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

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Objective: Evaluating the efficacy of pediatric weight loss treatments is critical. This is the first meta-analysis of the efficacy of RCTs comparing pediatric lifestyle interventions to no-treatment or information/education-only controls. Data Sources: Medline, PsyCINFO, and Cochrane Controlled Trials Register. Study Selection: Fourteen RCTs targeting change in weight status were eligible, yielding 19 effect sizes. Data Extraction: Standardized coding was used to extract information on design, participant characteristics, interventions, and results. Data Synthesis: For trials with no-treatment controls, the mean effect size was 0.75 (k = 9.95% confidence interval [CI] = 0.52–0.98) at end of treatment and 0.60 (k = 4, CI = 0.27–0.94) at follow-up. For trials with information/education-only controls, the mean ES was 0.48 (k = 4, CI = 0.13–0.82) at end of treatment and 0.91 (k = 2, CI = 0.32–1.50) at follow-up. No moderator effects were identified. Conclusions: Lifestyle interventions for pediatric overweight are efficacious in the short term with some evidence for extended persistence. Future research is required to identify moderators and mediators 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

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).

Although 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 et al., 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: (a) Haddock, Shadish, Klesges, and Stein’s (1994) meta-analytic review of behavioral treatments (treatments containing dietary, exercise, and/or behavioral modification components), (b) Epstein and Goldfield’s (1999) meta-analysis of physical activity in the treatment of pediatric overweight, and (c) Collins, Warren, Neve, McCoy, and Stokes’s (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, Williams, Gold, Smith, & Shipman, 2005). These authors raised two objections to a meta-analytic approach: (a) insufficient numbers of applicable
studies resulting in small sample sizes and (b) lack of standard-
ization, both in specific treatment components or combinations of
treatment components included in lifestyle interventions and in the
outcome measures reported across studies.

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 with either a wait-list/
no-treatment or information/education-only control. Although this
approach has the advantage of allowing for meta-analytic review,
it excluded widely cited studies that compare active treatments
with each other (i.e., Epstein, Wing, Koeske, Andrasik, & Ossip,
1981; Epstein, Valoski, Wing, & McCurley, 1990). This approach
also excluded pharmacological and surgical treatments as 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 treat-
ments of overweight youth). Second, 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 quan-
titatively evaluate the efficacy of lifestyle interventions in the
treatment of pediatric overweight by comparing lifestyle interven-
tions with 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 compo-
nents).

Method

Literature Search Strategy

An extensive literature search was conducted in Cochrane Con-
trolled 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 limi-
ted to pediatric and adolescent populations. In addition, the ref-
ference lists from recent major reviews on childhood overweight
were used to identify articles.

Study Inclusion Criteria and Selection

Each study selected for inclusion was a RCT of lifestyle inter-
ventions focused on weight loss or weight control for youth age 19
or younger that compared an active treatment with either a wait-
list/no-treatment control or with an information/education-only
control. Additional inclusion criteria were as follows: study results
reported in English, treatment duration of at least 4 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 review-
ers coded all studies for intervention and statistical information; all
of the intervention and outcome data were compared for consist-
tency and resolved to 100% agreement. Reviewers resolved discrep-
cencies through consultation and consensus with study authors.

Statistical Analysis

Effect size calculations. Effect sizes were computed as $d$ in-
dices 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 out-
come 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 sum-
mary 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 rel-
levance of effect sizes are described in terms of the area under
curve statistic, which indicates the percentage of participants in the
treatment group who score lower than the average participant in the
treatment group (Cohen, 1988).

Effect sizes were corrected for small-sample bias by transform-
ing the standardized mean difference, $d$, to Hedges’s $g$ before
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 fixed-effects and random-effects models.

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:
percentage overweight, $z$-body mass index (BMI), BMI, and
weight. The advantage of estimating effects using percentage
overweight, $z$-BMI, and BMI is that these outcome measures are
appropriate for use with a pediatric sample because 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 mea-
sured at the same time point were averaged before entry into the
analysis.

Moderator analyses. In our analyses, the omnibus homogene-
ty test ($Q$) was used to test for significant interstudy variation.
Moderators were examined using an omnibus test of between-
group differences in mean effects ($Q_g$; 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
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analysis to test for possible moderation of effect sizes; and (c) examination of potential moderators where indicated.

Results

Study Demographics and 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 = 2–19 years). Seven studies included both children (defined as those 12 years of age or younger) and adolescents (defined as those 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 1 study reported mean ages for its participants but did not provide the age ranges. The percentage of male participants in each study ranged from 0% to 66% with an average of 34.8% male participants. 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 = 8–87 sessions), whereas participants in the information/education-only conditions received an average of 3.6 sessions (SD = 6.4, range = 0–16 sessions). Timing of follow-up assessments varied from 1 month posttreatment to 5 years posttreatment. 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 were 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 = 8–74). Before 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 nine effect sizes for studies with wait-list control comparisons with an end-of-treatment time point (WAIT-I), and four 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 (M = 15 months, range = 1–60 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 four effect sizes for studies with an information/education-only control group with an end-of-treatment time point (INFO-I), and two 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 homogeneous (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, and 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) = 0.50, ns. Similarly, no difference was found within the information/education-only group, Q(1, k = 6) = 1.53, ns. 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 rerun to eliminate any effect of nested data. No significant effects were found. The effect of time was also 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,
Figure 1. Flow of studies into the review of randomized controlled trials (RCTs) of the effectiveness of lifestyle interventions for pediatric overweight.
<table>
<thead>
<tr>
<th>Study</th>
<th>Mean age in years (range)</th>
<th>Groups</th>
<th>N&lt;sup&gt;a&lt;/sup&gt;</th>
<th>% male</th>
<th>% Caucasian</th>
<th>Dose</th>
<th>Interventionist</th>
<th>Treatment length</th>
<th>Weight criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aragona, Cassady, &amp; Drabman (1975)</td>
<td>8.6 (5–10)</td>
<td>1. Diet, exercise, parent involvement, reinforcement, stimulus control, and self-monitoring</td>
<td>5</td>
<td>20</td>
<td>0</td>
<td>Not reported</td>
<td>Not reported</td>
<td>12 weeks</td>
<td>“Overweight”</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Diet, exercise, parent involvement, stimulus control, and self-monitoring</td>
<td></td>
<td></td>
<td></td>
<td>Weekly group sessions</td>
<td></td>
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<td></td>
<td></td>
<td>3. No-treatment control</td>
<td>5</td>
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</tr>
<tr>
<td>Epstein et al. (1984)</td>
<td>10.4 (8–12)</td>
<td>1. Diet, parent involvement, reinforcement, stimulus control, and self-monitoring</td>
<td>18</td>
<td>5</td>
<td>Not reported</td>
<td>Not reported</td>
<td>Therapist</td>
<td>6 months</td>
<td>20%–80% overweight for height, age, and sex</td>
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<tr>
<td></td>
<td></td>
<td>2. Traffic light diet, lifestyle exercise, parent involvement, reinforcement, stimulus control, and self-monitoring</td>
<td></td>
<td></td>
<td></td>
<td>8 weekly group sessions, 4 biweekly, 4 monthly</td>
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<tr>
<td></td>
<td></td>
<td>3. Wait-list control</td>
<td>17</td>
<td>11</td>
<td>45</td>
<td>5 family dietary counseling sessions, dietitian, therapist, and pediatrician</td>
<td></td>
<td></td>
<td>BMI greater than 23</td>
</tr>
<tr>
<td>Flodmark et al. (1993)</td>
<td>10–11</td>
<td>1. Diet and exercise</td>
<td>19</td>
<td>11</td>
<td>45</td>
<td>Not reported</td>
<td>Dietitian, therapist, and pediatrician</td>
<td>14–18 months</td>
<td>Greater than 20% overweight</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Diet, exercise, and 6 family therapy sessions</td>
<td>25</td>
<td></td>
<td></td>
<td>Not reported</td>
<td></td>
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<td></td>
<td></td>
<td>3. No-treatment control</td>
<td>50</td>
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<td></td>
</tr>
<tr>
<td>Israel, Stolmaker, &amp; Andrian (1985)</td>
<td>10.6 (8–12)</td>
<td>1. Diet, exercise, reinforcement, stimulus control, and self-monitoring</td>
<td>12</td>
<td>40</td>
<td>Not reported</td>
<td>Not reported</td>
<td>Graduate and undergraduate psychology students</td>
<td>9 weeks, plus 12 months fading contact</td>
<td>Greater than 20% overweight</td>
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<td></td>
<td></td>
<td>2. Diet, exercise, reinforcement, 2 parent sessions, stimulus control, and self-monitoring</td>
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<td></td>
<td>90-min group sessions weekly</td>
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<td></td>
<td></td>
<td>3. Wait-list control</td>
<td>12</td>
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<tr>
<td>Johnson et al. (1997)</td>
<td>11.0 (8–17)</td>
<td>1. 7-week traffic light diet, then 7 weeks exercise; intervention, reinforcement, parent involvement</td>
<td>11</td>
<td>13</td>
<td>28</td>
<td>Not reported</td>
<td>Not reported</td>
<td>16 weeks</td>
<td>Greater than 20% overweight</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. 7-week exercise, then 7 weeks traffic light diet; intervention, reinforcement, and parent involvement</td>
<td></td>
<td></td>
<td></td>
<td>90-min group sessions weekly, control group matched for contact</td>
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<tr>
<td>Kirschenbaum, Harris, &amp; Tomarken (1984)</td>
<td>10.7 (9–13)</td>
<td>1. Diet, exercise, parent involvement, reinforcement, stimulus control, and self-monitoring</td>
<td>10</td>
<td>16</td>
<td>25</td>
<td>Not reported</td>
<td>Graduate and undergraduate psychology students</td>
<td>9 weeks</td>
<td>Greater than 20% overweight</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Diet, exercise, parent involvement, stimulus control, and self-monitoring</td>
<td></td>
<td></td>
<td></td>
<td>90-min group sessions weekly for (a) family or (b) child only</td>
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<tr>
<td></td>
<td></td>
<td>3. Information control</td>
<td>15</td>
<td></td>
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<tr>
<td>Lansky &amp; Vance (1983)</td>
<td>13.1</td>
<td>1. Diet, exercise, parent involvement, reinforcement, stimulus control, and self-monitoring</td>
<td>9</td>
<td></td>
<td></td>
<td>Not reported</td>
<td>Physical education instructor</td>
<td>12 weeks</td>
<td>Greater than or equal to 10% overweight</td>
</tr>
<tr>
<td>Mellin, Slinkard, &amp; Irwin (1987)</td>
<td>15.6 (12–18)</td>
<td>1. Diet, exercise, parent involvement</td>
<td>37</td>
<td>16</td>
<td>21</td>
<td>Not reported</td>
<td>Nutritionists and dietitians</td>
<td>14 weeks, 2 parent sessions</td>
<td>“Obese”</td>
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<tr>
<td></td>
<td></td>
<td>2. No-treatment control</td>
<td>29</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Owens et al. (1999)</td>
<td>9.5 (7–11)</td>
<td>1. Exercise, reinforcement</td>
<td>40</td>
<td>13</td>
<td>33</td>
<td>40-min child-only group sessions 5 days per week</td>
<td>Not reported</td>
<td>16 weeks</td>
<td>Triceps skinfold greater than 85th percentile for gender, age, and ethnicity</td>
</tr>
<tr>
<td>Study</td>
<td>Mean age in years (range)</td>
<td>Groups</td>
<td>Attrition rate (%)</td>
<td>% male</td>
<td>% Caucasian</td>
<td>Dose</td>
<td>Interventionist</td>
<td>Treatment length</td>
<td>Weight criteria</td>
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<tr>
<td>Saelens et al. (2002)</td>
<td>14.2 (12–16)</td>
<td>1. Diet, exercise, parent involvement, reinforcement, stimulus control, and self-monitoring</td>
<td>23</td>
<td>16</td>
<td>59</td>
<td>70</td>
<td>8 10–20 minute telephone sessions weekly, 3 biweekly</td>
<td>14–16 weeks</td>
<td>20%–100% over 50th percentile for age &amp; sex</td>
</tr>
<tr>
<td>Schwingshandl et al.</td>
<td>11.6 (6–19)</td>
<td>2. Information control</td>
<td>21</td>
<td>14</td>
<td>33</td>
<td>43</td>
<td>Not reported</td>
<td>12 weeks</td>
<td>“Obese”</td>
</tr>
<tr>
<td>(1999)</td>
<td></td>
<td>1. Diet, exercise</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Not reported</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Senediak &amp; Spence</td>
<td>10.3 (6–13)</td>
<td>2. Information control</td>
<td>16</td>
<td>12</td>
<td>~66</td>
<td>Not reported</td>
<td>1. 90-min group sessions twice a week</td>
<td>1.4 weeks</td>
<td>Greater than 20% overweight</td>
</tr>
<tr>
<td>(1985)</td>
<td></td>
<td>1. Diet, exercise, parent involvement, reinforcement, stimulus control, self-monitoring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>2. Four 90-min group sessions weekly, 2 biweekly, 2 every 3 weeks</td>
<td>2.14 weeks</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Diet, exercise, parent involvement, reinforcement, stimulus control, self-monitoring</td>
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<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Wheeler &amp; Hess</td>
<td>7.1 (2–11)</td>
<td>3. Wait-list control</td>
<td>10</td>
<td>26</td>
<td>46</td>
<td>43</td>
<td>30-min family sessions biweekly, then spaced further apart as progress was made</td>
<td>Not reported</td>
<td>Average treatment length = 7 months</td>
</tr>
<tr>
<td>(1976)</td>
<td></td>
<td>1. Parent involvement, reinforcement, stimulus control, and self-monitoring</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>“Obvious obesity”</td>
</tr>
<tr>
<td>White et al. (2004)</td>
<td>13.2 (11–15)</td>
<td>2. No-treatment control</td>
<td>14</td>
<td>28</td>
<td>12</td>
<td>0</td>
<td>Weekly information on Web site, control group matched for contact</td>
<td>Case manager with graduate-level clinical psychology degree and dietitian</td>
<td>6 months</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. Information control</td>
<td>20</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

*Note.*  BMI = body mass index.

*N* at baseline.
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 toward 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) 5-year follow-up time point and Aragona, Cassady, and Drabman’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 with 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 posttreatment effects. For the eight RCTs that used percentage overweight as an outcome measure, the resulting decreases in percentage overweight, 8.2% and 8.9%, respectively, were consistent with the 5%–20% decrease in immediate and follow-up percentage overweight reported in other quantitative reviews (Goldfield et al., 2002; Jelalian & Saelens, 1999). Without treatment, there was a 2.1% increase in percentage overweight immediately following treatment and a 2.7% increase in percentage 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 used. 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.

Although 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, 2007). One concern occurs when two treatments have equivalent

<table>
<thead>
<tr>
<th>Study</th>
<th>Control type</th>
<th>Method used</th>
<th>Outcome</th>
<th>Months from baseline</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aragona et al. (1975)</td>
<td>No treatment</td>
<td>Change/change</td>
<td>Weight (kg)</td>
<td>3 (end of treatment)</td>
<td>2.91*</td>
</tr>
<tr>
<td>Epstein et al. (1984)</td>
<td>No treatment</td>
<td>Final outcomes</td>
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<td>6 (end of treatment)</td>
<td>1.02*</td>
</tr>
<tr>
<td>Flodmark et al. (1993)</td>
<td>No treatment</td>
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<td>BMI</td>
<td>26 (follow-up)</td>
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<tr>
<td>Israel et al. (1985)</td>
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<td>2 (end of treatment)</td>
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</tr>
<tr>
<td>Schwingshandel et al. (1999)</td>
<td>Information</td>
<td>Change/change</td>
<td>z-BMI</td>
<td>3 (end of treatment)</td>
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<tr>
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<td>7 (end of treatment)</td>
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<td>Information</td>
<td>Change/baseline</td>
<td>BMI</td>
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Note. BMI = body mass index. Formulas used were:

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

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\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})/2)
\]

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

* Indicates averaged effect size across two intervention conditions.

Table 3

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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 because of a general homogeneity in methods and study participants (e.g., the majority of the studies were conducted with preadolescents, were multicomponent 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, comorbid conditions, or ethnicity influence either the magnitude or the 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.

Because 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 RCTs, 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 nonstatistically 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 these 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 1-year postrandomization and also, ideally, at 24 months postrandomization. This standard would allow for a meaningful evaluation of the effects of weight loss interven-
tions over time. Furthermore, it would aid in empirically determining when posttreatment 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 as 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 socioeconomic status 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 important, 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 with 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, for instance, by evaluating the efficacy of lifestyle interventions for the needs of children with comorbid medical conditions, such as Type 2 diabetes (Zeitler et al., 2007). 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.

References


References marked with an asterisk indicate studies included in the meta-analysis.