Importance of Early Weight Change in a Pediatric Weight Management Trial

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KEY WORDS
obesity, child, weight loss, early response, family-based treatment

ABBREVIATIONS
FBT—family-based behavioral weight loss treatment
MT—maintenance treatment
SES—socioeconomic status
SSEHS—Social Support for Eating/Exercise Habits Survey

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WHAT'S KNOWN ON THIS SUBJECT: Early weight change predicts eventual weight loss treatment outcome in adults, but little is known about the importance of early response in children. Predictors of early weight change are unknown, which limits the clinical utility of this marker of outcome.

WHAT THIS STUDY ADDS: Children's weight change by session 8 of a family-based pediatric weight control intervention predicted BMI *z* score change up to 2 years after treatment. Better treatment attendance and greater early weight change in parents were associated with children's weight change by session 8.

abstract

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OBJECTIVE: Early weight change is associated with overall weight loss treatment response in adults but has been relatively unexplored in youth. We investigated the importance of early weight change in a pediatric weight control trial.

METHODS: Overweight children aged 7 to 12 years ($n = 204$) participated in a randomized controlled trial of 2 weight maintenance treatments (MTs) after a 20-week family-based behavioral weight loss treatment (FBT). Hierarchical regression was used to investigate the relation between children's percentage weight change at sessions 4, 6, and 8 of FBT and BMI *z*-score reductions after FBT and at the 2-year follow-up. Correlations and hierarchical regression were used to identify child and parent factors associated with children's early weight change.

RESULTS: Children's percentage weight change by FBT session 8 was the best predictor of BMI *z*-score reductions after FBT and at 2-year follow-up. Percentage weight change in children at the session 8 was associated with better FBT attendance and with greater percentage weight change in parents at FBT session 8.

CONCLUSIONS: Early weight change seems to be related to treatment response through the end of treatment and 2-year follow-up. Future research should include investigation of strategies to promote early weight change in children and parents and identification of mechanisms through which early weight change is related to overall treatment response. *Pediatrics* 2011;128:e33–e39

Obesity affects 18% of children in the United States[1] and is associated with adverse health consequences.[2,3] Moderate- to high-intensity family-based behavioral weight loss treatment (FBT) is the most well-established intervention for pediatric obesity,[4,5] and maintenance treatments (MTs) can extend its effects for up to 2 years.[6,7] Nevertheless, relapse remains a significant problem.[4] Identification of factors associated with better outcome can help maximize the effectiveness of existing interventions.

Results of several studies in adults suggest that early weight loss predicts overall treatment outcome.[8–10] Jelalian and colleagues[11] extended these findings to adolescents aged 13 to 16 years; weight loss within the first 4 weeks of treatment predicted ultimate weight loss after treatment. Replication of these results in preadolescent sample populations is needed, because weight control treatment is strongly indicated in this population as a means to minimize obesity chronicity and related comorbidities.[5]

It is unclear why early treatment response is such a potent predictor of overall treatment outcome among adolescents and adults. Identification of factors that promote early weight change is critical, because modification of these factors before the initiation of weight loss treatment may promote better early response. Self-efficacy and social support are important determinants of overall obesity treatment outcome[12]; theoretically, these factors may be especially important early in treatment, when families initiate most behavioral changes.[13] Moreover, given the importance of parental involvement in child treatment outcome,[14,15] it is relevant to examine the impact of parent early weight change and functioning on children's early weight change.

The ideal amount of weight loss early in treatment is unknown, which could hinder treatment planning. In this study we examined the relation between early weight change in children and their overall short-term and long-term treatment outcomes, and we sought to identify the optimal amount and timing of early weight loss in predicting overall short-term and long-term outcomes. We expected early treatment response to be associated with better short-term and long-term weight outcomes.[8–11] Our exploratory aims were to investigate demographic, behavioral, and psychosocial correlates of children's early treatment response. We hypothesized that greater early weight change in children would be related to greater early weight change in parents[14,15], higher child and parent baseline self-efficacy and social support[12], and higher FBT attendance.

METHODS

Participants

Participants in this randomized controlled trial of 2 MTs after FBT[6] were 204 overweight children (20%–100% above the median age-specific and gender-specific BMIs) aged 7 to 12 years, who had at least 1 overweight parent (BMI $\geq$ 25).

Participants were recruited via local media outlets, community organizations, and pediatric clinics in and around San Diego, California. Child and parent exclusion criteria included medical or psychiatric disturbances that would limit treatment participation, use of medications that affected appetite and/or weight, and involvement in weight-loss or psychological treatment. Of the 204 families who entered the study, weight data were available for 153 children after FBT, 145 children after MT, 138 children at 1-year follow-up, and 125 children at 2-year follow-up. The primary study analyses used the post-FBT sample of 153 participants. Detailed descriptions of the study flow are provided elsewhere.[6]

Procedures

After completing FBT, families were randomly assigned to 1 of 3 MT conditions: behavioral skills maintenance; social facilitation maintenance; or a no-continued-treatment control group. FBT and active MT consisted of 20-minute individual family (typically parent-child dyad) sessions, led by clinicians whose minimum education was a bachelor's degree, and 40-minute concurrent child and parent group sessions, led by doctoral student clinicians whose minimum education was a master's degree. In group sessions participants were taught basic weight control strategies (see below for modality-specific content). Group session content was similar for parents and children, except that parents received additional information on effective parenting skills. Family sessions reinforced group session content and provided more tailored treatment (eg, linking weekly weight change to eating/activity behaviors).

The same therapists administered FBT and both MTs. Treatment fidelity was monitored through ongoing supervision, which included audiotape review. Randomly selected audiotapes of treatment sessions were reviewed by 2 raters who evaluated the distinct content areas of each active MT (see ref[6] for additional details). For both raters, the content areas for the MT treatments significantly differed ($P <$ .003) across child group, parent group, and individual family sessions, which suggested that MTs were conducted with high treatment fidelity.

Psychosocial and anthropometric data were collected at baseline (before initiation of FBT), after FBT, after MT, and 1 and 2 years after FBT. Only baseline psychosocial measures were included in the current study; because we sought to examine the relation between early weight change and short-term and long-term weight outcomes, only post-FBT and 2-year follow-up anthropometric data were examined in relation to early weight change. Although interventionists sometimes collected baseline and follow-up data, every effort was made to ensure that interventionists did not evaluate their own patients at any time point, including obtaining weekly weights. Although it was not possible to blind assessors to MT assignment, a standard protocol was used to ensure objective height and weight measurements. Moreover, assessors were blinded to participants' previous height and weight values.

Children and parents provided written informed assent and consent, respectively. The study received institutional review board approval.

Interventions

FBT was delivered in 20 weekly sessions for a 5-month period. FBT content addressed dietary, activity, and behavioral aspects of weight control.[16] Behavior change techniques included self-monitoring of food intake and physical activity (introduced at session 1), modeling (introduced at session 4), positive reinforcement (introduced at session 6), and stimulus control (introduced at session 14). For the first 2 weeks of FBT, participants were instructed to self-monitor their food intake to master this essential skill, but were not asked to change their eating or activity behaviors. Children's weight loss goal thereafter was one-half pound per week. The dietary component of treatment was introduced at session 2, and used the "traffic light" approach[17] to reduce caloric intake and improve nutrition (a calorie goal of 1200–1500 kcal/day was introduced at session 3). Physical activity self-monitoring was introduced at session 7, and related goals at session 8, shaped to an ultimate goal of 90 minutes of moderate to intense activity for at least 5 days/week (additional content covered reduction of sedentary behaviors).

MT lasted 16 weeks. Although both MTs focused on achieving energy balance, they were theoretically and procedurally distinct: whereas behavioral skills maintenance focused on helping families develop behavioral weight-maintenance skills, social facilitation maintenance focused on helping families change their social environment to support weight maintenance. The control group received no additional treatment contact after FBT.

Measures

Demographic Measures

Child and parent weight and height were measured by trained research assistants using a calibrated balance beam scale and stadiometer. Weight was measured weekly and at major study time points; height was measured only at major study time points (ie, at baseline, after FBT, and at the 2-year follow-up). Children's BMI *z* scores were calculated by using age- and gender-specific CDC normative data[18] based on their most recent height measurement. Socioeconomic status (SES) was determined by using the Hollingshead 4-factor index.[19]

Self-Efficacy

On the 15-item Child Dietary Self-Efficacy Scale (current study $\alpha = .85$),[20] children self-reported their perceived efficacy in choosing healthy foods. The 4-item barriers subscale of the child-reported Self-Efficacy Scale for Children's Physical Activity (Kuder-Richardson formula 20 coefficient = .55)[21] assessed children's perceived efficacy in overcoming barriers to physical activity. Both measures have good reliability and validity in children.[20,21] The 8-item sticking to it subscale of the Eating/Exercise Habits Confidence Survey ($\alpha = .89$)[22] measured parents' self-reported exercise self-efficacy. This measure has acceptable psychometric properties.[22]

Social Support

Social support received for eating and physical activity were self-reported separately by children and parents using the Social Support for Eating/Exercise Habits Survey (SSEHS).[23] We included the child-reported family participation subscale, which contains 9 items ($\alpha = .86$) that measure familial involvement in physical activity with the respondent; and the parent-reported family encouragement subscale, which contains 5 items ($\alpha = .83$) that measure perceived familial support for the respondent's healthy eating behaviors. The scale has good criterion and discriminant validity in adults[23] and has been successfully adapted for children.[24]

Statistical Analyses

Data analyses were conducted using SPSS 16.0 (SPSS Inc, Chicago, IL). Because we detected 2 influential outliers in our previous study[6], we considered eliminating these participants from analyses; however, because results were similar with or without the outliers, the data reported henceforth are based on analyses that include these outliers. Missing weekly weights for children (458 of 3060 possible data points [a maximum of 20 weeks of FBT for 153 participants]) and parents (511 of 3060 possible data points) were handled by using linear interpolation.

A series of hierarchical linear regressions was conducted using the percentage change in body weight at FBT sessions 4, 6, and 8 (which corresponded to the introduction of major treatment targets; see "Interventions" section) to predict percentage reduction in BMI *z* score after FBT and at 2-year follow-up. Each model included child age, gender, race/ethnicity, and baseline BMI *z* score as covariates. Maintenance status (ie, whether the child was randomized to active MT versus control) was also considered as a covariate, but was dropped from the analyses because it did not significantly contribute to any of the regression models. Weekly weight change for the regression analyses was limited to the first 8 sessions of treatment to ensure that analyses truly captured early response data. BMI *z* score was used as a measure of short-term and long-term treatment response to account for expected changes in height over time, whereas absolute weight was used as a measure of early response because height changes were not expected over the course of 4 to 8 weeks. The optimal time point characterizing early response was selected on the basis of regression model that accounted for the most variance in BMI *z*-score reduction after FBT and at 2-year follow-up. The optimal amount of early weight change for predicting 5% and 10% post-FBT and 2-year reductions in BMI *z*-score was calculated on the basis of the unstandardized coefficients from the regression model.

An exploratory study aim was to identify demographic, behavioral, and psychosocial correlates of early treatment response (defined according to the best predictor from the regression analyses for percentage weight change). Correlations were used to examine associations between children's early percentage weight change and baseline BMI *z* score, SES, age, and number of FBT sessions attended. One-way ANOVAs were used to examine relations between children's early percentage weight change and race/ethnicity. We used *t* tests to examine percentage weight change among boys versus girls, and study completers (ie, participants who were available at 2-year follow-up) versus noncompleters. Hierarchical regression was used to examine parent and child predictors of children's early percentage weight change. Step 1 included the barriers subscale of the child-reported Self-Efficacy Scale for Children's Physical Activity, the Child Dietary Self-Efficacy Scale total scores, and the SSEHS family participation subscale. Step 2 included parent early percentage weight change (which corresponded to the FBT session identified as the best predictor in the child percentage weight change regressions), the Eating/Exercise Habits Confidence Survey sticking to it subscale, and the SSEHS family encouragement subscale. Child and parent measures comprised separate steps in the regression to determine their independent effects.

TABLE 1 Hierarchical Regression Results for Percentage Early Weight Change Predicting Post-FBT Reductions in BMI *z* Score

Variables	B	SE B	β	R^2	ΔR^2
Session 4 percentage weight change					
Step 1: child demographics				.20	.20[b]
Child gender	.01	.01	.04		
Child race/ethnicity	−.01	.01	−.05		
Child baseline age	−.01	.01	−.18[a]		
Child baseline BMI *z* score	−.14	.02	−.44[b]		
Step 2: Early weight change				.33	.13[b]
Session 4 weight change	1.90	.36	.36[b]		
Session 6 percentage weight change					
Step 1: child demographics				.20	.20[b]
Child gender	.01	.01	.07		
Child race/ethnicity	−.01	.01	−.06		
Child baseline age	−.01	.01	−.20[a]		
Child baseline BMI *z* score	−.14	.02	−.46[b]		
Step 2: early weight change				.42	.22[b]
Session 6 weight change	2.15	.29	.48[b]		
Session 8 percentage weight change					
Step 1: child demographics				.20	.20[b]
Child gender	.02	.01	.07		
Child race/ethnicity	−.01	.01	−.04		
Child baseline age	−.01	.00	−.20[a]		
Child baseline BMI *z* score	−.13	.02	−.44[b]		
Step 2: early weight change				.52	.32[b]
Session 8 weight change	2.02	.21	.57[b]		

[a] $P < .01$.
[b] $P < .001$.

RESULTS

Participant Characteristics

Children were, on average, 9.8 years old (SD: 1.3), with an average SES score of 46.6 (SD: 11.1), corresponding to middle class. Children's mean baseline BMI *z* score was 2.22 (SD: 0.30). Most children were female ($n = 131$ [64.2%]) and white/non-Hispanic ($n = 134$ [65.7%]) versus white/Hispanic ($n = 42$ [20.6%]), black ($n = 22$ [10.8%]), or other ($n = 6$ [2.9%]). Children's mean BMI *z*-score change was −10.3% (SD: 9.2; range: −58% [58% BMI *z*-score reduction] to +4% [4% BMI *z*-score increase]) from baseline to after FBT, and −9.0% (SD: 16.8; range: −79% to +17%) from baseline to 2-year follow-up.

Post-FBT and 2-Year Relative Weight Outcomes Prediction Based on Children's Early Weight Change

The regression models for predicting percentage reduction in BMI *z* score after FBT and at 2-year follow-up based on percentage weight change at ses-

TABLE 2 Hierarchical Regression Results for Percentage of Early Weight Change Predicting 2-Year Follow-up Reductions in BMI *z* Score

Variables	B	SE B	β	R^2	ΔR^2
Session 4 percentage weight change					
Step 1: child demographics				.05	.05
Child gender	.01	.03	.03		
Child race/ethnicity	.01	.03	.03		
Child baseline age	.01	.01	.04		
Child baseline BMI *z* score	−.13	.05	−.23[a]		
Step 2: early weight change				.09	.05[a]
Session 4 weight change	2.12	.85	.22[a]		
Session 6 percentage weight change					
Step 1: child demographics				.05	.05
Child gender	.02	.03	.05		
Child race/ethnicity	.01	.03	.03		
Child baseline age	.01	.01	.04		
Child baseline BMI *z* score	−.14	.05	−.24[a]		
Step 2: Early weight change				.10	.06[b]
Session 6 weight change	2.04	.73	.25[b]		
Session 8 percentage weight change					
Step 1: child demographics				.05	.05
Child gender	.02	.03	.05		
Child race/ethnicity	.01	.03	.04		
Child baseline age	.01	.01	.04		
Child baseline BMI *z* score	−.13	.05	−.23[a]		
Step 2: early weight change				.11	.07[b]
Session 8 weight change	1.69	.56	.26[b]		

[a] $P < .05$.
[b] $P < .01$.

sions 4, 6, and 8 were all significant ($P < .05$; see Tables 1 and 2). Session 8 percentage weight change accounted for the most variance in percentage reduction in BMI *z* score after FBT and 2-year follow-up, compared with sessions 4 and 6. After FBT, the full model, including child demographic variables and session 8 percentage weight change, accounted for 50.2% of the variance in BMI *z*-score reduction ($F_{5,152} = 31.64$; $P < .001$); percentage weight change at session 8 accounted for 31.8% of the variance beyond child age, gender, ethnicity, and baseline BMI *z* score ($\Delta F_{1,147} = 96.95$; $P < .001$). At 2-year follow-up, the full model accounted for 11.3% of the variance in BMI *z*-score reduction ($F_{5,124} = 3.03$; $P = .01$), with percentage weight change at session 8 accounting for 6.8% of the variance beyond child demographic variables ($\Delta F_{1,119} = 9.06$; $P = .003$).

Using the unstandardized coefficients from each regression model, we found that a loss of 5.9% of initial body weight at session 8 was necessary to achieve a 5% reduction in BMI *z* score by the completion of FBT; a loss of 4.4% of initial body weight was necessary to achieve a 5% reduction in BMI *z* score at 2-year follow-up. These values translated to average weight losses of 7.5 pounds (SD: 1.6 pounds) and 5.6 pounds (SD: 1.2 pounds), respectively. A loss of 8.4% of initial body weight at session 8 was necessary to achieve a 10% reduction in BMI *z* score by the completion of FBT, and a loss of 7.3% of initial body weight at session 8 was necessary to achieve a 10% reduction in BMI z score at 2-year follow-up. These values corresponded to average weight losses of 10.7 pounds (SD: 2.3) and 9.3 pounds (SD: 2.0), respectively.

Correlates of Children's Early Weight Change

Child percentage weight change at FBT session 8 was not associated at zero-order with child baseline BMI *z* score ($r = .01$; $P = .88$), SES ($r = .01$; $P = .91$), age ($r = .02$; $P = .84$), gender ($t_{174} = 1.56$; $P = .12$), or race/ethnicity ($F_{3,172} = 0.72$; $P = .54$). Percentage weight change at session 8 was associated with greater FBT attendance through session 8 ($r = .27$; $P = .001$), but not with attendance after session 8 ($r = .11$; $P = .15$). Study completers and noncompleters did not differ in terms of percentage weight change at session 8 ($t_{171} = 1.03$; $P = .30$).

The full regression model including child psychosocial functioning (step 1), and parent early percentage weight change and psychosocial functioning (step 2) accounted for 11.7% of the variance in child percentage weight change by session 8 ($F_{6,148} = 3.14$; $P = .006$). Parent functioning explained 8.9% of the variance in children's early percentage weight change beyond the effects of child functioning ($\Delta F_{3,142} = 4.77$; $P = .004$); child functioning did not independently contribute to the model ($F_{3,145} = 1.39$; $P = .25$). The only significant individual predictor was parent percentage weight change at session 8 ($\beta = .28$; $t = 3.33$; $P = .001$).

DISCUSSION

We investigated the importance of early weight change in a pediatric weight control trial. Children's percentage weight change at FBT session 8 was associated with weight outcomes after FBT and at 2-year follow-up, although effects were attenuated over time. Specifically, a loss of ∼4% to 8% of initial body weight by session 8 was necessary to achieve successful short-term and long-term treatment response (ie, 5% or 10% BMI *z*-score reduction). This rate of weight loss is in accordance with expert recommendations[25] and, thus, allays potential safety concerns regarding rapid weight loss. Overall, results support the existing literature, which indicates the importance of early weight change in predicting treatment response over time, at least while children are still in treatment and up to 2 years after treatment.

Although children's percentage weight change at FBT session 8 was associated with greater changes in BMI *z* score in both the short-term and long-term, early percentage weight change was a more potent predictor of short-term than long-term weight outcome. This result is not surprising, because different skills are required for early weight loss compared with sustained weight maintenance.[6,26] That said, successful weight maintenance likely involves building on behavioral skills acquired early in treatment, which may explain why early weight change was significantly related to long-term outcome.

Children's early treatment response was associated with early FBT attendance. This may be because better attendance early in treatment contributed to mastery of weight loss skills, which in turn promoted early weight change. Future studies should investigate whether children who fail to achieve significant early reductions in body weight would benefit from an alternative treatment approach. For example, more individualized attention to factors that inhibit initial progress may be necessary.

It remains unclear why early treatment response is such a potent predictor of overall treatment outcome, although many hypotheses exist. In this study, neither parent nor child psychosocial functioning predicted weight change by session 8. However, parent weight change at session 8 predicted child weight change at session 8, which suggests that similar constructs may promote early weight change in both parents and children (eg, changes to the home environment[27]); alternatively, parents' success with their own weight-control behaviors may have provided better modeling for their children. A logical next step is to examine a wider range of psychosocial characteristics in relation to early response. For example, motivation and readiness for change may be important in the initial stages of treatment[12] as families prepare to undertake dramatic changes in weight-related behaviors. It will also be important to identify factors (and obtain early and frequent assessment of them) that mediate the relation between early weight change and overall treatment response.

The current study has several limitations. Measures of adherence to targeted weight-related behaviors were not available during FBT, which precluded examination of the behavioral mechanisms by which early change mediated overall treatment response. All psychological measures were administered at baseline, thus reports on 1 measure could have influenced reports on related measures completed in a similar time frame. Finally, although our sample was more racially/ethnically diverse than many previous studies, the largely female and non-Hispanic white sample may limit generalizability of our findings. Nevertheless, the study had several strengths, including a large sample, and the availability of long-term follow-up data. Moreover, this is the first study to report on early weight change in preadolescent children and to examine predictors of early treatment response.

Overall, our findings warrant replication but have several important clinical implications. Because early weight change seems to be a marker for children's long-term treatment response (and one that is both reliable and easily obtained), providers are advised to assist their patients in achieving early weight loss to maximize overall treatment outcome. Children who are unable to achieve early weight loss may require additional encouragement from parents and/or treatment providers to attend treatment regularly and persist with behavioral changes. Future research should identify factors responsible for early weight change and further explore the relation between early response and overall treatment outcome. In summary, early treatment response seems to be an important factor in the ultimate outcome of pediatric weight loss treatment, and warrants further investigation as a means to maximize the long-term effectiveness of existing weight control interventions.

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