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

Brian H. Wrotniak, MS; Leonard H. Epstein, PhD; Rocco A. Paluch, MS; James N. Roemmich, PhD

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 r² 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.

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. 11

Family-based interventions have shown that parent weight change is related to child weight change. 12 Parent and child weight changes have been uniformly positive during treatment, with correlations ranging from 0.31 to 0.76. 13-15 Correlations over extended intervals have varied between the studies, with some studies 13 showing an improvement in the relationship over time, while others 14,15 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. 16 Kirschenbaum and colleagues 17 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 5 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 5 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 18,19 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 al14 and the Third National Health and Nutrition Examination. 15 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, 20 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 21 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 22 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-
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, -5.2, -2.4, and 1.4 kg. The influence of these groupings on child weight was determined using 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).26 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 31.2 (5.0), had a BMI percentile of 86.9 (10.4), and had a z-BMI of 2.9 (0.9). They were 60.9% (15.1%) overweight, had a BMI of 31.2 (5.8), had a BMI percentile of 86.9 (10.4), and had a z-BMI of 2.9 (0.9). Participating mothers (115 [81.0%]) were aged 40.8 (5.4) years, and their height was 166.1 (8.1) cm. Participating fathers (27 [19.0%]) were aged 41.9 (6.5) years, were 39.4% (25.7%) overweight, had a BMI of 31.1 (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 (5.0), had a BMI percentile of 88.0 (11.3), and had a z-BMI of 1.9 (1.3). In 126 (88.7%) of the families, both parents were greater than the 70th BMI percentile, while for the remaining 16 (11.3%) of the families, only the participating parent was greater than the 70th BMI percentile. The SES of the families was 47.1 (10.3) (upper middle class), ranging from 20 (lower class) to 66 (upper class). Family ethnicity was as follows: 95.0% white (n = 135), 4.2% black (n = 6), and 0.7% Hispanic (n = 1).

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 = .21) and the 0- to 24-month time point (β = .29; 95% confidence interval, .07-.51; P = .009, and r² = .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; and 0- to 24-month time point (β = .37; 95% confidence interval, -.06-.10).
and $r^2=0.18$; and 0–24 months: $\beta=0.19$; 95% confidence interval, 0.04–0.34; $P=0.02$; 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% ($F_{1,129}=28.78$, $P<0.001$), for a total multiple $R^2=0.69$ and an $R^2=0.48$ ($P<0.001$); and for 0 to 24 months, by 3.8% ($F_{1,129}=5.94$, $P<0.02$), for a total multiple $R^2=0.42$ and an $R^2=0.18$ ($P=0.01$). 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 ($F_{9,399}=2.87$, $P=0.003$). As shown in the Figure, A, children of parents in the category of greatest z-BMI quartile ($\geq-0.50$ z-BMI units) had greater reductions ($-0.97$) in z-BMI changes over time ($P=0.01$) than children of parents in the other 3 groups, who had smaller reductions or gains in z-BMI ($-0.68$). 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 ($P=0.002$, $P<0.001$, and $P=0.02$, 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, $-7.2$ kg; height, 3.0 cm; and percentage overweight, $-27.6$%) after 6 months compared with chi-

### 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>Coefficient (95% CI)</th>
<th>P Value</th>
<th>Coefficient (95% CI)</th>
<th>P Value</th>
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<tbody>
<tr>
<td></td>
<td>0-6 mo</td>
<td>0-24 mo</td>
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<td></td>
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<tr>
<td>Step 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Child sex</td>
<td>.181 (.013 to .349)</td>
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<td>.020 (−.240 to .280)</td>
<td>.88</td>
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<tr>
<td>Parent sex</td>
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<td>.25</td>
<td>.007 (−.316 to .331)</td>
<td>.96</td>
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<td>SES</td>
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<td>−.004 (−.016 to .008)</td>
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<td>Baseline age</td>
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<tr>
<td>Child</td>
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<td>.214 (.108 to .320)</td>
<td>.001</td>
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<td>Mother</td>
<td>−.010 (−.035 to .015)</td>
<td>.44</td>
<td>−.014 (−.053 to .024)</td>
<td>.46</td>
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<tr>
<td>Father</td>
<td>−.006 (−.013 to .024)</td>
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<td>.001 (−.028 to .029)</td>
<td>.95</td>
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<td>Baseline z-BMI</td>
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<td></td>
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<tr>
<td>Child</td>
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<td>.06</td>
<td>.032 (−.128 to .191)</td>
<td>.70</td>
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<td>Mother</td>
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<td>.032 (−.098 to .136)</td>
<td>.63</td>
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<tr>
<td>Father</td>
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<td>−.039 (−.139 to .072)</td>
<td>.53</td>
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<td>Dummy code</td>
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<tr>
<td>Study 1</td>
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<td>&lt;.001</td>
<td>−.342 (−.649 to −.035)</td>
<td>.03</td>
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<tr>
<td>Study 2</td>
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<td>&lt;.001</td>
<td>−.317 (−.628 to −.006)</td>
<td>.05</td>
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<td>Step 2</td>
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<tr>
<td>Parent z-BMI change</td>
<td>.483 (.305 to .661)</td>
<td>&lt;.001</td>
<td>.321 (.059 to .583)</td>
<td>.02</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 $R^2=0.12$, $P<0.01$; $P<.001$ 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 $R^2=0.04$, $P<0.05$; $P=.01$ for the complete model.
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.

What This Study Adds

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, Kirschenbaum 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. Garn and Clark suggest that childhood eating and exercise patterns are modeled after parental behaviors, and that parental behavior serves as the basis for developing and changing the health habits of children. Experimental research suggests that parent modeling can influence child eating behaviors and that parental reinforcement can alter children’s eating behavior and exercise behavior. 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.

The 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 

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Clark⁶ suggest 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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Corresponding author: Leonard H. Epstein, PhD, Department of Pediatrics, School of Medicine and Biomedical Sciences, The State University of New York at Buffalo, 3435 Main St, Bldg 26, Farber Hall, Room G56, Buffalo, NY 14214-3000 (e-mail: LHENET@acsu.buffalo.edu).

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