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Family-Based Treatment Program Contributors to Child Weight Loss

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Abstract

Background—Multi-component family-based behavioral treatment program for pediatric obesity (FBT) includes nutrition and physical activity education, as well as behavior therapy techniques. Studies suggest that parent weight loss is the best predictor of child weight loss in FBT. However, given the important role that parents play in the implementation of FBT for their child, isolating the effects of specific FBT treatment component requires consideration of parent influences over time.

Methods—The following treatment components were assessed: stimulus control (high/low-fat food items in home), nutrition knowledge, energy intake, physical activity, and parental monitoring, as well as weekly anthropometric measures. Adjusted models of interest using inverse probability weights (IPW) were used to evaluate the effect of specific FBT components on time-varying child weight loss rate, adjusting for time-varying influence of parent weight loss.

Results—137 parent-child dyads (CHILD: mean BMI = 26.4 (3.7) and BMIz=2.0 (0.3); mean age =10.4 (1.3); 64.1% female; ADULT: mean BMI = 31.9 (6.3); mean age= 42.9 (6.5); 30.1% Hispanic parents; 87.1% female) participated in an FBT program. In traditional model, adult BMI change (b=0.08; p<0.01) was the most significant predictor of child weight loss rates and no other treatment components were significant (p's>0.1). In models that accounted for potential influences from parental weight loss and differential attendance during treatment period, lower availability of high-fat items (b=1.10, p<0.02), higher availability of low-fat items (b=3.73; p<0.01), and higher scores on parental monitoring practices (b=1.10, p<0.01) were associated with greater rates of weight-loss, respectively.

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Conclusion—Results suggest that outside of parent weight change, changes in stimulus control strategies at home and improved parental-monitoring practices are important FBT components for child weight loss.

Keywords

child; parent; weight loss; family-based treatment

Introduction

Recent data suggest that 35% of children in the United States have overweight or obesity, affecting 4–5 million children in the United States.[1, 2] Children with overweight and obesity are at an increased risk for many negative health sequelae in childhood and adulthood, including endocrine conditions, cardiovascular disease, reduced quality of life, cancer and all-cause mortality.[3–11] Children with overweight and obesity are likely to have overweight or obesity in adulthood,[12, 13] and have significantly higher health care costs, including a higher frequency of outpatient and emergency room visits, compared to healthy weight children.[14]

The current model for the treatment of childhood obesity is a comprehensive Family-Based Behavioral Treatment (FBT), which combines nutrition and exercise education with behavior therapy techniques.[15–17] FBT includes multiple behavioral and parenting strategies, including stimulus control, positive reinforcement, goal-setting, problem-solving, planning ahead, modeling, daily meetings, self-monitoring, and relapse prevention. Overall, research over the last few decades shows that this multicomponent package results in significant changes in weight and weight loss behaviors in children.[18–20] However, the FBT program is both time and staff intensive, and includes 20–24 ninety-minute visits over 6 months with multiple staff required for each group session. Because FBT comprises a series of strategies to assist both the child and parent in losing weight, the intensity of the program and the skill base needed for interventionists is an import issue with implications for staff training and cost. Identifying specific components of the FBT program that contribute to child weight loss could allow for a reduction in treatment time (i.e., the weekly visit time or total number of visits over the 6-months due to reduced content) and in the need for staff training and monitoring time.

Parent weight loss is the most significant predictor of weight loss among children in FBT.[21, 22] However, considering the important role that parents play as agents of change, it is possible that the degree of success in parental weight loss during treatment may both influence adherence to prescribed treatment components and reflect other unmeasured social or biological factors that may be influencing child weight loss outcomes. Thus, identifying the differential effect of specific treatment components on child weight loss may be challenged by the potential confounding factors associated with parental weight loss. To date, no studies have attempted to isolate the specific contribution of FBT program components to child weight loss, accounting for parental weight changes over time.

This paper presents a secondary analysis of a randomized controlled trial that provided an FBT program to the parent and child or the parent-only,[15, 23] and attempts to identify the key components of the FBT program that contribute to child weight loss. Importantly, analyses include a traditional model and one adjusting for the influences of time-varying confounder effects from adult weight loss measured by body mass index (BMI) and adherence, measured by treatment session attendance.[24, 25] Expected effects of specific FBT treatment components were reflected by measures of behavior change, including energy balance behaviors (dietary intake and physical activity), parent nutrition knowledge, home food environment, and parent feeding behaviors (restriction, perceived responsibility, and monitoring).

Materials and Methods

Study design

The Family, Responsibility, Education, Support and Health (FRESH) study was a randomized clinical non-inferiority trial conducted between July 2011 and July 2015 in San Diego, California (Clinical Trial: NCT01197443). A detailed explanation of the design, methods and primary results are reported elsewhere.[15, 23] In brief, parent/child dyads were randomized to either family-based treatment (delivered to parent+child; FBT) or parent-based treatment (delivered to parent-only; PBT) which included all of the FBT skills (nutrition and physical activity recommendations, parenting skills, and behavioral modification strategies). Both the FBT and PBT treatment programs included 20 visits over 6 months. In FBT, parents and children attended simultaneous but separate groups. In PBT, only the parents attended groups. Both arms also included 20–30 minutes of individualized behavioral coaching. Children in the PBT arm did not attend any treatment meetings. Primary analyses showed that PBT was not inferior to FBT [15] and thus, for these analyses, groups were collapsed. Of note, the present study evaluated changes of within-treatment sessions over the first 6 months (see ref 23 for the result of primary outcome).

Eligibility included a child between 8.0 and 12.9 years of age with a BMI between the 85th and 99.9th percentiles, a parent in the household with a BMI of at least 25 kg/m^2 who could read English at a minimum of a fifth-grade level, and availability to participate in the study on designated evenings. Exclusion criteria included a major child or parent psychiatric disorder, child diagnosis of a serious current physical disease, child with physical limitations, or a family with food restrictions.

The Institutional Review Boards of the University of California San Diego and Rady Children’s Hospital, San Diego, California approved the study. Written consent and assent were obtained from parents and children, respectively.

Subjects

In total, 150 children who met the inclusion criteria and their parents were recruited through local advertisements, school listservs, and local pediatric clinics. The final sample for analysis was 137, after excluding 13 children who missed more than 90% of the anthropometry assessment time points. Of 137, 70% (n=96) provided anthropometry data at the end of treatment. Children with missing end time point was reverse-imputed using initial post-treatment data, which increased the number of children with anthropometry data from

70% to 87% (n=119). All 137 participants were included in the model for the estimation process. No significant difference was observed based on the increased number of participants at the end time point. Participant demographics are included in Table 1.

Assessment and outcome measures

All data collection and measurements were standardized per FRESH study protocol,[23] and all FRESH assessment staff were trained to perform all study procedures. Children and their parents completed up to 20 time points of anthropometry over 6 months of treatment, and instrument's responsiveness at baseline and post-treatment assessments in the following domains: energy balance behaviors (dietary intake and physical activity), parent nutrition knowledge, home food environment, and parent feeding behaviors (restriction, perceived responsibility, and monitoring). In addition to a description of measures, the measurement type (e.g. a Likert scale), along with corresponding time points are listed below.

***Anthropometry* (child and parent; continuous data; up to 20 sessions)—**Height and weight were measured in duplicate by trained staff at each assessment time point. The mean of two values were used to calculate adult body mass index (BMI = kg/m^2), and child age- and sex-adjusted BMI-z using CDC growth charts.[26] For children in the PBT group, self-reported weights were used.

***Dietary intake* (child and parent; continuous data; baseline and posttreatment visits)—**Dietary intake was assessed with three 24-hour multiple-pass dietary recalls on three non-consecutive days by telephone interview. All interviews used the Nutrition Data System for Research nutrient calculation software.[27] Total energy intake measured in kilocalories was included in the analysis.

***Physical activity* (child and parent; continuous data; baseline and posttreatment visit)—**Physical activity was assessed using an Actigraph accelerometer (model GT1M) worn on a belt around the waist for 7 consecutive days. A minimum of 4 of 7 days of wear time was required to be complete and accommodate error and noncompliance. All accelerometer data extraction, processing, and scoring was conducted with ActiLife software, version 6.11,[28] which provided transformed summaries aggregated across 30-second epochs. Mean minutes per day of moderate and vigorous intensity physical activity were included in the analysis.

***Home food environment: Home Food Inventory* (parent; Likert scale; baseline and posttreatment visits)—**The Home Food Inventory (HFI) asks parents 26 common food categories that represent items either high in fat content (>45% energy from fat; 14 items) or low in fat content (<18% energy from fat – 12 items).[29] Parents indicated whether or not each food category was currently available in their home regardless of amount. The HFI has shown strong test-retest reliability for high- and low-fat items.[29]

***Parent nutrition knowledge: Parent knowledge questionnaire* (parent; bivariate data; baseline and posttreatment visits)—**The parent knowledge questionnaire (PKQ) was created for this study and queried parents about 18 nutrition facts taught in the diet modules. The items are an adapted version on Epstein's traffic light manual quiz items.[30] Each item was dichotomized using the answer key (1= correct response; 0= incorrect response).

***Parent feeding behaviors: Birch Child Feeding Questionnaire* (parent; Likert scale; baseline and posttreatment visits)—**The 21-item Child Feeding Questionnaire (CFQ) was used to assess parent's beliefs, attitudes, and practices regarding child feeding.[31] Three scales reflecting the information conveyed in the treatment were included in the analysis: restriction, perceived responsibility, and monitoring. The questionnaire is a valid and reliable measure of parent feeding practices.[31, 32]

Attendance—The treatment program included 20 sessions over 6 months and attendance records were used to identify the number of sessions attended. Attendance is classed as a deterministic time-varying variable because its value is solely determined by the passage of time. As participants often cycle in and out of treatment which directly affects the treatment results, there is a possible bias contrasting parental weights between periods when individuals are being treated with periods when they are not. We applied the time-varying inverse probability weighting (IPW) to compensate for underlying differences of parental weight changes as results of attendance between the treatment groups, under the assumption of no unmeasured confounders.

***Demographics* (categorical; baseline visit)—**Self-reported basic demographic variables, including gender, ethnicity, and age were assessed at baseline.

Measures

Rate of child weight loss—In order to assess the weight loss of children over time, we used the rate of change to capture varying slope within person over time as well as varying across individuals at specific time point. To address non-linear and heterogeneous weight loss rate at each time point, we incorporated segmented mixed regression[33, 34] with splines and truncated knots along with random intercepts and slopes. A first-order continuous autoregressive error was used to capture residual serial correlation that arose from repeated measurement in the same child. The estimated slope from segmented mixed effects in child anthropometric changes were extracted and used for the subsequent analysis as the primary outcome (weight-loss rate). The slope estimated at each assessment (a total of 20 sessions) and the estimated values of weight-loss rate were multiplied by 100 for ease of interpretation. In the context of the current study, negative values indicate weight loss and positive values indicate weight gain.

Change in responses to research instruments—We explored associations between changes in individual treatment components from baseline to posttreatment and the child's weight loss rate. For unidimensional self-report ratings, such as CFQ, HFI, and PKQ, we incorporated the longitudinal item-response theory model to estimate change and measurement precision.[35] This model constructs within- and across-time constraints while fixing intercepts at zero for all time points. This, in turn, yields standardized parameters for changes that are generalizable across measures over time. For instruments with continuous variables, such as dietary recall and accelerometers, the degree of change was computed using the difference between baseline and posttreatment assessments.

Statistical analyses

To test the effects of specific treatment components conditional at each level of parental BMI changes over time, we conducted two planned analyses. The first was the conventional approach with all treatment components regressed to the child's weight loss rate as it varied over time. The second was the marginal approach to evaluate the effects of treatment components on the child's weight loss rate as it varied over time, adjusting for the influences of time-varying confounder effects measured from adult BMI and attendance to the treatment sessions using stabilized Inverse Probability Weighting.[24, 25] Final estimates were from models across 100 multiple imputed data sets of 137 participants over 20 treatment sessions and Benjamini-Hochberg corrected p-value for multiple comparisons. All models included covariates for sex, time, treatment group assignment, and the interaction of time and treatment group assignment. All statistical analyses were carried out with R version 3.4, using the *ipw*,[36] *jomo*,[37] and *nlme* [38] packages.

Results

Details of results from the clinical trial comparing the two intervention arms can be found in Boutelle et al.[15] Of the parent/child dyads enrolled, about one-third were Hispanic (31.33%) and were significantly overweight (mean child BMI=26.44, BMI-z = 2.01; mean parent BMI = 31.93). The participants attended an average of 14.43 of 20 treatment sessions.

Table 2 presents the main effects of each treatment component (unweighted) on weight changes using linear mixed effects models with planned covariates for age, sex, and time. Of the predictors examined, the change in adult BMI was the most significant predictor of the child's weight-loss rate. A decrease of one unit in the adult BMI was associated with an increase in the child weight-loss rate by 0.080 ($p<0.01$). We did not observe any significant associations between child weight-loss rates and measures of dietary intake and physical activity, parent nutrition knowledge, home food environment, and parent feeding behaviors (p's >0.1).

Table 3 presents effects of each treatment component on child weight-loss rate after adjusting for the conditional influence of parental weights varying over time. With weights, we confirmed that time-varying effect of adult BMI was properly managed as adult BMI was no longer significant predictor of the child weight loss rate (Estimate: −0.227, p=0.613); we removed adult BMI in the final model. Families who reported a higher than average number of high-fat items in their homes (≥1 SD above average) had child weight-loss rates that were 1.10 (p=0.02) lower than other families. Families with higher than average numbers of low-fat items had children who had weight-loss rates 3.73 ($p<0.01$) greater than other families. Lastly, higher than average (≥1 SD) parental monitoring in as food intake parenting practices was associated with an increase in the rate of child weight loss of 1.10 ($p<0.01$). We did not observe any significant effects of other treatment components on child weight-loss rate.

Discussion

To our knowledge, this is the first evaluation of specific components taught in an FBT program that adjusts for the conditional influence of parental weights varying over time. These analyses included not only diet and physical activity changes, but many of the behavioral components included in FBT. Our results show that the home food environment plays a significant role in contributing to child weight loss rate, with families that had more low-fat items in the home having higher child weight loss rates. Furthermore, parental monitoring of the child also contributed to higher child weight loss rates. Although this study does not include all of the individualized components of FBT, it does provide initial information regarding the FBT treatment components and suggests that home food environment and parent feeding practices play a significant role.

As expected, parent BMI change was the strongest predictor in the traditional model, which is consistent with the literature [21, 22] and confirms the importance of parents as the “agent of change” in FBT programs. This is not surprising, as FBT programs target both parent and child weight loss. However, when included in traditional modeling, parent BMI change absorbs the impact of the other competing components and does not allow for a direct test of the components that are taught in FBT. Considering these results, it is possible that parent weight loss alone could provide a trickle-down effect to the child, although randomized controlled trials comparing parent weight loss programs with PBT or FBT have yet to be conducted. However, provided all potential time-varying confounders are identified, and the IPW’s properly balance the groups by parent BMI as results of attendance to the treatment sessions, the weighted sample represents a conditional population where treatment effect is unimpacted at each timepoint, which in turn allows for estimation of the true effect of treatment components.

In models that accounted for potential influences from parental weight loss through differential attendance during the treatment period, change in the home food environment emerged as one of the largest contributors to child weight loss rate. This is consistent with studies that show that children with overweight or obesity live in homes that have more foods that can promote weight gain.[39–43] Furthermore, this result is consistent with a recent systematic review that identified environmental restructuring as one of six behavioral change components that were most effective for changing physical activity and/or eating behavior for the prevention or management of childhood obesity.[44] Future studies using FBT could emphasize and provide specific guidance and skills focusing on changing the home food environment.

The other important variable that influenced child weight loss rate in this study was change in parental monitoring of the child. The parental monitoring scale from the CFQ includes questions such as “How much do you keep track of the sweets that your child eats?”, “How much do you keep track of the snack food that your child eats” and “How much do you keep track of the high fat foods that your child eats”. Increasing monitoring of food intake in the child was associated with higher weight loss rates. This is consistent with data from over 4,000 adolescents that shows that parental general monitoring (awareness of money spending, friends, and whereabouts) is associated with lower weight status, as well as positively associated with healthy dietary intake and physical activity, and negatively associated with screen time.[45] Clinically, it makes sense that children that are not monitored closely may be more likely to give in to cravings and/or environmental opportunities to eat beyond nutritional needs. As children's ability to inhibit these urges develops throughout adolescence,[46] it is important for parents to provide the structure and monitoring for the child to succeed.

It is also interesting that the other variables, changes in parent and child dietary intake, changes in parent and child physical activity, changes in parent nutrition knowledge, or changes in parent restricting or perceived responsibility did not contribute to child weight loss rate. It is possible that these variables do not truly affect child weight loss rate, or it could be error in the measurement. Self-report bias is inherent in 24-hour recalls,[47] as well as in self-report questionnaires. In adults, a systematic review showed that combined behavioral weight management programs are more effective on weight loss than diet or physical activity alone.[48] However, it is important to note that the current study did not compare separate interventions with different components, we were limited in the ability to enter the program components into one model.

The current study has several strengths, including the large cohort of children and parents and the evaluation of a treatment (FBT) that is recommended by national guidelines.[19, 49, 50] Additionally, the present study contributes to the literature by capturing the rate of child weight loss to account for individual's time-specific slopes and change points of heterogeneous weight loss pattern, which permits statistical control of within-person variation and provides greater statistical power for detecting within-person change. Another strength of this study includes the adjustment for the conditional influence of parental weights varying over time, allowing a closer look at potential program components that can be used to improve the program or decrease the amount of time participants need to attend.

However, as in all studies, there are also limitations that need to be considered. Since this is a secondary data analyses, we were limited in the number of behavior therapy components that were measured. Self-monitoring, and changes in positive reinforcement, goal-setting, problem-solving, planning ahead, modeling, and the use of daily meetings were not included in the models. This is also a moderate sample of treatment seeking parents and their 8–12 year old child, and can not be applied to other samples or to families with children of other ages. Finally, we present child weight loss rate, but it should be noted, that when treating children, a reduction in weight gain and an increase in height can change BMI or BMIz scores and ultimately reduce overweight or obesity.

There are several future research implications from this study. It is possible, that FBT programs focusing specifically on changing the home food environment and changing parental monitoring may be sufficient to provide changes in the child weight loss rate, although randomized controlled trials are needed to confirm these results. Since we only had a subset of FBT behavior therapy components in this analysis, future planned dismantling studies should address all of these components, to obtain a more comprehensive analysis of the FBT program. It is also possible that FBT could be shortened to only focusing on changing the home food environment and parental monitoring, but again, randomized controlled trials are needed to evaluate this option. Although preliminary, this is one of the first studies that attempts to identify FBT program components that are important in child weight loss rate, which could reduce the need to provide a cadre of skills and could allow for reduced staff training and cost.

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Table 1.

Baseline sample characteristics

Characteristics	Mean (SD)
Child BMI	26.44 (3.67)
Child BMI z	2.01 (0.33)
Adult BMI	31.93 (6.34)
Child age	10.41 (1.27)
Adult age	42.89 (6.50)
Parent ethnicity	
Hispanic	47 (31.3%)
Non-Hispanic	103 (68.6%)
Attendance	14.43 (4.90)

Values are n (%) for categorical variables and mean (SD) for continuous variables

Abbreviation: BMI= body mass index; MVPA= moderate to vigorous physical activity

Table 2.

Estimation of unweighted predictors of child's intra-individual weight changes

Variables (unit)	Estimate	95% CI	p
Δ adult BMI (1 BMI unit)	0.080	0.027 to 0.133	0.003
Δ home food index – high fat (1 sd)	−0.200	−0.685 to 0.285	0.419
Δ home food index – low fat (1 sd)	0.339	−0.723 to 1.401	0.532
Δ CFQ – restriction (1 sd)	0.245	−0.127 to 0.617	0.198
Δ CFQ – monitoring (1 sd)	0.101	−0.116 to 0.318	0.364
Δ CFQ – perceived responsiveness (1 sd)	−0.194	−0.514 to 0.126	0.235
Δ kcal (1 sd; adult)	−0.126	−0.613 to 0.361	0.612
Δ kcal (1 sd; child)	0.255	−0.246 to 0.757	0.319
Δ parent knowledge questionnaire (1 sd)	−1.528	−3.421 to 0.355	0.112
Δ average MVPA day (1 sd; adult)	−0.055	−0.424 to 0.314	0.770
Δ average MVPA day (1 sd; child)	0.328	−0.035 to 0.692	0.078

Abbreviations: BMI, body mass index (unit kilogram/meters squared); CFQ, Birch child feeding questionnaire subscales; MVPA, moderate and vigorous intensity physical activity in minutes; sd, standard deviation. All models adjust for time, sex, randomization, time* randomization, and corresponding baseline demographics. P-value using Benjamini-Hochberg adjustment procedure. Negative estimate is better in the context of evaluating the weight-loss treatment.

Table 3.

Conditional estimation weighted predictors of child's intra-individual weight changes

Variables (unit)	Estimate	95% CI	p
Δ home food index – high fat (1 sd)	1.101	0.168 to 2.033	0.021
Δ home food index – low fat (1 sd)	−3.733	−5.674 to −1.791	0.001
Δ CFQ – restriction (1 sd)	−0.132	−1.532 to 1.267	0.485
Δ CFQ – monitoring (1 sd)	−1.107	−1.708 to −0.506	0.001
Δ CFQ – perceived responsiveness (1 sd)	0.313	−0.566 to 1.192	0.853
Δ kcal (1 sd; adult)	1.482	−0.627 to 3.591	0.168
Δ kcal (1 sd; child)	−1.407	−3.376 to 0.563	0.161
Δ parent knowledge questionnaire (1 sd)	−0.292	−7.244 to 6.661	0.934
Δ average MVPA day (1 sd; adult)	−0.267	−2.140 to 1.605	0.779
Δ average MVPA day (1 sd; child)	−0.564	−2.421 to 1.293	0.550

Abbreviations: BMI, body mass index (unit kilogram/meters squared); CFQ, Birch child feeding questionnaire subscales; MVPA, moderate and vigorous intensity physical activity. All models adjust for time, sex, randomization, and time* randomization. All models adjust for time, sex, randomization, time* randomization, and corresponding baseline demographics. P-value using Benjamini-Hochberg adjustment procedure. Negative estimate is better in the context of evaluating the weight-loss treatment. Weighted predictors include balancing time-varying covariates through inverse probability weighting of adult BMI and attendance.