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OBESITY + DIET (G RAO, SECTION EDITOR)

Recent Updates on the Efficacy of Group-Based Treatments for Pediatric Obesity

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Abstract There is limited research on optimal treatment formats for childhood obesity. Group-based interventions are popular, but it is unclear whether outcomes can be obtained without an additional individual component. The aim of the study was to examine statistically and clinically significant outcomes of recent group-based and mixed-format (group+individual) pediatric obesity interventions. Effect sizes and magnitudes of weight change were calculated for studies published between January 2013 and September 2014. Approximately half of the group-based studies reviewed produced significant results compared to control, and effect sizes were small. Mixed-format studies were less likely to include a control group, but those that did evidenced medium to large effects. Magnitudes of weight change post-intervention were generally greater in mixed-format studies than group-only studies. Recent studies in pediatric obesity interventions suggest including an individual component in a group-based intervention produces optimal outcomes. Future research should directly compare group-only and mixed formats to confirm this observation.

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Introduction

Rates of pediatric overweight and obesity have tripled in the USA in the past 30 years, with nearly 17 % of children and adolescents reported to be obese in 2011–2012 [1]. Unhealthy weight gain is associated with a variety of medical comorbidities, including coronary heart disease, type 2 diabetes, and premature death [2–6] making pediatric obesity a serious public health problem.

Both prevention and treatment strategies are needed to curb the childhood obesity epidemic. Children with obesity are likely to become adults with obesity, and this risk increases with severity and older age in childhood [7–9]. The US Preventative Services Task Force (USPSTF) has recommended that children with obesity be referred to comprehensive, intensive behavioral interventions with weight loss treatment aims that result in absolute and/or relative decrease in body mass index (BMI) [10]. These interventions include diet, physical activity, and behavior modification components and, in early and middle childhood populations, parent involvement. Parents' participation is vital for child weight loss due to their control of the home environment, ability to set rules to encourage healthy behaviors and potential to model healthy habits. Research shows parent involvement leads to better weight outcomes than treatment of the child alone [11]. This family-based approach to treatment has consistently demonstrated improvements in child weight outcomes at post-treatment and up to 10 years thereafter [12].

Pediatric obesity interventions may utilize group and/or individual family formats, each of which has unique elements that may contribute to overall weight loss success. While

existing reviews document the evidence base of childhood obesity interventions across different settings and modalities [13], little attention has specifically been given to intervention formats. Intervening with an individual family allows for tailoring of diet/physical activity recommendations and behavior modification strategies for each individual's needs, preferences, and capabilities, which is important considering the many causes and maintaining factors contributing to increased weight [14]. It also allows flexibility in scheduling, potentially increasing program adherence. However, while individual treatment maximizes contact, it requires considerable resources. Group treatment may be more pragmatic when considering dissemination, implementation, and ultimately access to care in the population [15]. Furthermore, unique therapeutic factors, such as universality, altruism, imitative behavior, and interpersonal learning, are at work in group settings [16]. Given the isolation, ostracism, and poor interpersonal relationships that children with overweight and obesity report, which have been tied to increased food intake and decreased physical activity, this population may benefit from a positive social environment that can facilitate socialization and enhance peer support and indeed research reinforces this notion [12, 17–22]. Yet, inherent to groups is the limited attention to individual needs, which may weaken outcomes.

Therefore, when considering treatment format, the challenge lies in meeting the unique needs of each individual child and/or family while providing peer support and group cohesion. A common approach is to supplement group sessions with shortened individual meetings to develop individualized strategies and skills [23, 24]. This mixed format approach may harness the beneficial effects of both individual and group formats, potentially enhancing treatment outcomes. Thus, this review will examine the intervention designs and weight outcomes of recent studies assessing group-based childhood obesity treatments, evaluate the effects of group treatment with and without an individual component, and note gaps in literature.

The Current Review

This descriptive review outlines recent randomized trials on pediatric obesity behavioral group treatments from 2013 to 2014 (Tables 1 and 2). Previous reviews have covered earlier time frames so this review was designed to cover recent updates. The review addresses age groups from early childhood through adolescence and focuses on treatments delivered in research, primary care, specialty outpatient, and community settings. PubMed and Google Scholar were searched with the terms "child," "obesity," "treatment," "group format" alone, or in combination. School-based programs (which are primarily public health interventions targeting all children in a school) and inpatient programs (which often fail to document time spent in each format and are less widely available) were not included. With those exclusions as well as exclusions of non-controlled trials, a total of 14 studies of group-only treatment studies (defined as little to no individual interaction with the interventionist) and eight studies of mixed format treatment (defined as group intervention with planned and structured individual meetings) were identified by the authors. The review will discuss effect sizes and magnitudes of change in post-treatment weight outcomes of group-only and mixed-format interventions separately and will then qualitatively compare the two formats to determine which maximizes outcomes for childhood overweight and obesity. It will conclude by identifying research priorities that would enhance our understanding of comparative outcomes of group and individual treatment format in childhood obesity.

Weight Outcomes

Measurement units for child weight vary across studies; however, effect sizes are a way to standardize variable measurement units and allow for interpretation of the magnitude of weight change with the inclusion of variability for practical interpretation [45] and are therefore helpful for interpreting results. Outcomes in intervention studies are frequently reported as mean change in zBMI for each group. We considered these outcomes, and using Cohen's d converted them to measure of effect size using the formula $d=(\text{Mean change}_1-\text{Mean change}_2)/((\text{Baseline SD}_1+\text{Baseline SD}_2)/2)$ [45, 46]. Between-group effect sizes were computed for all studies. Effect sizes comparing an intervention group to a control group provide information regarding the overall effects of treatment, with a negative effect size demonstrating superiority of control, while effect sizes comparing two active interventions provide more information on which intervention produces greater effects. General guidelines for interpretation of effect sizes for comparisons of two groups propose an effect size of 0.2 as small, 0.5 as medium, and 0.8 as large [47]. In addition, to provide a general understanding of impact of intervention, within-group effect sizes will be reported alongside the between-group effect sizes. The formula used for these effect sizes was similar, but employed pre- and post-treatment means and standard deviations within groups [45].

Weight outcomes should also be considered in terms of their clinical significance. In other words, regardless of statistical results, assessing whether change in weight has an impact on child health outcomes allows for qualitative interpretation of the usefulness of the intervention. While the literature is somewhat mixed on the weight loss necessary to produce clinically significant results in children, a loss of 0.25 zBMI points has been consistently tied to meaningful health changes, which continue to improve with additional weight

Table 1 Reviewed studies utilizing group-only treatment design

Citation	Number	Ages	Setting	Groups	Dose	Length	Post-treatment outcomes	Change score	ES-B	ES-W	Follow-up outcomes
Controlled studies											
Berry et al. [25]	358	7–10	Community	1. FBT 2. Usual Care/ Waitlist Control	1. 21 family group sessions: 60 m education+45 m PA 2. Monthly mailings	12 months	Between-group 1=2 for BMI percentile	1. −.62 % 2. −1.49 %	−0.04	1. 0.11 2. 0.15	Between-group (18 months) 1=2 for BMI percentile
Bloom et al. [26]	45	6–12	Research institution	1. CAAT program 2. Waitlist control	1. 6 weekly 60 m sessions 2. No active time	6 weeks	Between-group 1>2 for BMI reductions	1. −0.63 2. 0.15	0.20	1. 0.16 2. −0.04	Between-group 1=2 for BMI change
Bocca et al. [27]	75	3–5	Outpatient	1. BWL+F 2. Usual care	1. 6 30 m family group sessions+12 60 m child PA sessions+6 120 m parent counseling sessions 2. 3 30–60 m pediatrician sessions	16 weeks	Between-group 1>2 for zBMI reduction	1. −0.5 2. −0.3	0.20	1. 0.5 2. 0.31	Between-group (36 months) 1=2 for zBMI
Boutelle et al. [28]	44	8–12	Research institution	1. Regulation of cues program 2. Control	1. 14 105 m sessions: 45 m separated groups+30 m family groups 2. No active time	4 months	Between-group 1=2 for zBMI reductions 1=2 for % overweight	1. −0.13, −7 % 2. −0.04, −0.41 %	0.23	1. 0.3 2. 0.1	Between-group (6 months) 1=2 for zBMI reductions 1=2 for percent overweight
Davis et al. [29]	58	3rd–5th grade	Child: In-person Parents: Telemedicine	1: BWL+F 2: Physician Visit	1. 8 weekly+6 monthly 1 h separated group sessions 2. 1 session	8 months	Between-group 1=2 for zBMI Within-Group Reduction in zBMI in 1 and 2	1. −0.12 2. −0.15	–0.06	1. 0.23 2. 0.29	Not assessed
Esfarjani et al. [30]	156	7	Research institution	1: BWL+F: PO 2: Wait-list	1. 12 4 h sessions 2. No active time	6 months	Between-group 1<2 for BMI gains (trend) Within-group BMI increases over time in 1 and 2	1. 0.8 2. 1.3	0.24	1. −0.36 2. −0.66	Not assessed
Hofsteenge et al. [31]	122	11–18	Outpatient: Go4it	1. BWL+F 2. Dietician referral	1. 7 90 m adolescent group sessions+4 booster sessions 2. No specified time	6 months	Between-group 1=2 for BMI SDS reductions	1. −0.12 2. 0.02	0.3	1. 0.26 2. −0.04	Between-group (18 months) 1>2 for BMI SDS reductions
Lochrie et al. [32•]	130	8–11	Outpatient	1: BWL+F 2: Education control	1. 14 60–90 m sessions 2. 1 60 m session	6 months	Between-group 1>2 for zBMI reduction Within-group zBMI reductions in 1 and 2	1. −.13 2. −0.03	0.31	1. 0.46 2. 0.11	Between-group (12 months) 1>2 for zBMI reduction Within-group zBMI reductions in 1 and 2
Martinez-Andrade et al. [33]	306	2–5	Primary care: Creciendo Sanos	1. BWL+F: PO 2. Usual care	1. 6 2 h sessions 2. No specified time	6 weeks	Between-groups (3 months) 1=2 for zBMI	1. −0.16 2. −0.26	−0.13	1. 0.19 2. 0.35	Between-groups (6 months) 1=2 for zBMI
Mazzeo et al. [34]	84	6–11	Outpatient	1. FBT: PO 2. Education control	1. 6 or 12 90 m sessions 2. 1 session+3 mailings	6 or 12 weeks	Between-group 1>2 for BMI percentile reduction	1. −0.28 % 2. −0	0.11	1. 0.11 2. 0	Follow-up (6 m) N/A due to attrition
Morgan et al. [35]	132	5–12	Community-based	1: FBT 2: Wait-list	1. 7 weekly 90 m sessions 2. No active time	7 weeks	Between-group 1>2 for zBMI	1. −0.18 2. −0.08	0.10	1. 0.29 2. 0.11	Not assessed
Active intervention comparison studies											
Kalarchian et al. [36]	18	8–12	Research institution	1: FBT+menu plans 2: FBT+menu plans+meals	1 and 2. 8–9 weekly sessions	9 weeks	Between-group 1=2 for BMI Within-Group BMI reduction in 1 and 2	1. −1.2 2. −1.8	NC	1. SRM: 0.8 2. SRM: 1.2	Not assessed
Trost et al. [37]	75	8–12	Community-based	1: BWL+ F 2: BWL+ F+ active gaming console	1 and 2. 16 weekly 60 m family group sessions	16 weeks	Between-groups 1<2 for % overweight reduction 1<2 for zBMI reduction	1. −5.5 %, −0.11 2. −10.9 %, −0.25	0.30	1. 0.38 2. 0.49	Not assessed

ES-B between-group effect size, *ES-W* within-group effect size, *BWL* behavioral weight loss, *BWL+F* behavioral weight loss with family involvement, *FBT* family-based behavioral treatment, *BMI* body mass index, *zBMI* body mass index z-score, *PA* physical activity, *PO* parent only, *NC* not calculated, *SRM* standard responsiveness of the mean

Table 2 Reviewed studies utilizing a mixed-format design

Citation	N	Ages	Setting	Groups	Dose	Length	Post-treatment outcomes	Change score	ES-B	ES-W	Follow-up outcomes
Controlled studies											
Patrick et al. [38]	101	12–16	Research etting	1. BWL+F: Web-only[a] 2: BWL+F: Web+group 3. BWL+F: Web+SMS[1] 4: Usual care	1, 2, and 3. Tutorials+email check-ins 2. Monthly 90 m. family sessions and bimonthly phone 3. 3+ SMS per week 4. 3 1 h group	12 months	Between-group 1=2=3=4 for zBMI change 1=2=3=4 for BMI percentile	1. −0.1, −.9 % 2. −0.2, −.7 % 3. −0.1, −.8 % 4. 0, −.5 %	0.57	1. NC 2. 0.49 3. NC 4. 0	Not assessed
Quattrin et al. [39]	96	2–5	Primary care	1. BWL+F: PO 2. Information control	1 and 2. 13 60 m parent group sessions+10 individual phone calls	12 months	Between-group (12 months) 1>2 for zBMI reduction 1>2 for %OBMI	1. −0.45 2. −0.21	0.69	1. 1.3 2. 0.59	Between-group (24 months) 1>2 for zBMI reduction 1>2 for %OBMI
Stark et al.[b] [40]	42	2–5	Outpatient: LAUNCH	1. BWL+F: Clinic 2. BWL+F: Clinic Home 3: Pediatrician counseling	1 and 2. 9 90 m separated group sessions clinic 2. 9 60–90 m individual home sessions 3: 1 45 m visit	6 months	Between-group 1=3 for zBMI reduction 2>3 for zBMI reduction	1. −0.25 2. −0.37 3. −0.07	1 vs. 3=0.3 2 vs. 3=1	1. 0.34 2. 1.19 3. 0.24	Between-group 1>3 for zBMI reduction 2>3 for zBMI reduction
Active intervention comparison studies											
Berkowitz et al. [41]	169	12–16	Primary care	1: FBT: group 2. FBT: self-help	1 and 2. 6 45 m individual family visits 1. 17 separated groups	12 months	Between-group 1=2 for zBMI	1. −0.12 2. −0.12	NC	1. NC 2. NC	Not reported
Hystad et al. [42•]	99	7–12	Outpatient	1. FBT: Therapist-led group 2: FBT: Self-help group	1 and 2.15 2 h separated group sessions+10 individual family	24 months	Between-group 1=2 for zBMI reduction Within-group Reduction in zBMI for both groups	1. -0.22 2. −0.19	0.07	1. 0.41 2. 0.48	Between-group 1=2 for zBMI reduction Within-group Reduction in zBMI for both groups
Kokkvoll et al. [43]	97	6–12	Outpatient-based with community extensions	1: BWL+F: Single family intervention 2: BWL+F: Multiple-family intervention	1. 8 h 2. 36 h	12 months	Between-group (3 months) 1=2 for BMI SDS change	1. 0.07 2. −0.27	0.15	1. 0.14 2. 0.3	Between-group (12 months) 1=2 for BMI SDS change
Mirza et al. [44]	113	7–15	Community clinic	1. FBT: Low glycemic index 2: FBT: Low fat diet	1 and 2.12 weekly group sessions, separate+individual family sessions	3 months	Between-group 1=2 for zBMI reduction Within-group Reduction in zBMI for both groups	1. −0.13 2. −0.11	0.07	1. 0.36 2. 0.39	Between-group (24 months) 1=2 for zBMI reduction Within-group Reduction in zBMI for both groups
Saelens et al. [24]	72	7–11	Research institution	1: FBT 2: FBT+motivational interviewing	1 and 2. 20 weekly 20–30 m individual family sessions+40 m separated groups	21–22 weeks	Between-group 1=2 for zBMI: Within-groups: zBMI reduction in 1 and 2	1. −0.33 2. −0.34	0.03	1. 0.80 2. 0.83	Between-group (2 years) 1=2 for zBMI: Within-groups: zBMI reduction in 1 and 2

ES-B between-group effect size, *ES-W* within-group effect size, *BWL* behavioral weight loss, *BWL+F* behavioral weight loss with family involvement, *FBT* family-based behavioral treatment, *BMI* body mass index, *zBMI* body mass index z-score, *PA* physical activity, *PO* parent only, *NC* not calculated

[a] Condition not addressed in review

[b] Condition BWL+F: clinic discussed in group-only section, while BWL+F: clinic+home discussed in mixed-format section

loss; therefore, this will be considered a threshold of clinical significance when interpreting study results [48–51].

Group-Only Intervention Studies

Study Descriptions Positive results were found in five out of the 12 RCTs. Bocca et al. utilized a combination of family group sessions, as well as separate child physical activity sessions and group parent counseling sessions, for a duration of 4 months in an early childhood population and found a change of −0.5 zBMI in the intervention group as well as significant decreases in zBMI compared to a control group post-treatment, who lost 0.3 zBMI points (d=0.2) [27]. Four of eight studies using a control condition in middle childhood populations demonstrated significant effects. Mazzeo et al. utilized a parent-only approach and found that 6 or 12 90-min sessions (duration was adjusted during treatment) resulted in a loss of 0.28 BMI percentile points in the intervention group, which represented a small but significant decrease in BMI percentile compared to the control group, which did not experience any weight changes (d=0.11) [34]. Lochrie et al. used 14 sessions across a longer time period (6 months) and found a reduction in zBMI of 0.13 in the intervention group, but a negligible loss of 0.03 zBMI points in the control group (d=0.31) [32•]. A unique approach by Morgan et al. which primarily targeted fathers' weight, but had secondary aims to improve child lifestyle behaviors, also was successful in producing significantly improved zBMI weight outcomes (loss of 0.18 points) compared to a wait-list control group (loss of 0.08 points) (d=0.10) [35]. Finally, in an effort to address eating in the absence of hunger (EAH), a behavior that is associated with binge eating [52], Bloom et al. assessed Child Appetite Awareness Training (CAAT), which focuses on attending to internal hunger and satiety cues [26, 28], and showed favorable child BMI changes (−0.63 BMI points) following intervention compared to the control group, which gained 0.15 BMI points (d=0.20); however, changes from baseline to 6-month follow-up were no longer significant [26].

Seven out of 12 RCTs did not produce statistically significant changes on child weight compared to control. Two early childhood interventions with 12 and 13.5 h of contact time, respectively, failed to find weight outcomes different from controls [33, 40]. Two studies in middle childhood populations met USPSTF dosage guidelines of more than 25 contact hours, but did not produce positive results compared to a control condition. In one study, participants attended 21 family group sessions consisting of lifestyle modification training and physical activity across 12 months with a loss of 0.6 BMI percentile points in the intervention but no statistical difference compared to control [25] (d=−0.2) while in the other, parents attended 12 4-hour sessions and results demonstrated an increase of 0.8 BMI points in children, which trended toward but did not reach significance compared to a wait-list control condition in which children gained an average of 1.3 BMI points [30] (d=0.24).

Another study utilized technology and created virtual telemedicine parent groups and in-person child groups. While the intervention group lost 0.12 zBMI points, weight loss was not significantly different from a doctor visit control, potentially demonstrating the importance of face-to-face treatments for the parent (d=−0.06) [29]. Finally, another group treatment study targeting EAH combined CAAT and cue exposure treatment (CET) [53], which focuses on monitoring and resisting food cravings resulting from exposure to food cues, produced an average loss of 0.13 zBMI points in the intervention group, but was unable to produce significant change compared to control (d=0.23) [28].

Adolescents have previously demonstrated blunted response to traditional treatments [54]. This was also the case in the group-only study assessing the Go4it program, which did not find significant differences compared to a dietician referral control post-treatment (d=0.30, ΔzBMI=−0.12) [31]. However, a modest but significant difference was found from control at follow-up, suggesting benefits may only be realized over a longer time period.

Two studies examined enhanced versions of FBT by using two experimental groups. Active video gaming, or exergaming, promotes peer socialization (particularly when engaged in cooperatively) [55] and was found to improve both physical activity and weight outcomes with a loss of 0.25 zBMI points compared to a group FBT control condition that lost 0.11 zBMI points (between-group d=0.3; within-group d=0.49 for FBT+exergaming and 0.38 for FBT only) [37]. Incorporation of structured menu planning, which has been successful in adult samples, also shows promise with children in the context of group FBT, with the intervention group losing an average of 1.2 BMI points, although the inclusion of actual meals did not produce an additional statistically significant effect on weight loss[1] [36].

Conclusions Overall, 12 group-only intervention studies compared intervention to control and two studies compared two active interventions (Table 1). Effect sizes of the studies that included a control group ranged from −0.17 to 0.31 with a median of 0.20, a small effect. Approximately half of these studies showed statistically superior results of group-only intervention compared to control.

Magnitude of weight change was measured using zBMI in seven studies. The average magnitudes of zBMI change within active interventions ranged from −0.11 to −0.50 with a median of −0.15, and changes within control groups ranged from 0.02 to −0.3, with a median of −0.075. Of these studies, three out of ten interventions were able to meet and/or surpass

[1] Medians reported due to small sample size; therefore, effect size was not calculated.

the threshold of 0.25 zBMI points demarcating clinical significance [37, 39, 40].

Three studies used BMI as the measurement unit and the average magnitudes of BMI change within active interventions ranged from 0.8 to −1.8, with a median of −0.91. Two of these three studies provided control groups, which evidenced average gains of 1.3 and 0.15 BMI points. Two studies used BMI percentile change with intervention magnitudes of −0.28 and −0.62 % and control groups with BMI percentile changes of 0 and −1.49 %, respectively. Considering the lack of literature related to clinically significant changes in BMI and BMI percentile in children, it is difficult to ascertain the clinical effects of those studies. One study did not report change in means [27].

Mixed-Format Intervention Studies

Study Descriptions An intervention was compared to a control group in three mixed-format studies, two of which produced significant beneficial results of intervention [39, 40]. Stark et al. assessed an intervention with group-based clinic visits and individual home visits and found a weight loss of 0.37 zBMI points in preschool aged children, which was significantly greater than control (d=1) [40]. Another intervention in the preschool population tested an active information control against an intervention that also included behavioral modification and parenting skills. Both conditions had weekly parent-only group sessions and individual phone calls, but the experimental condition produced weight outcomes of 0.45 zBMI points, which was significantly better than control (d=0.69) [39]. However, null results were found in a mixed-format intervention with adolescents. This web-based study compared a usual care condition to three internet interventions, one in which in-person groups and bimonthly telephone calls were also provided [38]. While the group intervention produced reductions of 0.2 zBMI points and a medium effect size of 0.57, this was not sufficient to demonstrate change above and beyond usual care.

Many studies have replicated the finding that mixed-format interventions result in significant child weight loss compared to control [56]. Thus, recent research has moved beyond intervention to control comparisons and has begun to explore how mixed format interventions may be improved and/or supplemented to produce even better results by comparing two active interventions. An initial question may be whether the addition of the group sessions confers benefits above and beyond individual treatment. Kokkvoll compared an individual family intervention consisting of 8 hours of individual contact to the same treatment supplemented with a group component that included an additional 28 hours of treatment [43]. Results produced an effect size of 0.15 in favor of multifamily treatment, in which participants lost 0.16 zBMI points on average, but did not reach significance (p=0.068.)

Scaling of treatment is also an important consideration, as few individuals have access to evidence-based treatments [57]. Self-help interventions require few or no trained personnel to implement the intervention. Berkowitz and colleagues initiated a family-based weight loss study with six individual sessions with a trained interventionist then randomized families to a self-help condition or a group treatment condition [41]. Those in the self-help condition were given the treatment manual with instructions for parents and adolescents to complete lessons together on a weekly basis within the home, whereas those in the group condition returned to the clinic for 17 group sessions (separate parent and child groups). Results did not show a difference on weight outcomes among the groups, with a change in zBMI points of 0.12 in both the self-help and group conditions, suggesting group treatment may not provide benefits beyond those which may be achieved by family self-directed treatment.[2]

Hystad and colleagues assessed self-help within a group format, and parents were randomized to therapist-led group sessions or self-help group sessions [42•]. While both conditions also received ten individual family sessions, the therapist-led group sessions followed a detailed treatment manual administered by two trained therapists whereas the self-help condition was based on the principle of mutual help with no therapist guidance. Participants in both conditions lost statistically significant amounts of weight (therapist: within-condition d=0.41, ΔzBMI=−0.22; self-help: within-condition d=0.48, ΔzBMI=−0.19), but were not significantly different from each other (between-condition d=0.07). Results suggest that mutual self-help in a group setting can be just as powerful as a therapist-led group treatment. While both Hystad et al. and Berkowitz et al. demonstrate the promise of self-help, contribution of the group format to change remains unclear as self-help within group format and individual family format were not directly compared. Additionally, it should be noted that the individual family sessions at treatment initiation also likely contributed to successful treatment outcomes of the self-help conditions.

Promotion of family self-efficacy and autonomy may also help to improve treatment response. Saelens and colleagues assessed this principle by comparing a traditional prescribed, mixed-format, family-based treatment intervention with a focus on skills training and accountability for skills use by the interventionist to one that utilized the same format, materials, and concepts, but focused on activating goals and skills unique to each family with a motivational and autonomy-enhancing approach [24]. Results showed meaningful weight change post-intervention in both groups, as they both lost approximately 0.33 zBMI points (within-group d=0.80 and 0.83), but did not show group differences for child zBMI or parent BMI change (between-group d=0.03), suggesting this

[2] Post-intervention average SDs not available to calculate effect size

approach may be a useful alternative to the standard interventionist-prescribed family-based treatment.

Finally, within-group changes of a mixed format study assessing diet recommendations found losses of 0.11 and 0.13 zBMI points in the intervention groups (low glycemic vs. low fat), which demonstrated within-group effect sizes of 0.39 and 0.36, respectively, but did not reach a magnitude of clinical significance. [44].

Conclusions Three mixed-format studies compared intervention to control and five studies compared two active interventions. Effect sizes of those that included a control group ranged from 0.56 to 1.0, with a median of 0.69, demonstrating medium to large effects of intervention.

With regard to treatment response, all reviewed studies provided average magnitudes of change post-intervention and all used zBMI as at least one of the weight outcome measurements (Table 2). The magnitudes of zBMI change within interventions ranged from −0.11 to −0.45 with a median of −0.2. Three studies provided control groups with zBMI change from 0 to −0.21 with a median of −0.07. Three of these studies provided four interventions that met clinically significant thresholds for zBMI and percent overweight. In early childhood populations, Stark et al. demonstrated losses of 0.37 zBMI points in the clinic and home visit condition and Quattrin found a zBMI reduction of 0.45 points [39, 40]. In middle childhood, Saelens et al. reported clinically significant changes in magnitude of 0.33 and 0.34 zBMI points in both intervention groups [24]. Thus, four out of twelve mixed format interventions were able to achieve a loss of more than .25 zBMI points.

Summary of Group-Only and Mixed Format Studies

Effect Sizes Within the studies sampled from 2013 and 2014 with a control group, the median effect of group-only treatments was 0.20, while the median effect of mixed-format was 0.69. While this is only representative of 2 years, it seems that mixed-format intervention designs produce larger effect sizes on weight, on average, than group-only designs when compared to a control condition. If within-group effect sizes are considered, this also appears to be the case. Experimental groups of group-only studies in which means and standard deviations were reported (or able to be calculated) demonstrated a range of −0.36 (intervention group gained weight) to 0.50, with a median of 0.28, while experimental groups of mixed-format studies ranged from 0.30 to 1.33, with a median of 0.48; however, these must be considered with caution as effect sizes of control conditions were variable and in some cases, surprisingly high (−0.66 (weight gain) to 0.59, median: 0.18).

Weight Change Outcomes Magnitudes of weight change were variable across studies; however, the median weight loss in the mixed-format studies was 0.2 zBMI points, but only 0.15 in group-only, suggesting greater losses in mixed-format. Additionally, a weight change of 0.25 zBMI units was reached in four out of 12 mixed-format studies and three out of 10 group-only studies, suggesting some interventions in both groups are producing clinically significant weight change.

Other Considerations Given the diversity in weight outcomes, it is apparent that intervention format is not the only component of treatment that may influence results. Factors such as group size, dosage, modality, parent involvement, age of participants, and setting are important considerations when designing an effective treatment. While a full discussion of these treatment components is outside the scope of this review and may be found elsewhere [58], it is important to highlight that these also contribute to differential results in treatment studies.

Future Directions

While our findings suggest the superiority of mixed-format treatments compared to group-only treatments, concrete conclusions are difficult to draw due to the lack of direct comparison studies. One randomized-controlled trial demonstrated similar outcomes in group-only and mixed-format conditions [15]; however, due to the small sample size, a replication study would be advantageous in interpreting results. Dismantling study designs may also prove helpful, as they would allow for isolation of the effect of supplemental individual meetings on treatment outcomes and may be utilized to examine the importance of social support from participating peers and nonparticipating family and friends in enhancing and maintaining participant weight loss. If intervention group support proved helpful, relationship building among group members could be actively targeted in treatment to improve outcomes. Patient moderating variables may also predict different responses to assorted treatment options [59]. Assessing predictors of treatment format response would allow clinicians to prescribe treatment most beneficial to an individual.

Technology, the Internet, and social-media may also prove useful for group treatment delivery, as they are low cost and provide immediate feedback. In the context of group treatments, web- and mobile-technologies can serve to engage individuals in social networks remotely and can be used to encourage greater interaction among participants from in-person groups [60–62]. Technology use has contributed to weight loss in adults [62] and increases peer-to-peer supportive interactions and perceptions of diet and exercise support and social interaction in adolescents [63]. While telemedicine parent group meetings were unsuccessful in altering child

weight status, a web-based individual intervention with an in-group component showed positive, albeit non-significant, effects [29, 38].

Conclusions

Rates of childhood overweight and obesity are alarming and more research is needed to determine the most effective treatments that have wide reach, relatively low cost, and meaningful impact on child weight and overall health. Group-based treatments seem promising as they allow for the inclusion of more individuals, require fewer resources (e.g., staffing, time, space), and promote social support and a collaborative dynamic that may not be present in individual treatment formats. However, this review suggests results immediately post-treatment from recently completed group interventions are variable, only producing statistically significant changes above control approximately half the time, are not consistently producing changes of 0.25 zBMI points or above, and may be producing only small effects. Given these poor outcomes, it may be wise to reassess the value of current group-only interventions for treatment. Another approach may be to identify the intervention strategies of the treatments that have been effective and work to incorporate these into future group interventions.

Considering the heterogeneity of etiologic and maintenance factors in obesity, the inconsistency of results may be due to a lack of sufficient attention to individual needs within the larger group. When considering group-based approaches, mixed-format studies may be a better option as they generally produce superior outcomes. While control studies in this review were limited, they suggest medium to large treatment effects of mixed format, and weight change across interventions suggests greater magnitudes of weight loss than in group alone. Mixed format ensures that specific time and attention is given to each family unit while allowing for relationships to be formed among participants within the group setting [23, 24]. When resources limit this possibility, additional options for personalization, such as written summaries of patient goals and group summaries that highlight individual changes within the context of the group, should be utilized [64]. Technology is also a novel tool that, in addition to promoting social cohesion within a group, may allow for unique approaches to individualization of treatment and wide dissemination. A stepped-care approach that begins with treatment in a group setting and moves to individual treatment for non-responders may also prove beneficial.

Compliance with Ethics Guidelines

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Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by the author.

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