence-based childhood obesity screening and management guidelines, and a prepopulated standardized note template specific for obesity that included options for 1) documenting and coding for BMI percentile, 2) documenting and coding for nutrition and physical activity counseling, 3) placing referrals for weight management programs, 4) placing orders for lab studies if appropriate, and 5) printing educational materials. Clinicians were trained to use brief motivational interviewing to negotiate followup weight management plan with the patient and their family. A comprehensive set of educational materials were provided by pediatric clinicians to patients that focused on individual- and family-level behaviors, including 1) decreases in screen time, 2) decreases in consumption of sugar sweetened beverages, 3) increases in moderate and vigorous physical activity, and 4) improvement of sleep duration and quality. 4 newsletters were provided throughout the intervention period that included self-guided behavior change. 4 phone motivational interview sessions (time NR) with health coach and optional text messaging program for parents (2 texts/week, 1 educational message about a target behavior, 1 self-monitoring message asking how child did with specific target behavior with followup message after parent reply). Families were assigned a health coach who used motivational interviewing to support families by phone at 1, 3, 6, + 9 months. Parents were also invited to participate in interactive text message program. Parents who chose not to receive texts had option to receive same messages by email. Texts were received 2x/week during 1 year followup period and provided support for behavior change for the patient and their family. 1st text each week is an educational message about 1 of the recommended behaviors and 2nd is a self-monitoring message that asks how child did with a certain target behavior the day before. Outgoing text asks parents to reply to these messages, in turn they receive an automated feedback response message tailored to how they indicated they are doing meeting that behavior goal.	Usual care	Received the current standard of care offered by their pediatric office. No new decision support tools for obesity were made available in the electronic health records of the 4 usual care practices. Received generic health-related materials in the mail.

Appendix D Table 2. Detailed Intervention Descriptions of Included Behavior-Based Intervention Trials, Alphabetical Order (Key Questions 3–5)

Author, Year & Quality	Intervention Group	Intervention Description	Control Group	Control Group Description
	IG2: CDS	Modified the existing electronic health record to deploy a computerized, point-of-care clinical decision support (CDS) alert to pediatric clinicians at the time of a well-child visit for a child with a BMI at the 95th percentile or greater. Alert contained links to growth charts, evidence-based childhood obesity screening and management guidelines, and a pre-populated standardized note template specific for obesity that included options for (1) documenting and coding for BMI percentile, (2) documenting and coding for nutrition and physical activity counseling, (3) placing referrals for weight management programs, (4) placing orders for lab studies if appropriate, and (5) printing educational materials. Clinicians were trained to use brief motivational interviewing to negotiate a follow-up weight management plan with the patient and their family. A comprehensive set of educational materials were developed to be provided by pediatric clinicians to patients that focused on individual- and family-level behaviors, including (1) decreases in screen time, (2) decreases in consumption of sugar sweetened beverages, (3) increases in moderate and vigorous physical activity, and (4) improvement of sleep duration and quality. Additionally, 4 newsletters were provided throughout the intervention period that included self-guided behavior change.	Usual care	Received the current standard of care offered by their pediatric office. No new decision support tools for obesity were made available in the electronic health records of the 4 usual care practices. Received generic health-related materials in the mail.
Taylor, 2015[159] Good	IG1: Tailored lifestyle support	One individual 1-2 hour multidisciplinary session (mentor, dietician, exercise specialist, clinical psychologist) with parents followed by regular brief contact with mentor (nutritionist or exercise trainer) tailored to family's goals and priorities, monthly for 1st year, ~ every 3 months in the 2nd year (total sessions ~14). At baseline, extensive report generated from collected data, specialists used the report to identify areas for change, but families took lead in identifying specific targets. Remaining contacts alternated between in-person visits at the university or in the home (30-40 min) and phone calls (5-10 min). Individual goals were negotiated and relevant resources, based on well-established behavioral strategies, were discussed. Resources covered parenting (talking about the study, goals, action plan, influences on child's behavior, ground rules and rewards, actions and consequences, problem solving, stress management for parents), diet ("good food guide", healthy options for fast food, food labels, feeding fussy eaters, shopping), and physical activity (getting the whole family active). Provided support and continued monitoring and adjustment to target behaviors over time. Est total intervention contact 6-7 hrs per family.	Brief feedback and advice	Met with trained researcher at baseline and 6 months. At first appt (30-45min) parents received individualized feedback about their child's diet and activity habits based on comprehensive baseline assessment. Child's results were compared with guidelines, other published data. Provided generalized advice using publicly available resources. Reviewed progress at second appt (15-30min), no new information/resources provided.

Appendix D Table 2. Detailed Intervention Descriptions of Included Behavior-Based Intervention Trials, Alphabetical Order (Key Questions 3–5)

Author, Year & Quality	Intervention Group	Intervention Description	Control Group	Control Group Description
Van Grieken, 2013[160] Fair	IG1: Be Active Eat Right	Prevention protocol initiated during a well-child visit, using motivational interviewing approach; 3 additional structured healthy lifestyle counseling sessions to promote overweight-prevention behaviors could be offered (approximately 3, 6, and 12 months after well-child visit). Content of additional counseling sessions was matched to parents' stage of change as assessed during initial well-child visit. 4 behaviors targeted: play outside >1 hr/day, eat breakfast daily, ≤2 glasses sweet beverages/day, and maximum 2 hrs/day sedentary behavior). Parents together with staff chose 1-2 behaviors to target. Information materials provided, diet and activity diaries discussed, and family-oriented action plans for behavior change discussed.	Usual care	Parents were informed about the overweight status of their child but usual care was given, consisting of general information about a healthy lifestyle provided as part of a normal well-child visit.
Vos, 2011[161] Fair	IG1: Family-based multidisciplinary lifestyle intervention	2 individual family screening and counseling visits with a multidisciplinary team results in contract for behavioral goals, followed by 3-month intensive phase involving 7 group meetings, 2.5 hours each (7 child-only sessions, 5 parents-only sessions, 1 parent+child session, every 2 weeks) followed by booster sessions (2-3 per year) for 2 years. Individual visits include nutritional advice (traffic light nutrition), physical activity counseling, and psychological counseling (cognitive behavioral techniques for weight loss and help child deal with/accept their own body. Child group meetings focused on nutritional information, self-control techniques, problem solving, self-reward, self-regulation, stimulus control, self-image, coping strategies, and relapse prevention. Also included physical activity at each meeting (duration NR). Parent group meetings focused on lifestyle change, nutrition, and how to help child; parental role in family treatment conceived as therapeutic helper (positive feedback, positive support) and healthy lifestyle role model. Parenting style of strict rules but pleasant interactions encouraged. Booster sessions to maintain learned behavior through problem-solving and relapse prevention. Detailed description provided in study protocol.	Waitlist	Participants were given an initial physical activity and nutritional advice. After 12 months, they were offered multidisciplinary treatment.
Wake, 2009[162] Good	IG1: LEAP-2	Four GP consultations of brief solution-focused family therapy to support healthy lifestyle goals. 16-page family folder included 5 topic sheets each targeting one area of behavioral change (sedentary time, physical activity, water consumption, eating habits and lower fat food options). Topic sheets summarized supporting evidence for the target behavior, modelled solutions to common challenges, and provided suggestions for reaching the goal. Materials included wall chart, reward stickers, and shopping tips. Parents encouraged to offer family meals, engage in shared parent-child activities, use praise and non-food rewards, and use contracting for behavior change. Before first appointment, GPs received intervention materials, summary of parent's responses from baseline questionnaire regarding nutrition, physical activity and weight status concern, and child's BMI. GP also provided brief encouragement during non-counseling visits.	Usual care	Usual care. Control families notified of control status via letter and never identified to GPs. Medical records of CG children audited to assess possible contamination (i.e., discussion of weight at a medical visit).

Appendix D Table 2. Detailed Intervention Descriptions of Included Behavior-Based Intervention Trials, Alphabetical Order (Key Questions 3–5)

Author, Year & Quality	Intervention Group	Intervention Description	Control Group	Control Group Description
Wake, 2013[163] Good	IG1: HopSCOTCH	One hour-long family appointment with obesity specialist team (pediatrician and dietitian) followed by one 20-40 minute "long" GP consultation and 4-8 6-20 minute standard appointments; GP and specialist care linked by web-based software. Specialist team provided with individual patient summary about family and medical history, and daily diet, PA and sedentary activities. At this visit, clinicians and families agreed on an initial care plan and specific goals. Subsequent 20-40 minute GP session and regular 6-20 minute standard consultations every 4 to 8 weeks consisting of lifestyle and BMI progress review, problem solving, and goal setting using brief solution-focused techniques. All data entered into HopSCOTCH web-based software which was shared between specialist team and GP. 6 months after enrollment, specialist team accessed software to review participant progress and faxed a summary report to GP. Specialist team available to GP via email or phone.	Usual care	Participants were free to seek assistance from their GP or from any other service.
Weigel, 2008[164] Fair	IG1: Sea Lion Club	Twice weekly child group sessions of 45-60 minutes for 12 months consisting of PA, dietary education, and coping strategies. The first weekly session was for PA and the second for nutrition and coping strategies. Children encouraged to complete diet and PA logs (which included parent's signature) and discuss weekly with the group. Child groups divided by age for age-appropriate training and education. Parental support provided at optional separate 2-hour monthly meetings and feedback discussions; these included child-parent activities and social reinforcement.	Brief advice	2 pediatrician visits with parent and child that included written therapeutic advice and explanation. Written materials included PA recommendations, dietary education, and coping strategies (e.g., awareness of eating behavior and recommendations for habit books); materials were explained to the family by the pediatrician and followed German obesity guidelines. Children and adolescent versions of materials also provided. After 1 year, participants were offered open, fun-based lessons in the sports center where the intervention had been performed.

Abbreviations: AAP = American Academy of Pediatricians; apt = appointment; BL = baseline; BMI = body mass index; btwn = between; bx = behavior; CBT = cognitive behavioral therapy; CDS = clinical decision support; CG = control group; DVD = digital video disc; EMR = electronic medical record; F/U = followup; F/V = fruits and vegetables; GP = general practitioner; HE = health education; HR = heart rate; hr(s) = hour(s); IG = intervention group; IPT = interpersonal therapy; kg = kilogram(s); MI = motivational interviewing; min = minute(s); NP = nurse practitioner; PCP = primary care physician; pt = participant; RD = registered dietitian; SSB = sugar-sweetened beverage; TV = television; UC = usual care; w/ = with; WG = workgroup.

Appendix D Table 3. Weight Outcomes in Included Lifestyle-Based Weight Loss Trials (Key Question 4)

Author, Year & Quality	Followup (months since tx ended)	Est hrs of contact	Outcome (unit)	IG mean difference (SD)	IG n	CG mean difference (SD)	CG n	Between group p-value	Adjustment details
Lison, 2012[131]	6 (0)	122	BMI (kg/m^2)	-0.40 (NR)	32	1.60 (NR)	20	<0.0001	
	6 (0)	122	zBMI (BMI SDS)	-0.16 (NR)	32	-0.01 (NR)	20	0.002	
Fair	6 (0)	122	Weight (kg)	1.20 (NR)	32	7.80 (NR)	20	<0.0001	
	6 (0)	122	WC (cm)	-0.70 (NR)	32	2.70 (NR)	20	0.012	
Weigel, 2008[164]	12 (0)	114	BMI (kg/m^2)	-1.50 (3.04)	36	2.80 (3.86)	30	<0.001	
	6 (**)	114	BMI (kg/m^2)	-0.10 (3.76)	36	1.70 (3.92)	34	<0.01	
Fair	6 (**)	114	zBMI (BMI SDS)	-0.14 (0.48)	36	0.18 (0.57)	34	<0.05	
	12 (0)	114	zBMI (BMI SDS)	-0.34 (0.48)	36	0.26 (0.57)	30	<0.01	
Savoye, 2007[150]	6 (**)	82	BMI (kg/m^2)	-2.10 (2.88)	105	1.10 (2.97)	69	<0.001	BL outcome
	12 (0)	82	BMI (kg/m^2)	-1.70 (3.14)	105	1.60 (3.18)	69	<0.001	BL outcome
Fair	12 (0)	82	Weight (kg)	0.30 (8.89)	105	7.70 (9.96)	69	<0.001	BL outcome
	6 (**)	82	Weight (kg)	-2.60 (8.63)	105	5.00 (9.11)	69	<0.001	BL outcome
Savoye, 2014[149]	6 (0)	78	BMI (kg/m^2)	-0.37 (1.18)	31	0.67 (1.68)	27	0.005	BL outcome and body weight, HbA1c, HOMA, DIo
Fair	6 (0)	78	zBMI (BMI SDS)	-0.05 (0.13)	31	0.04 (0.12)	27	<0.001	BL outcome and body weight, HbA1c, HOMA, DIo
	6 (0)	78	Weight (kg)	0.60 (4.72)	31	3.70 (4.81)	27	0.006	BL outcome and body weight, HbA1c, HOMA, DIo
Reinehr, 2006[143]	12 (0)	78	BMI (kg/m^2)	0.10 (4.21)	174	2.00 (3.76)	37	0.013	
	24 (12)	78	BMI (kg/m^2)	1.20 (4.95)	174	2.90 (4.20)	37	NR	
Fair	24 (12)	78	zBMI (BMI SDS)	-0.30 (0.35)	174	0.00 (0.41)	37	NR	
	12 (0)	78	zBMI (BMI SDS)	-0.30 (0.35)	174	0.00 (0.41)	37	0.007	
Reinehr, 2009[144]	12 (0)	78	zBMI (BMI SDS)	-0.22 (0.35)	288	0.15 (0.17)	186	<0.001	Age, sex, BL zBMI, and pubertal stage
Fair	12 (0)	78	WC (cm)	-1.00 (12.53)	288	4.00 (10.54)	186	<0.001	Age, sex, BL zBMI, and pubertal stage
	12 (0)	78	Percent with obesity	216 (74.9)	288	185 (99.3)	186	NR	
Reinehr, 2010[145]	6 (0)	67	BMI (kg/m^2)	-0.85 (1.02)	34	0.76 (0.99)	32	0.001	
	6 (0)	67	zBMI (BMI SDS)	-0.26 (0.22)	34	0.05 (0.19)	32	<0.001	
Fair	6 (0)	67	WC (cm)	-6.00 (8.00)	34	0.00 (1.00)	32	0.008	
Vos, 2011[161]	12 (**)	45	zBMI (BMI SDS)	-0.40 (1.29)	32	-0.10 (1.12)	35	0.02	BL differences
Fair									
Kalarchian, 2009[126]	12 (0)	44	BMI (kg/m^2)	0.48 (2.95)	97	1.09 (2.24)	95	0.11	
	6 (**)	44	BMI (kg/m^2)	-0.68 (2.86)	97	0.54 (2.05)	95	0.0007	
	18 (6)	44	BMI (kg/m^2)	1.50 (2.95)	97	1.72 (2.05_	95	0.56	
Fair	12 (0)	44	Weight (kg)	6.92 (7.09)	97	9.22 (5.75)	95	0.014	
	6 (**)	44	Weight (kg)	1.56 (6.70)	97	4.76 (5.56)	95	0.0003	
	18 (6)	44	Weight (kg)	11.77 (6.89)	97	13.35 (5.36)	95	0.077	
	6 (**)	44	WC (cm)	1.11 (8.08)	97	4.94 (6.34)	95	0.0003	
	12 (0)	44	WC (cm)	6.18 (10.34)	97	9.59 (8.48)	95	0.014	

Appendix D Table 3. Weight Outcomes in Included Lifestyle-Based Weight Loss Trials (Key Question 4)

Author, Year & Quality	Followup (months since tx ended)	Est hrs of contact	Outcome (unit)	IG mean difference (SD)	IG n	CG mean difference (SD)	CG n	Between group p-value	Adjustment details
Kalavainen, 2007[127]	6 (0)	44	BMI (kg/m^2)	-0.80 (0.91)	35	0.00 (1.06)	35	0.003	
	6 (0)	44	zBMI (BMI SDS)	-0.30 (0.15)	35	-0.20 (0.30)	35	0.022	
	6 (0)	44	Weight (kg)	0.50 (1.80)	35	1.80 (2.20)	35	NR	
Fair	6 (0)	44	WC (cm)	-0.70 (3.17)	35	0.80 (3.62)	35	0.062	
Stark, 2011[154]	6 (0)	38	BMI percentile	-2.10 (1.90)	7	0.30 (2.00)	10	0.03	
	12 (6)	38	BMI percentile	-1.10 (1.90)	7	1.60 (2.70)	9	0.04	
Fair	6 (0)	38	zBMI (BMI SDS)	-0.49 (0.36)	7	0.10 (0.32)	10	0.003	
	12 (6)	38	zBMI (BMI SDS)	-0.37 (0.41)	7	0.40 (0.49)	9	0.005	
	6 (0)	38	Weight (kg)	-0.90 (2.30)	7	1.80 (0.90)	10	0.004	
	12 (6)	38	Weight (kg)	0.60 (3.50)	7	4.80 (1.50)	9	0.005	
	12 (6)	38	Percent Obese	1 (14.3)	7	5 (55.6)	9	NR	
Croker, 2012[118]	6 (0)	38	BMI (kg/m^2)	-0.36 (1.06)	31	-0.03 (1.07)	27	0.17	Age, baseline value
	6 (0)	38	zBMI (BMI SDS)	-0.11 (0.16)	31	-0.10 (0.16)	27	NS	Age, baseline value
Fair	6 (0)	38	Weight (kg)	0.79 (2.84)	31	2.78 (2.85)	27	0.002	Age, baseline value
	6 (0)	38	WC (cm)	-0.51 (3.23)	31	0.18 (3.24)	27	0.33	Age, baseline value
DeBar, 2012[120]	12 (7)	37	BMI percentile	-1.90 (5.99)	90	-0.82 (2.94)	83	0.067	
	6 (1)	37	BMI percentile	-1.29 (3.66)	100	-0.60 (2.65)	95	0.067	
Good	6 (1)	37	zBMI (BMI SDS)	-0.12 (0.38)	100	-0.06 (0.36)	95	0.012	
	12 (7)	37	zBMI (BMI SDS)	-0.15 (0.41)	90	-0.08 (0.36)	83	0.012	
	6 (1)	37	Weight (kg)	0.17 (15.67)	100	1.63 (16.32)	95	0.015	
	12 (7)	37	Weight (kg)	2.22 (16.38)	90	3.21 (16.33)	83	0.015	
Sacher, 2010[147]	6 (3.75)	36	BMI (kg/m^2)	-1.50 (3.52)	37	0.60 (5.06)	45	<0.0001	Baseline
	6 (3.75)	36	zBMI (BMI SDS)	-0.30 (0.51)	37	-0.01 (0.65)	45	<0.0001	Baseline
Fair	6 (3.75)	36	WC (z-score)	-0.36 (0.56)	37	0.06 (0.62)	45	<0.0001	Baseline
	6 (3.75)	36	WC (cm)	-4.10 (7.81)	37	1.70 (8.60)	45	<0.0001	Baseline
Nemet, 2005[138]	12 (9)	33	BMI (kg/m^2)	-1.60 (4.26)	20	0.60 (5.52)	20	<0.05	
	12 (9)	33	BMI percentile	-5.90 (2.86)	20	-1.10 (1.21)	20	<0.05	
Fair	12 (9)	33	Weight (kg)	0.60 (16.67)	20	5.20 (24.22)	20	<0.05	
Stark, 2014[153]	6 (0)	30	zBMI (BMI SDS)	-0.25 (0.25)	11	-0.07 (0.18)	12	0.08	
	12 (6)	30	zBMI (BMI SDS)	-0.59 (0.75)	11	-0.03 (0.36)	12	0.04	
Fair	12 (6)	30	Weight (kg)	2.30 (3.10)	11	5.20 (2.60)	12	0.03	
	6 (0)	30	Weight (kg)	1.10 (2.40)	11	1.90 (0.90)	12	0.37	
Bryant, 2011[114]	12 (0)	24	zBMI (BMI SDS)	0.03 (0.24)	35	-0.03 (0.27)	35	NR	
Fair									
Mellin, 1987[137]	6 (3)	24	Weight (kg)	-1.40 (NR)	34	-1.05 (NR)	29	NR	
Fair	6 (3)	24	% excess of 50th percentile (% relative weight)	-6.2 (NR)	34	-5.2 (NR)	29	NR	

Appendix D Table 3. Weight Outcomes in Included Lifestyle-Based Weight Loss Trials (Key Question 4)

Author, Year & Quality	Followup (months since tx ended)	Est hrs of contact	Outcome (unit)	IG mean difference (SD)	IG n	CG mean difference (SD)	CG n	Between group p-value	Adjustment details
Golley, 2007[124]	6 (1)	24	zBMI (BMI SDS)	-0.22 (0.56)	29	NR (NR)	NR	NR	
	12 (7)	24	zBMI (BMI SDS)	-0.24 (0.43)	31	-0.13 (0.40)	31	0.76	
Fair	6 (1)	24	WC (z-score)	-0.27 (0.70)	29	NR (NR)	NR	NR	
	12 (7)	24	WC (z-score)	-0.31 (0.53)	31	-0.02 (0.58)	31	0.03	
Hofsteenge, 2014[125]	6 (0)	17	BMI (kg/m^2)	-0.50 (4.65)	53	0.60 (5.20)	44	NSD	Age, sex, ethnicity
	6 (0)	17	zBMI (BMI SDS)	-0.12 (0.46)	53	0.02 (0.53)	44	NSD	Age, sex, ethnicity
	6 (0)	17	Weight (kg)	1.20 (18.06)	53	2.90 (18.65)	44	NSD	Age, sex, ethnicity
Fair	6 (0)	17	WC (cm)	0.30 (12.30)	53	3.30 (12.26)	44	NSD	Age, sex, ethnicity
Gerards, 2015[123]	12 (8.5)	17	zBMI (BMI SDS)	0.05 (0.26)	35	-0.08 (0.27)	32	NSD	
Fair	12 (8.5)	17	WC (cm)	3.88 (2.99)	35	3.44 (3.46)	32	NSD	
Nowicka, 2008[140]	12 (0)	16	BMI (kg/m^2)	0.00 (4.45)	65	1.20 (4.75)	23	NR	
	12 (0)	16	zBMI (BMI SDS)	-0.06 (0.46)	65	0.09 (0.53)	23	NS	Age and sex
Fair	12 (0)	16	Weight (kg)	3.10 (18.80)	65	8.10 (19.36)	23	NR	
Boudreau, 2013[111] Fair	6 (0)	11	zBMI (BMI SDS)	-0.03 (0.14)	13	-0.05 (0.08)	10	0.31	Caregiver education and maternal BMI
Norman, 2015[139]	8 (**)	8 (**)	BMI (kg/m^2)	0.2 (4.1)	53	0.3 (3.9)	53	NR	
	12 (0)	8	BMI (kg/m^2)	0.2 (4.2)	53	0.4 (4.11)	53	NR	
Fair	8 (**)	8	zBMI (BMI SDS)	-0.1 (0.36)	53	-0.1 (0.3)	53	NR	
	12 (0)	8	zBMI (BMI SDS)	-0.1 (0.36)	53	-0.1 (0.44)	53	NR	
	12 (0)	8	WC (cm)	-0.1 (11.48)	53	-0.1 (11.21)	53	NR	
Raynor, 2012a[142]	12 (6)	6	zBMI (BMI SDS)	-0.10 (NR)	35	-0.13 (NR)	33	NSD	
Fair	6 (0)	6	zBMI (BMI SDS)	-0.08 (NR)	35	-0.11 (NR)	33	NSD	
Raynor, 2012b[142]	12 (6)	6	zBMI (BMI SDS)	-0.22 (NR)	26	-0.22 (NR)	29	NR	
Fair	6 (0)	6	zBMI (BMI SDS)	-0.16 (NR)	26	-0.13 (NR)	29	NR	
Taylor, 2015[159]	12 (**)	5	BMI (kg/m^2)	0.10 (2.66)	91	0.40 (2.11)	90	NR	
Good	24 (**)	5	BMI (kg/m^2)	0.80 (2.98)	89	1.20 (2.29)	92	NR, significant	BL value, age, sex, feedback condition, and interactions btwn time and feedback condition and time and intervention condition
	12 (**)	5	zBMI (BMI SDS)	-0.19 (0.52)	91	-0.08 (0.43)	90	NR	
	24 (**)	5	zBMI (BMI SDS)	-0.27 (0.53)	89	-0.12 (0.44)	92	NR, significant	BL value, age, sex, feedback condition, and interactions btwn time and feedback condition and time and intervention condition

Appendix D Table 3. Weight Outcomes in Included Lifestyle-Based Weight Loss Trials (Key Question 4)

Author, Year & Quality	Followup (months since tx ended)	Est hrs of contact	Outcome (unit)	IG mean difference (SD)	IG n	CG mean difference (SD)	CG n	Between group p-value	Adjustment details
	12 (**)	5	Weight (kg)	2.90 (9.34)	91	3.50 (7.45)	90	NR	
	24 (**)	5	Weight (kg)	7.50 (10.42)	89	8.10 (8.02)	92	NR	NR
	12 (**)	5	WC (cm)	1.40 (10.15)	91	2.90 (7.87)	90	NR	
	24 (**)	5	WC (cm)	4.90 (11.03)	89	6.50 (8.18)	92	NR, significant	BL value, age, sex, feedback condition, and interactions btwn time and feedback condition and time and intervention condition
Kong, 2013[130] Fair	9 (0)	4	Weight (kg)	1.70 (4.05)	28	2.50 (4.28)	23	0.12	
	9 (0)	4	WC (cm)	0.00 (3.78)	28	1.70 (3.06)	23	0.04	
Stettler, 2014[155] Fair	12 (0)	4	BMI (kg/m^2)	0.60 (2.65)	46	1.70 (3.31)	24	0.04	Cluster design
	12 (0)	4	zBMI (BMI SDS)	-0.06 (0.50)	46	0.10 (0.41)	24	0.02	Cluster design
	12 (0)	4	Weight (kg)	5.50 (10.01)	46	8.60 (13.75)	24	0.04	Cluster design
	12 (0)	4	Percent Obese	15 (15)	46	9 (38)	24	0.05	Cluster design
Saelens, 2002[148] Fair	7 (3)	4	BMI (kg/m^2)	0.10 (4.09)	18	1.40 (3.50)	19	NR	
	7 (3)	4	zBMI (BMI SDS)	-0.05 (0.22)	18	0.06 (0.17)	19	<0.04	
	7 (3)	4	Weight (kg)	2.00 (15.06)	18	5.30 (14.08)	19	NR	
	7 (3)	4	% excess of 50th percentile (%)	-2.40 (22.83)	18	4.10 (18.90)	19	NR	
Broccoli, 2016[113] Good	12 (9)	4	BMI (kg/m^2)	0.49 (1.36)	187	0.79 (1.25)	185	0.007	
	12 (9)	4	zBMI (BMI SDS)	-0.11 (0.42)	187	0.01 (0.38)	185	NR, significant	
	12 (9)	4	% overweight or obese	137 (73.3)	187	143 (77.3)	185	0.169	
O'Connor, 2013[141] Fair	7 (0)	4	zBMI (BMI SDS)	NR (NR)	20	NR (NR)	20	0.86	LS Mean adjusted for child's age and parent BMI at BL
Sherwood, 2015[151] Fair	6 (0)	3	BMI percentile (%)	-0.35 (9.66)	26	-1.81 (15.04)	29	0.64	
	6 (0)	3	zBMI (BMI SDS)	-0.02 (0.36)	26	-0.01 (0.54)	29	0.89	
Taveras, 2011[157] Good	12 (0)	3	BMI (kg/m^2)	0.31 (1.43)	253	0.49 (1.39)	192	0.15	Age, sex, race/ethnicity, parent education and overweight/ obesity status at BL, household income, and time elapse from BL to followup visit

Appendix D Table 3. Weight Outcomes in Included Lifestyle-Based Weight Loss Trials (Key Question 4)

Author, Year & Quality	Followup (months since tx ended)	Est hrs of contact	Outcome (unit)	IG mean difference (SD)	IG n	CG mean difference (SD)	CG n	Between group p-value	Adjustment details
	12 (0)	3	zBMI (BMI SDS)	NR (NR)	NR	NR (NR)	NR	0.28	Age, sex, race/ethnicity, parent education and overweight/ obesity status at BL, household income, and time elapse from BL to followup visit
Looney, 2014[132] Fair	6 (0)	3	zBMI (BMI SDS)	-0.16 (0.48)	7	-0.07 (0.61)	8	NS	
Resnicow, 2015[146] Fair	24 (0)	3	BMI percentile	-4.90 (15.18)	154	-1.80 (13.79)	158	0.02	Age, race, gender, BL BMI, household income, parent BMI, provider age, and practice effects
Wake, 2013[163] Good	12 (0)	3	BMI (kg/m^2)	0.90 (3.39)	56	0.80 (4.19)	49	0.7	Child's age and sex at randomization, neighborhood socioeconomic disadvantage score, raw BL BMI and BL value of outcome measure where available
	12 (0)	3	zBMI (BMI SDS)	-0.20 (0.50)	56	-0.10 (0.36)	49	0.2	Child's age and sex at randomization, neighborhood socioeconomic disadvantage score, raw BL BMI and BL value of outcome measure where available
	12 (0)	3	WC (cm)	NR (NR)	56	NR (NR)	49	0.1	Child's age and sex at randomization, neighborhood socioeconomic disadvantage score, raw BL BMI and BL value of outcome measure where available
Van Grieken, 2013[160] Fair	24 (12)	2	BMI (kg/m^2)	1.37 (1.53)	277	1.44 (1.71)	230	0.46	Age, cluster
	24 (12)	2	zBMI (BMI SDS)	NR (NR)	NR	NR (NR)	NR	0.07	Age, cluster
	24 (12)	2	WC (cm)	7.20 (5.49)	262	7.33 (5.30)	222	0.506	Age, cluster
	24 (12)	2	% overweight or obese	209 (75.4)	277	170 (73.7)	230	NR	
	24 (12)	2	% obese	40 (14.4)	277	25 (11.0)	230	NR	
Taveras, 2015[158] Good	12 (0)	1	BMI (kg/m^2)	0.80 (4.41)	164	1.20 (4.41)	171	NR	Parent age and country of birth and child race/ethnicity, sex, and age at visit
	12 (0)	1	zBMI (BMI SDS)	-0.09 (0.33)	164	-0.04 (0.32)	171	NR	parent age and country of birth and child race/ethnicity, sex, and age at visit

Appendix D Table 3. Weight Outcomes in Included Lifestyle-Based Weight Loss Trials (Key Question 4)

Author, Year & Quality	Followup (months since tx ended)	Est hrs of contact	Outcome (unit)	IG mean difference (SD)	IG n	CG mean difference (SD)	CG n	Between group p-value	Adjustment details
McCallum, 2007[136]	15 (12)	1	BMI (kg/m^2)	1.20 (2.76)	70	1.20 (2.16)	76	1	SES, age, sex, baseline BMI
	9 (6)	1	BMI (kg/m^2)	0.50 (2.42)	73	0.80 (2.03)	80	0.25	SES, age, sex, baseline BMI
	9 (6)	1	zBMI (BMI SDS)	-0.04 (0.58)	73	0.03 (0.54)	80	0.12	SES, baseline zBMI
Good	15 (12)	1	zBMI (BMI SDS)	0.00 (0.61)	70	0.02 (0.55)	76	0.62	SES, baseline zBMI
Wake, 2009[162]	6 (3)	1	BMI (kg/m^2)	0.30 (2.46)	132	0.30 (2.07)	118	0.4	Social disadvantage index, age, sex, BL score for outcome, raw BMI at BL
Good	12 (9)	1	BMI (kg/m^2)	0.60 (2.59)	127	0.70 (2.19)	115	0.5	Social disadvantage index, age, sex, BL score for outcome, raw BMI at BL
	6 (3)	1	WC (cm)	NR (NR)	131	NR (NR)	117	0.8	Social disadvantage index, age, sex, BL score for outcome, raw BMI at BL
	12 (9)	1	WC (cm)	NR (NR)	125	NR (NR)	114	0.8	Social disadvantage index, age, sex, BL score for outcome, raw BMI at BL

Abbreviations: BL = baseline; BMI = body mass index; CG = control group; cm = centimeter(s); DIo = basal disposition index; est = estimated; HbA1c = glycated hemoglobin; HOMA = homeostatic model assessment; hrs = hours; IG = intervention group; kg = kilogram(s); m = meter(s); NR = not reported; NS = not significant; NSD = no significant difference; SD = standard deviation; SDS = standardized deviation score; tx = treatment; WC = waist circumference; zBMI = BMI z-score.

Appendix D Table 4. Change in Mean zBMI in Lifestyle-Based Weight Loss Trials, With Columns Showing Mean ± 1 Standard Deviation (Key Question 4)

Age category	Author, Year Quality	Intervention Group, zBMI					Control Group, zBMI				
		BL Mean	Mean Change	SD Change	Mean -SD	Mean +SD	BL Mean	Mean Change	SD Change	Mean -SD	Mean +SD
52+ hours											
Wide Age Range	Lison, 2012[131] Fair	2.10	-0.16	NR	NR	NR	2.23	-0.01	NR	NR	NR
	Weigel, 2008[164] Fair	2.24	-0.34	0.48	-0.82	0.14	2.48	0.26	0.57	-0.31	0.83
	Savoye, 2014[149] Fair	2.20	-0.05	0.13	-0.18	0.08	2.30	0.04	0.12	-0.08	0.16
	Reinehr, 2006[143] Fair	2.40	-0.30	0.35	-0.65	0.05	2.30	0.00	0.41	-0.41	0.41
	Reinehr, 2009[144] Fair	2.48	-0.22	0.35	-0.57	0.13	2.43	0.15	0.17	-0.02	0.32
	Reinehr, 2010[145] Fair	1.73	-0.26	0.22	-0.48	-0.04	1.59	0.05	0.19	-0.14	0.24
26-51 hours											
Wide Age Range	Vos, 2011[161] Fair	4.20	-0.40	1.29	-1.69	0.89	4.30	-0.10	1.12	-1.22	1.02
Preschool	Stark, 2014[153] Fair	2.50	-0.59	0.75	-1.34	0.16	2.40	-0.03	0.36	-0.39	0.33
	Stark, 2011[154] Fair	NR	-0.37	0.41	-0.78	0.04	NR	0.40	0.49	-0.09	0.89
Elementary	Croker, 2012[118] Fair	3.10	-0.11	0.16	-0.27	0.05	3.30	-0.10	0.16	-0.26	0.06
	Kalavainen, 2007[127] Fair	2.60	-0.30	0.15	-0.45	-0.15	2.50	-0.20	0.30	-0.50	0.10
	Sacher, 2010[147] Fair	2.77	-0.30	0.51	-0.81	0.21	2.76	-0.01	0.65	-0.66	0.64
Adolescent	DeBar, 2012[120] Good	2.00	-0.15	0.41	-0.56	0.26	2.00	-0.08	0.36	-0.44	0.28

Appendix D Table 4. Change in Mean zBMI in Lifestyle-Based Weight Loss Trials, With Columns Showing Mean ± 1 Standard Deviation (Key Question 4)

Age category	Author, Year Quality	Intervention Group, zBMI					Control Group, zBMI				
		BL Mean	Mean Change	SD Change	Mean -SD	Mean +SD	BL Mean	Mean Change	SD Change	Mean -SD	Mean +SD
6-25 hours											
Wide Age Range	Bryant, 2011[114] Fair	2.86	0.03	0.24	-0.21	0.27	3.11	-0.03	0.27	-0.30	0.24
	Hofsteenge, 2014[125] Fair	2.93	-0.12	0.46	-0.58	0.34	2.93	0.02	0.53	-0.51	0.55
	Norman, 2015[139] Fair	2.1	-0.1	0.36	-0.46	0.26	2.1	-0.1	0.44	-0.54	0.34
Elementary	Gerards, 2015[123] Fair	1.82	0.05	0.26	-0.21	0.31	1.87	-0.08	0.27	-0.35	0.19
	Golley, 2007[124] Fair	2.74	-0.24	0.43	-0.67	0.19	2.75	-0.13	0.40	-0.53	0.27
	Boudreau, 2013[111] Fair	2.00	-0.03	0.14	-0.17	0.11	2.20	-0.05	0.08	-0.13	0.03
	Taylor, 2015[159] Good	1.69	-0.19	0.52	-0.71	0.33	1.54	-0.08	0.43	-0.51	0.35
	Raynor, 2012a[142] Fair	2.15	-0.10	NR	NR	NR	2.45	-0.13	NR	NR	NR
	Raynor, 2012b[142] Fair	2.25	-0.22	NR	NR	NR	2.27	-0.22	NR	NR	NR
Adolescent	Nowicka, 2008[140] Fair	3.27	-0.06	0.46	-0.52	0.40	3.21	0.09	0.53	-0.44	0.62
0-5 hours											
Preschool	Taveras, 2011[157] Good	1.88	NR	NR	NR	NR	1.82	NR	NR	NR	NR
Elementary	Broccoli, 2016[113] Good	1.35	-0.11	0.42	-0.53	0.31	1.35	0.01	0.38	-0.37	0.39
	Sherwood, 2015[151] Fair	1.01	-0.02	0.37	-0.39	0.35	0.86	-0.01	0.54	-0.55	0.53

Appendix D Table 4. Change in Mean zBMI in Lifestyle-Based Weight Loss Trials, With Columns Showing Mean ± 1 Standard Deviation (Key Question 4)

Age category	Author, Year Quality	Intervention Group, zBMI					Control Group, zBMI				
		BL Mean	Mean Change	SD Change	Mean -SD	Mean +SD	BL Mean	Mean Change	SD Change	Mean -SD	Mean +SD
	Stettler, 2014[155] Fair	1.22	-0.05	0.54	-0.59	0.49	1.34	0.10	0.41	-0.31	0.51
	Looney, 2014[132] Fair	2.45	-0.16	0.48	-0.64	0.32	2.21	-0.07	0.61	-0.68	0.54
	Wake, 2013[163] Good	2.20	-0.20	0.50	-0.70	0.30	2.10	-0.10	0.36	-0.46	0.26
	Taveras, 2015[158] Good	2.08	-0.09	0.33	-0.42	0.24	2.05	-0.04	0.32	-0.36	0.28
	McCallum, 2007[136] Good	2.00	0.00	0.61	-0.61	0.61	1.90	0.02	0.55	-0.53	0.57
Adolescent	Saelens, 2002[148] Fair	2.06	-0.05	0.22	-0.27	0.17	2.09	0.06	0.17	-0.11	0.23

Abbreviations: BL = baseline; SD = standard deviation.

Appendix D Table 5. Reported or Calculated Change in Mean Weight (Pounds) in Lifestyle-Based Weight Loss Trials, With Columns Showing Mean ± 1 Standard Deviation (Key Question 4)

Age category	Author, Year Quality	Follow-up (months)	Mean age (years)	BL BMI	Intervention Group, lbs					Control Group, lbs				
					BL Mean	Mean Change	SD Change	Mean -SD	Mean +SD	BL Mean	Mean Change	SD Change	Mean -SD	Mean +SD
52+ hours														
Wide Age Range	Lison, 2012[131]* Fair	6	11.9	29.1	162.9	2.6	NR	NR	NR	152.4	17.2	NR	NR	NR
	Weigel, 2008[164]† Fair	12	11.2	28.6	127.1	-7.0	14.2	-21.2	7.2	139.7	13.0	18.0	-5.0	31.0
	Savoye, 2007[150]* Fair	12	12.1	36	191.6	0.7	19.6	-18.9	20.3	200.8	17.0	21.9	-4.9	38.9
	Savoye, 2014[149]* Fair	6	12.9	33.3	184.3	1.3	10.4	-9.1	11.7	202.6	8.1	10.6	-2.5	18.7
	Reinehr, 2006[143]† Fair	12	10.4	26.9	117.3	0.4	18.3	-17.9	18.7	113.4	8.7	16.3	-7.6	25.0
	Reinehr, 2010[145]† Fair	6	11.5	23.8	116.5	-4.1	4.9	-9.0	0.8	112.1	3.7	4.8	-1.1	8.5
26-51 hours														
Wide Age Range	Nemet, 2005[138]* Fair	12	11.1	28.2	130.1	1.3	36.7	-35.4	38.0	139.6	11.5	53.3	-41.8	64.8
	Vos, 2011[161] Fair	12	13.2	32.5	NR§	NR§	NR§	NR§	NR§	NR§	NR§	NR§	NR§	NR§
Preschool	Stark, 2014[153]* Fair	12	4.5	NR	58.6	5.1	6.8	-1.7	11.9	57.5	11.5	5.7	5.8	17.2
	Stark, 2011[154]* Fair	12	4.1	NR	NR	1.3	7.7	-6.4	9.0	NR	10.6	3.3	7.3	13.9
Elementary	Croker, 2012[118]* Fair	6	10.3	30.6	155.9	1.7	6.3	-4.6	8.0	144.2	6.1	6.3	-0.2	12.4
	Kalavainen, 2007[127]* Fair	6	8.1	23.2	94.9	1.1	4.0	-2.9	5.1	89.0	4.0	4.8	-0.8	8.8
	Sacher, 2010[147]† Fair	6	10.3	27.2	116.7	-6.4	15.1	-21.5	8.7	116.3	2.6	21.7	-19.1	24.3

Appendix D Table 5. Reported or Calculated Change in Mean Weight (Pounds) in Lifestyle-Based Weight Loss Trials, With Columns Showing Mean ± 1 Standard Deviation (Key Question 4)

Age category	Author, Year Quality	Follow-up (months)	Mean age (years)	BL BMI	Intervention Group, lbs					Control Group, lbs				
					BL Mean	Mean Change	SD Change	Mean -SD	Mean +SD	BL Mean	Mean Change	SD Change	Mean -SD	Mean +SD
	Kalarchian, 2009[126]* Fair	12	10.2	32.1	154.5	15.2	15.6	-0.4	30.8	160.2	20.3	12.7	7.6	33.0
Adolescent	DeBar, 2012[120]* Good	12	14.1	31.9	189.7	4.9	36.1	-31.2	41.0	186.4	7.1	36.0	-28.9	43.1
6-25 hours														
Wide Age Range	Hofsteenge, 2014[125]* Fair	6	14.5	33.4	208.5	2.6	39.8	-37.2	42.4	203.0	6.4	41.1	-34.7	47.5
	Norman, 2015[139]† Fair	12	11.9	29.3	147.3	1.1	20.9	-19.8	22.0	143.8	2.0	20.5	-18.5	22.5
Elementary	Boudreau, 2013[111]‡ Fair	6	10.3	NR	111.2	6.6	NR	NR	NR	119.8	5.9	NR	NR	NR
	Raynor, 2012a[142]‡ Fair	12	7.2	NR	75.2	10.0	NR	NR	NR	84.1	9.7	NR	NR	NR
	Raynor, 2012b[142]‡ Fair	12	7.1	NR	76.6	7.0	NR	NR	NR	77.3	6.8	NR	NR	NR
Adolescent	Nowicka, 2008[140]* Fair	12	14.7	34.5	215.4	6.8	41.4	-34.6	48.2	212.1	17.8	42.6	-24.8	60.4
	Mellin, 1987[137]* Fair	6	15.6	NR	174.4	-3.1	NR	NR	NR	169.4	-2.3	NR	NR	NR
0-5 hours														
Preschool	Taveras, 2011[157]† Good	12	4.9	19.2	49.4	0.8	3.7	-2.9	4.5	49.1	1.3	3.6	-2.3	4.9
	Van Grieken, 2013[160]† Fair	24	5.8	18.13	51.3	3.9	4.3	-0.4	8.2	51.1	4.1	4.8	-0.7	8.9
Elementary	Resnicow, 2015[146]‡ Fair	24	5.1	NR	50.6	12.1	NR	NR	NR	50.0	14.1	NR	NR	NR

Appendix D Table 5. Reported or Calculated Change in Mean Weight (Pounds) in Lifestyle-Based Weight Loss Trials, With Columns Showing Mean ± 1 Standard Deviation (Key Question 4)

Age category	Author, Year Quality	Follow-up (months)	Mean age (years)	BL BMI	Intervention Group, lbs					Control Group, lbs				
					BL Mean	Mean Change	SD Change	Mean -SD	Mean +SD	BL Mean	Mean Change	SD Change	Mean -SD	Mean +SD
	Broccoli, 2016[113]† Good	12	6.6	18.3	57.0	1.5	4.2	-2.7	5.7	56.8	2.5	3.9	-1.4	6.4
	O'Connor, 2013[141] Fair	7	6.8	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Stettler, 2014[155] Fair	12	10.8	21.6	103.1	12.1	22.0	-9.9	34.1	108.3	18.9	30.3	-11.4	49.2
	Looney, 2014[132]‡ Fair	6	8	NR	96.9	0.9	NR	NR	NR	87.6	4.6	NR	NR	NR
	Wake, 2009[162]† Good	12	7.5	20.2	69.4	2.1	8.9	-6.8	11.0	69.7	2.4	7.5	-5.1	9.9
	Wake, 2013[163]† Good	12	7.3	22.5	74.7	3.0	11.3	-8.3	14.3	76.4	2.7	14.0	-11.3	16.7
	Taveras, 2015[158]† Good	12	9.8	25.8	108.4	3.3	18.4	-15.1	21.7	107.1	5.0	18.4	-13.4	23.4
	McCallum, 2007[136]† Good	15	7.4	20.3	69.3	4.1	9.3	-5.2	13.4	67.6	4.1	7.3	-3.2	11.4
Adolescent	Saelens, 2002[148]* Fair	7	14.2	30.7	188.3	4.4	33.2	-28.8	37.6	177.3	11.7	31.0	-19.3	42.7
	Kong, 2013[130]* Fair	9	14.8	NR	172.9	3.7	8.9	-5.2	12.6	172.0	5.5	9.4	-3.9	14.9

*Study-reported weight change.
†Calculated weight change.
‡Calculated weight change using zBMI.

Abbreviations: BL = baseline; BMI = body mass index; Lbs = Pounds; SD = standard deviation.

Appendix D Table 6. Blood Pressure Outcomes in Included Lifestyle-Based Weight Loss Trials (Key Question 4)

Outcome (unit)	Author, Year & Quality	Est hrs of contact	Planned followup (months since tx ended)	IG mean difference (SD)	IG n	CG mean difference (SD)	CG n	Between group p-value	Adjustment details
SBP (mm Hg)	Weigel, 2008[164] Fair	114	12 (0)	-2.0 (10.5)	36	5.0 (9.2)	30	<0.01	
	Savoye, 2007[150] Fair	82	12 (0)	-2.0 (12.3)	105	-0.4 (14.0)	69	0.45	BL outcome
	Savoye, 2014[149] Fair	78	6 (0)	-6.2 (9.3)	31	-0.7 (8.5)	27	0.005	BL outcome and body weight, HbA1c, HOMA, DIo
	Reinehr, 2006[143] Fair	78	12 (0)	-4.3 (14.4)	174	5.3 (16.2)	37	0.002	
	Reinehr, 2009[144] Fair	78	12 (0)	-7.0 (16.1)	288	2.0 (14.5)	186	<0.001	Age, sex, BL zBMI, and pubertal stage
	Reinehr, 2010[145] Fair	67	6 (0)	-7.0 (4.0)	34	-1.0 (5.0)	32	<0.001	
	Vos, 2011[161] Fair	45	12 (**)	-6.6 (18.1)	32	-4.3 (19.0)	35	NSD	BL differences
	Kalarchian, 2009[126] Fair	44	12 (0)	-4.9 (17.6)	97	0.4 (18.8)	95	0.045	
	Kalavainen, 2007[127] Fair	44	6 (0)	-0.9 (6.7)	34	0.0 (5.0)	35	0.503	
	Sacher, 2010[147] Fair	36	6 (3.75)	-9.6 (12.1)	36	-8.2 (10.6)	45	0.7	Baseline
	Golley, 2007[124] Fair	24	12 (7)	NR	NR	NR	NR	0.49	
	Hofsteenge, 2014[125] Fair	17	6 (0)	-1.0 (13.5)	53	-2.0 (12.5)	44	NR	Age, sex, ethnicity
	Norman, 2015[139] Fair	8	12 *0)	2.4 (11.75)	53	-1.2 (11.55)	53	NR	

Appendix D Table 6. Blood Pressure Outcomes in Included Lifestyle-Based Weight Loss Trials (Key Question 4)

Outcome (unit)	Author, Year & Quality	Est hrs of contact	Planned followup (months since tx ended)	IG mean difference (SD)	IG n	CG mean difference (SD)	CG n	Between group p-value	Adjustment details
DBP (mm Hg)	Weigel, 2008[164] Fair	114	12 (0)	-4.0 (9.2)	36	3.0 (9.6)	30	NS	
	Savoye, 2007[150] Fair	82	12 (0)	1.4 (11.5)	105	2.8 (13.6)	69	0.47	BL outcome
	Savoye, 2014[149] Fair	78	6 (0)	-0.9 (23.6)	31	8.3 (26.2)	27	0.09	BL outcome and body weight, HbA1c, HOMA, DIo
	Reinehr, 2006[143] Fair	78	12 (0)	-3.2 (10.5)	174	-1.2 (9.8)	37	0.467	
	Reinehr, 2009[144] Fair	78	12 (0)	-2.0 (12.0)	288	3.0 (11.5)	186	<0.001	Age, sex, BL zBMI, and pubertal stage
	Reinehr, 2010[145] Fair	67	6 (0)	-6.0 (4.0)	34	-2.0 (7.0)	32	0.003	
	Vos, 2011[161] Fair	45	12 (**)	-7.3 (13.6)	32	-5.7 (13.9)	35	NSD	BL differences
	Kalarchian, 2009[126] Fair	44	12 (0)	-3.0 (14.2)	97	0.0 (17.5)	95	0.2	
	Kalavainen, 2007[127] Fair	44	6 (0)	0.2 (4.3)	34	-0.7 (6.5)	35	0.489	
	Sacher, 2010[147] Fair	36	6 (3.75)	-5.1 (7.9)	36	-2.2 (7.8)	45	0.07	Baseline
	Golley, 2007[124] Fair	24	12 (7)	NR	NR	NR	NR	0.82	
	Hofsteenge, 2014[125] Fair	17	6 (0)	-1.0 (8.0)	53	0.0 (7.5)	44	NR	Age, sex, ethnicity
	Norman, 2015[139] Fair	8	12 (0)	-1.7 (10.48)	53	-0.2 (10.44)	53	NR	

Abbreviations: BL = baseline; CG = control group; DBP = diastolic blood pressure; DIo = basal disposition index; est = estimated; HbA1c = glycated hemoglobin; HOMA = homeostatic model assessment; hrs = hours; IG = intervention group; mm Hg = millimters of mercury; NR = not reported; NSD = no significant difference; SBP = systolic blood pressure; SD = standard deviation; tx = treatment; zBMI = body mass index z-score.

Appendix D Table 7. Glucose Outcomes in Included Lifestyle-Based Weight Loss Trials (Key Question 4)

Outcome (unit)	Author, Year & Quality	Est hrs of contact	Planned followup (months since tx ended)	IG mean difference (SD)	IG n	CG mean difference (SD)	CG n	Between group p-value	Adjustment details
FPG (mg/dL)	Savoye, 2007[150] Fair	82	12 (0)	-3.4 (8.9)	105	-1.8 (10.8)	69	0.3	BL outcome
	Savoye, 2014[149] Fair	78	6 (0)	-0.5 (8.0)	31	2.5 (9.9)	27	0.16	BL outcome and body weight, HbA1c, HOMA, DIo
	Reinehr, 2006[143] Fair	78	12 (0)	-0.6 (6.5)	174	1.0 (6.6)	37	0.328	
	Reinehr, 2009[144] Fair	78	12 (0)	1.8 (7.2)	288	1.8 (7.2)	186	0.318	Age, sex, BL zBMI, and pubertal stage
	Vos, 2011[161] Fair	45	12 (**)	-3.6 (8.7)	32	0.0 (14.4)	35	NSD	BL differences
	Kalavainen, 2007[127] Fair	44	6 (0)	0.0 (5.4)	34	1.8 (5.4)	34	0.145	
	Golley, 2007[124] Fair	24	12 (7)	NR	NR	NR	NR	0.88	
	Hofsteenge, 2014[125] Fair	17	6 (0)	0.0 (7.2)	53	1.8 (7.2)	44	NR	Age, sex, ethnicity
	Norman, 2015[139] Fair	8	12 (0)	-2.1 (7.35)	53	-2.9 (7.45)	53	NR	
	Kong, 2013[130] Fair	4	9 (0)	5.4 (7.3)	28	1.8 (6.6)	23	0.04	
2-hr OGTT (mg/dL)	Savoye, 2014[149] Fair	78	6 (0)	-27.2 (25.3)	31	-10.1 (25.8)	27	0.005	BL outcome and body weight, HbA1c, HOMA, DIo
	Reinehr, 2009[144] Fair	78	12 (0)	-9.0 (24.4)	288	3.6 (25.2)	186	<0.001	Age, sex, BL zBMI, and pubertal stage
HOMA*	Savoye, 2007[150] Fair	82	12 (0)	-1.5 (2.4)	105	0.9 (4.5)	69	<0.001	BL outcome
	Savoye, 2014[149] Fair	78	6 (0)	-1.2 (4.2)	31	1.4 (5.7)	27	0.03	BL outcome and body weight, HbA1c, HOMA, DIo

Appendix D Table 7. Glucose Outcomes in Included Lifestyle-Based Weight Loss Trials (Key Question 4)

Outcome (unit)	Author, Year & Quality	Est hrs of contact	Planned followup (months since tx ended)	IG mean difference (SD)	IG n	CG mean difference (SD)	CG n	Between group p-value	Adjustment details
	Reinehr, 2006[143] Fair	78	12 (0)	-0.3 (2.8)	174	0.9 (3.1)	37	0.012	
	Kalavainen, 2007[127] Fair	44	6 (0)	-0.4 (1.1)	34	0.1 (1.2)	34	0.113	
	Hofsteenge, 2014[125] Fair	17	6 (0)	0.1 (2.5)	53	0.0 (2.7)	44	NR	Age, sex, ethnicity
	Kong, 2013[130] Fair	4	9 (0)	0.0 (95% CI, -0.6 to 1.1)†	28	0.7 (95% CI, -0.7 to 2.1)	23	1	
Insulin (µIU/mL)	Savoye, 2007[150] Fair	82	12 (0)	-6.1 (31.6)	105	4.5 (19.9)	69	<0.001	BL outcome
	Savoye, 2014[149] Fair	78	6 (0)	-4.9 (17.5)	31	5.2 (22.0)	27	0.03	BL outcome and body weight, HbA1c, HOMA, DIo
	Reinehr, 2006[143] Fair	78	12 (0)	-1.1 (12.4)	174	3.3 (13.4)	37	0.008	
	Vos, 2011[161] Fair	45	12 (**)	1.0 (20.0)	32	3.9 (15.9)	35	0.05	BL differences
	Kalavainen, 2007[127] Fair	44	6 (0)	-1.6 (4.5)	34	0.0 (4.6)	34	0.142	
	Golley, 2007[124] Fair	24	12 (7)	NR	NR	NR	NR	0.84	
	Hofsteenge, 2014[125] Fair	17	6 (0)	2.0 (59.0)	53	-1.0 (69.4)	44	NR	Age, sex, ethnicity
	Kong, 2013[130] Fair	4	9 (0)	-1.45 (-3.43 to 4.95)†	28	0.20 (-0.28 to 3.60)†	23	0.59	
Diabetes	Savoye, 2014[149] Fair	78	6 (0)	0 (0)‡	38	0 (0) ‡	37	NR	
	Love-Osborne, 2014[133] Fair	3	8 (0)	0 (0) ‡	82	2 (2.4) ‡	83	NR	

*HOMA-IR (insulin resistance): insulin [µIU/mL] x glucose [mmol/L]/22.5.

Appendix D Table 7. Glucose Outcomes in Included Lifestyle-Based Weight Loss Trials (Key Question 4)

†Median change from baseline (95% CI).
‡Number (%).

Abbreviations: CG = control group; CI = confidence interval; dL = deciliter; hr = hour(s); IG = intervention group; IU = international unit; FPG = fasting plasma glucose; HOMA = homeostatic model assessment; L = liter(s); mg = milligram(s); mL = milliter(s); mmol = millimole(s); NR = not reported; OGTT = oral glucose tolerance test; SD = standard deviation; tx = treatment; µ = micro.

Appendix D Table 8. Lipid Outcomes in Included Lifestyle-Based Weight Loss Trials (Key Question 4)

Outcome (unit)	Author, Year & Quality	Est hrs of contact	Planned followup (months since tx ended)	IG mean difference (SD)	IG n	CG mean difference (SD)	CG n	Between group p-value	Adjustment details
LDL-C (mg/dL)	Savoye, 2007[150] Fair	82	12 (0)	-2.4 (23.8)	105	1.5 (26.9)	69	0.26	BL outcome
	Savoye, 2014[149] Fair	78	6 (0)	-1.3 (25.8)	31	3.5 (22.7)	27	0.37	BL outcome and body weight, HbA1c, HOMA, DIo
	Reinehr, 2006[143] Fair	78	12 (0)	-4.4 (36.0)	174	10.6 (42.0)	37	0.059	
	Reinehr, 2009[144] Fair	78	12 (0)	-7.7 (30.9)	288	7.7 (29.1)	186	0.002	Age, sex, BL zBMI, and pubertal stage
	Kalavainen, 2007[127] Fair	44	6 (0)	1.2 (13.2)	34	0.4 (20.4)	35	0.5	
	Golley, 2007[124] Fair	24	12 (7)	NR	NR	NR	NR	0.42	
	Norman, 2015[139] Fair	8	12 (0)	-13.5 (24.79)	53	-14.9 (26.8)	53	NR	
HDL-C (mg/dL)	Weigel, 2008[164] Fair	114	12 (0)	NR	NR	NR	NR	NSD	
	Savoye, 2007[150] Fair	82	12 (0)	3.2 (10.2)	105	1.4 (11.9)	69	0.32	BL outcome
	Savoye, 2014[149] Fair	78	6 (0)	-2.8 (9.6)	31	-3.9 (9.3)	27	0.6	BL outcome and body weight, HbA1c, HOMA, DIo
	Reinehr, 2006[143] Fair	78	12 (0)	1.5 (9.4)	174	2.2 (11.3)	37	0.368	
	Reinehr, 2009[144] Fair	78	12 (0)	0.0 (13.9)	288	0.0 (11.6)	186	0.775	Age, sex, BL zBMI, and pubertal stage
	Vos, 2011[161] Fair	45	12 (**)	0.0 (18.7)	32	0.0 (18.5)	35	NSD	BL differences
	Kalavainen, 2007[127] Fair	44	6 (0)	4.6 (6.3)	34	2.7 (8.7)	35	0.317	

Appendix D Table 8. Lipid Outcomes in Included Lifestyle-Based Weight Loss Trials (Key Question 4)

Outcome (unit)	Author, Year & Quality	Est hrs of contact	Planned followup (months since tx ended)	IG mean difference (SD)	IG n	CG mean difference (SD)	CG n	Between group p-value	Adjustment details
	Golley, 2007[124] Fair	24	12 (7)	NR	NR	NR	NR	0.96	
	Hofsteenge, 2014[125] Fair	17	6 (0)	-1.2 (9.1)	53	-2.3 (8.0)	44	NR	Age, sex, ethnicity
	Norman, 2015[139] Fair	8	12 (0)	4.5 (10.16)	53	3.6 (10.05)	53	NR	
	Kong, 2013[130] Fair	4	9 (0)	0.0 (9.4)	28	-1.5 (5.2)	23	0.5	
TC (mg/dL)	Weigel, 2008[164] Fair	114	12 (0)	NR	NR	NR	NR	NSD	
	Savoye, 2007[150] Fair	82	12 (0)	-9.2 (29.5)	105	3.7 (32.2)	69	0.005	BL outcome
	Savoye, 2014[149] Fair	78	6 (0)	-10.8 (35.2)	31	-2.1 (29.0)	27	0.24	BL outcome and body weight, HbA1c, HOMA, DIo
	Reinehr, 2009[144] Fair	78	12 (0)	0.0 (34.7)	288	0.0 (31.6)	186	0.311	Age, sex, BL zBMI, and pubertal stage
	Kalavainen, 2007[127] Fair	44	6 (0)	7.7 (23.0)	34	3.9 (23.3)	35	0.493	
	Golley, 2007[124] Fair	24	12 (7)	NR	NR	NR	NR	0.47	
	Boudreau, 2013[111] Fair	11	6 (0)	-8.4 (19.0)	14	0.9 (16.9)	12	0.08	Primary household language
	Norman, 2015[139] Fair	8	12 (0)	-12.2 (28.34)	53	-12.1 (28.24)	53	NR	
Triglycerides (mg/dL)	Weigel, 2008[164] Fair	114	12 (0)	NR	NR	NR	NR	NSD	
	Savoye, 2007[150] Fair	82	12 (0)	-21.3 (38.7)	105	-8.1 (60.0)	69	0.11	BL outcome

Appendix D Table 8. Lipid Outcomes in Included Lifestyle-Based Weight Loss Trials (Key Question 4)

Outcome (unit)	Author, Year & Quality	Est hrs of contact	Planned followup (months since tx ended)	IG mean difference (SD)	IG n	CG mean difference (SD)	CG n	Between group p-value	Adjustment details
	Savoye, 2014[149] Fair	78	6 (0)	-28.4 (35.4)	31	-4.6 (42.2)	27	0.005	BL outcome and body weight, HbA1c, HOMA, DIo
	Reinehr, 2006[143] Fair	78	12 (0)	-6.3 (74.5)	174	-4.1 (91.9)	37	0.803	
	Reinehr, 2009[144] Fair	78	12 (0)	0.0 (62.0)	288	0.0 (62.0)	186	0.493	Age, sex, BL zBMI, and pubertal stage
	Vos, 2011[161] Fair	45	12 (**)	-8.9 (128.5)	32	8.9 (84.6)	35	NSD	BL differences
	Kalavainen, 2007[127] Fair	44	6 (0)	-20.4 (41.5)	33	-1.8 (33.4)	35	0.093	
	Golley, 2007[124] Fair	24	12 (7)	NR	NR	NR	NR	0.98	
	Hofsteenge, 2014[125] Fair	17	6 (0)	NR	53	NR	44	NSD	Age, sex, ethnicity
	Norman, 2015[139] Fair	8	12 (0)	-14.9 (62.17)	53	-13.6 (54.05)	53	NR	
	Kong, 2013[130] Fair	4	9 (0)	8.9 (83.6)	28	8.9 (43.3)	23	0.95	
Dyslipidemia	Love-Osborne, 2014[133] Fair	3	8 (0)	1 (1.2)*	82	1 (1.2)*	83	NSD	

*Number (%).

Abbreviations: BL = baseline; CG = control group; DIo = basal disposition index; dL = deciliter(s); est = estimated; HbA1c = glycated hemoglobin; HDL-C = high-density lipoprotein cholesterol; HOMA = homeostatic model assessment hrs = hours; IG = intervention group; L = liter(s); LDL-C = low-density lipoprotein cholesterol; mg = milligram(s); mmol = millimole(s); NR = not reported; NSD = no significant difference; SD = standard deviation; TC = total cholesterol; zBMI = body mass index z-score.

Appendix D Table 9. Results of Lifestyle-Based Weight Maintenance and Non-Lifestyle Weight Loss Trials (Key Question 4)

Author, Year & Quality	Followup (months since tx ended)	Est hrs of contact	Outcome (unit)	IG mean difference (SD)	IG n	CG mean difference (SD)	CG n	Between group p-value	Adjustment details
Davis, 2012[119]	8 (0)	16	zBMI (BMI SDS)	NR	NR	NR	NR	NSD	
	8 (0)	16	HDL-C (mg/dL)	1.70 (8.50)	30	1.0 (7.38)	23	NSD	
Fair	8 (0)	16	Insulin (µIU/mL)	-4.6 (9.90)	30	-6.6 (11.34)	23	NSD	
Boutelle, 2014[112]	8 (4)	28	BMI (kg/m^2)	-0.1 (4.73)	21	0.6 (4.66)	18	0.23	Baseline BMI
	8 (4)	28	zBMI (BMI SDS)	-0.1 (0.43)	21	-0.05 (0.40)	18	0.16	Baseline zBMI
Fair									
Tanofsky-Kraff, 2010[156]	6 (3)	18	BMI (kg/m^2)	0.87 (0.5)	19	0.31 (1.59)	19	NSD	
	12 (9)	18	BMI (kg/m^2)	0.81 (1.25)	19	0.68 (2.13)	19	NR	
	6 (3)	18	zBMI (BMI SDS)	0.05 (0.40)	19	-0.07 (0.44)	19	NSD	
Fair	12 (9)	18	zBMI (BMI SDS)	-0.1 (0.46)	19	-0.1 (0.46)	19	NR	

Abbreviations: BMI = body mass index; CG = control group; dL = deciliter(s); est = estimated; HDL-C = high-density lipoprotein cholesterol; hrs = hours; IG = intervention group; IU = international unit; kg = kilogram(s); m = meter(s); mg = milligram(s); mL = milliter(s); NR = not reported; NSD = no significant difference; SD = standard deviation; SDS = standardized deviation score; tx = treatment; µ = micro; zBMI = body mass index z-score.

Appendix D Table 10. Weight Outcomes of Included Pharmacotherapy Trials (Key Question 4)

Drug	Author, Year & Quality	Followup (months)	Outcome (unit)	IG mean difference (SD)	IG n	CG mean difference (SD)	CG n	Between group p-value	Adjustment details
Metformin	Freemark, 2001[122] Fair	6	BMI (kg/m^2)	-0.5 (NR)	14	0.9 (NR)	15	<0.02	
		6	zBMI (BMI SDS)	-0.12 (0.3)	14	0.23 (0.39)	15	<0.02	
	Wiegand, 2010[165] Fair	6	BMI (kg/m^2)	0.07 (5.13)	34	-0.31 (5.47)	29	0.964	Age, sex, pubertal stage
		6	zBMI (BMI SDS)	-0.03 (0.7)	34	-0.02 (0.7)	29	0.677	Age, sex, pubertal stage
	Kendall, 2013[129] Fair	6	BMI (kg/m^2)	-0.25 (6.32)	55	0.21 (6.41)	55	0.005	Baseline BMI
		6	zBMI (BMI SDS)	-0.09 (0.61)	55	-0.03 (0.52)	55	0.02	Baseline zBMI
		6	Weight (kg)	2.4 (24.46)	55	0.4 (21.32)	55	0.02	Baseline weight (also possibly pubertal status, age, sex, and ethnicity in a secondary analysis; methods reporting somewhat unclear)
	Love-Osborne, 2008[133] Fair	6	BMI (kg/m^2)	-0.16 (1.89)	48	0.63 (1.29)	16	0.11	
		6	≥5% BMI loss (number of participants)	11 (22.9)	48	0 (0)	16	0.001	
	Clarson, 2014[117] Fair	6	zBMI (BMI SDS)	-0.14 (0.44)	31	-0.04 (0.39)	30	NR	
		12		-0.17 (0.44)	23	0.05 (0.40)	24	0.01	
		6	BMI (kg/m^2)	-0.88 (5.63)	31	-0.02 (5.54)	30	NR	
		12		-0.56 (5.60)	23	1.30 (5.67)	24	0.01	
	Srinivasan, 2006[152] Fair	6	BMI (kg/m^2)	NR (NR)	NR	NR (NR)	NR	0.002	
		6	zBMI (BMI SDS)	NR (NR)	NR	NR (NR)	NR	0.005	
		6	Weight (kg)	NR (NR)	NR	NR (NR)	NR	0.02	
		6	WC (cm)	NR (NR)	NR	NR (NR)	NR	0.003	
	Wilson, 2010[166] Fair	12	BMI (kg/m^2)	-0.9 (3.12)	27	0.2 (3.08)	27	0.03	Site, sex, race, ethnicity and age
		12	zBMI (BMI SDS)	-0.09 (0.25)	27	-0.01 (0.25)	27	0.09	Site, sex, race, ethnicity and age
	Yanovski, 2011[167] Good	6	BMI (kg/m^2)	-0.78 (2.84)	53	0.32 (3.01)	47	0.006	Age, sex, race/ethnicity
		6	zBMI (BMI SDS)	-0.11 (0.2)	53	-0.04 (0.21)	47	0.02	Age, sex, race/ethnicity
		6	Weight (kg)	1.47 (6.59)	53	4.85 (7.01)	47	<0.001	Age, sex, race/ethnicity
		6	WC (cm)	1.84 (10.57)	53	4.38 (11.02)	47	0.02	Age, sex, race/ethnicity

Appendix D Table 10. Weight Outcomes of Included Pharmacotherapy Trials (Key Question 4)

Drug	Author, Year & Quality	Followup (months)	Outcome (unit)	IG mean difference (SD)	IG n	CG mean difference (SD)	CG n	Between group p-value	Adjustment details
Orlistat	Yanovski, 2012[102] Fair	6	BMI (kg/m^2)	-1.44 (2.6)	100	-0.50 (2)	100	NR	
		6	Weight (kg)	-2.9 (7)	100	-0.6 (7)	100	NR	
		6	zBMI (BMI SDS)	-0.12 (0.2)	100	-0.06 (0.2)	100	0.007	
	Chanoine, 2005[116] Fair	12	BMI (kg/m^2)	-0.55 (NR)	352	0.31 (NR)	181	0.001	Treatment center, treatment x center interaction, body weight < or ≥80 kg; weight loss during run-in. Corrected for age and sex by BMI z-score
		12	Weight (kg)	0.53 (NR)	352	3.14 (NR)	181	<0.001	Treatment center, treatment x center interaction, body weight < or ≥80 kg; weight loss during run-in. Corrected for age and sex by BMI z-score
		12	WC (cm)	-1.33 (NR)	352	0.12 (NR)	181	<0.05	Treatment center, treatment x center interaction, body weight < or ≥80 kg; weight loss during run-in. Corrected for age and sex by BMI z-score
	Maahs, 2006[135] Fair	6	BMI (kg/m^2)	-1.3 (7.16)	16	-0.8 (13.42)	18	0.7	
		6	Weight (kg)	-5.5 (23.91)	16	-1.6 (39.39)	18	0.76	

Abbreviations: BMI = body mass index; CG = control group; cm = centimeter(s); IG = intervention group; kg = kilogram(s); m = meter(s); NR = not reportedSD = standard deviation; SDS = standardized deviation score; WC = waist circumference; zBMI = BMI z-score.

Appendix D Table 11. Change in Mean zBMI in Pharmacotherapy Weight Loss Trials, With Columns Showing Mean ± 1 Standard Deviation (Key Question 4)

Age group	Author, Year Quality	Intervention Group					Control Group				
		BL Mean	Mean Change	SD Change	Mean -SD	Mean +SD	BL Mean	Mean Change	SD Change	Mean -SD	Mean +SD
Metformin											
52+ hours											
Wide Age Range	Clarson, 2014[117] Fair	2.22	-0.14	0.44	-0.58	0.30	2.12	-0.04	0.39	-0.43	0.35
26-51 hours											
Wide Age Range	Wiegand, 2010[165] Fair	2.46	-0.03	0.70	-0.73	0.67	2.46	-0.02	0.70	-0.72	0.68
6-25 hours											
Adolescent	Wilson, 2010[166] Fair	2.28	-0.09	0.25	-0.34	0.16	2.29	-0.01	0.25	-0.26	0.24
0-5 hours											
Wide Age Range	Kendall, 2013[129] Fair	3.44	-0.09	0.61	-0.70	0.52	3.34	-0.03	0.52	-0.55	0.49
	Yanovski, 2011[167] Good	2.56	-0.11	0.20	-0.31	0.09	2.58	-0.04	0.21	-0.25	0.17
Adolescent	Freemark, 2001[122] Fair	NR	-0.12	0.30	-0.42	0.18	NR	0.23	0.39	-0.16	0.62
Orlistat											
Adolescent	Yanovski, 2012[102] Fair	NR	-0.12	0.2	-0.32	0.08	NR	-0.06	0.2	-0.26	0.14

Abbreviations: BL = baseline; BMI = body mass index; SD = standard deviation.

Appendix D Table 12. Reported or Calculated Change in Mean Weight (Pounds) in Pharmacotherapy Weight Loss Trials, With Columns Showing Mean ± 1 Standard Deviation (Key Question 4)

Age group	Author, Year Quality	Follow-up (months)	Mean age (years)	BL BMI	Intervention Group					Control Group				
					BL Mean	Mean Change	SD Change	Mean -SD	Mean +SD	BL Mean	Mean Change	SD Change	Mean -SD	Mean +SD
Metformin														
52+ hours														
Wide Age Range	Clarson, 2014[117] Fair	6	13.7	32.5	185.0	-3.1	31.5	-34.6	28.4	84.0	-1.4	14.3	-15.7	12.9
26-51 hours														
Wide Age Range	Wiegand, 2010[165]† Fair	6	15.0	34.9	197.7	0.4	29.6	-29.2	30.0	204.8	-1.8	31.5	-33.3	29.7
6-25 hours														
Adolescent	Wilson, 2010[166]† Fair	12	14.9	35.9	210.3	-5.3	18.0	-23.3	12.7	208.5	1.1	17.8	-16.7	18.9
0-5 hours														
Wide Age Range	Yanovski, 2011[167]* Good	6	10.2	34.4	168.2	3.2	14.5	-11.3	17.7	176.4	10.7	15.4	-4.7	26.1
	Srinivasan, 2006[152] Fair	6	12.5	35.2	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
	Kendall, 2013[129]* Fair	6	13.7	36.5	220.9	5.3	53.9	-48.6	59.2	212.3	0.9	46.9	-46.0	47.8
Adolescent	Love-Osborne, 2008[134]† Fair	6	15.7	39.7	228.8	-0.9	11.0	-11.9	10.1	228.1	3.7	7.5	-3.7	11.2
	Freemark, 2001[122]† Fair	6	14.9	40.0	239.1	-2.9	NR	NR	NR	222.8	5.3	NR	NR	NR
Orlistat														
6-25 hours														
Adolescent	Yanovski, 2012[102]* Fair	6	14.59	41.7	NR	-6.4	15.4	-21.8	9.0	NR	-1.3	15.4	-16.7	14.1
	Chanoine, 2005[116]* Fair	12	13.6	35.6	215.1	1.2	NR	NR	NR	209.4	6.9	NR	NR	NR

Appendix D Table 12. Reported or Calculated Change in Mean Weight (Pounds) in Pharmacotherapy Weight Loss Trials, With Columns Showing Mean ± 1 Standard Deviation (Key Question 4)

Age group	Author, Year Quality	Follow-up (months)	Mean age (years)	BL BMI	Intervention Group					Control Group				
					BL Mean	Mean Change	SD Change	Mean -SD	Mean +SD	BL Mean	Mean Change	SD Change	Mean -SD	Mean +SD
0-5 hours														
Adolescent	Maahs, 2006[135]* Fair	6	15.8	40.4	244.6	-12.1	52.6	-64.7	40.5	251.7	-3.5	86.8	-90.3	83.3

*Study-reported weight change.
†Calculated weight change.

Abbreviations: BL = baseline; BMI = body mass index; SD = standard deviation.

Appendix D Table 13. Glucose and Insulin Outcomes of Included Pharmacotherapy Trials (Key Question 4)

Drug	Outcome (unit)	Author, Year & Quality	Followup (months)	IG mean difference (SD)	IG n	CG mean difference (SD)	CG n	Between group p-value	Adjustment details
Metformin	FPG (mg/dL)	Freemark, 2001[122] Fair	6	-9.20 (14.59)	14	8.70 (12.78)	15	<0.01	
		Kendall, 2013[129] Fair	6	-0.72 (8.29)	55	0.18 (7.93)	55	0.53	Baseline FPG
		Clarson, 2014[117] Fair	6	-5.77 (6.23)	31	-3.96 (9.42)	30	NR	
			12	-1.62 (5.73)	23	1.80 (7.92)	24	NR	
		Srinivasan, 2006[152] Fair	6	NR	NR	NR	NR	0.048	
		Wiegand, 2010[165] Fair	6	0.60 (8.51)	34	2.00 (11.00)	29	0.189	Age, sex, pubertal stage
		Yanovski, 2011[167]* Good	6	-0.88 (10.88)	53	3.47 (11.70)	47	0.007	Age, sex, race/ethnicity
	2-hr OGTT (mg/dL)	Kendall, 2013[129] Fair	6	-5.59 (25.38)	55	-5.77 (25.42)	55	0.88	Baseline 2-hr OGTT
		Clarson, 2014[117] Fair	6	-0.54 (19.28)	31	-2.88 (22.74)	30	NR	
			12	3.42 (17.97)	23	-1.80 (22.31)	24	NR	
		Wiegand, 2010[165] Fair	6	2.00 (16.33)	34	3.90 (22.68)	29	0.377	Age, sex, pubertal stage
	HOMA†	Freemark, 2001[122] Fair	6	-3.08 (2.56)	14	-0.07 (5.75)	15	NR	
		Kendall, 2013[129] Fair	6	0.20 (3.21)	55	0.29 (3.29)	55	0.53	Baseline HOMA
		Clarson, 2014[117] Fair	6	-1.04 (1.94)	31	-0.5 (2.09)	30	NR	
			12	-0.87 (1.95)	23	0.03 (1.97)	24	NR	
		Wiegand, 2010[165] Fair	6	NR	34	NR	29	0.855	Age, sex, pubertal stage
		Wilson, 2010[166] Fair	12	-0.10 (5.00)	27	-0.80 (4.32)	27	0.48	Site, sex, race, ethnicity and age

Appendix D Table 13. Glucose and Insulin Outcomes of Included Pharmacotherapy Trials (Key Question 4)

Drug	Outcome (unit)	Author, Year & Quality	Followup (months)	IG mean difference (SD)	IG n	CG mean difference (SD)	CG n	Between group p-value	Adjustment details
		Yanovski, 2011[167]* Good	6	0.68 (4.01)	53	2.23 (4.21)	47	0.006	Age, sex, race/ethnicity
	Insulin (µIU/mL)	Freemark, 2001[122] Fair	6	-12.30 (11.04)	14	-1.60 (25.95)	15	NR	
		Kendall, 2013[129] Fair	6	-0.65 (16.30)	55	3.77 (18.05)	55	0.97	Baseline fasting insulin
		Srinivasan, 2006[152] Fair	6	NR	NR	NR	NR	0.011	
		Wiegand, 2010[165] Fair	6	NR	34	NR	29	0.995	Age, sex, pubertal stage
		Yanovski, 2011[167] Good	6	3.24 (17.09)	53	9.00 (18.03)	47	0.02	Age, sex, race/ethnicity
Orlistat	FPG (mg/dL)	Chanoine, 2005[116] Fair	12	NR	282	NR	136	0.06	Center, tx, tx x center
		Maahs, 2006[135] Fair	6	2.80 (7.79)	16	4.80 (8.22)	18	0.12	
	2-hr OGTT (mg/dL)	Chanoine, 2005[116] Fair	12	NR	283	NR	136	0.68	Center, tx, tx x center
	Insulin (µIU/mL)	Chanoine, 2005[116] Fair	12	NR	271	NR	132	0.41	Center, tx, tx x center
		Maahs, 2006[135] Fair	6	-0.70 (15.00)	16	1.40 (12.27)	18	0.43	
	2-hr insulin (µIU/mL)	Chanoine, 2005[116] Fair	12	NR	276	NR	133	0.44	Center, tx, tx x center

*Unadjusted analyses from plots not significant.
†HOMA-IR (insulin resistance): insulin [µIU/mL] x glucose [mmol/L]/22.5.

Abbreviations: CG = control group; dL = deciliter; hr = hour(s); IG = intervention group; IU = international unit; FPG = fasting plasma glucose; HOMA = homeostatic model assessment; L = liter(s); mg = milligram(s); mL = milliter(s); mmol = millimole(s); NR = not reported; OGTT = oral glucose tolerance test; SD = standard deviation; tx – treatment; µ = micro.

Appendix D Table 14. Lipid and Blood Pressure Outcomes of Included Pharmacotherapy Trials (Key Question 4)

Drug	Outcome (mg/dL)	Author, Year & Quality	Followup (months)	IG mean difference (SD)	IG n	CG mean difference (SD)	CG n	Between group p-value	Adjustment details
Metformin	LDL	Freemark, 2001[122] Fair	6	-6.50 (24.91)	14	-3.30 (32.97)	15	NR	
		Kendall, 2013[129] Fair	6	-1.93 (29.24)	55	2.32 (25.56)	55	0.51	Baseline LDL
		Clarson, 2014[117] Fair	6	-0.77 (22.17)	31	-1.93 (25.31)	30	NR	
			12	-1.93 (25.11)	23	-4.63 (25.62)	24	NR	
		Wiegand, 2010[165] Fair	6	3.30 (36.74)	34	-18.60 (39.20)	29	0.44	Age, sex, pubertal stage
		Wilson, 2010[166] Fair	12	0.00 (24.98)	27	0.00 (24.66)	27	0.97	Site, sex, race, ethnicity and age
		Yanovski, 2011[167] Good	6	-6.57 (27.93)	53	-2.78 (29.94)	47	0.37	Age, sex, race/ethnicity
	HDL	Freemark, 2001[122] Fair	6	0.80 (8.98)	14	-1.40 (6.40)	15	NR	
		Kendall, 2013[129] Fair	6	1.93 (9.43)	55	4.63 (10.02)	55	0.95	Baseline HDL
		Clarson, 2014[117] Fair	6	-0.39 (12.55)	31	-0.77 (13.14)	30	NR	
			12	3.47 (13.56)	23	-2.32 (11.83)	24	NR	
		Wiegand, 2010[165] Fair	6	-0.70 (14.52)	34	0.80 (14.02)	29	0.36	Age, sex, pubertal stage
		Wilson, 2010[166] Fair	12	1.00 (6.24)	27	0.00 (6.16)	27	0.38	Site, sex, race, ethnicity and age
		Yanovski, 2011[167] Good	6	0.12 (9.90)	53	-0.27 (10.51)	47	0.79	Age, sex, race/ethnicity
	TC	Freemark, 2001[122] Fair	6	-7.10 (21.11)	14	-6.80 (39.17)	15	NR	
		Kendall, 2013[129] Fair	6	-2.32 (30.46)	55	0.00 (31.51)	55	0.93	Baseline TC

Appendix D Table 14. Lipid and Blood Pressure Outcomes of Included Pharmacotherapy Trials (Key Question 4)

Drug	Outcome (mg/dL)	Author, Year & Quality	Followup (months)	IG mean difference (SD)	IG n	CG mean difference (SD)	CG n	Between group p-value	Adjustment details
		Wiegand, 2010[165] Fair	6	-7.60 (31.08)	34	-7.60 (32.36)	29	0.55	Age, sex, pubertal stage
		Yanovski, 2011[167] Good	6	-9.05 (28.17)	53	-4.52 (29.78)	47	0.27	Age, sex, race/ethnicity
	Triglycerides	Freemark, 2001[122] Fair	6	-1.50 (39.70)	14	-13.80 (80.74)	15	NR	
		Kendall, 2013[129] Fair	6	-12.39 (57.97)	55	-21.24 (77.74)	55	0.66	Baseline triglycerides
		Clarson, 2014[117] Fair	6	-2.65 (74.38)	31	-7.08 (55.94)	30	NR	
			12	-19.47 (61.44)	23	-12.39 (48.12)	24	NR	
		Wiegand, 2010[165] Fair	6	NR	34	NR	29	0.37	Age, sex, pubertal stage
		Wilson, 2010[166] Fair	12	-2.00 (74.94)	27	1.00 (73.97)	27	0.80	Site, sex, race, ethnicity and age
		Yanovski, 2011[167] Good	6	7.70 (76.26)	53	3.79 (81.06)	47	0.72	Age, sex, race/ethnicity
	LDL:HDL	Freemark, 2001[122] Fair	6	-0.20 (0.75)	14	0.00 (0.77)	15	NR	
	SBP (mm Hg)	Kendall, 2013[129] Fair	6	1.5 (14.0)*	55	0.8 (13.9)*	55	0.42	Baseline SBP
		Wiegand, 2010[165] Fair	6	-5 (15.6)*	34	-2 (14.6)*	29	0.828	Age, sex, pubertal stage
	DBP (mm Hg)	Kendall, 2013[129] Fair	6	0.3 (9.4)*	55	-1 (8.9)*	55	0.36	Baseline DBP
		Wiegand, 2010[165] Fair	6	1 (9.3)*	34	1 (12.1)*	29	0.876	Age, sex, pubertal stage

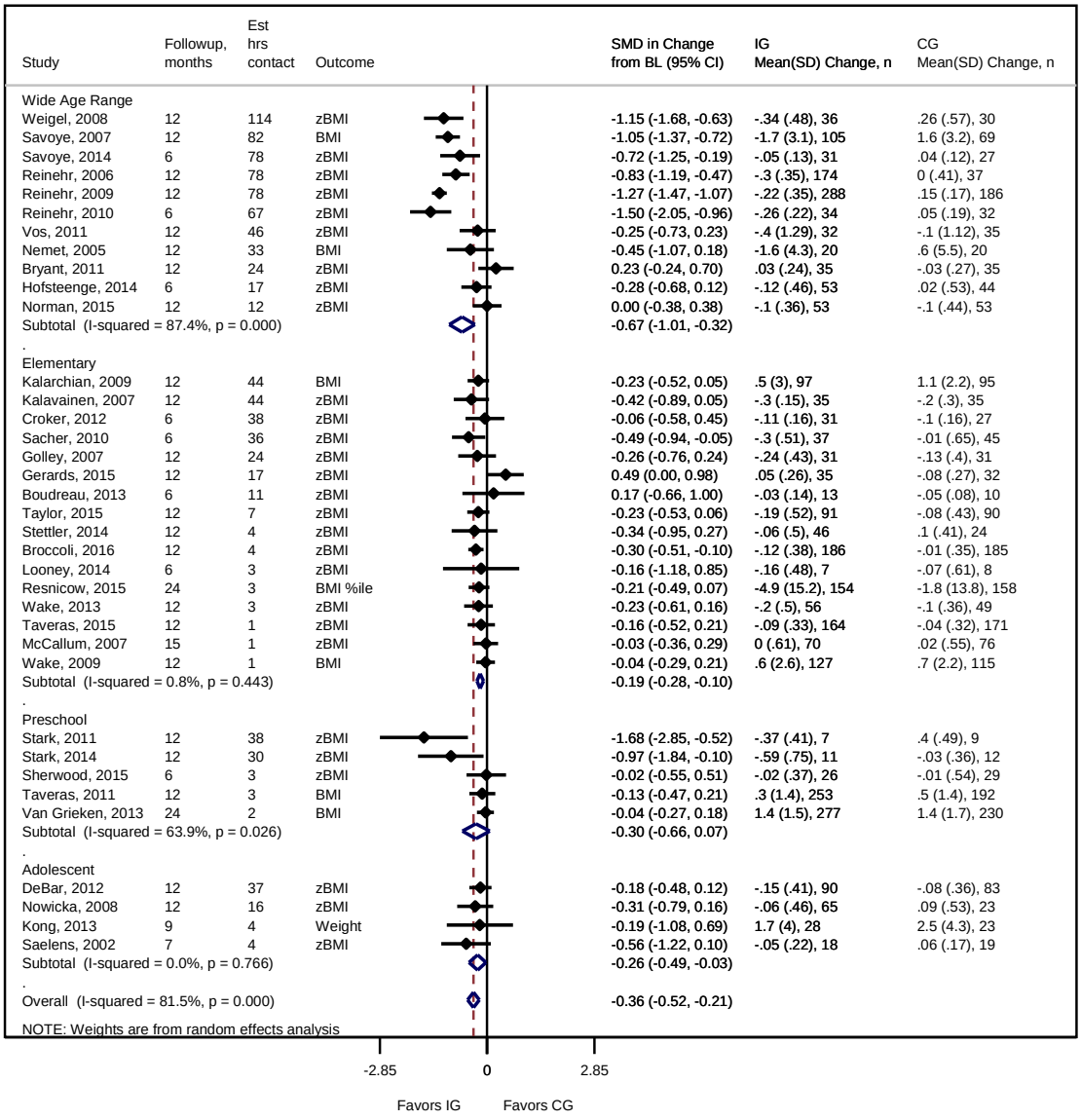
Appendix D Table 14. Lipid and Blood Pressure Outcomes of Included Pharmacotherapy Trials (Key Question 4)

Drug	Outcome (mg/dL)	Author, Year & Quality	Followup (months)	IG mean difference (SD)	IG n	CG mean difference (SD)	CG n	Between group p-value	Adjustment details
Orlistat	LDL	Chanoine, 2005[116] Fair	12	-0.99* (NR)	322	0.88* (NR)	162	0.29	Center, tx, tx x center
		Maahs, 2006[135] Fair	6	1.40 (31.63)	16	-4.00 (25.73)	18	0.13	
	HDL	Chanoine, 2005[116] Fair	12	0.07* (NR)	323	-0.31* (NR)	163	0.62	Center, tx, tx x center
		Maahs, 2006[135] Fair	6	-0.20 (8.68)	16	0.90 (8.60)	18	0.47	
	TC	Chanoine, 2005[116] Fair	12	2.26* (NR)	323	3.39* (NR)	163	0.59	Center, tx, tx x center
		Maahs, 2006[135] Fair	6	-1.10 (39.71)	16	-3.00 (35.42)	18	0.49	
	Triglycerides	Chanoine, 2005[116] Fair	12	17.90* (NR)	323	11.68* (NR)	163	0.30	Center, tx, tx x center
		Maahs, 2006[135] Fair	6	-12.40 (75.36)	16	0.60 (56.14)	18	0.52	
	SBP (mm Hg)	Chanoine, 2005[116] Fair	12	1.09* (NR)	347	1.31* (NR)	180	0.84	Center, tx, tx x center
	DBP (mm Hg)	Chanoine, 2005[116] Fair	12	-0.51*(NR)	347	1.30* (NR)	180	0.04	Center, tx, tx x center

*Study-reported.

Abbreviations: CG = control group; DBP = diastolic blood pressure; dL = deciliter; hr = hour(s); HDL = high-density lipoprotein; IG = intervention group; LDL = low-density lipoprotein; mg = milligram(s); mL = milliter(s); NR = not reported; SBP = systolic blood pressure; SD = standard deviation; TC = total cholesterol; tx = treatment.

Appendix D Figure 1. Forest Plot of Change in Weight (zBMI, BMI, Weight in Kilograms, or BMI Percentile) in Behavior-Based Weight Loss Intervention Trials, by Estimated Hours of Contact, Showing DerSimonian & Laird Pooled Estimates, by Age Category (Key Question 4)



Abbreviations: BL =baseline; BMI = body mass index; CG = control group; CI = confidence interval; DBP = diastolic blood pressure; est = estimated; hrs = hours; IG = intervention group; m = month(s); SBP = systolic blood pressure; SD = standard deviation; SMD = standardized mean difference; tx = treatment.

Nineteen included studies (18 behavior-based interventions and one pharmacotherapy with counseling) reported on the acceptability of weight management interventions, which varied in intensity from a brief use of a computerized clinical decision support system using motivational interviewing for weight management[158] to multiple group sessions addressing healthy lifestyle behaviors with the parents and child meeting separately.[127] Participants—both parents and children—rated their satisfaction with the weight management interventions highly on various satisfaction questionnaires. In most trials, 80 percent or more of participants had high satisfaction or acceptability ratings, and continuous satisfaction scores typically were above 4 on a 5-point scale (**Table 1**).[112, 123, 124, 130, 141, 154, 157, 158] In a good-quality trial that involved a computerized clinical decision support system with point of care prompts at well-child visits, motivational interviewing with their primary care provider, and four health coaching phone sessions with an optional text messaging component, ninety-one percent of parents would recommend the intervention to family and friends.[157] In another fair-quality trial in younger children (age 6 to 9 years) involving an estimated 24 hours of contact via group and phone sessions, the majority of parents reported that they would undergo the intervention again.[124] Many of the participants also found the behavior-based interventions to be helpful or useful in weight loss (**Table 1**).[112, 120, 123, 124, 132, 134, 141, 160] The interventions were also rated high in quality and value; for example, all the parents of one fair-quality study rated the Positive Parenting Program (Triple P) as good to excellent.[124] Primary care providers also found the interventions to be valuable[137, 160] and helpful[163] and intended to deliver the intervention again.[137] The participants of four included studies reported that the intervention met their particular weight loss needs.[120, 124, 141, 160]

A few themes emerged when asking families for feedback on their experiences, both in the included trials and other studies, including a qualitative study of 14 parents who had dropped out of a weight management program.[301] Themes included a desire for more frequent and direct contacts or visits with the interventionist, appreciation for a component or option directed in the home, and increased parental involvement and family education, rather than only targeting the child. In one good-quality trial evaluating monthly individual family sessions with health advisors, the parents liked involving both themselves and their child during the sessions as well as the broad selection of lifestyle behaviors for modification from which to choose.[141] About half wanted to target more than one behavior change a month, attend more frequent visits, and receive more frequent followup telephone calls between sessions. A few parents would have also preferred home visits or for the intervention to take place at an alternative site for convenience or due to transportation issues. The parents of one-fair quality trial found the home component of the intervention essential to following the treatment recommendations (e.g., clean out pantry of junk food).[153] In another fair-quality study of an intervention aimed at parenting skills with an estimated 38 hours of contact, the parents indicated that they would have liked a booster session to refresh their knowledge and skills since the intervention only lasted 14 weeks and followup assessment occurred at 12 months.[123] Other studies have reported that parents of children in weight management programs strongly support interventions that include behavioral modification through collaborative goals and family support,[302, 303] which the majority of interventions in included studies provided. At least one included fair-quality study reported modifying the SHAPEDOWN intervention to include more extensive parental involvement and supportive family education materials based on feedback from group leaders.[137] Similarly, the survey of families dropping out of a weight management program indicated a preference for greater family involvement rather than the child being the primary target.[301]

When designing weight management interventions, consideration of the preferences of the participating children and adolescents, such as focusing on healthy eating and physical activity and not restricting activities that they enjoy (e.g., playing computer games), is also important. A survey of middle school students reported that the most important components were those that focused on adopting healthy eating and physical activity behaviors as opposed to drinking less soda pop, playing less video/computer games, and watching less television.[304] The survey among middle school students also reported that they preferred to increase physical activity, rather than reduce calories, for improved energy balance.[304] In contrast, the caretakers of children in one included fair-quality trial suggested reducing sugar-sweetened beverages was the easiest behavior to target in children compared to increasing intake of fruits and vegetables, increasing moderate-to-vigorous physical activity, or decreasing television time.[132]

Weight management interventions should also be developed to be relevant, applicable, and feasible to a primary care setting by considering the perspective of the primary care provider. Four included trials that involved primary care providers assessed the acceptability of the interventions from their perspective (**Table 2**). One good-quality trial evaluated the effect of four consultations with a general practitioner on weight management.[136] At each consultation, the family could choose an appropriate healthy lifestyle behavior change from a set of evidence-based materials (e.g., drink more water), and the general practitioner provided solution-based support to families during the consultations. Eighty-five percent of the general practitioners found the intervention materials had good or very good relevance to primary care. In another good-quality trial, intervention participants visited their general practitioners every 4 to 8 weeks after an initial hour-long family session with an obesity specialist team.[163] The general practitioner reviewed BMI and lifestyle change progress, identified and solved problems, and set new goals using a brief solution-focused technique. Data from all sessions was shared between the obesity specialist team and the general practitioner using the HopSCOTCH web-based shared care software, which provided a structured intervention for each session. The majority of general practitioners thought that the overall shared care approach was helpful (77%), the specialists management plan was helpful (88%), and being able to contact the specialist team was helpful (67%). Half of general practitioners, however, did not find the HopSCOTCH software easy to use. In a fair-quality trial that evaluated the use of an overweight prevention protocol during a well-child visit, 65 percent of the professionals (72% of which were pediatricians) at the Youth Health Center graded the intervention as a seven or higher on a 10-point scale (directionality not reported).[160] The professionals indicated that motivating the parents to attend additional sessions and changing the family health-related lifestyle were the most often experienced difficulties while using the overweight prevention protocol (specific details not reported). And finally, the majority of pediatric primary care physicians who provided a brief session to participants in one fair-quality trial reported the training (88%) and materials (68 to 71%) were helpful and useful.[151] Although children in these interventions were not more likely to reduce excess weight than the usual care groups, the generally positive attitude of the participating providers suggests that these interventions may be useful and feasible components of a more intensive intervention.

Study investigators also need to consider reasons participants choose to discontinue a weight management intervention. High attrition rates and poor adherence are important limitations of weight management studies. Although the followup rates of included studies in this review were adequate (ranging from 63.4 percent[111] to 100 percent[144]), some interventions were modified to

improve adherence and compliance. One trial, for example, changed calorie goals to goals on food types and portion size, and removed goals for daily weighing due to considerable resistance from families and health professionals during the pilot study (specific details not reported).[118] It is possible that adhering to such frequent self-monitoring is difficult whereas monthly monitoring of weight and height was rated as very or extremely easy to do in another fair-quality study.[132] A survey of 14 parents who did not return to the Canadian Nutrition Services Pediatric Weight Management Program reported physical barriers (e.g., logistics), organizational barriers (e.g., clinic environment), motivation (i.e., the family's readiness to change), and components of the interventions as common reasons for attrition.[301] The qualitative responses indicated that information-only interventions were vulnerable to dropouts because many participants were already knowledgeable about the information (e.g., what is a food pyramid).[301] The survey also indicated that parents wanted the intervention to be targeted more toward the family and not the child only.[301] Tailoring the counseling technique in weight management interventions based on sex or race/ethnicity and other sociodemographic characteristics (e.g., immigration status) may also improve attendance and satisfaction.[211] The survey also reported that parents would prefer having the interventionist gain an understanding of what the family knows and how to address diet and lifestyle areas with which the family struggles (and thus, tailoring the intervention).[301] Overall, addressing preferences and barriers may improve adherence and compliance in weight management interventions.

Although we identified no studies on screening for childhood overweight or obesity, we did find studies reporting that parents believe primary care physicians play an integral role in identifying and treating childhood weight issues[305, 306] and find screening to be acceptable[307] in a health care setting. Primary care physicians who provide parents with weight-related feedback improve the parent's recognition and awareness of child overweight and increase the likelihood of participating in weight loss and healthy lifestyle programs.[308-310]

Appendix E Table 1. Acceptability of Behavior-Based Interventions in Included Studies, Participant Report

Author, Year & Quality	Details of Acceptability Ascertainment	Satisfaction	Usefulness/ Helpfulness	Quality/Value	Component Preferences	Brief Intervention Description
Behavior-based interventions						
Croker, 2012[118] Fair	NR				Based on feedback from pilot participants, study investigators changed calorie goals to goals on food types and portion size, and removed goals for daily weighing	15 90-min comprehensive multicomponent family-based behavioral therapy group sessions, parents and children meeting separately for 10 sessions and together for 5 sessions
DeBar, 2012[120] Good	Ratings of quality of intervention and whether treatment met their needs (rated on scale of 1-5, higher is better)		Program met their needs (4.0 ± 1.0 for teens and 3.9 ± 1.1 for parents)	Quality of intervention (4.4 ± 0.8 for teens and 4.4 ± 0.8 for parents)		16 90-min developmentally-tailored multicomponent behavioral intervention group sessions for adolescent girls; 12 with concurrent parent sessions; trained PCP to support behavioral weight management goals; 2 PCP meetings
Gerards, 2015[123] Fair	CSQ, 13 items rated on a scale of 1-7 (overall rated on scale 13-91, higher is better) What is your general impression of the program? (rated on scale of 1-5, directionality NR) Do you think program was interesting? (rated on scale of 1-5, directionality NR) Do you think the program was clear? (rated on scale of 1-5, directionality NR) Overall rating for intervention value (rated on scale of 1-10, directionality NR)	Parent-report CSQ mean score, 66.67 (10.57) General impression, 4.04 (0.66) Interesting, 4.12 (0.77) Clear, 4.15 (0.73)		Value of intervention, 7.7 (1.03) 85% of parents rated intervention as 7 or higher	The recipes provided were found to be quite difficult for parents and not always appropriate to the Dutch eating habits. Furthermore, parents indicated that they would have liked a booster session (for example after 6 months) to refresh their knowledge and skills.	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

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Author, Year & Quality	Details of Acceptability Ascertainment	Satisfaction	Usefulness/ Helpfulness	Quality/Value	Component Preferences	Brief Intervention Description
Golley, 2007[124] Fair	Parent satisfaction assessed using a validated 16-item questionnaire Response rate to satisfaction questionnaire: IG1 26/38 (68%) IG2 10/37 (27%) Additional questions about perceived barriers to program attendance and implementation were included	85% IG1 and 100% IG2 satisfied to very satisfied with amount of help received 77% IG1 and 60% IG2 would repeat program	50% IG1 and 80% IG2 reported generally to definitely receiving the type of help they wanted 92% IG1 and 100% IG2 found study helped somewhat to help a greater deal to make family lifestyle changes Reported as being useful training resources: parenting sessions 58%, calls 53%, manual 44%, lifestyle sessions 14%, lifestyle written material 17%	100% rated quality of service as good to excellent		IG1: 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 IG2: 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
Kalavainen, 2007[127] Fair	Parents asked to evaluate each group session immediately after the session; to be returned during fall and spring term (rated on a scale of 0-10, higher is better) 21 (64%) of parents returned fall term questionnaires; 26 (79%) of parents returned spring term questionnaires. Ratings broken down by session in Tables 3 and 4			Fall term session ratings, ranged from 8.1 (1.0) to 9.6 (0.4); mean, 8.9 (0.7) Spring term session ratings, ranged from 8.7 (0.9) to 9.0 (1.1); mean, 8.8 (0.8)		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

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Author, Year & Quality	Details of Acceptability Ascertainment	Satisfaction	Usefulness/ Helpfulness	Quality/Value	Component Preferences	Brief Intervention Description
Kong, 2013[130] Fair	Participant satisfaction (rated on scale of 0-5, higher is better) Survey completed by: 93% of IG students, 88% of caregivers, and 100% of CG students	IG student average satisfaction score, 4.4 IG caregiver average satisfaction score, 4.4 CG students average satisfaction score, 4.2				Initial MI visit with PCP and student to review medical history/lab results, assess diet and PA, receive DVD; 7 followup MI visits with PCP to discuss DVD and work toward healthy lifestyle goals; newsletter and 8 post-visit MI calls to parents/caregivers
Looney, 2014[132] Fair	At 6 months, families evaluated usefulness; number of additional contacts and additional overall comments; ease of achieving program-related goals and ability to implement behavioral changes		95% of families reported the program provided caretaker with important information about their child's health	90% of families reported the information provided was easy to understand 90% of families rates the overall program as very good or excellent	Reported monitoring monthly very easy or extremely easy: height (69.3%), weight (92.3%), using BMI wheel (96.3%), plotting on growth chart (53.9%) In IG1, easiest behavior change was decreasing SSBs (83.4%) Most commonly used strategies were caretakers modeling drinking fewer SSBs (100%), keeping F/V in home (100%), removing SSBs from home (73.3%) and praising child (73.3%)	IG1: Six 20-30 min in-person or phone sessions for growth monitoring/feedback and caretaker behavioral counseling; 6 monthly educational newsletters on nutrition and activity; usual care from the pediatrician IG2: Six 10-15 minute in-person or phone growth monitoring sessions with standardized feedback; 6 monthly educational newsletters on nutrition and leisure-lime activity; usual care from the pediatrician

Appendix E Table 1. Acceptability of Behavior-Based Interventions in Included Studies, Participant Report

Author, Year & Quality	Details of Acceptability Ascertainment	Satisfaction	Usefulness/ Helpfulness	Quality/Value	Component Preferences	Brief Intervention Description
O'Connor, 2013[141] Fair	NR	Exit interviews (85% of IG parents interviewed) revealed they were positive about the Helping HAND program and received what they wanted from the Helping HAND program			Parents liked involving both themselves and their child and the broad selection of lifestyle behaviors to choose from. Approximately half wanted to target more than 1 behavior a month, attend more frequent program visits or receive more frequent phone calls A few would have preferred home visits or alternative site for the program session usually because of convenience or transportation issues.	Six monthly individual family sessions with health advisors with followup phone call after each session; set monthly child-behavior goals with implementation plan and behavior-specific parenting practice goals
Saelens, 2002[148] Fair	Rated satisfaction with intervention components (computer program, physician counseling, manual and other written materials) at posttreatment for helpfulness, perceived satisfaction, perceived impact on weight-related behaviors, and overall appeal (rated on scale of 1-5, higher is better)	Telephone counseling satisfaction, 4.05 Mailing satisfaction, 3.57 Physician counseling satisfaction, 3.39 Computer program, 2.98			Adolescents more satisfied with telephone counseling (4.05) than all other intervention components ($p<0.01$ for all other components) More satisfied with mailed materials/manual than computer interaction ($p<0.01$)	Computer assessment with 1 pediatrician session to discuss results with family; 11 phone counseling calls, 3 mailings

Appendix E Table 1. Acceptability of Behavior-Based Interventions in Included Studies, Participant Report

Author, Year & Quality	Details of Acceptability Ascertainment	Satisfaction	Usefulness/ Helpfulness	Quality/Value	Component Preferences	Brief Intervention Description
Sherwood, 2015[151] Fair	Parent satisfaction survey assessed on the 6-month survey		Phone coaching helped family improve or maintain health behaviors, 72% of intervention parents			One brief primary care session followed by 8 15-30 min phone coaching sessions for goal setting and MI
Stark, 2011[154] Fair	Treatment Satisfaction Questionnaire, measures parents satisfaction with treatment content and ability to make recommended changes at treatment completion (rated on scale 1-5, higher is better)	Nutritional information, 4.86 Physical activity, 4.71 Ability to make recommended changes, 4.26			Anecdotally, parents reported the home component to be essential to following recommendations	Nine clinic-based 90-min comprehensive behavioral lifestyle group sessions for parents and children separately plus 9 home visits; vegetable taste tests, pedometers, parents received 2 weeks worth of vegetables, child sessions included 15-min PA.
Taveras, 2011[157] Good	Asked parents of IG during the 12 month interview how satisfied they were with program and if they would recommend it to family and friends and whether to had chosen to work on specific behaviors	97% reported being somewhat or very satisfied with the intervention 91% would recommend it to family and friends				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.
Taveras, 2015[158] Good	Parents rated how satisfied they were with program and whether they would recommend the program to family and friends	Parent very satisfied with experience in STAR intervention, % IG1: 81.3 IG2: 46.9 Increased satisfaction with health care system, % IG1: 62.7 IG2: 47.9			Ratings consistently lower for program without health coach contact; text message component lower satisfaction than phone calls	IG1: 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 IG2: Computerized clinical decision support system with point of care prompts at well-child visit, motivational interview, pt materials

Appendix E Table 1. Acceptability of Behavior-Based Interventions in Included Studies, Participant Report

Author, Year & Quality	Details of Acceptability Ascertainment	Satisfaction	Usefulness/ Helpfulness	Quality/Value	Component Preferences	Brief Intervention Description
Taveras, 2015[158] (cont.)		Would recommend STAR to friends and family, % IG1: 94.0 IG2: 85.1 Telephone calls w/health coach: Very satisfied with counseling received, %: 87.1 Very good/ excellent quality of advice provided, %: 73.7 Text message or email from health coach Very satisfied with the content received, %: 68.8 Very good/ excellent quality of advice received, %: 55.1				
Van Grieken, 2013[160] Fair	Parents asked to indicate whether the information provided during the sessions was appreciated; also gave an overall grade (rated on a scale of 1-10, directionality NR)		87% (78/90) of parents reported receiving overall useful information 79% (71/90) of parents reported receiving advice suited to them	90% (81/90) of parents rated the additional sessions w/ a grade of 7 or higher		Prevention protocol involving MI during a well-child visit; three additional structured healthy lifestyle counseling sessions matched to parents' stage of change could be offered.

Appendix E Table 1. Acceptability of Behavior-Based Interventions in Included Studies, Participant Report

Author, Year & Quality	Details of Acceptability Ascertainment	Satisfaction	Usefulness/ Helpfulness	Quality/Value	Component Preferences	Brief Intervention Description
Wake, 2013[163] Good	Various measures of acceptability (rated as agree, neutral or disagree)	85% of parents felt understood by specialist; 89% by GP	81% of parents understood how to implement goals set by specialist; 79% by GP 72% of parents confident of weight change after meeting specialist; 77% after meeting GP			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 with GP
Non-lifestyle counseling						
Boutelle, 2014[112] Fair	How much did you like the ROC program? (rated on scale of 1-5, higher is better) Because of ROC, I feel more control of my eating? (rated on scale of 1-3, higher is better)? Do you think other kids your age would like the ROC program? (Yes/No)	50% of kids rated it a 4 or 5 (liked a lot, loved it) 67% of parents rated it a 4 or 5 (liked a lot, loved it) 47% of parents thought their child rated it a 4 or 5 (liked a lot, loved it) 85% of kids thought other kids would like ROC program	62% of kids rated it a 3 on helpfulness 81% of parents believed it taught child to be more in control of eating			14 group sessions behavioral counseling based on appetite awareness and cue exposure treatment; core components included psychoeducation, parenting skills, coping skills, self-monitoring of hunger and cravings, and experiential learning
Pharmacotherapy						
Love-Osborne, 2008[134] Fair	NR				"In this study, subjects almost universally felt that goal setting was helpful to them, regardless of outcome"	Metformin 850 mg bid + 6 monthly individual goal-setting sessions; initial session included written material and video

Abbreviations: bid = twice daily; BMI = body mass index; CG = control group; CSQ = Client Satisfaction Questionnaire; DVD = digital video disc; F/V = fruits and vegetables; GP = general practitioner; hr = hour; IG = intervention group; mg = milligram(s); MI = motivational interviewing; mi = minute; msg = message; NR = not reported; PA = physical activity; PCP = primary care physician; pt = participant; ROC = regulation of cues; SSB = sugar-sweetened beverages; STAR = Study of Technology to Accelerate Research; w/ = with.

Appendix E Table 2. Acceptability of Behavior-Based Weight Management Interventions in Included Studies, Provider Report

Author, Year & Quality	Details of Acceptability Ascertainment	Satisfaction	Usefulness/ Helpfulness	Quality/Value	Component Preferences	Brief Intervention Description
Behavior-based interventions						
McCallum, 2007[136] Good	34 GPs asked to provide feedback on the conduct of the study Materials edited and refined according to expert opinion and GP feedback then piloted successfully with family attending a weight management clinic (unclear if occurred during trial or previously)			85% reported good or very good relevance to general practice		Four GP consultations using brief solution-focused family therapy for healthy lifestyle goals; 16-page folder of materials included topic sheets, wall cart, reward stickers, and shopping tips
Mellin, 1987[137] Fair	Group leaders perceptions of program content, process and outcomes were elicited at the conclusion of the intervention…through post-intervention interviews and questionnaires	All group leaders indicated they intended to deliver the program again		Group leaders rated the process, content and outcomes of program highly with all evaluating those aspects as good or excellent	Group leaders made numerous recommendation for minor content and process changes, many of which were subsequently incorporated into program materials Program revised to include more extensive parental involvement and supportive family education (unclear if this is what the group leaders suggested)	14 90-minute weekly group adolescent sessions and 2 90-minute parent sessions plus separate workbooks for parent and adolescent; focus on successive, sustainable, small lifestyle modifications
Sherwood, 2015[151] Fair	Provider feedback obtained by survey after they completed 3 well-child visits; it assessed comfort level addressing BMI percentile and obesity and safety/injury prevention with parents as well as study training and resource usefulness	96% comfortable addressing health eating and physical activity	88% reported study training was helpful		71% reported pamphlet was useful for communicating with families 68% reported flipchart was useful for communicating with families	One brief primary care session followed by 8 15-30 min phone coaching sessions for goal setting and MI

Appendix E Table 2. Acceptability of Behavior-Based Weight Management Interventions in Included Studies, Provider Report

Author, Year & Quality	Details of Acceptability Ascertainment	Satisfaction	Usefulness/ Helpfulness	Quality/Value	Component Preferences	Brief Intervention Description
Van Grieken, 2013[160] Fair	YHC professionals (72% were pediatricians) could indicate the challenges of the prevention protocol and give an overall grade (rated on a scale of 1-10, directionality NR) 54 YHC professionals completed evaluation form			65% (15/23) reported a grade of 7 or higher	Difficulties included motivating parents to attend additional sessions and changing the family health-related lifestyle.	Prevention protocol involving MI during a well-child visit; three additional structured healthy lifestyle counseling sessions matched to parents' stage of change could be offered.
Wake, 2013[163] Good	Various measures of acceptability (rated as agree, neutral or disagree)		77% of GPs thought overall shared care approach was helpful 88% of GPs thought specialist's management plan was helpful 67% of GPs thought being able to contact specialist helpful		40% of GPs thought opening sidebar was easy 24% of GPs thought speed of sidebar was easy 21% of GPs thought general usability of sidebar was easy	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 with GP

Abbreviations: GP = general practitioner; MI = motivational interviewing; YHC = youth health center.

Appendix F. Ongoing Studies

Author, Year Study Country	Aim	Participants (number of participants)	Intervention	Comparator	Relevant Outcomes	Status as of April 2016
Alia, 2015[311] Families Improving Together (FIT) for weight loss United States	Multi-theoretical, multilevel process evaluation was used to assess implementation of the Families Improving Together (FIT) for weight loss intervention	African American adolescent ages 11–16 who is overweight or obese, defined as having a BMI ≥85th and <99th percentile for age and sex (n=520)	(1) Group Motivational coaching and Family Weight Loss (M + FWL) *-re-randomised* (2) M+ FML + online health education program + booster sections	(1) Group comprehensive health education program *-re-randomised* (2) Online health education program + booster sections	zBMI	In progress, estimated cometion date: Jun 2017
Anderson, 2015[312] Whanau Pakari: a multidisciplinary intervention for child and adolescent obesity New Zealand	Inform the development of mgmt programs for obese children and adolescents that are appropriate for indigenous populations and investigate whether those at the preparation/action stage of "readiness" to make lifestyle changes are more successful in making changes than those who are contemplative	Children from the Taranaki region ages 5–16, with a BMI ≥98th percentile, or those >91st percentile with weight related comorbidities (n=107)	Individualized, culturally appropriate program: home visits + group PA sessions or psychology sessions	Standard practice: Brief dietary edu (pamphlet)	BMI SDS; HRQoL; PA; Diet knowledge and behavior; sedentary behavior; cardiovascular and metabolic profile	Protocol Published, Follow-up continuing
Ayala, 2015[313] Our Choice/Nuestra Opcion: the Imperial County, California, Childhood Obesity Research Demonstration study (CA-CORD) United States	1 of 3 CORD studies funded by the CDC in 2011 to test multisector, multilevel approaches to prevent and control childhood obesity; multisector, multilevel intervention targets improvements in 4 health behaviors: fruit, vegetable, and water consumption; physical activity; and quality sleep	Families with 1 child per household ages 2 to 10, with BMI ≥75th percentile (n=1184)	Family Wellness workshops + family PA sessions (targeting health behaviors: F/V intake, water consumption, PA, and sleep)	No intervention	zBMI; WC (child & parent); Parent BMI	In progress: estimated completion date: Sep 2016

Appendix F. Ongoing Studies

Author, Year Study Country	Aim	Participants (number of participants)	Intervention	Comparator	Relevant Outcomes	Status as of April 2016
Bean, 2014[314] Nourishing Our Understanding of Role modeling to Improve Support and Health +Motivational Interviewing (NOURISH +MI) United States	Investigate if a brief, motivational interviewing intervention improves retention and treatment adherence for parents enrolled in program for their overweight child	Parents aged ≥18 years with a child aged 5-11 years with BMI >85th percentile (n=NR)	Telephone and in person MI session prior to starting an 8 week parent-exclusive treatment focused on parenting skills to improve child's overweight	Received no MI sessions prior to starting 8 week parent-exclusive treatment focused on parenting skills to improve child's overweight	BMI	Currently recruiting participants
Boutelle, 2015[315] Intervention for Regulation of Cues (iROC) United States	Text extinction processes as a method of decreasing physiological and psychological responses to food cures in overweight children and those with obesity	Overweight children and those with obesity with BMI ≥ 85th percentile	Single or multiple context with consistent of enhanced partial reinforcement schedule (2x2 trials)	NA	Medical history, psychopathology (e.g., anxiety), physical activity, acceptability	Only protocol published
Christie, 2011[316] Healthy Eating and Lifestyle Programme (HELP) United Kingdom	Assess the efficacy of HELP in improving management of adolescent obesity	Adolescents aged 13-17 years with BMI >98th percentile (n=162)	MI and solution-focused approach, 12 sessions with families over 6 months	Enhanced standard care – only 1 session delivered	BMI, HR-QOL, cardiometabolic risk factors,	Completed, only protocol published
Cohen, 2013[317] McGill Youth Lifestyle Intervention for Food and Exercise (MYLIFE) Canada	Determine effects of family-centered lifestyle intervention focused on nutrient dense food intake plus total and weight-bearing physical activity on body composition in overweight children or those with obesity	Children aged 6-12 years who are overweight or have obesity, BMI >97th percentile (n=NR)	6 planning sessions based on TTM and TPB to increase intake of vegetables, fruits, and milk along with increased activity and less screen time	Usual care - no intervention delivered	BMI Z-score, anthropometric measures	Completed, only protocol published

Appendix F. Ongoing Studies

Author, Year Study Country	Aim	Participants (number of participants)	Intervention	Comparator	Relevant Outcomes	Status as of April 2016
Dalton, 2013[318] Parent-Led Activity and Nutrition (PLAN) United States	Develop and evaluate a parent-mediated approach utilizing physician's brief MI and parent group sessions to treat child overweight and obesity	Children aged 5-11 years, BMI ≥85th percentile (n=67)	10 week intervention with parents of children who were overweight or obese consisting of 2 individual MI sessions and 4 group sessions focused on providing the tools needed to make healthy changes in eating and physical activity using NIH We Can! Curriculum + copy of the NIH We Can! "Families Finding the Balance: A Parent Handbook"	Routine care + copy of the NIH We Can! "Families Finding the Balance: A Parent Handbook"	HR-QOL, BMI	Completed, only protocol and parental outcomes published
Danielsen, 2015[319] Family-based behavioral treatment of obesity – the FABO study Norway	Evaluate the effect of family-based behavioral weight loss treatment (FBBT) compared with the effect of today's standard treatmetnn geivn to children and adolescents suffering from obesity	Children and adolescents (8-16 years) with BMI ≥35, or BMI ≥30 with obesity related comorbidity (n=120)	Behavioral treatment sessions	Not specified	BMI, WC & body compositions; physiologic measures	Poster abstract presented 2015. No published results
Ek, 2015[320] The More & Less Study: A Trial Testing Different Treatment Approaches to Obesity in Preschoolers (M&L) Sweden	Evaluate the effectiveness of early treatment of childhood obesity with respect to treatment focus (parenting practices or lifestyle), length and intensity. Examine the influence of gender, age, parental weight status, parenting practices, child behavior as well as parents' socioeconomic status and child and parental psychosocial health on children's weight status.	Families with children aged 4–6 years with obesity as defined by the age and gender specific international cut-offs for BMI (n=180)	1) Parent group sessions (parenting practices + lifestyle coaching) or 2) Parent group sessions + booster sessions (phone calls)	Standard care	BMI; Parenting practices; child PA, diet, metabolic health; Parent and family functioning	In Progress: Recruitment 2012-2016; estimated completion date Mar 2017

Appendix F. Ongoing Studies

Author, Year Study Country	Aim	Participants (number of participants)	Intervention	Comparator	Relevant Outcomes	Status as of April 2016
Eneli, 2015[321] Feeding Dynamic Intervention (FDI) study for self-regulation of energy intake in preschoolers United States	Investigate the efficacy of the FDI for decreasing Eating in the Absence of Hunger (EAH) and improving energy compensation (COMPX).	Parent-reported child BMI ≥85th percentile (to be confirmed at the baseline visit) and child age 3–5. (n=84)	Group education: Lifestyle counseling + Feeding behaviors	No intervention (Wait-list)	Energy regulation; BMI	Competion date Jul 2015. No published results
Farpour-Lambert, 2012[322] Switzerland	Determine the effects of family-based behavioral therapy in a group or individual setting in children with obesity	Pre-pubertal children with obesity (n=75)	Family-based therapy group 1 session/week or 1 individual session/month for 6 months	No intervention	BMI z-score, blood pressure, glucose, cardio-respiratory fitness	Published meeting abstract only
Foster, 2015[323] A randomized clinical trial of the effects of parent mentors on early childhood obesity United States	Evaluate the effects of parent mentors trained to use a positive-deviance approach on early childhood obesity in a high-risk population of low-income Latino children in south Texas enrolled in Head Start	Children ages 2–5 at the time of enrollment who were obese (BMI ≥95th percentile for age and gender) (59)	Peer mentoring (parent) + community education meetings	Invitation to monthly community education meetings (separate from tx group)	zBMI; HRQoL; Screen time; sleep; play; feeding behaviors	Protocol published Nov 2015. No published results
Hage, 2013[324] France	Determine the effects of a 6-month physical training program on body composition in children with obesity	Children aged 7-11 years with obesity (n=37)	6 month physical training program where children engaged in exercise for 90 minutes twice a week	Did not participate in any kind of exercise	Weight, height, body composition	Published meeting abstract only
Hare, 2012[325] The Positive Lifestyles for Active Youngsters trial (Team PLAY) United States	Assess the efficacy of a 6-month, moderate intensity, primary care feasible, family-based behavioral intervention, targeting both young children and parents, in promoting healthy weight change	Children aged 4-7 who are overweight and have obesity with BMI ≥85th percentile (n=270)	14 1-hour group sessions focused on dietary, physical activity, and behavioral components. Parents attended co-occuring sessions based on SCT using the NIH We Can! curriculum	Routine care – no intervention	BMI z-score, cardiovascular function, anthropometric measures, body esteem	Completed, only protocol published

Appendix F. Ongoing Studies

Author, Year Study Country	Aim	Participants (number of participants)	Intervention	Comparator	Relevant Outcomes	Status as of April 2016
Hingle, 2015[326] The EPIC Kids Study: a randomized family focused YMCA-based intervention to prevent type 2 diabetes in at-risk youth United States	Develop and test a group-randomized family-centered community-based type 2 diabetes prevention intervention targeting at-risk children, 9- to 12-years-old.	9 to 12-years-olds that have a BMI ≥85th percentile for age and sex, AND have ≥1 T2D risk factors (n=60)	Group education sessions (adapted YMCA Diabetes Prevention Program) + mobile technology	Group education sessions (adapted YMCA Diabetes Prevention Program))	BMI; WC; PA; Diet; Cardiometabolic measures	Protocal Published. Estimated completion date: Hun 2016
Janicke, 2013[327] The Community-based Healthy-lifestyle Intervention for Rural Preschools (CHIRP) United States	Assess the effectiveness of a behavioral family weight management intervention among overweight children in underserved rural locations	Overweight children aged 3-6 years, BMI ≥85th percentile	12 family-based behavioral sessions addressing healthy habits and improved weight status	Waitlist control – no intervention	BMI z-score	Completed, only protocol published
Matthan, 2015[328] Effect of a Family Based Intervention on Biomarkers of Diet Quality/Endogenous Metabolism and BMI z-score United States	Assess how participation in a family-based weight management intervention affected biomarkers of diet quality/endogenous metabolism and cardiometabolic outcomes in children	Children aged 7-12 years with baseline BMI z-score (BMIz) >85th percentile (n=309)	Weekly lifestyle counseling sessions and follow up	Quarterly lifestyle counseling sessions + Educational material given	zBMI, dietary metabolism biomarkers	Poster Abstract published Mar 2015. No additional published results
McGavock, 2014[329] Physical Activity for Overweight Youth at Risk for Type 2 Diabtes Mellitus (POWER) Canada	Assess effectiveness of high intensity exercise training in reducing risk factors for type 2 diabetes compared to moderate intensity exercise training in overweight adolescents	Sedentary adolescents aged 13-19 years who are overweight and have obesity (n=120)	High- or moderate-intensity exercise training at local YMCA 3 days a week for 6 months	No intervention	BMI z-score	Completed, published meeting abstracts only

Appendix F. Ongoing Studies

Author, Year Study Country	Aim	Participants (number of participants)	Intervention	Comparator	Relevant Outcomes	Status as of April 2016
Moore, 2013[330] Ideas Moving Parents and Adolescents to Change Together (IMPACT) United States	Compare the effects of three distinct behavioral obesity management interventions on BMI in middle school, urban youth who are overweight or have obesity	Children with BMI ≥85th percentile entering 6th grade (target: n=360)	2 distinct behavioral interventions; SystemCHANGE focused on system redesign of family environment and routine, and HealthyCHANGE focused on cognitive behavioral motivational interviewing techniques	Attention Control – Tools4change focused on diet and physical activity counseling	BMI	Protocol published, study recruiting participants
Onnerfalt, 2012[331] Lund Overweight and Obesity Preschool study (LOOP) Sweden	Evaluate effects of family-based intervention program for parents of pre-school children who are overweight or have obesity	Children aged 4-6 years who are overweight and have obesity (target: n=260)	Behavioral interventions using internet-based information and communication tool "Sundabarn.se" in conjunction with either parent-targeted, psychologist-led seminars focused on tools to change family patterns or lifestyle, OR parent-targeted group treatment led by occupational therapist focused on daily life patterns alterations	No Intervention	BMI z-score	Protocol published, study recruiting participants
Polacsek, 2009[332] Keep ME Healthy – The Maine Youth Overweight Collaborative (MYOC) United States	Evaluate the effect of a pediatric primary-care based intervention on improved clinical decision support and family management of risk behaviors for childhood overweight	Youth aged 5-18 years	Family and patient counseling using motivational interviewing techniques to promote 5-2-1-0 behavioral goals	No intervention	BMI	Completed, only protocol and preliminary findings published

Appendix F. Ongoing Studies

Author, Year Study Country	Aim	Participants (number of participants)	Intervention	Comparator	Relevant Outcomes	Status as of April 2016
Raben, 2015[333] PREVIEW: Prevention of diabetes through lifestyle intervention and population studies in Europe andaround the world International	To identify the most efficient lifestyle pattern for the prevention of type-2 diabetes in a population of pre-diabetic overweight and obese individuals. Six year project involving 15 partners from Europe, Australia, Canada, and New Zealand	RCT with up to 2,500 participants as well as large population studies in about 170,000 individuals across all age groups	(1) impact of a high-protein, low-glycemic index diet *in combination with* (2) moderate or high intensity physical activity	(1) high-carbohydrate, medium-glycemic index diet *in combination with* (2) moderate or high intensity physical activity	Not described (incidence of type-2 diabetes and related end-points)	Poster abstract presented 2015. No published results. Estimated completion date 2018
Robertson, 2013[334] Families for Health V2 United Kingdom	Assess the effectiveness of the Families for Health program in reducing BMI z-score in children who are overweight or have obesity	Children aged 6-11 years who are overweight or have obesity, BMI ≥91st percentile	Family-based group delivered program combining information on parenting skills, social and emotional development , as well as lifestyle change based on the Nurturing Programme from Family Links	No intervention – usual care	BMI z-score	Completed, only protocol published
Sherwood, 2013[335] Healthy Homes/Healthy Kids (HHHK 5-10) United States	Evaluate the efficacy of low cost pediatric primary-care based obesity prevention intervention	Children aged 5-10 years with BMI between 70th and 95th percentiles	Brief pediatrician counseling based on SCT and motivational interviewing as well as phone counseling for parents of overweight children	Contact control group	BMI percentile change	Completed, only protocol published
Sousa, 2014[336] Next.Step Portugal	Determine effectiveness of an e-therapeutic intervention program on behavior change and health impact	Adolescents aged 12-18 years with obesity , BMI ≥95th percentile	POC standard treatment protocol including behavioral counseling combined with access to internet-based e-therapeutic platform with resources, self-monitoring, social support, interactive training modules, and motivational tools	POC standard treatment protocol – initial evaluation session with pediatrician and one session with a nutritionist and exercise physiologist	BMI	Protocol published

Appendix F. Ongoing Studies

Author, Year Study Country	Aim	Participants (number of participants)	Intervention	Comparator	Relevant Outcomes	Status as of April 2016
Stoner, 2013[337] Combating Obesity in Maori and Pasifika Adolescent School-Children Study (COMPASS) New Zealand	Investigate efficacy of culturally-sensitive, non-contact, boxing-oriented training program on obesity in Maori and Pasifika adolescents	Male and female Maori and Pasifika adolescents aged 14-16 years with obesity (BMI >95th percentile)	6-month theory-based program conducted 3 times per week in culturally appropriate setting, each session included 40 min boxing-oriented training and 20 min resistance training	Control group – wait list	BMI	Protocol published
Taveras, 2015[338] Connect for Health: clinical-community childhood obesity intervention testing best practices of positive outliers United States	Assess whether a novel approach to care delivery that leverages clinical and community resources and addresses socio-contextual factors will improve BMI and family-centered, obesity-related outcomes of interest to parents and children	2–12 year old children with overweight or obesity (BMI ≥85th percentile) (n=721)	Tailored health coaching, community resources, & interactive text messaging program	Enhanced primary care (best-practice) + non-tailored health coaching	BMI, zBMI, QoL; Behavioral: PA, screentime, sleep, diet. Pediatric obesity care quality, effectiveness, and family-centeredness	Estimated completion date Nov 2016
van der Aa, 2014[276] METFORMIN The Netherlands	Assess effectiveness of adding metformin treatment to lifestyle intervention in reducing BMI in adolescents with obesity	Children aged 10-16 years defined as having obesity (BMI-SDS ≥3.4)	Metformin + lifestyle intervention	Placebo + lifestyle intervention	BMI	Study recruiting, only protocol published
Willeboordse, 2013[339] Multifactorial intervention for children with asthma and overweight (Mikado) The Netherlands	Evaluate the effectiveness of long-term multifactorial weight reduction intervention on asthma in children with asthma and high body weight	Children aged 6-16 years with asthma diagnosis and BMI indicating overweight/obese	Multifaceted intervention based on theoretical health counseling model including physical exercise, nutrition counseling, and behavioral intervention in the form of group and individual sessions, and parental sessions	No intervention – usual care	BMI	Completed, only protocol published

Abbreviations: BMI = body mass index; HR-QOL = helath-related quality of life; MI = motivational interviewing; min = minute(s); NIH = National Institutes of Health; SCT = social cognitive theory; SDS = standardized deviation score; POC = point of care; TPB = theory of planned behavior; TTM = transtheoretical model; YMCA = Young Men's Christian Association.