Parent Weight Change as a Predictor of Child Weight Change in Family-Based Behavioral Obesity Treatment

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Background: Family-based behavioral weight control treatment involves the parent in the modification of child and parent eating and activity change.

Objective: To assess if parent standardized body mass index (z-BMI) change predicts child z-BMI change.

Design: Secondary data analysis based on parent and child z-BMI changes from 3 family-based, randomized, controlled weight control studies. Hierarchical regression models tested whether parent z-BMI change increased prediction of child z-BMI change through treatment and 24-month follow-up beyond other factors that influence child weight change, such as child age, sex, socioeconomic status, and baseline child and parent z-BMI. Differences in child z-BMI change as a function of quartiles of parental z-BMI change were tested using an analysis of covariance.

Setting: Pediatric obesity research clinic.

Participants: Obese 8- to 12-year-old children and their parents from 142 families who participated in family-based weight control programs.

Main Outcome Measures: Child and parent z-BMI changes over time.

Results: Parent z-BMI change significantly predicted child z-BMI change for the 0- to 6-month \( (P < .001) \) and 0- to 24-month \( (P < .009) \) time points. In hierarchical regression models, parent z-BMI change was a significant incremental predictor of child z-BMI change at 6 and 24 months, with the additional \( r^2 \) ranging from 11.6% at 6 months \( (P < .001) \) to 3.8% at 24 months \( (P = .02) \). Parents in the highest quartile of z-BMI change had children with significantly greater z-BMI change than that of children with parents in the other quartiles \( (P = .01) \).

Conclusion: Parent z-BMI change is an independent predictor of obese child z-BMI change in family-based behavioral treatment, and youth benefit the most from parents who lose the most weight in family-based behavioral treatments.


FAMILY-BASED BEHAVIORAL treatments for obese youth are among the most successful for pediatric obesity, and meet evidence-based criteria for successful interventions. These interventions teach parenting techniques, such as reinforcement, stimulus control, and environmental restructuring, to create an environment that facilitates the acquisition and maintenance of healthier eating and activity for the obese child. In addition, obese parents also make behavior changes that are similar to those that the child makes. Parents who participate in family-based pediatric weight control lose weight, although long-term (10-year) data suggest that parents may not be as successful as their children in weight maintenance. The concurrent treatment of parents and children may motivate parents to make bigger changes in the home eating and activity environment than they might have made if they were not targets for behavior change in treatment. In addition, parent changes in eating and activity can provide models for child behavior change.

Families in which the children and parents are obese are common. Parental obesity may increase the risk of a child becoming obese, and the parent-child association is stronger when obesity is found in both, rather than in only one, of the parents. Family-based weight control that targets the parent and child may enhance treatment effectiveness compared with child-only interventions, and may also provide benefits for parental obesity resulting in improved cost-effectiveness of treatment compared with treating the child and parent separately. In fact, treatments...
that target only the parent are associated with better childhood weight control than those treatments that target only the child, which highlights the potential contributions of modifying parental behavior to treat problems that are shared within families.

Family-based interventions have shown that parent weight change is related to child weight change. Parent and child weight changes have been uniformly positive during treatment, with correlations ranging from 0.31 to 0.76. Correlations over extended intervals have varied between the studies, with some studies showing an improvement in the relationship over time, while others have shown a reduction in the relationship as follow-up is extended.

Including parents in pediatric obesity treatment, even if the parents are not specifically targeted for weight change, may lead to a relationship between parent and child weight change. Kirschenbaum and colleagues found that child weight loss was positively correlated (r = 0.57) with parent weight loss when the parents and children were included in treatment, but child weight change in the child-only group was negatively (r = −0.86) related to parental weight change. Israel and colleagues found that correlations between change in child and parent weights showed an increased association from intensive treatment (r = 0.06) to 1-year follow-up (r = 0.43) for the intervention group targeting parent’s own weight loss behaviors. The researchers suggested that the weight loss parental role enhances the association between parent and child patterns of weight change during periods of minimal therapeutic contact.

These studies suggest that family-based modification of physical activity and nutrition patterns may be related in part to treatment effects observed in parent participants in family treatment programs. It is possible there is common shared variance for factors that influence child and parent weight loss. Parent weight is related to child weight, but it may not make an independent contribution. Rather, parent weight may be related through some of the same variables that predict child weight change, such as child age, sex, and baseline obesity or parental obesity and family socioeconomic status (SES). To our knowledge, no study has evaluated the incremental effects of knowledge of parental weight control on child weight success while controlling for variables that influence child weight loss. This study evaluates the influence of parent standardized body mass index (z-BMI) changes on child z-BMI changes, to evaluate if these parental z-BMI changes added significant incremental prediction when accounting for other factors and to examine child and parent patterns of z-BMI changes by parent changes from baseline through 2 years (BMI is calculated as weight in kilograms divided by the square of height in meters).

**METHODS**

**PARTICIPANTS**

One participating parent and one 8- to 12-year-old child from each of 142 families recruited for 1 of 3 family-based weight control programs at the University at Buffalo were studied. Inclusion criteria included children greater than the 85th BMI percentile and participating parents greater than the 70th BMI percentile who were willing to attend treatment meetings. Participating parents were asked to change their eating and activity patterns and home environment. If the parents were not overweight, they were asked to eat more fruits and vegetables and low-fat dairy products and be more physically active; therefore, all parents could make positive health changes, even if they were not obese. We chose the 70th BMI percentile as a minimum amount of excess weight to include parents for these analyses. These parents may not have been obese, but they could lose excess weight if they changed their eating and activity patterns, and most parents were interested in losing weight even if they were not greater than the 85th BMI percentile. Only families with complete parent and child data at all time points were included for analyses. Families were participating in 1 of 3 studies designed to treat childhood obesity. All data were collected using identical procedures in all 3 studies, and were combined for this article. Consent and assent forms for each study were approved by the Social Sciences Human Subjects Review Committee at The State University of New York at Buffalo.

**MEASUREMENT**

**Height and Weight**

Height was measured in 0.32-cm increments using a stadiometer (Seca, Columbia, Md), and weight was measured in 0.11-kg increments using a balance beam scale, calibrated daily. Height and weight were used to calculate BMI. Body mass indexes standardized (z-BMI) for mean (M) and standard deviation (z-BMI = [BMI – M]/SD) were determined for each child and participating parent using norms based on Rosner et al and the Third National Health and Nutrition Examination. Percentage overweight was calculated by the following formula: (BMI – BMI at the 50th BMI percentile)/BMI at the 50th BMI percentile.

Most heights and weights were measured in the laboratory, with self-reported heights and weights used when families were unable to attend assessment. Because of underestimation of weight and overestimation of height, self-reported data were adjusted based on a data set of more than 1000 cases in which adult and child heights and weights were self-reported and then measured. Of child observations, 3.0% were parent reported, and 3.5% of participating parent observations were self-reported.

**Socioeconomic Status**

The Hollingshead Four Factor Index of Social Status was used to assess family SES. The 4 factors used to determine status were sex, marital status, educational level, and occupation. Educational level and occupation status are scored on a predetermined scale, and these values are multiplied by a weight of 3 and 5, respectively. The resulting values are then summed for the head of household, and if there is more than one head of household, their individual scores are averaged.

**WEIGHT CONTROL STUDIES**

All families were provided with an educational program based on the Traffic Light diet and a physical activity program. The Traffic Light diet is a color-coded food exchange system that categorizes foods based on macronutrient and micronutrient content. Green foods are low in fat and high in nutrient density, and are encouraged to be increased. Yellow foods have between 2 and 5 g of fat per serving and have moderate nutrient density, and should be eaten in moderation. Red foods have 5 g or more of fat per serving, or a high content of simple sug-
Regression analysis was used to determine the influence of parent z-BMI change on child z-BMI change for the 0- to 6-month and 0- to 24-month time points. β Coefficients, the 99% confidence intervals, P values, and coefficients of determination were calculated. Regression analysis also examined the influence of parent weight change on child weight change.

Hierarchical regression models were used to establish if parental change in z-BMI accounts for a significant amount of incremental variance in child z-BMI change when controlling for variables forced into step 1 of the model. Variables forced into step 1 included child’s sex, parent’s sex, SES, child’s age, mother’s age, father’s age, baseline child z-BMI, baseline mother z-BMI, and baseline father z-BMI; to control for the different studies, dummy variables were created for study group. Hierarchical regression models also examined the influence of parent weight change on child weight change.

To further examine the relationship of child weight change by parent weight change, parent 0- to 24-month weight change was divided into 4 categories (n=36, 35, 35, 36) by z-BMI change: −0.50 or less, −0.49 to −0.24, −0.23 to −0.06, and greater than −0.06. The mean parent weight change over 24 months for each respective category was as follows: −14.4, −3.2, −2.4, and 1.4 kg. The influence of these groupings on child weight change was determined using a 2-factor mixed analyses of covariance with grouping as the between variable and time as the within factor. Linear contrasts were used to compare differences in the rate of change between groups. Covariates included SES, child sex and age, and parent sex and baseline z-BMI to control for variables that might influence child z-BMI change. Mean child weight for height and percentage overweight changes for each parent z-BMI change category were also determined.

Parent weight change was also examined in relationship to the four 0- to 24-month parent z-BMI categories. The influence of these groupings on parent weight was determined using a similar 2-factor mixed analysis of covariance with grouping as the between variable, time as the within factor, and SES, child sex and age, and parent sex and baseline z-BMI as covariates. Mean parent weight and percentage overweight changes for each parent z-BMI change category were determined. All data analyses were conducted using computer software (SYSTAT). Data are given as mean (SD) unless otherwise indicated.

### RESULTS

Baseline descriptive statistics for child and parent data and change from baseline through 24 months are presented in Table 1. Children (58 boys and 84 girls) were aged 10.2 (1.2) years, were 60.9% (15.1%) overweight, had a BMI of 27.9 (3.0), had a BMI percentile of 94.7 (1.4), and had a z-BMI of 2.9 (0.9), and were 59.0% (n=84) girls. Parents were aged 40.8 (5.4) years, and their height was 166.1 (8.1) cm. Participating mothers (115 [81.0%]) were aged 41.9 (6.5) years, were 34.7% (11.3%) overweight, had a BMI of 31.2 (5.8), had a BMI percentile of 86.9 (10.4), and had a z-BMI of 1.3 (1.0). Participating fathers (27 [19.0%]) were aged 41.9 (6.5) years, were 34.7% (22.2%) overweight, had a BMI of 31.2 (5.8), had a BMI percentile of 86.9 (10.4), and had a z-BMI of 1.3 (1.0). Participating fathers (27 [19.0%]) were aged 41.9 (6.5) years, were 34.7% (22.2%) overweight, had a BMI of 31.2 (5.8), had a BMI percentile of 86.9 (10.4), and had a z-BMI of 1.3 (1.0).

### STATISTICAL ANALYSIS

Regression analysis was used to determine the influence of parent z-BMI change on child z-BMI change for the 0- to 6-month and 0- to 24-month time points. β Coefficients, the 99% confidence intervals, P values, and coefficients of determination were calculated. Regression analysis also examined the influence of parent weight change on child weight change.

Hierarchical regression models were used to establish if parental change in z-BMI accounts for a significant amount of incremental variance in child z-BMI change when controlling for variables forced into step 1 of the model. Variables forced into step 1 included child’s sex, parent’s sex, SES, child’s age, mother’s age, father’s age, baseline child z-BMI, baseline mother z-BMI, and baseline father z-BMI; to control for the different studies, dummy variables were created for study group. Hierarchical regression models also examined the influence of parent weight change on child weight change.

Regression analyses revealed that parent z-BMI change significantly predicted child z-BMI change for the 0- to 6-month time point (β = .46; 95% confidence interval, .31-.61; P<.001; and r² = 0.21) and the 0- to 24- month time point (β = .29; 95% confidence interval, .07-.51; P = .009, and r² = 0.05). Regression analyses also determined that parent weight change was a significant predictor of child weight change for both time points (0-6 months: β = .24; 95% confidence interval, .15-.32; P<.001; 0-24 months: β = .24; 95% confidence interval, .15-.32; P<.001;
and \( r^2 = 0.18 \); and 0-24 months: \( \beta = 0.19 \); 95% confidence interval, .04-.34; \( P = .02 \); and \( r^2 = 0.04 \).

Hierarchical regression models to predict average change in child z-BMI from the 0- to 6-month and the 0- to 24-month time points are shown in Table 2. Parent z-BMI, introduced in step 2 of the model, made a significant contribution to the model, increasing the variance accounted for at each time point: for 0 to 6 months, by 11.6% (\( F_{1,129} = 28.78, P < .001 \)) for a total multiple \( R^2 = 0.69 \) and an \( R^2 = 0.48 \) (\( P < .001 \)); and for 0 to 24 months, by 3.8% (\( F_{1,129} = 5.94, P < .02 \)) for a total multiple \( R^2 = 0.42 \) and an \( R^2 = 0.18 \) (\( P = .01 \)). A separate hierarchical regression model using parent and child weight rather than parent and child z-BMI also determined that parent weight change, introduced in step 2 of the model, made a significant contribution to the model at all time points.

Child z-BMI change differed over time as a function of parent z-BMI change quartiles (\( F_{9,399} = 2.87, P = .003 \)). As shown in the Figure, A, children of parents in the category of greatest z-BMI quartile (\( z \geq -0.50 \) z-BMI units) had greater reductions (\( z \geq -0.97 \) in z-BMI changes over time (\( P = .01 \)) than children of parents in the other 3 groups, who had smaller reductions or gains in z-BMI (\( z \geq -0.68 \)). Child z-BMI changes for this category significantly differed from those of the other 3 parent z-BMI change categories at the 0- to 6-month, 0- to 12-month, and 0- to 24-month time points (\( P = .002, P < .001, \) and \( P = .02, \) respectively). Likewise, children of the parents in the greatest z-BMI change quartile had greater reductions in weight for height and in percentage overweight (weight, \( z \geq -7.2 \) kg; height, \( z \geq 3.0 \) cm; and percentage overweight, \( z \geq -27.6 \)) after 6 months compared with chil-

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### Table 2. Hierarchical Regression Model Predicting Child z-BMI Change Through Treatment and 24 Months of Follow-up

<table>
<thead>
<tr>
<th>Variable</th>
<th>0-6 mo</th>
<th>0-24 mo</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Coefficient (95% CI)</td>
<td>P Value</td>
</tr>
<tr>
<td>0-6 mo</td>
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<td></td>
</tr>
<tr>
<td>Child sex</td>
<td>.181 (.013 to .349)</td>
<td>.04</td>
</tr>
<tr>
<td>Parent sex</td>
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<td>.25</td>
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<tr>
<td>SES</td>
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<td>Baseline age</td>
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<td></td>
</tr>
<tr>
<td>Child</td>
<td>.174 (.105 to .243)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Mother</td>
<td>-.010 (-.035 to .015)</td>
<td>.44</td>
</tr>
<tr>
<td>Father</td>
<td>-.006 (-.013 to .024)</td>
<td>.53</td>
</tr>
<tr>
<td>Baseline z-BMI</td>
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<td></td>
</tr>
<tr>
<td>Child</td>
<td>-.099 (-.202 to .004)</td>
<td>.06</td>
</tr>
<tr>
<td>Mother</td>
<td>-.017 (-.102 to .067)</td>
<td>.69</td>
</tr>
<tr>
<td>Father</td>
<td>-.003 (-.371 to .086)</td>
<td>.94</td>
</tr>
<tr>
<td>Dummy code</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Study 1</td>
<td>-.543 (-.742 to -.345)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>Study 2</td>
<td>-.549 (-.750 to -.348)</td>
<td>&lt;.001</td>
</tr>
<tr>
<td>0-24 mo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Parent z-BMI change</td>
<td>.483 (.305 to .661)</td>
<td>&lt;.001</td>
</tr>
</tbody>
</table>

Abbreviations: CI, confidence interval; SES, socioeconomic status; z-BMI, standardized body mass index.

*The 0- to 6-month values were as follows: for step 1, \( R^2 = 0.36 \); step 2, \( R^2 = 0.48 \); incremental \( R^2 = 0.12, P < .01 \); \( P = .001 \) for the complete model. The 0- to 24-month values were as follows: for step 1, \( R^2 = 0.14 \); step 2, \( R^2 = 0.18 \); incremental \( R^2 = 0.04, P < .05 \); \( P = .01 \) for the complete model.

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Mean (SEM) child (A) and parent (B) standardized body mass index (z-BMI) change from baseline as a function of quartiles of 0- to 24-month parent z-BMI changes. The BMI is calculated as weight in kilograms divided by the square of height in meters; the z-BMI, as \( \frac{(BMI - \text{mean BMI for age and sex})}{\text{SD of BMI for age and sex}} \).
Family-based interventions have shown that parent weight change is related to child weight change, with studies showing consistent positive correlations between parent and child changes. Research suggests that family-based modification of physical activity and nutrition patterns may be related to treatment effects observed in participants of family treatment programs. To our knowledge, there is no study that has evaluated the incremental effects of parental weight change on child weight change while controlling for variables that influence child weight loss.

This study found significant correlations between changes in child and parent z-BMI. Parent z-BMI change was a significant predictor of child z-BMI change over 6 and 24 months. An analysis of the patterns of child weight change over time suggests that youth benefit the most from parents who lose the most weight in family-based behavioral treatments.

The results of this study show that parent z-BMI change is a significant predictor of child z-BMI change through treatment and follow-up periods, consistent with previous research. The size of the relationship decreased from 0 to 6 months ($r^2=0.21$) to 0 to 24 months ($r^2=0.05$), which may reflect differences among parent and child weight mechanisms between treatment and follow-up. Research has also supported an increase in the relationship from treatment to follow-up. For example, Kirschbaum and colleagues reported that, although weight changes within parent-child dyads were not strongly related during treatment, by the 3-month and 1-year follow-up assessments, weight loss in the parent-plus-child group was positively correlated. Other studies have reported that parent-child weight change correlations diminish during follow-up, suggesting that different mechanisms may be at work during acquisition and maintenance of eating and exercise behaviors for the parents and children. Identification of the exact mechanisms underlying the differences in the pattern of treatment and follow-up changes for children and parents must await further study. Whereas a parent may lose self-control over time, child behavior can be maintained by consistent parent support or child self-regulation. Bandura argued that reciprocally reinforcing relationships between family members is important for acquiring and maintaining new behaviors, and that the family provides an ideal environment in which parents and children can mutually reinforce healthier behaviors among family members. Parents also modify the shared family environment that can influence eating, activity, and sedentary behaviors, and investigators have shown that parental feeding and television viewing practices can influence child weight.

When parent z-BMI change is broken down into quartiles that differ as a function of 2-year success, child z-BMI changes are largest for those with parents in the largest z-BMI change quartile, with no differences in child z-BMI change for those with parents in the lower 3 quartiles. The children in the largest z-BMI quartile showed significantly greater reductions in z-BMI changes over time ($P<.001$) compared with the children in the other 3 quartiles. One way in which parent weight change may influence child weight change may be the modification of the shared family environment to facilitate weight change of themselves and their child. It is likely that parents who are more successful have decreased the sedentary behaviors they engage in and have modified the foods that they eat at home and the amount of physical activity they attain, which may set models for healthier behavior and provide a healthier environment for their children. Support for the influence of family environment on the treatment of childhood obesity is provided by research demonstrating a strong negative parent-child weight loss correlation when children were treated without their parents, in contrast to the positive correlation in the parent-plus-child group.

This study is limited to families who choose to join an obesity treatment program that focuses on parental involvement. Weight control programs that do not include parents as active participants may demonstrate different treatment results, and parental involvement may be less predictive of long-term success. In addition, most participating parents were women, and additional research is needed to investigate the role of parent sex in influencing familial weight change patterns. Garn and...
Clark suggests that the sex of the parent does not differentiate children with obesity, because fatness correlations overall were of the same order of magnitude for various parent-child combinations (father-daughter, father-son, mother-daughter, and mother-son). When only one parent in the family was obese, the fatness level of the child was affected whether the parent was a man or a woman, with an obese father having more influence on the overall level and dispersion of child fatness. Another limitation is that there may be other variables that predict child body composition changes not available in our common data set that were not controlled for, which could impact or confound this relationship between parent and child changes.

To our knowledge, this study is the first to examine the incremental effects of parental weight change on child weight change while controlling for variables that influence child weight loss. The results of this study support the inclusion of parents into family-based programs for their children. Including the parent is not only clinically important for improving the efficacy of the treatment for the children, but also provides treatment for the obese parent. Concurrent treatment of the parent and child may also prove to be a cost-effective way to improve the health of multiple family members. Additional research is needed to better understand how parental weight change influences child weight change. Such knowledge may provide insights into variables that enhance pediatric weight control and lead to a new generation of more powerful family-based interventions.

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REFERENCES


