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Lifestyle Interventions in the Treatment of Childhood Overweight: A Meta-Analytic Review of Randomized Controlled Trials

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Abstract

Context—Identifying and evaluating efficacious treatments for pediatric weight loss is of critical importance.

Objective—This quantitative review represents the first meta-analysis of the efficacy of randomized controlled trials comparing lifestyle interventions to control conditions.

Data Sources—MEDLINE, PsychINFO, and Cochrane Controlled Trials Register were searched up to August 2005.

Study Selection—Eligible studies were randomized controlled trials involving lifestyle interventions for pediatric overweight that had as a comparison either a no-treatment or information/education-only control. The primary outcome of interest was change in weight status. Fourteen trials were eligible, resulting in 19 effect sizes.

Data Extraction—Information on study design, participant characteristics, interventions, and results were extracted using a standardized coding protocol.

Data Synthesis—For trials with no-treatment controls, the mean effect size was 0.75 ($k=9$, 95% CI 0.52 to 0.98) at end of treatment and 0.60 ($k=4$, CI 0.27 to 0.94) at follow-up. For trials with information/education only controls, the mean effect size was 0.48 ($k=4$, CI 0.13 to 0.82) at end of treatment and 0.91 ($k=2$, CI 0.32 to 1.50) at follow-up. No significant moderator effects were identified.

Conclusions—Lifestyle interventions for the treatment of pediatric overweight are efficacious in the short-term with some evidence for persistence of effects. Future research is required to identify moderators and mediators of outcome and to determine the optimal length and intensity of treatment required to produce enduring changes in weight status.

Keywords

overweight; youth; lifestyle treatment; meta-analysis

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Overweight in children has increased dramatically over the past two decades (Dietz & Robinson, 2005; Hedley et al., 2004; Morgan, Tanofsky-Kraff, Wilfley, & Yanovski, 2002). This increase is alarming because childhood overweight is associated with serious medical and psychosocial problems that can persist into adulthood (Dietz, 1998; Ebbeling, Pawlak, & Ludwig, 2002; Fairburn et al., 1998; Hayden-Wade et al., 2005; Striegel-Moore et al., 2005). Fortunately, weight-loss treatments for overweight youth have been associated with significant health benefits (Faith, Saelens, Wilfley, & Allison, 2001; Tanofsky-Kraff, Hayden-Wade, Cavazos, & Wilfley, 2003), increased physical fitness (Epstein & Goldfield, 1999) and psychosocial benefits such as reduced risk for the development of eating disorders (Braet & Van Winckel, 2000; Epstein et al., 2001).

While reports of treatment efficacy from clinical trials and qualitative reviews can guide clinical decision-making (Daniels, 2001; Dietz & Robinson, 2005; Edmunds, Waters, & Elliott, 2001; Epstein, Myers, Raynor, & Saelens, 1998; Goldfield, Raynor, & Epstein, 2002; Jelalian & Saelens, 1999; Kaur, Hyder, & Poston, 2003; Kirk, Scott, & Daniels, 2005; Whitlock, Williams, Gold, Smith, & Shipman, 2005; Yanovski, 2001), meta-analytic reviews allow for an objective assessment of the overall magnitude of treatment effects across a number of tests of treatment efficacy (Cooper, 1998). Currently, there are only three such meta-analyses to guide treatment recommendations: 1) Haddock, Shadish, Klesges, & Stein's (1994) meta-analytic review of behavioral treatments (treatments containing dietary, exercise, and/or behavioral modification components), 2) Epstein and Goldfield's (1999) meta-analysis of physical activity in the treatment of pediatric overweight, and 3) Collins, Warren, Neve, McCoy, and Stokes' (2006) meta-analysis of dietetic interventions in the treatment of pediatric overweight. There have also been two recent, qualitative reviews of randomized controlled trials (RCTs) that examined the effects of lifestyle interventions on the treatment of pediatric overweight (Summerbell et al., 2003; Whitlock et al., 2005). These authors raised two objections to a meta-analytic approach: (1) insufficient numbers of applicable studies resulting in small sample sizes and (2) lack of standardization, both in specific treatment components or combinations of treatment components included in lifestyle interventions and in the outcome measures reported across studies.

In order to address these objections, we defined "active" treatment as a lifestyle intervention involving any combination of diet, physical activity, and/or behavioral treatment recommendations. Similar to the approach used by Haddock et al. (1994), we then only included studies that compared the active treatment to either a wait-list/no-treatment or information/education-only control. While this approach has the advantage of allowing for meta-analytic review, it excluded widely cited studies that compare active treatments to each other (i.e., Epstein, Wing, Koeske, Andrasik, & Ossip, 1981; Epstein, Valoski, Wing, & McCurley, 1990). This approach also excluded pharmacological and surgical treatments since no RCTs have evaluated surgical interventions (see Inge, Zeller, Lawson, & Daniels, 2005; Strauss, Bradley, & Brolin, 2001 for qualitative reviews of surgical interventions) and only a few have evaluated pharmacological approaches with children or adolescents (see Daniels, 2001 for a review of studies of pharmacological treatments of overweight youth). Secondly, we limited our review to RCTs, considered to be the "gold standard" for research design. This is different than the approach taken by Haddock et al., which included quasi-experimental designs.

Our primary aim was to use meta-analytic techniques to quantitatively evaluate the efficacy of lifestyle interventions in the treatment of pediatric overweight by comparing lifestyle interventions to wait-list/no-treatment control groups or information/education-only control groups. Secondary aims were to examine variables that potentially moderated treatment outcome (e.g., age, sex, duration of treatment, and number of intervention components).

Methods

Literature Search Strategy

An extensive literature search was conducted in Cochrane Controlled Trials Register, MEDLINE, and PsycINFO from the first available year to August 2005. Searches included variations on the words “overweight” and “treatment” and related terms and were limited to pediatric and adolescent populations. In addition, the reference lists from recent major reviews on childhood overweight were used to identify articles.

Study Inclusion Criteria and Selection

Each study selected for inclusion was an RCT of lifestyle interventions focused on weight-loss or weight-control for youth age 19 or younger that compared an active treatment to either a wait-list/no-treatment control or to an information/education-only control. Additional inclusion criteria were: study results reported in English; treatment duration of at least four weeks; and participants overweight at baseline (defined differently across studies).

Data Extraction

A coding document was developed for data extraction and analysis purposes. Two uniformly trained and supervised reviewers coded all studies for intervention and statistical information; all of the intervention and outcome data were compared for consistency and resolved to 100% agreement. Reviewers resolved discrepancies through consultation and consensus with study authors.

Statistical Analysis

Effect size calculations.—Effect sizes (ES) were computed as *d*-indices and expressed the difference in outcome between youth who participated in an intervention and a comparison group of youth who participated in a wait-list control or information/education-only control group, with positive values indicating a better outcome for the intervention group. The *d*-indices were calculated from the means and standard deviations of the change scores (i.e., the difference between baseline and end of treatment or follow-up time points). When the standard deviation of the change score was not reported, either the pooled standard deviation at baseline or the endpoint means and standard deviations were used. When summary statistics were not reported, formulas provided by Rosenthal (1994) were used to estimate *d*-indices from the significance levels of statistical tests (Shadish & Haddock, 1994). The practical relevance of effect sizes are described in terms of the AUC statistic, which indicates the percentage of participants in the control group who score lower than the average participant in the treatment group (Cohen, 1988).

Effect sizes were corrected for small sample bias by transforming the standardized mean difference, *d*, to Hedges' *g* prior to analysis (Lipsey & Wilson, 2001). In addition, each effect size was weighted by the inverse of its variance to provide for a more efficient estimation of true population effects (Hedges & Olkin, 1985). This procedure gives greater weight to larger samples and is the generally preferred alternative (Cooper, 1998). Effect sizes were analyzed using both a fixed-effects and a random-effects model.

Selection of effect sizes.—Although multiple measures of weight-loss were reported in some studies, we estimated each effect using only one measure, in descending order of priority, as follows: (1) percent overweight, (2) z-BMI, (3) BMI, and (4) weight. The advantage of estimating effects using percent overweight, z-BMI, and BMI is that these outcome measures are appropriate for use with a pediatric sample since they adjust for changes in children's height. Weight was selected as a potential outcome only when it was the sole outcome reported.

Finally, some studies contributed multiple effect sizes based on comparisons between two different interventions and the same control group. For example, a study may have compared the effects of a dietary intervention and an exercise intervention with a common control group. In such a case, separate effect sizes were calculated for each treatment-control comparison; effects measured at the same time point were averaged prior to entry into the analysis.

Moderator analyses.—In our analyses, the omnibus homogeneity test (Q) was employed to test for significant inter-study variation. Moderators were examined using an omnibus test of between-group differences in mean effects (Qb) (Cooper & Hedges, 1994).

Summary of meta-analytic data analyses.—Data analyses were conducted using SAS (Cooper & Hedges, 1994; Wang & Bushman, 1999). Analyses included: (a) calculation of weighted effect sizes and 95% confidence intervals under assumptions of a fixed effects and random effects model; (b) use of homogeneity analysis to test for possible moderation of effect sizes, and (c) examination of potential moderators where indicated.

Results

Study Demographics & Treatment Components

A total of 1,456 journal articles were identified in the literature as potentially relevant. Of these, 14 studies were used in the present meta-analysis (see Figure 1). See Table 1 for a summary of the characteristics of each of the RCTs included in this review. The average age of participants was 11.5 years (range 2 to 19 years). Seven studies included both children (defined as 12 years of age or younger) and adolescents (defined as 13 years of age or older). Of the studies including both children and adolescents, 3 had mean ages in the adolescent range and 4 had mean ages in the child range. Six studies included *only* children 12 years of age or younger, and one study reported mean ages for their participants but did not provide the age ranges. The percentage of male subjects in each study ranged from 0 to 66% with an average of 34.8% males. Treatment duration ranged from 9 weeks to 77 weeks, and participants in active treatments received an average of 18.3 sessions ($SD = 18.1$; range 8 to 87 sessions), while participants in the information/education-only conditions received an average of 3.6 sessions ($SD = 6.4$; range 0 to 16 sessions). Timing of follow-up assessments varied from one month post-treatment to five years post-treatment. Attrition rates for the overall sample ranged from 5% to 46%, with an average attrition rate of 19.7%.

Overall Effects

Effect sizes.—The 14 RCTs included in this review contributed 29 separate effect sizes. After averaging effect sizes across multiple intervention groups as described previously, 19 separate effect sizes remained, with 13 effect sizes based on comparisons at the end of treatment and 6 effect sizes from a follow-up time point. The total number of participants reported across treatment and control groups for all studies, and for whom data was available at the end of treatment, was 527. Within the 19 independent samples, the average sample size per study was 35.2 participants ($SD = 20.6$; range 8 to 74). Prior to the main analyses, all effect sizes were coded as to type of control group (i.e., wait-list only control or information/education-only control) and assessment time point (i.e., “end of treatment” or “follow-up”). No studies reported multiple follow-up time points. Effect sizes and confidence intervals are provided for each study by type of control and assessment time point (see Figure 2 and Table 2).

Wait-list control comparisons.—There were 9 effect sizes for studies with wait-list control comparisons with an end of treatment time point (WAIT-I), and 4 effect sizes for wait-list control and follow-up time points (WAIT-F). For comparisons involving a lifestyle intervention and a control condition in which no intervention was delivered, the weighted mean

effect sizes within a fixed-effects model at both end of treatment ($g = .75$; $p < .001$) and follow-up ($g = .60$; $p < .001$) were significantly different from zero, indicating positive effects of the lifestyle interventions on weight outcomes (see Table 3). A similar pattern of results existed within a random-effects model. In addition, the effect size at the end of treatment suggests that children at the mean of the treatment distribution in the intervention group showed greater improvement than about 78% of those in the control group. The effect size at follow-up (mean = 15 months; range 1 to 60 months) suggests that children at the mean of the treatment distribution in the treatment group showed greater improvement than about 73% of those in the control group.

Information/education-only control comparisons.—There were 4 effect sizes for studies with an information/education-only control group with an end of treatment time point (INFO-I), and 2 effect sizes for information/education-only control and follow-up time points (INFO-F). The weighted mean effect sizes within a fixed-effect model at both end of treatment ($g = .48$; $p < .01$) and follow-up ($g = .91$; $p < .01$) were significant, indicating positive effects of the lifestyle treatments on weight outcomes (see Table 3). A similar pattern of results existed within a random-effects model. The effect size at the end of treatment suggests that children at the mean of the treatment distribution in the intervention group had a better outcome than about 68% of those in the control group, and the effect size at the follow-up time point suggests that children at the mean of the treatment distribution in the intervention group had a better outcome than about 82% of those in the control group at follow-up.

Homogeneity Analyses and Moderators

Examination of univariate effects.—Results suggest that the effect sizes are homogenous (see Table 3). Sufficient data and variability existed for the examination of moderators (i.e., age, treatment length, number of sessions, sample size, gender, effect size formula, type of weight outcome, number of components) within the subset of data comparing a lifestyle intervention and a wait-list control at the end of treatment. No significant effects were found.

Comparison of wait-list control to information/education-only controls.—A further analysis tested for a potential difference between the wait-list control group effect size and the information/education-only control group effect size at the two time points. No significant difference was revealed at the end of treatment, $Q(1, k = 13) = 1.69$, ns, or at the long-term follow-up time point, $Q(1, k = 6) = 0.77$, ns.

Comparison of results from the end of treatment and from the follow-up assessment.—Within the wait-list control group, no significant difference was found between the end of treatment and the follow-up assessment, $Q(1, k = 13) = .50$. Similarly, no difference was found within the information/education-only group, $Q(1, k = 6) = 1.53$. For those studies that had both an end of treatment time point and a follow-up assessment time point, the end of treatment time point was removed, and the analyses were re-run to eliminate any effect of nested data. No significant effects were found. The effect of time also was examined as a continuous variable, using both the actual number of weeks during which the assessment was conducted and a variable for time, transformed to the natural logarithm. No significant effects were identified.

Exploratory Examination of Time and Length of Treatment/Follow-up

To examine the relationship between time and treatment length, as well as the relationship between time and length of follow-up, the effect sizes of the studies were plotted as a function of time from baseline. The results are shown in Figure 3, with lines showing a trend towards larger effect sizes associated with longer treatment periods and for decreasing effect sizes as follow-up moves further from baseline. Johnson et al.'s (1997) five-year follow-up time point

and Aragona et al.'s (1975) two large effect sizes were excluded as outliers from this figure. Their exclusion did not qualitatively affect the trend lines.

Discussion

The present meta-analysis found that lifestyle interventions produced significant treatment effects when compared to no-treatment wait-list control groups. These effects were evident both immediately following treatment and at follow-up. Studies comparing lifestyle interventions to information/education-only control groups also resulted in significant immediate and long-term post-treatment effects. For the eight RCTs that used percent overweight as an outcome measure, the resulting decreases in percent overweight, 8.2% and 8.9% respectively, were consistent with the 5–20% decrease in percent overweight reported in other qualitative reviews (Goldfield et al., 2002; Jelalian & Saelens, 1999). Without treatment, there was a 2.1% increase in percent overweight immediately following treatment and a 2.7% increase in percent overweight at the follow-up time point. Therefore, the average participant receiving no treatment or information/education-only can be expected to continue to gain weight. The results of the present meta-analysis provide clinicians with encouragement to offer lifestyle interventions to overweight youth even if only modest weight changes or maintenance result from their efforts.

Although treatment effect sizes for the studies included in this review remained significant at follow-up time points, there was a decline in the magnitude of the effects over time for the wait-list/no-treatment comparison groups. This observation, based on a very limited sample, is consistent with the conclusion reached by Epstein et al. (1998) in their qualitative review of the pediatric weight loss treatment literature. However, conclusions regarding the maintenance of weight loss or the decay of treatment effects over time must be approached with caution because of the paucity of follow-up data and the variation among studies in the follow-up time points employed. Analyses of the effect sizes at follow-up were based on a small number of RCTs with wait-list/no-treatment control comparison groups ($k=4$) and an even smaller number of RCTs with information/education-only control groups ($k=2$). In addition, only three of the RCTs reported follow-up outcomes from time points of 12 months or more from baseline.

While effect size has become the standard metric for comparison of treatments across studies, there are limitations to using effect sizes as the only piece of data to compare treatments. Effect sizes are based on the magnitude of change and the variability in treatment response (Epstein, Paluch, Roemmich, & Beecher, in press). One concern occurs when two treatments have equivalent magnitudes of response but differ markedly in their variability. Another challenging issue occurs when evaluating a treatment study in which the effect sizes are equal, but the magnitude of change and variability is greater for one treatment. Thus, some families given the treatment associated with a larger magnitude would show a greater treatment effect, but the response would be more variable. An interesting area for future study is how clinicians and clinical investigators use effect sizes, variability, and treatment comparisons to identify which treatment to recommend to families with obesity. As the benefits of specific treatments for pediatric obesity are identified, evaluating how clinicians advise families' choices may become increasingly important.

In these analyses there was a limited role for moderators, but this may be in part due to a general homogeneity in methods and study participants (e.g., the majority of the studies were conducted with pre-adolescents, were multi-component interventions, and involved parents). However, potential moderators of treatment effects have been identified in other studies. Age has been associated with weight loss success in the inpatient treatment setting (Braet, 2006). In addition, recent studies have shown that parental weight loss is a consistent predictor of child weight loss (e.g., Golan & Crow, 2004; Wrotniak, Epstein, Paluch, & Roemmich, 2004,

2005;Wrotniak, Epstein, Roemmich, Paluch, & Yak, 2005). It is likely that parental modeling of healthy behaviors and positive changes in the shared home environment are potent contributors to the success of weight loss interventions with children. Therefore, further research is warranted to explore how parental involvement interacts with other variables such as participant age or gender and how participant variables such as age, extreme overweight, co-morbid conditions, or ethnicity influence either the magnitude or variability of treatment response.

In addition to determining the relationship of treatment components to efficacy, researchers and clinicians have studied the degree to which duration or dose is related to outcome (e.g., Barkham et al., 2006). Although treatment length was not a significant moderator of treatment effects in the present review, a trend toward more powerful effects with longer treatments was observed (see Figure 3). For adults, extended and “continuous care” approaches have led to better weight loss maintenance for several years (Perri, 1998;Perri & Corsica, 2002), with meaningful benefits in the management or prevention of diabetes and hypertension (e.g., Knowler et al., 2002;Whelton et al., 1998). The optimal level of treatment contact and duration for pediatric populations has yet to be established.

Since the focus of the present review was limited to the impact of lifestyle interventions on weight outcomes, we may have underestimated the breadth of the effectiveness of lifestyle interventions. In addition, despite restricting our meta-analysis to RCT’s, insufficiencies in reporting of the design, implementation, and analysis of studies were present. For example, in most of the studies included in this meta-analysis, both confidence intervals and effect sizes were not reported, making it difficult for treatment providers to determine the clinical significance of any non-statistically significant results. In addition, all of the included studies conducted completer analyses rather than intent-to-treat analyses that can result in larger effect sizes. Moreover, patient and study demographic features such as ethnicity, socioeconomic status, location, and setting of treatment were infrequently reported; such omissions can make it difficult to generalize results to other treatment settings or populations. Adverse effects and treatment preferences were not routinely reported in studies of lifestyle interventions for weight loss, making it difficult to empirically compare the safety and acceptability of lifestyle interventions to other interventions. An additional limitation of the present review was the reliance on published, English language articles, allowing for the possibility of publication bias.

Taking the above limitations into consideration, the following recommendations for future pediatric weight loss studies are made. The first is to adopt standard guidelines for sufficient follow-up assessment time points at one-year post-randomization and also, ideally, at 24 months post-randomization. This standard would allow for a meaningful evaluation of the effects of weight loss interventions over time. Furthermore, it would aid in empirically determining when post-treatment changes in weight may begin to diminish and what treatment approaches or patient variables protect against decays in treatment efficacy over time. Second, we recommend that studies of pediatric weight loss use measures that take into account changes in height since the measurement of weight outcomes in pediatric populations is complicated by the fact that weight naturally changes as a child grows. Third, we recommend increased attention to the analysis and reporting of results that would improve the meaningfulness of research findings to clinicians. More complete information regarding participant characteristics such as ethnicity and SES as well as the inclusion of effect sizes and the use of intent-to-treat analyses would not only satisfy the increasingly rigorous reporting recommendations of major journals (Moher et al., 2001;Stone, 2003), but most importantly would allow clinicians to make more informed decisions regarding which treatments are most likely to be efficacious with their patient populations under what circumstances (Glasgow et al., 2006).

In conclusion, this meta-analytic review demonstrated that lifestyle interventions for the treatment of pediatric overweight produce significant and clinically meaningful changes in weight status in the short-term as compared to wait-list/information-only controls. In addition, there are encouraging results regarding the persistence of effects in the long-term. Still, much work remains to determine the optimal length and intensity of treatment required to produce enduring changes in weight status. Future research needs to identify the components or types of treatments that achieve the most comprehensive and persistent effects as well as those participant characteristics that are related to long-term success in pediatric obesity weight loss programs. Most of the studies reviewed targeted children 6–13 years of age; therefore future research should strive to evaluate lifestyle interventions in the treatment of overweight adolescents as well as the prevention or treatment of overweight in very young children. In addition to the impact of lifestyle interventions on weight status, future research is necessary to determine the breadth of lifestyle treatment effects across other indices of health and psychosocial functioning by, for instance, evaluating the efficacy of lifestyle interventions for the needs of children with co-morbid medical conditions, such as type 2 diabetes (Zeitler et al, in press). Finally, identifying methods for dissemination of lifestyle interventions into routine clinical practice and primary care settings is of the utmost importance given the epidemic proportions of children suffering from pediatric overweight.

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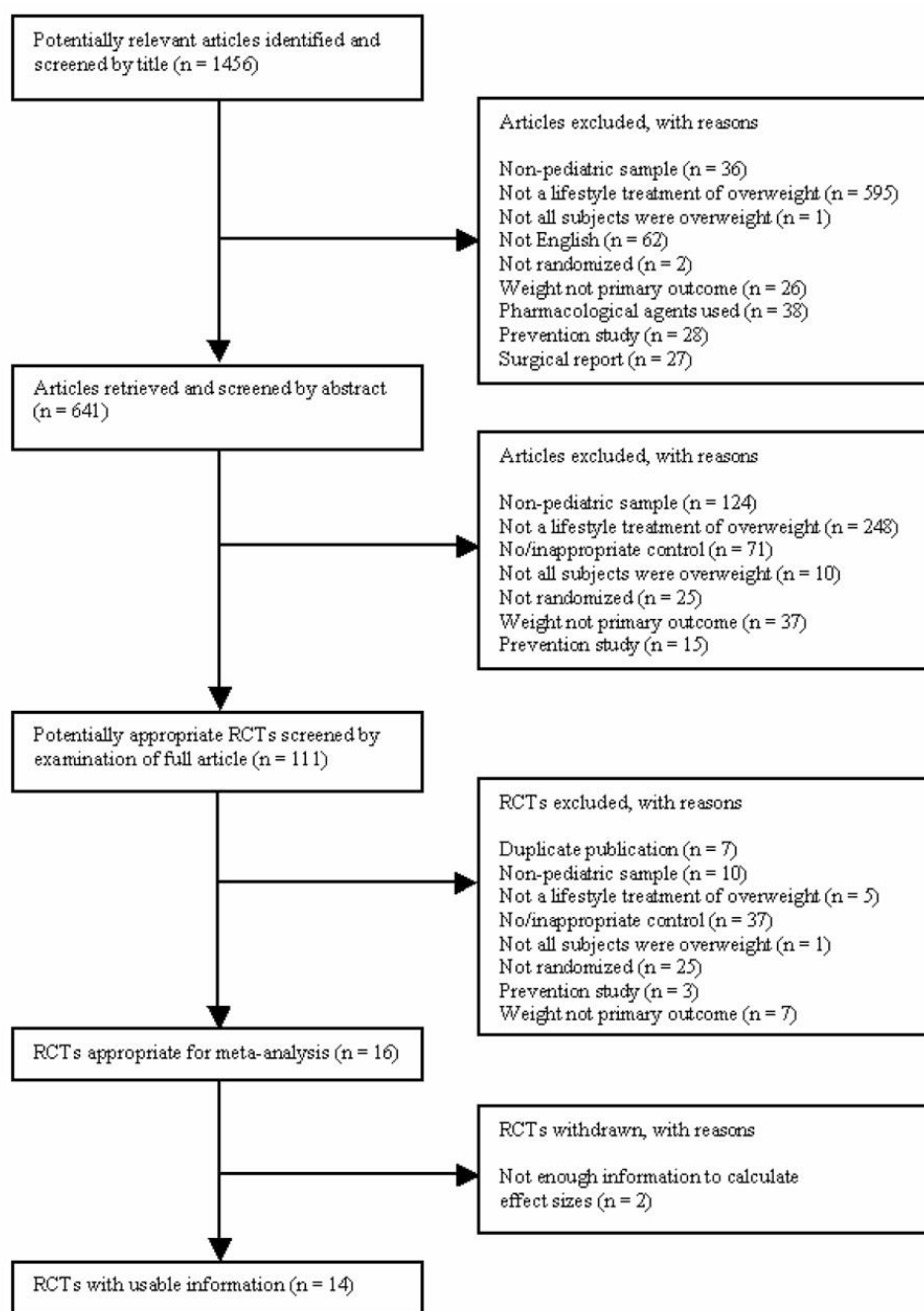
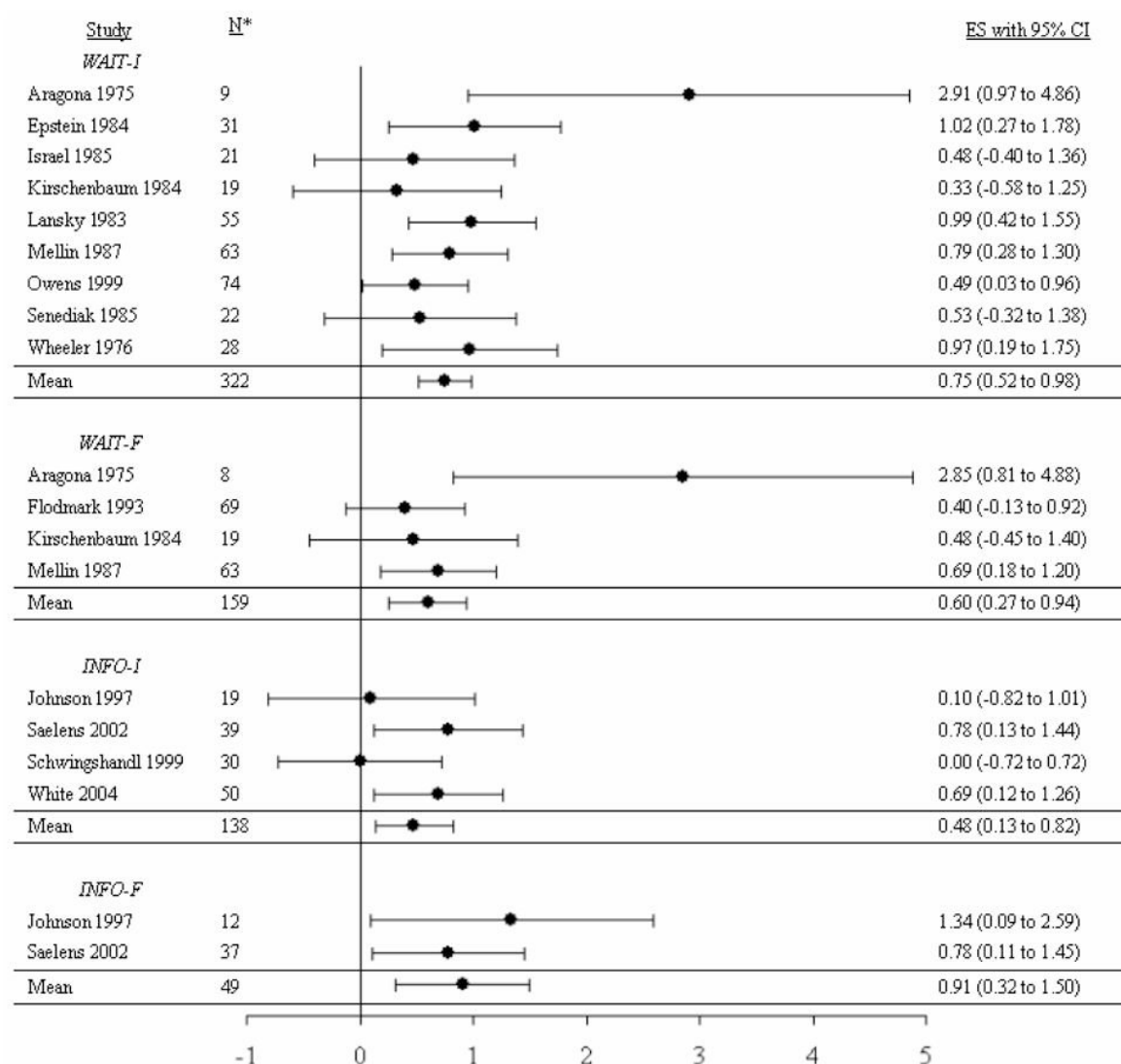


Figure 1. Flow of studies into the review of randomized controlled trials of the effectiveness of lifestyle interventions for pediatric overweight.



* N values based on N at the time of assessment, with n values from treatment groups averaged in cases of studies with multiple interventions.

WAIT-I = Active behavioral intervention compared to a wait-list or no-treatment control immediately following the end of treatment; WAIT-F =

Active behavioral intervention compared to a wait-list or no-treatment control, follow-up effects; INFO-I = Active behavioral intervention

compared to an education/information-only control immediately following the end of treatment; INFO-F = Active behavioral intervention

compared to an education/information-only control, follow-up effects.

Figure 2.
Study-specific and weighted mean effect sizes and confidence intervals, categorized by comparison group.

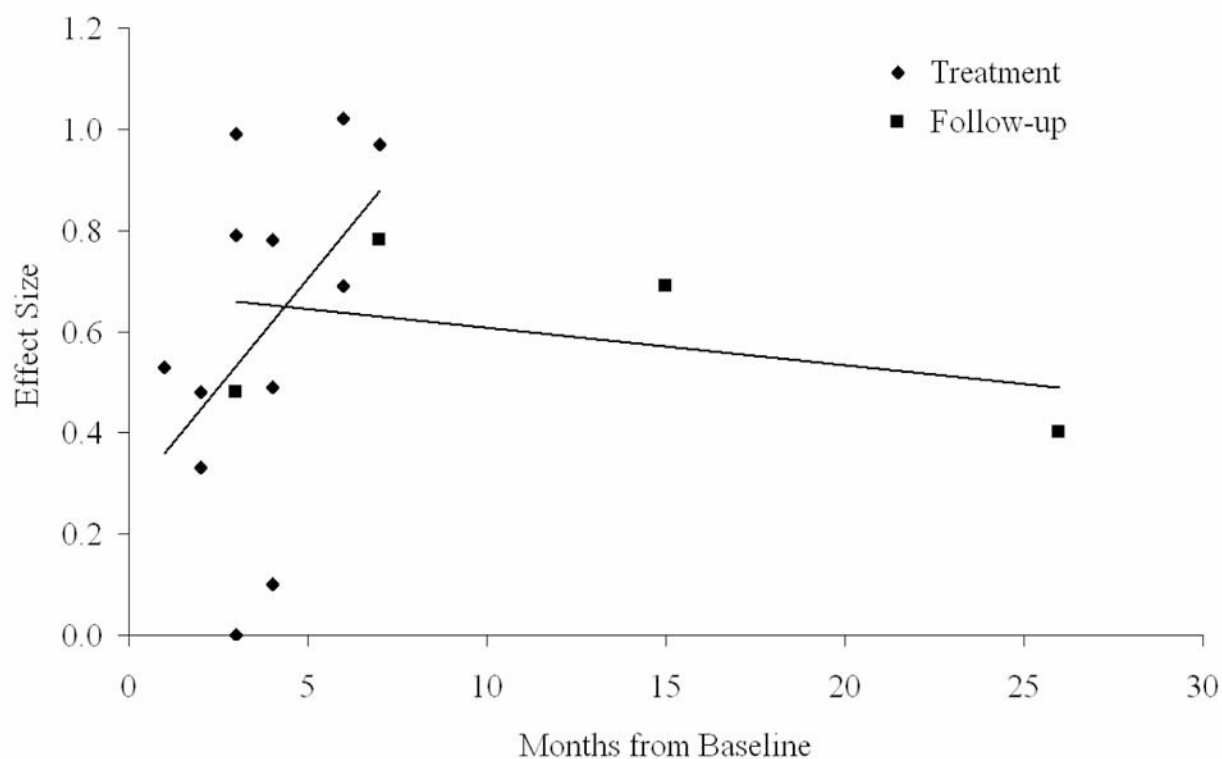


Figure 3. Effect sizes plotted by time, showing an increasing trend for treatment time points and a decreasing trend for follow-up time points.

Table 1

Characteristics of controlled studies examining interventions for pediatric overweight.

Study	Age, Mean (Range)	Groups	N ^a	Attrition Rate	Percent Male	Percent Caucasian	Dose	Interventionist	Treatment Length	Weight Criteria
Aragona, Cassidy, & Drabman 1975	8.6 (5–10)	1. Diet, exercise, parent involvement, reinforcement, stimulus control, self-monitoring	5	20%	0%	Not reported	Weekly group sessions	Not reported	12 weeks	“Overweight”
		2. Diet, exercise, parent involvement, stimulus control, self-monitoring	5							
		3. No-treatment control	5							
Epstein et al. 1984	10.4 (8–12)	1. Diet, parent involvement, reinforcement, stimulus control, self-monitoring	18	5%	Not reported	Not reported	8 weekly group sessions, 4 biweekly, 4 monthly	Therapist	6 months	20–80% overweight for height, age, and sex
		2. Traffic light diet, lifestyle exercise, parent involvement, reinforcement, stimulus control, self-monitoring	18							
		3. Waitlist control	17							
Flodmark et al. 1993	10–11	1. Diet, exercise	19	11%	45%	Not reported	5 family dietary counseling sessions	Dietitian; therapist; pediatrician	14–18 months	BMI greater than 23
		2. Diet, exercise, 6 family therapy sessions	25							
Israel, Stolmaker, & Andrian 1985	10.6 (8–12)	3. No-treatment control	50							
		1. Diet, exercise, reinforcement, stimulus control, self-monitoring	12	40%	Not reported	Not reported	90 minute group sessions weekly	Graduate and undergraduate Psychology students	9 weeks, plus 12 months fading contact	Greater than 20% overweight
		2. Diet, exercise, reinforcement, 2 parent sessions, stimulus control, self-monitoring	12							
Johnson et al. 1997	11.0 (8–17)	3. Waitlist control	9							
		1. 7 week traffic light diet, then 7 weeks exercise intervention, reinforcement, parent involvement	11	13%	28%	Not reported	90 minute group sessions weekly, control group matched for contact	Not reported	16 weeks	Greater than 20% overweight
		2. 7 week exercise, then 7 weeks traffic light diet intervention, reinforcement, parent involvement	11							
Kirschenbaum, Harris, & Tomarken 1984	10.7 (9–13)	3. Information control	10							
		1. Diet, exercise, parent involvement, reinforcement, stimulus control, self-monitoring	16	25%	23%	Not reported	90 minute group sessions weekly for (1) family or (2) child-only	Graduate and undergraduate Psychology students	9 weeks	Greater than 20% overweight
		2. Diet, exercise, parent involvement, reinforcement, stimulus control, self-monitoring	15							
Lansky & Vance 1983	13.1	3. Waitlist control	9							
		1. Diet, exercise, parent involvement, reinforcement, stimulus control, self-monitoring	30	Not reported	45%	Not reported	45 minute child- only group sessions weekly	Physical education instructor	12 weeks	Greater than or equal to 10% overweight
		2. No-treatment control	25							
Mellin, Slinkard, & Irwin 1987	15.6 (12–18)	1. Diet, exercise, parent involvement	37	16%	21%	88%	90 minute group sessions weekly	Nutritionists; dietitians	14 weeks, 2 parent sessions	“Obese”
		2. Waitlist control	29							
		1. Exercise, reinforcement	40	13%	33%	80%	40 minute child- only group sessions 5 days per week	Not reported	16 weeks	Triceps skinfold greater than 85 th percentile for

Study	Age, Mean (Range)	Groups	N ^a	Attrition Rate	Percent Male	Percent Caucasian	Dose	Interventionist	Treatment Length	Weight Criteria
Saelens et al. 2002	14.2 (12–16)	2. No-treatment control 1. Diet, exercise, parent involvement, reinforcement, stimulus control, self-monitoring	39 23	16%	59%	70%	8 10–20 minute telephone sessions weekly, 3 biweekly	Counselors with at least a bachelors in psychology or nutrition; pediatricians	14–16 weeks	gender, age, and ethnicity 20–100% over 50 th percentile for age & sex
Schwingshandl et al. 1999	11.6 (6–19)	2. Information control 1. Diet, exercise	21 14	33%	43%	Not reported	4 group dietary sessions, 60 minute child-only group physical training sessions twice a week	Not reported	12 weeks	“Obese.”
Senediak & Spence 1985	10.3 (6–13)	2. Information control 1. Diet, exercise, parent involvement, reinforcement, stimulus control, self-monitoring 2. Diet, exercise, parent involvement, reinforcement, stimulus control, self-monitoring	16 12 12	44%	~ 66%	Not reported	1. 90 minute group sessions twice a week 2. Four 90 minute group sessions weekly, 2 biweekly, 2 every 3 weeks	Clinical Psychologist; graduate student in Psychology	1. 4 weeks 2. 14 weeks	Greater than 20% overweight
Wheeler & Hess 1976	7.1 (2–11)	4. Waitlist control 1. Parent involvement, reinforcement, stimulus control, self-monitoring	10 26	46%	43%	Not reported	30 minute family sessions biweekly, then spaced further apart as progress was made	Not reported	Average treatment length = 7 months	“Obvious obesity”
White et al. 2004	13.2 (11–15)	2. No-treatment control 1. Diet, exercise, parental involvement, self-monitoring 2. Information control	14 28 29	12%	0%	0%	Weekly information on website, control group matched for contact	Case manager with graduate-level clinical psychology degree; dietitian	6 months	BMI greater than or equal to 85 th percentile

^aN at baseline

Table 2

Individual study effect sizes.

Study	Control Type	Method Used	Outcome	Months from Baseline	Effect Size
Aragona 1975	No treatment	Change/change	Weight (kg)	3 (end of treatment)	2.91 ^a
Epstein 1984	No treatment	Final outcomes	Percent overweight	5 (follow-up)	2.85 ^a
Flodmark 1993	No treatment	Change/baseline	BMI	6 (end of treatment)	1.02 ^a
Israel 1985	No treatment	Change/baseline	Percent overweight	26 (follow-up)	0.40 ^a
Johnson 1997	Information	Change/baseline	Weight (kg)	2 (end of treatment)	0.48 ^a
				4 (end of treatment)	0.10 ^a
				64 (follow-up)	1.34 ^a
Kirschenbaum 1984	No treatment	Change/baseline	Percent overweight	2 (end of treatment)	0.33 ^a
				3 (follow-up)	0.48 ^a
Lansky 1983	No treatment	Change/change	Percent overweight	3 (end of treatment)	0.99
Mellin 1987	No treatment	Change/change	Percent overweight	3 (end of treatment)	0.79
Owens 1999	No treatment	Change/change	Weight (kg)	15 (follow-up)	0.69
Saelens 2002	Information	Change/baseline	Percent overweight	4 (end of treatment)	0.49
				4 (end of treatment)	0.78
Schwingshandl 1999	Information	Change/change	z-BMI	7 (follow-up)	0.78
Senediak 1985	Information	Change/baseline	Percent overweight	3 (end of treatment)	0.00
Wheeler 1976	No treatment	Final outcomes	Percent overweight	1 (end of treatment)	0.53 ^a
White 2004	Information	Change/change	BMI	7 (end of treatment)	0.97
				6 (end of treatment)	0.69

^aIndicates averaged effect size across two intervention conditions.

Note. Formulas used were:

$$\text{Change / change} = \frac{(\text{Mean Change for the Control} - \text{Mean Change for Intervention})}{((\text{Change score SD for the Control} + \text{Change score SD for the Intervention SD}) / 2)}$$

$$\text{Change / baseline} = \frac{(\text{Mean Change for the Control} - \text{Mean Change for Intervention})}{((\text{SD at Baseline for the Control} + \text{SD at Baseline for the Intervention SD}) / 2)}$$

$$\text{Final outcomes} = \frac{(\text{Mean at Endpoint for the Control} - \text{Mean at Endpoint for Intervention})}{((\text{SD at Endpoint for the Control} + \text{SD at Endpoint for the Intervention SD}) / 2)}$$

Table 3

Summary of meta-analysis findings.

Comparison	k	Total N	Adjusted ES range	Fixed effects				Random Effects				Homogeneity of studies - fixed		Homogeneity of studies - random	
				ES _M	95% CI	z	p	ES _M	95% CI	z	p	Q	p	Q	p
WAIT-I	9	321	.33 to 2.91	.75	.52 to .98	6.41	<.001	.75	.50 to 1.00	6.03	<.001	8.83	NS	8.29	NS
WAIT-F	4	158	.39 to 2.85	.60	.27 to .94	3.51	<.001	.66	.15 to 1.17	2.54	<.05	5.46	NS	4.49	NS
INFO-I	4	137	.00 to .78	.48	.13 to .82	2.72	<.01	.46	.07 to .85	2.33	<.05	3.75	NS	3.00	NS
INFO-F	2	49	.78 to 1.34	.91	.32 to 1.50	3.01	<.01	.86	.62 to .98	8.70	<.001	0.59	NS	1.00	NS

Note. k = number of studies; ES = effect size; ES_M = mean effect size; CI = confidence interval; NS = not significant at p < .05;

WAIT-I = Active behavioral intervention compared to a wait-list or no-treatment control immediately following the end of treatment; WAIT-F = Active behavioral intervention compared to a wait-list or no-treatment control, follow-up effects; INFO-I = Active behavioral intervention compared to an education/information-only control immediately following the end of treatment; INFO-F = Active behavioral intervention compared to an education/information-only control, follow-up effects.