Ten-Year Outcomes of Behavioral Family-Based Treatment for Childhood Obesity

Leonard H. Epstein, Alice Valoski, Rena R. Wing, and James McCurley

We report 10-year treatment outcomes for obese children in 4 randomized treatment studies. At 10 years, 34% decreased percentage overweight by 20% or more, and 30% were not obese. Significant effects were observed when parents and children were targeted and reinforced for weight loss in comparison with nontargeted controls and for children given lifestyle or aerobic exercise in comparison with a calisthenics control. Thirty-four percent of the variance in change in percentage overweight was predicted from sex, baseline percentage overweight, self-monitoring weight, meals eaten at home, and family and friends' support for eating and exercise. Results show long-term changes in children depend on the treatment, and evidence converges on the importance of the family and other sources of support for eating and activity change.

Key words: child, obesity, diet, exercise, parenting, interaction


Research supports the efficacy of behavioral treatments for obese children (Epstein, 1990; Epstein & Wing, 1987). Behavioral treatments are superior to no treatment (Epstein, Wing, Koeske, & Valoski, 1984; Israel, Stolmaker, Sharp, Silverman, & Simon, 1984; Kirschenbaum, Harris, & Tomarken, 1984) and to attention placebo controls (Epstein, Wing, Steranchak, Dickson, & Michelson, 1980; Epstein, Wing, Woodall, et al., 1985). Five-year follow-up studies have demonstrated that including parents as active participants in behavior change and weight loss (Epstein, Valoski, Wing, & McCurley, 1990; Epstein, Wing, Koeske, & Valoski, 1987) provide lifestyle exercise (Epstein, Wing, Koeske, & Valoski, 1985) and nonobese parent weight status (Epstein, Wing, Valoski, & Gooding, 1987) influence child weight control.

There is a paucity of other data on long-term treatment in obese children. Nuutinen and Knip (1992) reported a 5-year follow-up of obese children who participated in a weight-control program. They found no significant differences between standard and experimental treatments, which both showed equivalent improvements from baseline. In contrast, we have demonstrated the influence of parent participation on child weight regulation over a 10-year interval (Epstein, Valoski, et al., 1990). Weight change did not differentially influence growth over the 10 years of observation (Epstein, Valoski, & McCurley, 1993).

The main goal of this article is the presentation of the 10-year outcome for obese children treated in four randomized studies. The 10-year outcome results for the first study in this series have been presented (Epstein, Valoski, et al., 1990). At follow-up, the average child was 20 years of age, and this provided an evaluation of treatment effects from childhood into young adulthood. Because variables other than treatment may influence the change in the percentage overweight over 10 years, we attempted to assess several important variables that influence weight, such as smoking (Noppa & Bengston, 1980), joining other weight-control programs, eating disorders (Maloney, McGuire, Daniels, & Specker, 1989), and psychiatric problems (Black, Goldstein, & Mason, 1992).

The secondary goal of this article is to identify variables associated with long-term weight regulation and to extend the research on predictors of 5-year changes in percentage overweight (Epstein, Valoski, & McCurley, 1992). The variables included ones that were manipulated during treatment or were conceptually related to the treatments that were studied, such as adherence to weight regulatory behaviors, energy and macronutrient intake, and activity levels, and ones that reflect environmental, familial, and peer influences.
Method

Subjects

Subjects were participants in one of four weight-control studies at the University of Pittsburgh. Entrance criteria for the treatment programs included: a child of 6–12 years of age, 20%–100% overweight for age, sex, and height, no current psychiatric diagnosis or treatment, no learning disability, and one parent willing to participate in treatment with the child. Parents or children with current psychological problems were referred for treatment before entrance in the study. Parents or children could have had psychiatric problems that had been successfully treated or were in remission when they entered treatment.

Families that participated in Study 1 were intact, and families who participated in the exercise studies (2 and 4) could not have a medical problem that limited exercise. With the exception of one group, at least one parent was obese, which may increase the risk that an obese child will become an obese adult (Charny et al., 1976). The exception was in Study 3, where the obesity status of the parents was an independent variable. Socioeconomic status of the families at entry was 45.2 ± 12.0, within the range of middle-class Social Stratata IV (Hollingshead, 1975). One hundred eighty-five families were originally randomized, and data from 158 families (85%) were available at the 10-year follow-up. Five-year growth (Epstein, McCurley, Valoski, & Wing, 1990) and changes in percentage overweight (Epstein, McCurley, Wing, & Valoski, 1990) for these studies and 10-year height and weight results from Study 1 have been reported (Epstein, Valoski, et al., 1990).

Characteristics of Treatment

The basic treatment package for all groups included weekly treatment meetings for 8–12 weeks, with monthly meetings continuing for 6–12 months from the start of the program. All families were also provided the Traffic Light Diet to help reduce caloric intake and improve nutrient density, with intake for most nutrients exceeding the minimum goals for the RDA (Epstein, Valoski, Koeseke, & Wing, 1986; Valoski & Epstein, 1990). Food diaries were reviewed weekly, and behavior modification techniques were used to encourage a balanced diet within the 900–1,200 calorie range.

The diet was continued until a participant was within 10% of the goal weight for height. The parent or child was then instructed to increase the caloric intake by 100 kcal/day up until the child began to gain weight. Participants remained on the intake that did not result in immediate weight gain, and energy intake was adjusted to maintain growth. Parents were taught how to calculate goal weight for height as the child grew.

The variables manipulated in each study are presented in Table 1. In Study 1, children were randomized to one of three groups: Both the parent and child were targeted for weight loss, only the child was targeted for losing weight, or there was a nonspecific target (Epstein, Valoski, et al., 1990; Epstein, Wing, Koeseke, Andrasik, & Osip, 1981; Epstein, Wing, Koeseke, & Valoski, 1987). Targeting involved contingency management for habit and weight change, with the contingencies for the parent-and-child group arranged so that both the parent and child had multiple habits and weight loss. Thus, contingencies required cooperative and joint change in both parents and children.

Study 2 randomized families to regimes of diet and lifestyle exercise or diet alone or to a no-treatment control (Epstein, Wing, et al., 1984). The exercise program increased energy expenditure by the equivalent of 4 miles (6.4 km) of walking per day, or 2,600 kcal per week for a 150 lb. person. The diet alone group was given information on low expenditure calisthenics and stretching but were not reinforced for any exercise changes. Contingencies in this study were oriented toward child weight change, with no requirement for joint parent and child behavior or weight change. The no-treatment control group was treated after 6 months, and no long-term data on these children are available.

Study 3 assessed the effects of parental weight status (two nonobese parents vs. at least one obese parent) and child self-control on child weight loss (Epstein, Wing, Koeske, & Valoski, 1986; Epstein, Wing, Valoski, & Gooding, 1987). Contingencies were oriented toward child weight change, with no requirement for joint parent and child behavior or weight change. This is consistent with the emphasis in treatment on child self-control and the fact that targeting weight change was not possible for the group with two nonobese parents. The child self-control treatment showed no short- or long-term effects, and the results have been collapsed across this variable.

In Study 4, children were randomized to one of three groups, aerobic exercise, lifestyle exercise, and a calisthenics control group. The groups were similar in exercise time, goal setting, and feedback, but the control group required considerably less caloric expenditure than the isocaloric aerobic or lifestyle groups. The exercise-expenditure goal was the equivalent of 9 miles (14.5 km) per week to facilitate adherence (Epstein, Koeske, & Wing, 1984). Parents and children had reciprocal reinforcement contingencies, in which they were instructed to independently support the behavior change of each other.

These studies were approved by the University of Pittsburgh Institutional Review Board, and informed consent for follow-up was obtained from parents and children.

Measurement

Height and weight. Ten-year follow-up data were collected in one of three ways. Most of the subjects (127 of 158, or 80%) were weighed and measured in our office with a balance scale and laboratory-constructed height board. After 10 years some participants had moved from the area, and it was necessary to obtain height and weight information in other ways. Measurements for 3 subjects (2%) were obtained from their physician. In the other 28 cases (18%), self-report of height and weight was used. Families were paid for participation in follow-up as follows: $100 each to parent and child for coming to our office and being measured, $50 each to parent and child for a doctor report, and $25 each for a self-report.

Given that self-report can underestimate the degree of obesity, researchers have recommended adjusting self-reported height and weight with sample-specific equations (Bowman & DeLuca, 1992; Charney et al., 1976). We used equations based on a data set that included over 1,000 pairs of measured and self-reported data. The correlations between the estimated and measured height and weight were as follows: rs = .991 and .993 for height and rs = .996 and .998 for weight, for girls and boys, respectively, and rs = .977 and .952 for height and rs = .996 and .992 for weight, for women and men, respectively. In 7 subjects, 5-year data were not available. To maximize the number of cases available for repeated measures analysis, 5-year data points for these subjects were extrapolated from graphs of the baseline, 6-month, 1-, 2-, 3-, and 10-year data. Percentage overweight was calculated for children less than 19 years of age on the basis of child sex and height (Jelliffe, 1966). For children 19 years or older and all parents, percentage overweight was calculated with adult standards (Metropolitan Life Insurance Company, 1983). This measure provides a dependent variable for assessing weight change in relation to height change that has served as the basis for initial reports of treatment outcome for this and almost all other reports of behavioral treatment of childhood obesity (Epstein & Wing, 1987).

Another way to evaluate weight for height is the body mass index (BMI; Weight ÷ Height^2 [kg ÷ m^2]). There is a reliable pattern in BMI during development; namely, BMI increases up to approximately 6
months of age, decreases through about age 7, and then increases throughout the remainder of development (Hammer, Kraemer, Wilson, Ritter, & Dornbusch, 1991). Normal changes in BMI during development are quite marked. The average BMI increases approximately 27.5% (from 16.72 to 23.07) for a boy from age 10 to age 20 and about 20.7% (from 17.00 to 21.46) for a girl over the same period (Must, Dallal, & Dietz, 1991). These developmental changes can be taken into account in interpreting long-term changes by comparing BMI values to the average BMI at that age. In addition to evaluating changes in percentage overweight, we also evaluated changes in BMI referenced to the 50th percentile of BMI for a child's age and sex (Must et al., 1991), which we labeled percentage overBMI. The correlation between 10-year changes in percentage overweight and changes in percentage overweight (BMI change) was .96 (df = 158, p < .001).

Additional dependent measures included the percentage of children who showed at least 20% increase or decrease in weight over 10 years and the percentage of children who were not overweight (i.e., less than 20% overweight) at 10 years.

**Demographic variables, weight, and medical history.** At 10 years respondents completed questionnaires that assessed variables that could influence weight, such as tobacco use (Noppa & Bengston, 1980), use of drugs that influence weight (e.g., appetite suppressants and oral contraceptives; Bradley, 1985), pregnancy (Forster, Bloom, Sorensen, Jeffery, & Prineas, 1986), long periods of inactivity, and participation in other weight-control programs. Interviews at the 10-year follow-up were used to complete any details.

Information about participation in other weight-control programs was collected retrospectively on a yearly basis, including the type of program (e.g., other diets, exercise programs, or weight control under a doctor's care), duration of participation, amount of weight loss during the program, and amount of weight loss that was maintained. Psychiatric problems were assessed as a part of the collection of medical history information. Attempts were made to confirm specific psychiatric diagnoses with the treating professionals. Decisions about the severity of the problems were guided by the *Diagnostic and Statistical Manual of Mental Disorders* (rev. 3rd ed.; American Psychiatric Association, 1987). The interviews focused on the medical history, and no attempts were made to do clinical interviews that might provide information on subjects who did not report but may have had a psychiatric problem. Adult binge eating disorder was not assessed, because most of the work in this area began after the initiation of the 10-year follow-up investigations. Although the prevalence of this disorder is low in the general population, it is quite high in obese adults who seek treatment (Spitzer et al., 1992; Spitzer et al., 1993). It is not known if the prevalence is high in obese adults who seek treatment for their children. Completed medical history questionnaires were available for 37 boys and 100 girls (87% of the sample). All estimates of the proportion of children with psychiatric problems were based on the sample of 137 children who provided medical history forms.

Measurement of diet and activity.** Dietary intake was assessed with a modified version of the Food Frequency Questionnaire (Willett, Reynolds, Cottrell-Hoechner, Sampson, & Browne, 1987; Willett et al., 1985) and was analyzed with Nutritionist III (N-Squared Computing, Salem, OR) software adapted for food frequency use. The Food Frequency Questionnaire has been widely used and validated over a 1-year interval, and it provides information on energy intake and percentage of macronutrients (fats, carbohydrates, and protein). After the questionnaire was completed, a registered dietician (Alice Valoski) interviewed each child to fill in any details.

Caloric expenditure of regular activities was estimated with the Paffenbarger Index (Paffenbarger, Hyde, Wing, & Hsieh, 1986). The Paffenbarger Index is a widely used estimate of activity, which relates to fitness (Sisomol, Laster, Snow, & Carelton, 1985) and a variety of health outcomes (Paffenbarger et al., 1986; Paffenbarger, Wing, & Hyde, 1978).

**Program adherence.** Subjects indicated how often they used program techniques, such as the diet, self-monitoring, and stimulus-control methods, and how useful they found them. The questionnaire

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1 The equations to adjust reported weight and height were as follows: girls weight, \( Y_G = 2.472 + 1.006X_G \); boys weight, \( Y_B = 0.373 + 1.016X_G \); girls height, \( Y_G = 2.860 + 9491.006X_G \); boys height, \( Y_B = 2.642 + 0.952X_G \); mothers height, \( Y_M = 1.513 + 0.999X_M \); fathers weight, \( Y_F = 4.589 + 0.987X_M \); mothers height, \( Y_M = 2.803 + 0.953X_M \); fathers height, \( Y_F = 2.316 + 0.955X_F \).

2 The 5-year data presented in Figure 1 present data from the 151 measured cases.
Environmental support for eating and exercise change. Sallis, Grossman, Pinski, Patterson, and Nader (1987) developed and validated scales on young adults that assess support for changing eating and exercise behavior. The scales measure the degree of support by family members, friends, and persons with whom they have lived over the last year.

Environmental assessment. Aspects of the environments that can influence weight control were assessed. The variables were: (a) subjects’ current living situation, including where they live and the number of persons with whom they live; (b) subjects’ perception of the weight of people with whom they regularly eat; (c) the exercise pattern of the people with whom they regularly exercise; and (d) subjects’ perception of the general activity level of their family, roommates, and any people with whom they eat or exercise. Activity perception was assessed with items from the Framingham Offspring Study (Hubert, Eaker, Garrison, & Castelli, 1987; Siconolfi et al., 1985).

Each of the self-report measures provided estimates of intake and activity over the previous year. Increasingly remote intervals increase memory confounds, and information beyond 1 year was considered less useful for understanding variables that influence current weight.

Analytic Procedures

The data were combined across the four studies to increase power for the between-groups comparisons and to provide a database for assessing correlational relations. This database was used to address several issues. First, analyses of covariance assessed interstudy, between-groups changes in percentage overweight from baseline to 5 and 10 years, with initial BMI as the covariate. All repeated measures analyses of covariance were checked for violations of sphericity with Greenhouse-Geisser adjustments. Residuals were examined for each model to assess outliers and cases with undue leverage. Between-groups comparisons were based on linear contrasts in the general linear model.

Second, chi-square analyses assessed differences by group in the percentage of children who showed sustained increases or decreases of 20% overweight and the percentage of children who were obese or nonobese. Third, a combination of correlational and analysis of variance techniques assessed the contribution of variables that could influence interpretation of treatment effects, such as smoking or participation in other weight-control programs. Fourth, multiple regression techniques assessed the contribution of a variety of demographic, intake, expenditure, and social-environmental variables to changes over 10 years. The fit of the models was evaluated by plotting residuals against the estimates. Variables within conceptually similar subgroups were analyzed separately, and significant variables were entered into the final model with backward regression procedures. Nonsignificant terms were removed in sequential fashion. Fifth, differences in parent and child baseline characteristics and child weight changes at 5 and 10 years were compared for children who developed eating disorders or psychiatric problems versus children who did not report these problems. All analyses were performed with SYSTAT software (Wilkinson, 1992).

Results

Baseline

The baseline characteristics of children and parents in all studies are shown in Table 2. Children’s percentage overweight, $F(3, 154) = 1.37, p > .05$, and BMI, $F(3, 154) = 1.97$, $p > .05$, were not different across groups. Significant differences were observed in age, $F(3, 154) = 5.59, p = .001$, height, $F(3, 154) = 6.78, p < .001$, and weight, $F(3, 154) = 4.63, p = .004$. No post hoc analyses showed children in Study 1 were significantly younger than children in Study 2 ($p = .006$), Study 3 ($p < .001$), and Study 4 ($p = .024$); children were accepted at younger ages (6–12) in Study 1 than in the other studies (8–12). Although children in Studies 2–4 were older and taller and weighed more, their weight for height considered by percentage overweight or BMI was equivalent. There were no differences in Sex Distribution × Study, $X^2(3, N = 158) = 3.54, p > .05$.

No significant differences across studies were observed in mothers’ height, $F(3, 153) = 1.61, p > .05$, or age, $F(3, 154) = 0.75, p > .05$, or fathers’ height, $F(3, 149) = 2.10, p > .05$, or age, $F(3, 152) = 1.66, p > .05$. Significant differences were observed in percentage overweight, $F(3, 153) = 3.11, p = .028$, and BMI, $F(3, 153) = 3.37, p = .02$, for mothers and percentage overweight, $F(3, 148) = 5.91, p < .001$, and BMI, $F(3, 148) = 5.08, p = .002$, for fathers, as some families were chosen in Study 3 because both parents were nonobese. There were no differences for participating parents in Sex Distribution × Study, $X^2(3, N = 152) = 6.20, p > .05$.

Treatment Outcome

The change in children’s percentage overweight by study is presented in Figure 1. To facilitate assessment of the magnitude of treatment effects, the 95% confidence intervals for 10-year change in percentage overweight across all subjects are presented in Figure 1 by dotted lines. Analysis of covariance showed a significant interaction of Group × Time for percentage overweight, $F(18, 294) = 1.77, p = .028$, and percentage overweight BMI, $F(18, 294) = 1.67, p = .044$.

Contrasts for Study 1 showed that the parent-and-child group had significantly greater changes than the nonspecific control at both 5, $F(1, 145) = 12.94, p < .001$, and 10 years, $F(1, 145) = 7.11, p = .009$. The parent-and-child group was significantly different from the child-only group at 5 years, $F(1, 145) = 5.15, p = .025$, but not at 10 years, $F(1, 145) = 1.88, p = .17$. Children in the parent-and-child group decreased their

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3 We have reported results using the WHO (Jelliffe, 1966) standards, since the newer NCHS standards (Hamill, Drizd, Johnson, Reed, Roche, & Moore, 1979) were not available when we began these studies, and the initial reports used the WHO standards. The WHO standards present a more conservative test of the treatment, since comparisons of percent overweight calculated between WHO and NCHS standards show NCHS to be 4.5 ± 6.2 lower. Correlations of 0- to 10-year change between the two methods for calculating percent overweight were .98, and the Group × Time interaction for the ANOVA calculated using the NCHS standards was also significant, $F(18, 294) = 1.79, p = .0225$.

4 Six subjects were identified as outliers in this analysis. The outliers were subjects with excessive increases in percent overweight ($M = 71.4$, range, 47.9–108.5). Redoing the analysis without the outliers resulted in a significant model, $F(18, 278) = 1.86, p = .019$. Given the possibility that these excessive weight gains represented a small, but important percentage of the children, and to make the results more conservative, the final model included all subjects.
TEN-YEAR OBESITY OUTCOMES

Table 2
Baseline Characteristics (Means and Standard Deviations) of Overweight Children and Their Parents

<table>
<thead>
<tr>
<th>Measure</th>
<th>Total</th>
<th>Study 1</th>
<th>Study 2</th>
<th>Study 3</th>
<th>Study 4</th>
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<tbody>
<tr>
<td>Child (N = 158; 42 boys and 116 girls)</td>
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<tr>
<td>% overweight</td>
<td>45.0 ± 16.6</td>
<td>43.8 ± 16.4</td>
<td>43.8 ± 13.7</td>
<td>43.0 ± 16.4</td>
<td>49.9 ± 18.4</td>
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<tr>
<td>Body Mass Index</td>
<td>25.5 ± 3.2</td>
<td>24.8 ± 3.3</td>
<td>25.6 ± 2.1</td>
<td>25.9 ± 3.1</td>
<td>26.2 ± 3.5</td>
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<tr>
<td>Height</td>
<td>57.5 ± 4.6</td>
<td>55.9 ± 4.5</td>
<td>58.4 ± 4.3</td>
<td>59.8 ± 4.2</td>
<td>57.1 ± 4.2</td>
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<tr>
<td>Weight</td>
<td>121.9 ± 29.1</td>
<td>112.3 ± 29.1</td>
<td>124.7 ± 21.9</td>
<td>133.4 ± 29.1</td>
<td>123.6 ± 29.0</td>
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<tr>
<td>Age</td>
<td>10.4 ± 1.6</td>
<td>9.8 ± 1.8</td>
<td>10.8 ± 1.3</td>
<td>10.9 ± 1.1</td>
<td>10.5 ± 1.3</td>
</tr>
<tr>
<td>SES</td>
<td>33.7 ± 11.0</td>
<td>36.2 ± 6.9</td>
<td>34.6 ± 11.9</td>
<td>30.2 ± 13.2</td>
<td>35.2 ± 9.6</td>
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<tr>
<td>Mother (N = 152)</td>
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<tr>
<td>% overweight</td>
<td>20.9 ± 23.5</td>
<td>20.9 ± 21.8</td>
<td>22.5 ± 21.1</td>
<td>12.6 ± 23.0</td>
<td>28.8 ± 25.9</td>
</tr>
<tr>
<td>Body Mass Index</td>
<td>27.8 ± 5.4</td>
<td>27.8 ± 5.0</td>
<td>27.9 ± 4.8</td>
<td>25.8 ± 5.2</td>
<td>29.7 ± 6.0</td>
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<tr>
<td>Height</td>
<td>64.2 ± 2.5</td>
<td>63.9 ± 2.3</td>
<td>65.1 ± 3.1</td>
<td>64.4 ± 2.4</td>
<td>63.8 ± 2.7</td>
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<tr>
<td>Weight</td>
<td>162.9 ± 33.8</td>
<td>161.9 ± 31.6</td>
<td>168.7 ± 33.1</td>
<td>152.3 ± 33.1</td>
<td>171.9 ± 36.4</td>
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<tr>
<td>Age</td>
<td>39.4 ± 6.3</td>
<td>39.5 ± 6.9</td>
<td>41.0 ± 7.0</td>
<td>39.0 ± 5.6</td>
<td>38.5 ± 5.7</td>
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<td>Father (N = 152)</td>
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<tr>
<td>% overweight</td>
<td>26.5 ± 19.1</td>
<td>25.8 ± 16.3</td>
<td>26.5 ± 21.3</td>
<td>18.1 ± 15.2</td>
<td>36.0 ± 21.6</td>
</tr>
<tr>
<td>Body Mass Index</td>
<td>29.3 ± 4.4</td>
<td>29.2 ± 3.8</td>
<td>29.3 ± 4.7</td>
<td>27.4 ± 3.4</td>
<td>31.3 ± 5.0</td>
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<tr>
<td>Height</td>
<td>69.4 ± 2.6</td>
<td>69.0 ± 2.5</td>
<td>69.4 ± 2.7</td>
<td>69.0 ± 2.7</td>
<td>70.3 ± 2.3</td>
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<tr>
<td>Weight</td>
<td>200.8 ± 33.3</td>
<td>198.2 ± 27.6</td>
<td>201.4 ± 38.9</td>
<td>186.1 ± 28.7</td>
<td>219.6 ± 34.9</td>
</tr>
<tr>
<td>Age</td>
<td>41.8 ± 7.2</td>
<td>42.1 ± 8.0</td>
<td>44.4 ± 8.8</td>
<td>40.8 ± 6.4</td>
<td>40.5 ± 5.3</td>
</tr>
<tr>
<td>Family SES</td>
<td>45.2 ± 12.0</td>
<td>47.5 ± 11.7</td>
<td>45.3 ± 10.2</td>
<td>44.4 ± 12.2</td>
<td>40.9 ± 13.3</td>
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Note. Height was measured in inches; weight was measured in pounds. SES = socioeconomic status. Child SES refers to level for children who were employed at follow-up; family SES refers to level at entry.

percentage overweight by 15.3% whereas children in the control group increased theirs by 7.6%. No significant differences for change in percentage overweight were observed between groups in Study 2 after 5 or 10 years, though children in both groups showed decreases (8.4% and 10.0%) in long-term percentage overweight. In Study 3, a trend was observed for children with nonobese parents (-11.1%) to do better than children with obese parents (+3.1%); however, these differences were not significant, F(1, 145) = 2.44, p = .12. Children in Study 4 given lifestyle (-19.7%), F(1, 145) = 7.18, p = .008, or aerobic exercise (-10.9%), F(1, 145) = 3.90, p = .05, had greater 10-year change than the calisthenics control group (+12.2%). Contrasts of changes from 5 to 10 years were significant in comparisons of the lifestyle, F(1, 145) = 7.05, p = .009, or the aerobic exercise, F(1, 145) = 4.12, p = .044, to the calisthenics control group.5

The percentage of children who maintained decreases of 20%, χ²(18, N = 158) = 31.84, p = .02, differed by group (Table 3). In Study 1 the percentages of children in the parent-and-child, child-only, and control groups who maintained decreases of 20% were 43%, 22%, and 29%, respectively. In Study 4, 58% of the children in the aerobics group and 64% of those in the lifestyle exercise group maintained a decrease of 20%, as compared with an increase of 20% in the calisthenics group. Thirty percent of the children in the four studies were not obese after 10 years. No significant differences in this outcome were observed by group, χ²(9, N = 158) = 8.38, p = .50.

Confounding variables that could influence outcome. Six girls reported that they were treated for eating disorders. One child had been treated for depression, and another had sought treatment for alcohol abuse. Nineteen other children developed major psychiatric disorders that required hospitalization or long-term medication use. These included 16 children with depression and 3 children with alcohol or drug abuse. A child was treated for irritable bowel syndrome, a medical problem often associated with psychiatric morbidity. Three women who had been treated as children had been pregnant and delivered within 6 months of the 10-year measurement. By self-report no subjects were pregnant when measured. Treatment outcome data were analyzed with and without these psychiatric, medical, and pregnant subjects. The between-groups changes in percentage overweight are significant if subjects with potentially confounding psychiatric and medical problems are excluded, F(18, 230) = 2.04, p = .014. Analyses were also conducted to determine if smoking and other weight-control attempts differentially influenced long-term weight control. Results of these analyses indicated none of these factors significantly affected the findings.6

5 To evaluate whether the use of self-report data influenced evaluation of the outcomes, percent overweight changes were analyzed using only directly measured data. The analyses showed a differential effect of treatment over time, F(18, 234) = 1.76, p = .032, with no major differences in outcome when self-reported data were not used.

6 Twenty three percent of the subjects reported being active smokers, 13% former smokers, and 64% nonsmokers. No significant differences were observed in long-term percent overweight change as a function of smoking, with percent overweight change for nonsmokers, former smokers and regular smokers as follows: −6.4 ± 29.9; −1.9 ±
Regression analyses to predict change in percentage overweight.

The demographic and height and weight predictors included child's age and sex, participating parent's age and sex, family socioeconomic status, child's height and percentage overweight at baseline, parent's height and percentage overweight at baseline, and child's and parent's response to treatment as shown by respective percentages overweight from Months 0–6 and from Months 0–60. Analyses of all predictors showed 0- to 60-month change to be predictive of 10-year changes ($r = .72$, $r^2 = .52$). When the 5-year change was not included, a best fitting model was developed that accounted for 34% of the variance in long-term outcome (Table 4). The variables in this model included child's sex, child's baseline percentage overweight, and -4.2 ± 30.0. No differences in percent of smokers by group were observed, $\chi^2(9, N = 158) = 9.05, p = .43$. Ninety-four percent of the subjects attempted additional weight control efforts over the 10 years of follow-up. The average subject attempted 3.4 ± 3.0 other times to lose weight over the 10 years, which resulted in an average of 3.2 ± 5.6 pounds per attempt. The majority of efforts were self-directed. Analyses of variance showed no differences in the number of additional weight loss attempts per group ($p = .69$), and no relationship between the number of programs and long-term success ($r = .10, p = .26$). No differences were observed in the average amount of weight change by these programs per group ($p = .10$). There were too few subjects reporting use of appetite suppressants or long periods of inactivity for analysis of these factors.

Figure 1. Changes in percentage overweight after 5 and 10 years of follow-up for obese children randomly assigned to 10 interventions across four studies. (The 95% confidence interval for the total sample of children is represented by dotted lines.)
weight, number of meals eaten at home, percentage overweight for people with whom the child lives, self-monitoring daily weight, good eating encouragement from the family, discouragement of bad eating from a friend, exercise participation by a roommate, and exercise rewards by a roommate. Child’s age and fat intake were related to outcome in individual models but were not retained when other variables were included.  

Factors related to eating disorders and child psychiatric problems. We attempted to evaluate factors that may have been related to the development of eating disorders and child psychiatric problems. Because the number of cases in the eating disorder and psychiatric disorders samples were small, traditional between-groups statistics were not appropriate for comparisons. The 95% confidence interval for the children who were not treated for psychiatric disorders for each variable was constructed, and children and parents with psychiatric problems were compared with these intervals. Variables that were outside the 95% confidence intervals for the nonpsychiatric cases are noted in Table 5. In spite of the limitations of these small sample sizes, there were several suggestive differences. Children who developed psychiatric disorders were below the 95% confidence interval for baseline percentage overweight in comparison with children without psychiatric disorders. These children also showed changes in percentage overweight that were below the 95% confidence interval at 5 and 10 years. Children who developed eating disorders had mothers who were less obese and fathers who were more obese at baseline than the respective 95% confidence intervals for parents of children without psychiatric problems.

Discussion

Treatment Outcome

Between-groups differences were shown from 0 to 10 years in Studies 1 and 4, consistent with previous data published on

Table 3

Differences in Percentage of Children Who Showed Increases or Decreases of 10% or 20% From Baseline Percentage Overweight or Who Were Nonobese at the Final Follow-Up

<table>
<thead>
<tr>
<th>Condition</th>
<th>%age children</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>≤20%</td>
<td>-19%−19%</td>
</tr>
<tr>
<td>Study 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parent-child</td>
<td>43</td>
<td>43</td>
</tr>
<tr>
<td>Child</td>
<td>22</td>
<td>50</td>
</tr>
<tr>
<td>Nonspecific</td>
<td>29</td>
<td>33</td>
</tr>
<tr>
<td>Study 2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diet and information</td>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td>Diet and lifestyle</td>
<td>31</td>
<td>69</td>
</tr>
<tr>
<td>Study 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Family history +</td>
<td>33</td>
<td>33</td>
</tr>
<tr>
<td>Family history −</td>
<td>16</td>
<td>77</td>
</tr>
<tr>
<td>Study 4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Diet and aerobic</td>
<td>58</td>
<td>25</td>
</tr>
<tr>
<td>Diet and lifestyle</td>
<td>64</td>
<td>21</td>
</tr>
<tr>
<td>Diet and calisthenics</td>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td>Total (N = 158)</td>
<td>53</td>
<td>73</td>
</tr>
<tr>
<td>%</td>
<td>33.5</td>
<td>46.2</td>
</tr>
</tbody>
</table>

Table 4

Regression Model for Change in Percentage Overweight Over 10 Years

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>SE</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Child’s sex</td>
<td>-8.85</td>
<td>4.40</td>
<td>2.01</td>
<td>.046</td>
</tr>
<tr>
<td>Child’s baseline %age overweight</td>
<td>-0.46</td>
<td>0.13</td>
<td>3.64</td>
<td>.000</td>
</tr>
<tr>
<td>No. meals eaten at home per week</td>
<td>1.66</td>
<td>0.44</td>
<td>3.74</td>
<td>.000</td>
</tr>
<tr>
<td>%age overweight of people child</td>
<td>0.35</td>
<td>0.30</td>
<td>1.24</td>
<td>.231</td>
</tr>
<tr>
<td>lives with</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-monitoring daily weight</td>
<td>-4.78</td>
<td>1.64</td>
<td>2.92</td>
<td>.004</td>
</tr>
<tr>
<td>Good eating encouragement from</td>
<td>0.96</td>
<td>0.35</td>
<td>2.77</td>
<td>.007</td>
</tr>
<tr>
<td>family</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bad eating discouragement from</td>
<td>-0.73</td>
<td>0.31</td>
<td>2.35</td>
<td>.021</td>
</tr>
<tr>
<td>friend</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exercise participation with room-</td>
<td>-0.73</td>
<td>0.31</td>
<td>2.35</td>
<td>.021</td>
</tr>
<tr>
<td>mate</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exercise rewards from roommante</td>
<td>2.07</td>
<td>1.07</td>
<td>1.94</td>
<td>.055</td>
</tr>
</tbody>
</table>

Note. N = 129, R = .584, R² = .341; F for equation = 7.77, p < .001. Sex was coded 0 for boys and 1 for girls. A negative relation suggests that the greater level of a variable is associated with more success (larger decreases in percentage overweight), whereas a positive relation suggests that a lower level of the variable is associated with greater success.

the 5-year changes (Epstein, McCurley, Wing, & Valoski, 1990). In Study 1, the parent-and-child group had a significantly greater change in percentage overweight than did the control group, which supports the idea of treating both parents and children in families in which obesity is represented in both generations. The long-term superiority of including exercise with diet is shown in Study 4, as both of the exercise groups showed better effects than the calisthenics control group. In addition to the statistically significant between-groups differences, Figure 1 shows the changes in these treatment groups were at or above the 95% confidence interval and the control group was below the 95% confidence interval for magnitude of change. Thus, the changes were statistically significant and of large magnitude. It is interesting that even in Studies 2 and 3, which did not show significant between-groups differences in comparisons with internal control groups, large magnitude decreases in percentage overweight for individual groups were shown.

Thirty percent of all children achieved nonobese status, and about one third had a decrease to at least 20% overweight. Although comparing experimental treatments to within-study

7 Regressions to test significant variables within each conceptually similar subgroup of variables were conducted prior to the establishing the complete model. The model using only baseline characteristics included sex, age and initial percent overweight (R = .357, R² = .127, F for equation = 7.48, p < .001). Children who were older, female, with those more obese showing the greatest change. Grams of fat intake (r = .21, p < .05) and percent fat intake of calories (r = .19, p < .05) were related to long-term success. Total caloric expenditure per week (r = .06, p = .05) was not related to outcome. Frequency of self-monitoring of weight was the only self-reported aspect of program adherence related to 10-year outcome, r = .22, p = .012. Two environmental variables were related to outcome, the number of meals eaten at home and the number of obese people with whom the child currently lives (R = .309, R² = .095, F for equation = 6.92, p = .001).
control groups provides a rigorous test of treatment efficacy, it may be interesting to know the effectiveness of these interventions in contrast with a no-treatment or a standard minimal treatment or usual care control group. Research has shown that children who are obese (on the average 40% or more overweight) are more likely to maintain their obesity and become obese adults than their leaner peers (Abraham et al., 1981), but there are no longitudinal data to estimate the natural changes of obese children with obese parents who seek treatment. It is likely that nontreated children are less successful than children in the internal control groups in our studies. Children provided with these internal control treatments showed large magnitude within-treatment changes, and significant treatment-control differences emerged only during follow-up. The treatment groups generally maintained their effects, and the control groups showed a more rapid return to baseline or even greater levels of obesity.

One methodological factor that can influence the evaluation of treatment outcome is power (Cohen, 1977). For example, families in the group with no obese parent in Study 2 were outside the 95% confidence interval for change in percentage overweight and marginally different ($p = .12$) from the group with at least one obese parent. The sample size needed for significant ($p < .05$) between-groups differences was determined with power analysis based on the standard deviation of the pooled sample (29.7). Sample sizes of 72 subjects per group are needed to demonstrate the difference of 14.05 we observed between children with at least one obese parent and no obese parent. Also, the difference in Study 1 between the parent-and-child and child-only groups of 10.6 requires almost 140 subjects per group to be significant. These power analyses suggest that only very large between-groups effects can be detected over 10-year intervals, and future studies may require large sample sizes to detect differences between alternative treatments.

**Prediction of Long-Term Outcome**

The best predictor of change over the 10 years was change during the first 5 years ($r = .72$). When this variable was not included, variables of baseline characteristics, the eating and exercise environment, and support from family and friends were predictive of outcome. The multiple correlation of .34 for the best fitting model to predict 10-year change was encouraging because many of the variables are theoretically relevant and may be manipulated in treatment. These measures include variables collected prospectively as well as variables collected at the 10-year follow-up. Some of the variables collected at 10 years assessed current status, such as who the person lives with, how obese or active these persons are, and how supportive they may be in regard to eating or activity change. Other variables are designed to assess current levels of factors related to energy balance, such as caloric or macronutrient intake or activity level. These variables were collected retrospectively by asking about behaviors over the last year. Variables collected retrospectively must be interpreted cautiously in long-term studies, as was discussed in the presentation of the 5-year results (Epstein et al., 1992).

**Relationship of Weight Loss and Psychological Problems**

There is a high prevalence of psychiatric illness (Black et al., 1992; Goldsmith et al., 1992) and eating disorder (Spitzer et
al., 1992; Spitzer et al., 1993) in obese adults who seek treatment for obesity, in contrast to community samples. Given the increased prevalence of psychiatric problems in persons who seek specialized treatment for obesity and the increased prevalence of bulimia in young adult females with obesity or a history of obesity (Pyle, Neuman, Halvorson, & Mitchell, 1991), a higher prevalence of problems might be expected in this population of children who sought treatment for obesity in comparison to obese children in families who do not seek this type of treatment. The prevalence of bulimia nervosa or other psychiatric problems during the 10-year follow-up do not appear high. Approximately 4% of the children reported seeking treatment for bulimia nervosa. Self-report studies have shown an average prevalence for eating disorders of 9% in girls, but structured-interview studies have shown a lower prevalence of up to 5% (Fairburn & Beglin, 1990). Research is needed to evaluate if sensible weight-control programs can prevent eating disorders by providing other weight regulatory coping responses than bingeing and purging.

The most prevalent psychiatric problem was depression (11.6%). More of the parents of children who sought help for psychiatric problems also sought such help than did parents of obese children without psychiatric problems. There is very little data on the prevalence of psychiatric problems in children who enter obesity treatment, but research on adults suggests a high prevalence of psychological problems in adults who enter weight-control programs (Black et al., 1992; Goldsmith et al., 1992). In a different sample of obese children entering treatment, Epstein, Klein, and Wisniewski (1994) found that 29% met or exceeded clinical levels for psychological problems on the Child Behavior Checklist (Achenbach, 1991), with the most prevalent elevations on the Anxiety–Depression and Social Problem scales. In that sample, child psychopathology was not related to degree of childhood obesity but rather to degree of parent psychological distress.

Children who developed psychiatric disorders were less obese and less successful in long-term weight control than children who did not. Parents of the former may have a lower weight threshold before they think treatment is indicated and may have been seeking help for their child’s psychological discomfort, though these efforts did not result in better weight loss.

In summary, the results of these studies provide support for the family-based behavioral treatment of childhood obesity. These studies provide the first evidence that weight regulation in children can be achieved and maintained over extended periods from childhood through adolescence to adulthood. The studies point to two treatment variables that can be replicated and extended in subsequent studies. Study 1 suggested that in intact families effects are improved for children by including a parent with the child in treatment. This effect ought to be replicated in other populations, in particular, single-parent and disadvantaged families. The power of these family-based procedures may be enhanced by including in treatment other family members that influence the eating and exercise regulation of the targeted child, such as both parents and siblings. Study 4 suggested that exercise enhances the long-term effects of diet interventions, but additional work is needed on other types of exercise programs, such as resistance exercise or cross training. Likewise, the interaction between diet and exercise change needs to be explored, and the type of diet that best compliments activity change and the order of implementation (together or sequential) of diet and exercise change addressed. The treated children generally showed long-term decreases in percentage overweight, and some interventions that did not show between-groups differences at 10 years showed sustained decreases in percentage overweight and may warrant additional research. Given that these studies involve 10-year follow-up, with the series initiated in 1977, the interventions are quite old and may not represent state-of-the-art treatment. Newer studies, which take advantage of advances in understanding child development, methods of incorporating many family members in treatment, and behavioral and biological research on eating and activity may result in further improvements in the outcome of attempts to prevent obese children from becoming obese adults (Epstein, 1990).

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