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ORIGINAL ARTICLE

Family-Based Interventions Targeting Childhood Obesity: A Meta-Analysis

Jerica M. Berge, PhD, LMFT[1] and Jessie C. Everts, MS, LMFT[2]

Abstract

Background: With the rising prevalence of childhood obesity over the last several decades, and the call for more family-based intervention research to combat childhood obesity, it is important to examine the extant research on family-based interventions in order to make recommendations and improve future research.

Objective: To conduct a meta-analysis of family-based interventions targeting childhood obesity in the last decade in order to inform the research in the next decade.

Methods: A literature review was conducted between December 2009-April 2010. Studies published between the years 2000-2009 that used family-based interventions to treat childhood obesity were included. A total of 20 studies met inclusionary criteria.

Results: Although results varied by study design, the majority of studies had a moderate to large effect size for change in the target child's BMI (BMI percentile, zBMI, percent overweight) after participating in a family-based intervention. Long-term change varied by study, but the majority of studies produced sustainable change in child BMI, although smaller effect sizes. Change in secondary variables (dietary intake, sugar-sweetened beverage intake, physical activity) were substantially different between studies and are reported as trends.

Conclusion: To date, there is preliminary evidence that suggesting that family-based interventions targeting childhood obesity are successful in producing weight loss in the short and long-term. Including families in weight loss treatment of obese children warrants further implementation and study. Limitations with the research, recommendations for future research, and implications for practitioners working with overweight/obese children are discussed.

Introduction

Over the last two decades obesity prevalence in children has more than doubled,[1–3] Childhood overweight and obesity are associated with increased risk for adverse health problems, including hypertension, cardiovascular disease, metabolic syndrome, and Type II diabetes.[4–6] This seemingly uncontrollable problem has been deemed an "epidemic" by public health researchers and professionals.[7] Numerous expert panels and national meetings have been convened to address the problem.[8] These expert panels and committees, along with other researchers, have identified family involvement in the treatment of childhood obesity as a neglected area of research and have called for more family-based interventions.[8–10] Specifically, experts suggest that intervening in the family system may provide greater change and longer sustainability of change in the child because of the ability of the family to shape child behaviors on a daily basis.[9,10] Thus, the purpose of this meta-analysis is to assess the state of the science on family-based interventions targeting childhood obesity in the last decade, in order to determine the success of these interventions and inform research in the next decade.

Family Systems Theory

Family systems theory indicates that families live in complex systems in which multiple interactions occur simultaneously.[11–13] Within family systems there are sub-systems, or domains (e.g., parent/child, sibling). Interactions that occur within the family sub-systems are reciprocal. That is, each family member is shaping and being shaped by other family members' actions. These mutually influencing patterns within the family are important to consider when designing childhood obesity interventions because targeting child health behaviors may be contingent on family interactions and modeling. For instance, health behaviors occur within a family system that can either support and model them, or downplay the importance of them. Thus, this meta-analysis uses family systems theory to guide the understanding of findings from family-based interventions used in treating childhood obesity in the last decade.

[1]Department of Family Medicine and Community Health, [2]Department of Family Social Science, University of Minnesota, Minneapolis, MN.

State of the Research Prior to the Year 2000

There have been very few family-based interventions to treat childhood obesity prior to the year 2000.[10,14,15] Family-based interventions include the target children and one or more family member(s) directly involved in the treatment intervention. Typically a parent, most commonly the mother, participates in the intervention with the target child. The most successful family-based obesity treatment interventions have been conducted by Epstein and his colleagues in a clinical setting using the *Stoplight Diet*.[16] The *Stoplight Diet* includes elements of nutritional/physical activity education, parent skills training, and behavioral monitoring of eating and physical activity at home. Epstein has shown that using the *Stoplight Diet* with children and their parent(s) produces significantly more weight loss than control groups.[16] In addition, the treatment groups have continued weight loss or maintenance after 6 months, 2 years and 10 years.[16] Although these findings are promising, participants in Epstein's studies have been primarily white and from higher socio-economic classes and there have been few other family-based intervention studies conducted in order to compare findings. Thus, this meta-analysis focuses on studies conducted in the last decade in order to identify the state of the research on family-based interventions during the time when calls for family-based interventions were issued.

Methods

Study Abstraction

We followed the recommendations of Lipsey and Wilson for study abstraction.[17] First, a literature search was performed by both a professional librarian and the first author to increase the likelihood that all pertinent articles were retrieved. Searches were performed on PubMed, MedLine, PsycINFO, Cochrane Library, CINAHL and Social Science Abstracts search engines using various combinations of the following key terms: child, childhood, obesity, overweight, family, family-based, parent, treatment, weight-loss, interventions. Second, the tables of content for journals that commonly publish in childhood obesity studies were reviewed (e.g. *Journal of Pediatrics, Preventive Medicine, Journal of Pediatric Psychology, Journal of Family Psychology, American Journal of Public Health, Journal of the American Dietetic Association, Obesity*). Third, additional articles were identified by searching each article's reference section and the Web of Science database. Fourth, established researchers in the field of childhood obesity treatment were contacted and asked for copies of unpublished articles (under review or in press). Over 300 articles were originally identified. After applying the inclusion criteria (described below) to all studies, a final sample of 20 family-based intervention studies were eligible for the current analysis (Table 1).

Inclusion/Exclusion Criteria

Studies were selected for inclusion in the meta-analysis if they met the following criteria: 1) published in peer-reviewed journals between 2000 and 2009; 2) written in English; 3) studies were childhood obesity interventions (treatment not prevention). Studies were not required to be randomized control trials (RCT's) because this is a relatively new area of research and there were few RCT's that included family members directly in interventions; 4) included a member or members of the target child's family in the intervention; the parent or family member component was defined as an intervention strategy that directly engaged parent or family member support or assistance in child health behavior change; 5) recruited children between the ages 5–18; and 6) included pre- and post- measurements of body mass index (BMI) (e.g. BMI percentile, BMIz, percent overweight) on the target child. Secondary outcomes of interest were also identified and included in the analysis (e.g. fruit/vegetable intake, consumption of water and sugar-sweetened beverages, physical activity and sedentary behaviors). We did not use variation in study quality as an exclusion criteria. Due to the relatively small amount of studies using family-based interventions, we included all available studies in the meta-analysis as a first step in understanding the existing literature on family-based treatment interventions.

Data Extraction

Data from the studies were extracted using standardized forms developed by the authors. Extracted data included: lead author, publication year, geographic location of intervention, sample size (initial and ending), age, sex, ethnicity, and SES of participants, primary intervention location (e.g. school, home, health care center), study design, theoretical framework used to guide intervention design, recruitment methods, subject participation/attendance in intervention, primary and secondary outcomes, BMI measurement, description of intervention, intervention frequency and duration, main findings, methods of parent/family involvement in intervention, and any analysis that assessed whether subsequent changes in child or parent behavior could be attributed to involvement in the intervention. Many of the variables extracted are listed in Table 1.

Publication Bias

To assess the presence of publication bias we computed a "fail-safe N" for each of the main outcomes (BMI percentile, BMIz, percent overweight).[18] This value is an estimate of the number of unretrieved or unpublished studies with null results that would be required to render the observed effect nonsignificant. Rosenthal[18] suggested that a fail-safe N greater than 5k + 10 (with k being the number of studies included in the analysis) indicates a robust effect. In the present analysis the fail-safe N exceeded Rosenthal's recommendation, suggesting a low probability of publication bias.

Table 1. Family-based Intervention Studies to Reduce Childhood Overweight/Obesity Included in the Meta-Analysis

STUDY	Description of Intervention	Sample	Ages	Duration	Design	Primary/ Secondary Outcome variables	Effect Sizes	Key Findings
Beech et al. (2003)	Nutrition & physical activity program with three groups: 1) parents only targeted, 2) girls only targeted, and 3) control group focused on self-esteem only	60 families African American girls	8-10	12 weeks	3-grp RCT	P*: BMI percentile S**: F/V intake, water/sweet bev intake, physical activity	Group 1 d***= -0.703 Group 2 d= -0.202 G2-G1 d= 0.539	• Girls in both intervention groups demonstrated a trend towards reduced BMI • Girls in both intervention groups significantly reduced consumption of sweetened beverages and increased level of physical activity
Bermudez de la Vega et al. (2007)	Parental involvement & behavioral modification for nutrition & physical activity	50 families Caucasian/ Spanish sample	6-13	1 year	Single group pre- and post-	P: BMI percentile, zBMI	BMI d= -0.162 zBMI d= 0.393	• Family-based treatment program was effective for obese children in reducing BMI & increasing physical activity
Epstein, Gordy, et al. (2001)	Stoplight Diet with two groups: 1) increase fruit/ vegetable intake, 2) reduce fats/sugar intake Groups included one obese parent & two children (one obese, one not obese)	27 families	6-11	6 months FU: 6 mo post	2-grp randomized (no control)	P: % overweight S: F/V intake	Group 1 d= -0.199 Group 2 d= -0.426	• Treatment influenced targeted parent & child fruit & vegetable intake & high-fat/high-sugar intake for both groups • Parents in the increased F/V group showed greater decreases in percent overweight than parents in the decreased fats/sugar group • Generally, the intervention benefited those with poorer baseline eating habits
Epstein, Paluch, Gordy, et al. (2000)	Stoplight Diet with four groups: 1) reduce sedentary behavior, 2) increase physical activity, 3) low-dose, and 4) high-dose All groups included child & at least one parent.	90 families	8-12	6 months FU: 6, 18 mo post	4-grp randomized (no control)	P: % overweight S: Physical activity, sedentary behavior	Group 1 d= -0.085 Group 2 d= -0.427	• Targeting either sedentary behaviors or physical activity was associated with significant decreases in % overweight & body fat, & improved aerobic fitness • % overweight for children decreased in all 4 groups • No significant dose response
Epstein, Paluch, & Raynor (2001)	Stoplight Diet with control (increase physical activity) and treatment (combined increase physical activity/decrease sedentary behaviors), Group 1 = boys, Group 2 = girls	67 families (+ 89 siblings)	8-12	6 months FU: 6 mo post	2-grp randomized (no control)	P: BMI percentile	Group 1 d= -0.683 Group 2 d= 0.818	• Boys showed significantly better percentages of overweight changes for the combined group than girls, no gender differences in the increase physical activity intervention group • Predictors of sibling weight loss included age, # of siblings, target child's % overweight change, & gender of treated sibling • Increases in BMI were found for parent & sibling same-sex girls in increase physical activity group & for opposite-sex dyads in both groups
Epstein, Paluch, Saelens, et al. (2001)	Stoplight Diet & problem-solving with 1) children only, 2) with parents & children, & 3) Diet only with parents & children (control)	47 families	8-12	6 mo tx, FU: 2 yr post	3-grp RCT	P: % overweight	%OW**** d= -0.916	• Obese children showed significant decreases in percent overweight, internalizing problems & total behavior problems, & increases in behavioral competence • Parents showed significant decreases in weight, parental distress, & disturbed eating & weight-related cognition

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STUDY	Description of Intervention	Sample	Ages	Duration	Design	Primary/ Secondary Outcome variables	Effect Sizes	Key Findings
Germann et al. (2007)	Physical activity & food intake self-monitoring program for two groups: 1) parents targeted & 2) adolescents targeted	228 families Majority African American	11-15	6 months	Single group pre- and post-	P: BMI percentile, zBMI	BMI d= 0.122 zBMI d= 0.098	• Children who self-monitored regularly lost more weight than inconsistent self-monitors • Children whose parents self-monitored were more likely to self-monitor & lose weight
Golan & Crow (2004)	Dietician education & support program with two groups: 1) parents only targeted, and 2) children only targeted (control)	50 families	7-12	1 year FU: 1, 2, 7 yr post	Single group, pre- and post-	P: % overweight	%OW d= -0.577	• Mean reduction in percent overweight was greater at all follow-up points in children of the parent-only group compared with those in the children-only group
Golan et al. (2006)	Dietician education & support program with two groups: 1) parents only, & 2) parents & children together	32 families	6-11	6 months FU: 6 mo post	Single group, pre- and post-	P: % overweight, zBMI	%OW d= 1.233 zBMI d= 0.870	• Only the intervention aimed at parents-only resulted in a significant reduction in the percentage overweight at the end of the program & at 1 year follow-up
Goldfield et al. (2001)	Stoplight Diet with two groups: 1) mixed treatment (individualized and group treatment) and 2) group only treatment	24 families	8-12	8 weeks FU: 6, 12 mo post	2-grp randomized (no control)	P: % overweight, zBMI	%OW d= -1.116 zBMI d= -1.178	• Group treatment with families was more cost-effective than individualized + group treatment with same weight control results (decreased)
Golley et al. (2007)	Positive Parenting Program with three groups: 1) Parenting skills alone, 2) parenting skills plus lifestyle education, & 3) wait-list control group	111 families	6-9	1 year	3-grp randomized	P: zBMI	Group 1 d= -0.050 Group 2 d= -0.265 G2-G1 d= -0.200	• BMIz score was reduced by 10% with parenting skills training plus intensive lifestyle education vs. 5% with parenting skills alone or wait-list control • There was a significant gender effect, with greater reduction in boys' BMI versus girls'
Janicke et al. (2008)	Behavioral intervention for three groups: 1) parents only, 2) families, & 3) wait-list control	93 families	8-14	4 months FU: 6 mo post	3-grp randomized	P: zBMI	Group 1 d= -0.730 Group 2 d= -0.423 G2-G1 d= 0.348	• Both intervention programs led to significantly greater decreases in weight status relative to the control condition at 10-month follow-up
Jiang et al. (2005)	Behavior modification program for two groups: 1) treatment group & 2) control group Groups included parents & children.	33 families Chinese sample	Grades 7-9	2 years	2-grp randomized	P: BMI percentile	BMI d= -1.911	• BMI was significantly reduced in the treatment group but not in the control group • Blood pressure values decreased significantly in the treatment group
Kalavainen et al. (2007)	Nutrition and physical activity education and behavior therapy program with two groups: 1) family-based treatment and 2) routine counseling (control)	70 families	7-9	6 months FU: 6 mo post	2-grp randomized	P: BMI percentile, zBMI	BMI d= -0.835 zBMI d= -0.330	• Children attending the group treatment lost more weight for height than children receiving routine counseling • At 6-month follow-up the differences in changes in BMI between the two treatment programs were still significant, & was a trend for zBMI

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Table 1. Family-based Intervention Studies to Reduce Childhood Overweight/Obesity Included in the Meta-Analysis

STUDY	Description of Intervention	Sample	Ages	Duration	Design	Primary/ Secondary Outcome variables	Effect Sizes	Key Findings
Levine, et al. (2001)	Stoplight Diet behavioral intervention with parents & children separately	24 families	8-12	10-12 weeks	Single group, pre- and post-	P: BMI percentile	BMI d= -0.189	• 1/3 of families did not complete treatment • Children who did complete treatment lost a significant amount of weight & reported significant improvements in depression, anxiety, & eating attitudes
McGarvey et al. (2004)	Fit WIC education program focused on parental feeding practices & role modeling with two groups: 1) intervention group and 2) control group	186 families (121 tx, 65 control) Majority Hispanic sample	2-4	12 months	2-grp non-randomized control trial	P: none S: water intake, physical activity, sedentary behavior, F/V intake		• There were significant changes in parent behaviors of increasing the frequency of offering the child water instead of sweetened beverages & increasing family activities to promote fitness
Reinehr et al. (2003)	Physical exercise & nutrition course for children with family behavior therapy	75 families German sample	7-15	1 year	Single group, pre- & post-	P: BMI percentile	BMI d= -0.400	• 63% of the children had successful weight loss
Sothern et al. (2002)	"Committed to Kids" psychosocial, nutrition, & exercise program for parents & adolescents	93 families	13-17	1 year	Single group, pre- and post-	P: BMI percentile	BMI d= -3.137	• 56 participants finished the treatment • Subjects reduced BMI significantly
Stein et al. (2005)	Stoplight Diet with single group, focused on parenting style	51 families	8-12	6 months FU: 6 mo post	Single group, pre- and post-	P: % OW	%OW d= -0.938	• Children's percentage overweight significantly decreased • Significantly greater percentage overweight decrease for youth with fathers who increased parental acceptance
Temple et al. (2006)	Stoplight Diet with single group, looked at same-sex versus opposite-sex parent-child dyads	164 families	8-12	6 months FU: 6, 18 mo post	Single group, pre- and post-	P: zBMI	zBMI d= -0.410	• Children within opposite-sex parent/child dyads had greater weight loss compared with children in same-sex parent/ child dyads • Parents in opposite-sex parent/ child dyads had significantly greater weight loss at 24 months than same-sex parent/child dyads

* P is primary outcome; ** D is secondary outcome; *** d = cohen's d, or effect size; **** %OW = percent overweight.

Meta-analysis Procedures

Effect sizes were calculated for tests of change in primary weight/health-related outcomes: BMI (kilograms/meters^2) compared to CDC growth chart percentiles,[19] percent overweight, and standardized BMI z-score (zBMI). Nine studies reported BMI scores pre- and post-intervention; seven studies reported percent overweight pre- and post-intervention; and eight studies reported data on zBMI scores before and after the intervention. Some studies reported two measures of the primary outcome (e.g. zBMI and % overweight) and are reported separately.[20] Effect sizes were calculated using Wilson's effect size determination program. Effect sizes convey the estimated magnitude of a relationship on a standardized scale, thus allowing for comparison across studies. Cohen's criteria for small (d = .20), medium (d = .50) and large (d = .80) effects were used to address the magnitude of effect sizes.[21]

Inverse variance weighted effect sizes,[22] were calculated or generated for all studies, whether they reported

significant findings or not. Effect sizes were then compared across studies. Studies varied in design, with some measuring change in primary and secondary variables for the entire sample, and others comparing one or two treatment conditions with a control group. Thus, effect sizes are calculated based on the difference in pre- and post- intervention measures for treatment conditions as compared to control groups or in isolation, as appropriate given each study design.

Results

Results of the meta-analysis are presented in order by research design and the primary outcome variable (BMI percentile, zBMI, % overweight). Because there was a significant degree of heterogeneity among study designs, we separated studies according to research design. First, average effect sizes are given for studies that had no control or comparison group. For these studies, effect sizes indicate change from pre-test to post-test for the overall sample. Next, effect sizes are given for studies in which there was one or more treatment group compared to a control group. Third, effect sizes are given for studies that included two treatment groups and for which effect sizes could be calculated between treatment conditions. Some studies compared treatment groups to both and control group and another treatment group. These studies are discussed under both sections, in order to show effect sizes for change in child weight for both components of the study. Effects at follow-up measurement points are reported last. Secondary variables and trends are reported separately at the end of the results section.

Average effect sizes are reported, but it should be noted that some studies produced negative effects, while others produced positive effects. In general, negative effect sizes for BMI, standardized BMI (BMIz), and percent overweight are results in the expected direction, meaning that the treatment condition had more weight loss than the control condition.

Single Group Studies (N=8)

Primary variables. The average effect size for change in BMI percentile for studies in which there was no control group was -0.753.[23–27] This corresponds to an average loss of .75 kilograms/meters^2 over the course of treatment. Four of these five studies found negative effects on BMI ranging from -3.137 to -0.162,[23,25–27] while one found positive effects on BMI for the sample as a whole.[24] The negative effects on BMI reported by Levine et al.;[25] Sothern et al.;[27] and Bermudez de la Vega et al.[23] were significant, while Reinehr et al.[26] and Germann et al.[24] did not report significance of effects for the overall sample in their studies.

The average effect size for change in standardized BMI (zBMI) for studies in which there was no control group was -0.229.[23,24,28] This indicates an average loss of .23 standardized, rescaled BMI units. Bermudez de la Vega et al.[23] and Germann et al.[24] found positive effects on zBMI (0.393 and 0.098, respectively), while Goldfield et al.[28] found a large negative effect (-1.178) due to treatment. Only the effects on zBMI reported by Goldfield et al.[28] were found to be significant.

Three of the studies that reported results in terms of percent overweight (%OW),[28–30] reported an average effect size of -0.990. These studies all found negative effects on %OW ranging from -0.916 to -1.116, and effects were significant.[28–30] This corresponds to a decrease of 1% overweight compared to age and gender standards.

Follow-up measurement. Three of the single-group studies repeated measurement of the primary weight variables at a follow-up point after intervention.[28,29] For all three studies, significant changes in primary weight variables persisted to follow-up at six months,[29] one year,[28] and 2 years post-intervention.[30]

Summary. While there were findings in both directions for BMI percentile and zBMI, all significant findings were in the expected direction for all three primary outcome variables (BMI percentile, zBMI, %OW). Family treatment groups that made significant changes in primary weight variables reduced body-mass indices and percentage overweight. Effect sizes were large for BMI percentile (-0.753) and %OW (-0.990), small for zBMI (-0.229). Changes were significant at follow-up points for all studies that included follow-up measurement.

Treatment and Control Group Studies (N=10)

Primary variables. In studies in which at least one treatment condition was compared to a control condition, the average effect size for change in BMI percentile was -0.502. The average effect size for the first treatment group as compared to the control group was -1.033, ranging from -0.683 to -1.911,[31–34] while the average effect size reported between a second treatment group and the control group was 0.308, ranging from -0.202 to 0.818.[31,32] In short, first treatment groups decreased BMI (kg/m^2) by 1.033 more than the control group, while second treatment groups decreased BMI by .308 more than controls. These differences between treatment and control groups were significant for Jiang et al.[33] (effect size=-1.911) and Kalavainen et al.[34] (effect size=-0.835). Results were not significant for Beech et al.[31] and significance was not reported in the study by Epstein, Paluch, & Raynor.[32]

The average effect size for change in zBMI was -0.36 (ranging from -0.05 to -0.73). The average effect size for the first treatment group as compared to the control group was -0.37, ranging from -0.05 to -0.73.[34–36] The average effect size reported between a second treatment group and control was -0.344, ranging from -0.265 to -0.423.[35,36] Results were significant for Golley et al.[35] and Kalavainen et al.,[34] and were significant for the second treatment group in the study performed by Janicke et al.[36] (effect size = -0.423) but not for the first treatment group (effect size= -.073).

The average effect size for change in % OW was -0.343 (ranging from -0.085 to -0.577). The average effect size for the first treatment group compared to a control group was -0.287, ranging from -0.085 to -0.577.[37–39] When a second treatment group was compared the control group, the average effect size was -0.427, ranging from -0.426 to -0.427.[38,39] On average, first treatment groups decreased .29% overweight more than control groups, while second treatment groups decreased .43% overweight more than control groups. These results were reported to be significant for Epstein, Paluch, Gordy, et al.[39] and Golan & Crow,[37] but were not significant for Epstein, Gordy, et al.[38]

Follow-up measurement. Six of the ten studies comparing one or more treatment groups to a control group measured primary weight variables at a follow-up time point. Results were significant at 6-month follow-up for Epstein, Gordy, et al.[38] and Janicke et al.,[36] at 6- and 18-month follow-up for Epstein, Paluch, Gordy, et al.;[39] and at 1-, 2-, and 7-year follow-ups for Golan & Crow.[37] Kalavainen et al.[34] found significant effects on BMI at 6-month follow-up, but effects on standardized BMI were no longer significant. Significance was not reported at six-month follow-up in the study by Epstein, Paluch, & Raynor.[32]

Summary. Findings varied in studies in which one or more treatment groups were compared to a control (non-treatment) condition. However, all significant findings were negative (in the expected direction). Overall effect sizes for treatment conditions versus control were considered medium for BMI (-0.502), and small-to-medium for zBMI (-0.36) and %OW (-0.343). Five studies that reported significance at follow-up measurement found that differences between treatment and control groups persisted to follow-up, except in one case for zBMI (Kalavainen et al., 2007).

Between-treatment Group Studies (N=5)

Primary variables. For studies with two treatment conditions in which a first and second treatment group were compared to each other, the average effect size for change in BMI percentile was 0.539.[31] The positive effect size between treatment groups indicates that the first group (parent-focused) decreased BMI more than did the second group (child-focused); however, these results were not significant.[31]

The average effect size between treatment groups for change in zBMI was 0.152, ranging from -0.41 to 0.87.[35,36,40,41] Group 1 was defined as "parents only targeted," while Group 2 was "parents and children" for Golan et al.[40] and Janicke et al.[36] Both of these studies found positive effect sizes between treatment groups, indicating that the first treatment groups (parents only) decreased zBMI more than the second (family) treatment groups; however, the change in the parent-only group for Janicke et al.[36] was not significant. In the study by Golley et al.,[35] treatment Group 1 was the "parenting skills only" condition while Group 2 was "parenting skills plus lifestyle education." The negative effect size in this study (-0.2) indicates that the second treatment group ("parenting skills plus lifestyle education") decreased zBMI more than the first treatment group ("parenting skills only"). For Temple et al.,[41] all participants received the same intervention, but Group 1 was comprised of same-sex parent-child dyads, while Group 2 was opposite-sex dyads. The negative effect size in this study (-0.41) indicates that the second treatment group (opposite-sex dyads) decreased zBMI more than the first treatment group (same sex dyads).

For studies with two treatment conditions in which a first and second treatment group were compared to each other, the average effect size for change in %OW was 1.233.[40] The positive effect size between treatment groups indicates that the first group ("parents only targeted") decreased overweight 1.23% more than did the second group ("parents and children"); however, the change reported for the "parents and children" group was not significant.[40]

Follow-up measurement. Three of the studies that compared two treatment conditions conducted follow-up measurements. The difference between treatment conditions ("parents only" and "family" focused) was not significant at 6-month follow-up for Janicke et al.[36] The difference between treatment conditions ("same-sex" and "opposite-sex" parent-child dyads) was not significant at 24-month follow-up.[41] Golan et al.[40] found that significant changes in primary health variables persisted for the "parents only" group at 6-month follow-up.

Summary. Differences in effect sizes between two treatment groups were difficult to generalize or compare because studies compared different types of treatments/treatment groups. There were no significant findings for differences between treatment groups for BMI. There was a small positive difference in effect sizes for zBMI (0.152), indicating support for parent-only versus parent-child treatment modalities, parenting skills training in combination with lifestyle education versus parenting skills training alone, and opposite-sex parent-child dyads versus same-sex dyads. Only one study examined differences in effects on %OW between treatment groups, and found sizeable but questionably significant support for a parents-only group versus a parent-child treatment. Follow-up studies found that most differences between treatment groups were insignificant at follow-up, except for differences between a parents-only group and a parent-child group for zBMI and %OW in one study.[40]

Secondary Variables

A number of studies examined links between family-based interventions for child obesity and secondary health outcomes for the target child(ren), such as fruit/vegetable intake, consumption of water and sugar-sweetened beverages, physical activity and sedentary behaviors. Average effect sizes are not reported because there were only single studies for a particular secondary outcome variable or because change in the variable was not quantified.

None of the single group studies that looked at effects on primary weight variables examined any of the identified secondary variables. Several of the studies that compared one or more treatment group(s) to a control group examined effects on secondary variables. Beech et al.[31] found significant increases in physical activity and significant decreases in servings of sweetened beverages. No significant differences were found in water consumption post-treatment.[31] Epstein, Gordy, et al.[38] found significant increases in fruit/vegetable intake post-intervention for both treatment groups, despite non-significant changes in primary weight variables. Epstein, Paluch, Gordy, et al.[39] found significant increases in physical activity and significant decreases in sedentary behaviors. McGarvey et al.[42] did not include any primary weight variables but found significant increases in physical activity and water consumption. Changes in sedentary behaviors and fruit/vegetable intake were not significant.[42] None of the reviewed articles compared changes in secondary health variables between two treatment conditions.

Discussion

The main aim of this meta-analysis was to identify the state of the research on family-based interventions targeting childhood obesity in the last decade, in order to inform research in the next decade. The majority of the studies, 70%, showed statistically significant moderate to large effect size changes in child BMI, after participating in a family-based intervention for weight loss. Of these, 50% showed statistically significant child weight loss change at 6-month, 1-year and 2-year follow-up, although effect sizes were more modest (small to moderate). Thus, the scientific evidence suggests the usefulness of using family-based interventions in childhood obesity treatment. Overall, there has been movement to respond to the calls by expert panels and committees to include the family in childhood obesity interventions. Strengths and limitations of the studies in the meta-analyses provide implications to guide future research and clinical practice in the next decade.

Strengths of the Research

The studies in the meta-analysis had several strengths including: being family-based, using comparison groups and randomized controlled designs, follow-up designs, and well-researched curriculum.

Multiple family members. All 20 of the studies in this meta-analysis used one or more family members in the treatment. Family members were involved in various degrees, ranging from being a part of education components, helping to encourage and monitor weight loss efforts of the target child, being directly involved with the target child's weight loss through participating in own weight loss, and targeting parents only in weight loss efforts. Two of the studies also included other family members such as siblings. Results from the analysis indicate the importance of including a parent in child weight loss efforts. There are still unanswered questions regarding whether it is important if the involved parent is the same-sex or opposite-sex of the target child, or whether the intervention should target only the parent in treating childhood obesity. In addition, it is unclear whether including more family members (e.g. siblings) would be beneficial. Research in the next decade should replicate these findings in order to confirm or dispute the importance of parent sex, parent-only treatment and sibling involvement.

Using comparison groups and RCT's. The majority of the studies, 75% (15 of 20) included a control group or more than one treatment group for comparison. Of these studies, half (10 of 20) were randomized control trials. Using RCT's allows for conclusions about cause and effect to be more confidently drawn. For instance, when participants are randomly assigned to treatment groups versus control or other treatment groups, each participant has an equal chance of being assigned to the groups. Single group designs can have self-selection bias, such as participants who are more motivated for weight loss, which makes it difficult to determine whether the intervention was really the cause of the weight loss. Future research should continue using comparison groups and RCTs in order to maintain the rigor of the research.

Follow-up studies. More than half of the studies (11 of 20), used follow-up designs. Most of these studies measured 6-month or 1 year follow-up. Only two studies, followed-up participants past 2 years. Long term follow-up studies are important for establishing the success of family-based interventions in producing sustainable weight loss over time in children. With the issue of childhood obesity especially, it is important to be able to show continued weight loss or maintenance in order to counteract the devastating outcomes of adult obesity such as: hypertension, cardiovascular disease, metabolic syndrome, and Type II diabetes. Researchers should consider using designs with longer term follow-up time points (e.g. > 1 year follow-up), in order to demonstrate long term effects of family-based interventions.

Intervention curriculum. The curriculum used in the family-based interventions included three main components: (1) nutritional and physical activity education, (2) psychoeducational parenting groups, and (3) behavioral control/monitoring of diet and exercise. Most studies had at least one or more of these elements. The interventions that targeted both parenting skills and nutrition/physical activity education showed more statistically significant results with larger effect sizes compared to interventions that used education only or education plus behavioral control/monitoring. This implies the importance of teaching parents both structure/setting limits skills and empathic/caring skills in treating childhood obesity.

Epstein and colleagues' *Stoplight Diet* was used in 40% (8 of 20) of the studies. This well-researched curriculum was developed by Epstein and colleagues' and includes

components of education, parenting training and behavioral modification. This family-based curriculum has been shown to produce significant weight loss in children and their family members at 6 month, -2 year and -10 year follow-up time points. It would be important for future research to test this curriculum with ethnic/racial minorities. To-date most of Epstein's studies have been conducted with white, middle to upper socio-economic status, families. It would be important to adapt the material for other cultures and ethnicities in order to determine whether this curriculum is as useful for ethnic/racial minorities, who are at highest risk for obesity.

Limitations and Recommendations for Future Research

There are also several limitations in the current research that provide implications for future research. These include: increasing sample diversity, measurement of BMI, need for theory driven research, need for long-term follow up studies, importance of sex comparisons, and a need for more family-based research conducted by various researchers.

Sample diversity. Only 30% (6 of 20) of the studies included ethically/racially diverse families in their studies. This is a limitation of the current research on family-based interventions that needs to be addressed. It is well know that ethnic/racial minorities are at highest risk for overweight/obesity.[1–3] Thus, it is crucial to identify family-based interventions that are suitable for children from diverse ethnic/racial and low socioeconomic backgrounds. To-date most interventions with these groups have been conducted in the schools.[43–48] Based on the results of this meta-analysis, and the importance of "family" to many ethnic/racial groups, family-based interventions targeting minority children need to be developed and tested.

Measurement of BMI. All studies in the meta-analysis used BMI percentile, BMIz or percent overweight to measure the primary outcome of change in child BMI. Results from the meta-analysis indicated that there were different effect sizes depending on which measurement the investigator used. For instance, the majority of studies using BMI percentile showed larger effect size changes in child weight loss compared to BMIz and % overweight. Current recommendations suggest using child BMIz score.[49] Because children are growing, analyzing the Z-transformation of BMI, which uses the Centers for Disease Control (CDC) Growth Charts[19] to compare the child's BMI against gender- and age(month)-specific standards, is preferred.[50,51] Thus, future intervention research would benefit from using a standardized measure (e.g. BMIz score) in order to make comparisons across studies more easily and precisely.

Secondary health outcomes. Although a few (n=4) studies examined links between family-based childhood obesity interventions and secondary health outcomes (e.g. child fruit/vegetable intake, consumption of water and sweetened beverages, physical activity and sedentary behaviors), the current study did not report effect sizes because only single studies looked at secondary outcome variables or because change in the variable was not quantified. The studies that measured secondary outcomes found: (1) significant increases in physical activity and significant decreases in servings of sweetened beverages;[31] (2) significant increases in fruit/vegetable intake post-intervention for both treatment groups, despite non-significant changes in primary weight variables;[38] (3) significant increases in physical activity and decreases in sedentary behaviors;[39] and (4) significant increases in physical activity and water consumption.[42] These significant findings suggest that it would be important to measure secondary outcomes in childhood obesity intervention research. This is important because it is likely that there are multiple pathways to child weight change, rather than a magic variable or program that will solve the childhood obesity problem. Thus, measuring secondary outcomes will allow for identifying variables that are upstream from child weight loss in order to identify targets for intervention (e.g. increased water consumption, family meals, family shared physical activity). It may also be important to consider using these "secondary outcome" variables (e.g. dietary intake, physical activity) as primary study outcomes, rather than secondary, in childhood obesity treatment studies. This approach would be useful because once a variety of upstream variables are effectively modified, weight change would potentially follow.[52]

Need for theory driven research. As family-based intervention research continues to show significant results for treating childhood obesity, it will be important to use theory in conceptualizing study designs that will allow for sustainability of weight loss in children. For instance, family systems theory suggests the importance of systemic-level support in order to maintain change in any given family member.[11–13] It would be important for future research to identify ways in which systemic-level support can be utilized in intervention delivery. For instance, it might be important to have maintenance sessions, such as "check-ups" to make sure the family system is continuing to support and model health changes in the target child.

Sex differences. Research on this meta-analysis suggest the importance of looking at sex differences in weight loss treatment. There were significant findings for opposite-sex parent/child dyads in weight loss treatment groups. Other research confirms this finding. Several studies have identified an association between opposite sex parent/child dyads in regards to authoritative parenting style and child BMI, dietary intake and frequency of family meals.[9,53–55] Taken together, these results suggest that the opposite sex parent may play a unique role in influencing child weight loss and sustainability of weight loss. This is an interesting and important finding that should be explored further in future research.

Attrition. In 25% of the studies (5 of 20) there was significant attrition (between 1/4–1/3 of the sample). This suggests that those who stayed in the treatment may be significantly different than those who dropped out. It may be the case that families who dropped out were less motivated for participation. Studies that reported differences between participants who stayed in treatment versus dropped out identified that the target children in these families were typically more overweight/obese, from lower SES households, and were ethnically/racially diverse. These results suggest the importance of conducting an intent-to-treat analysis, including all participants that began the study, regardless of their drop out status or adherence to the study protocol. These types of analyses are important because participant withdrawal occurring after randomization might be treatment related and excluding subjects who withdraw could bias results.

Need for further research. Although the last decade has shown an increase in family-based interventions for childhood obesity, more is needed. Twenty studies in one decade can not be considered a preponderance of evidence. More studies, conducted by more researchers, are necessary in order to firmly establish the evidence in favor of family-based interventions. Of the twenty studies in the meta-analysis, 35% (7 of 20) of the studies were conducted by Epstein and colleagues. While Epstein's work has provided a good solid path for family-based intervention research, it would be important for different researchers to replicate findings and conduct studies with more diverse populations. This would help confirm the evidence supporting family-based interventions to target childhood obesity.

Implications for Clinical Practice

Results from the current meta-analysis provide implications for practitioners who treat children with overweight and obesity issues. First, results suggest that referring children with overweight or obesity concerns to family-based interventions is a good option for practitioners. The current meta-analysis showed moderate to large effect sizes for effectiveness of family-based interventions in reducing child weight. This means that the change in child weight was more likely due to the family-based intervention versus another factor. Second, it would be important for practitioners to find interventions that are truly family-based. Interventions that include one parent visit, or only send home materials for parents, are not considered family-based interventions. The current meta-analysis showed that including at least one parent in the childhood obesity intervention was important and that the sex of the parent may also be important. In addition, family-based interventions that showed child weight loss in the short and long term were more likely to target weight change/management in the child, as well as, the parent/family. Thus, identifying family-based interventions that include both individual level change and system level change (e.g. Epstein's *Stop Light Diet*) would be important in order for practitioners to have resources to provide referrals to families with children who are overweight/obese.

Although findings from the met-analysis show positive results for using family-based interventions to combat childhood obesity, family-based interventions or treatment centers are not always readily available to providers. Many pediatric specialty clinics, or clinics located at research Universities have family-based obesity treatment programs. In addition, many community mental health clinics are beginning to include obesity treatment options, but it is important to identify whether they are individually-based treatments or family-based treatments. Further, there is likely to be more childhood obesity intervention options available in the near future as the topic has become one of national and international importance.[8]

Conclusion

There is preliminary evidence suggesting that family-based interventions treating childhood obesity are successful in producing weight loss in the short and long term. Including families in weight loss treatment of overweight/obese children warrants further implementation and study.

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Address for correspondence:
Jerica M. Berge, PhD, LMFT
Department of Family Medicine and Community Health
University of Minnesota
Phillips Wangensteen Building
516 Delaware Street SE
Minneapolis, MN 55455

Email: mohl0009@umn.edu