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PEDIATRIC HIGHLIGHT

'Adventure therapy' combined with cognitive-behavioral treatment for overweight adolescents

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Objective: Since peers have such an important influence on adolescents, we evaluated the efficacy of adding peer-based 'adventure therapy' to a standard cognitive-behavioral weight control program for overweight adolescents.
Methods: Adolescents ($N=76$) aged 13–16 years and 20 to 80% overweight ($M=60.56\%$, s.d. $=15.17\%$), were randomly assigned to one of two treatment conditions: cognitive-behavioral group treatment with 'adventure therapy' similar to Outward Bound® (cognitive-behavioral treatment with peer-enhanced adventure therapy (CBT + PEAT)) or cognitive-behavioral group treatment with aerobic exercise (CBT + EXER). Anthropometric and psychosocial measures were obtained at baseline, at the end of the 16-week intervention, and at 10 months following randomization.
Results: Adolescents assigned to both treatment conditions demonstrated significant weight loss over time, $F=29.06$, $df=2$, 53, $P<0.01$. Average weight loss did not differ significantly between groups (−5.31 kg for CBT + PEAT and −3.20 kg for CBT + EXER) at the end of treatment. There was a significant difference in the percentage of participants maintaining a minimum 4.5 kg (10 pounds) weight loss (35% in the CBT + PEAT condition vs 12% in the CBT + EXER condition, $P=0.042$) 10 months from randomization. We also observed a significant age by treatment group interaction, such that older adolescents randomized to CBT + PEAT demonstrated more than four times the weight loss of older adolescents assigned to CBT + EXER ($M=-7.86$ kg vs $M=-1.72$ kg) at the end of treatment.
Conclusions: Peer-based 'adventure therapy' is a promising adjunct to standard cognitive-behavioral weight control intervention for adolescents, and may be most effective for older adolescents.
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Introduction

Obesity in children and adolescents is a significant public health concern. Data from the most recent National Health and Nutrition Examination Survey data (NHANES 1999–2000) indicate that approximately 15% of children and adolescents are overweight as defined by criteria of body mass index (BMI; kg/m^2) at or above the 95th% for age.[1] The rise in prevalence of pediatric obesity has been associated with a rise in the diagnosis of noninsulin-dependent diabetes,[2] as well as risk factors for heart disease.[3] Weight increases during adolescence have also been associated with fasting insulin, HDL-cholesterol, and systolic blood pressure in young adulthood.[4] Furthermore, childhood and adolescent obesity are significant predictors of overweight status in adulthood[5–7] and pose a risk factor for adult morbidity and mortality, particularly for males.[8,9] The recent Surgeon General's 'Call to Action'[10] describes overweight and obesity as a public health epidemic, with specific focus on the impact of overweight for children and adolescents.

A number of randomized clinical trials have been conducted with overweight children, aged 8–12 years. Comprehensive treatment programs, including diet, exercise, and behavior modification, have demonstrated decreases of 5–20% in percent overweight immediately following intervention,[12] and long-term efficacy at 5- and 10-year follow-up.[11,12] Among adolescents treated in outpatient settings, the majority of behavioral programs have resulted in modest weight loss (i.e. 2.1–2.8 kg over the course of 20 sessions) and there is a trend toward weight gain at follow-up.[13–18] While recent studies demonstrate promising results from sibutramine and behavior therapy with overweight adolescents,[19,20]

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there is continued need for innovative psychosocial interventions in this area.

One potential avenue for increasing the efficacy of adolescent weight management interventions is creative adjuncts to standard behavioral treatment. We adopted an approach similar to that used in Outward Bound® programs, *peer-enhanced adventure therapy,* because it targets increasing self-confidence, increasing mutual support within the group, and developing a greater level of agility and physical coordination,[21] all of which may be related to weight loss and maintenance during adolescence. Adventure therapy also relies on peers to support change, which is important given that adolescents increasingly rely on peers[21] and peers may serve as models of positive health behaviors.[22] From a developmental perspective, adolescence is a time during which peer influences on behavior increase significantly.[23] For example, peer and family involvement with physical activity are predictors of activity level for adolescent females[24] and peer support has been used as a key element of interventions targeting other health risk behaviors of adolescents.[25] Middle adolescence, defined as 14–16 years of age, has been identified as a time during which adolescents may be most influenced by peers,[26] suggesting that a peer intervention may have particular significance for this age group.

Studies utilizing 'adventure therapies' have documented significant positive effects on self-concept, locus of control, and sociability,[22,27,28] which in turn have been related to increased levels of physical activity in adolescents,[29] and are expected to contribute to weight loss. Furthermore, social functioning has been observed to be an area of difficulty for overweight children and adolescents,[30,31] and social support for eating and exercise was found to be a significant predictor of long-term weight loss in a 10-year follow-up of children treated for obesity.[32] Consequently, an intervention that targets both self-efficacy and social function may have particular benefit for overweight adolescents.

The objective of this pilot study was to test the hypothesis that addition of peer-enhanced adventure therapy (CBT + PEAT) to a cognitive-behavioral weight control program would enhance adolescent weight loss compared to cognitive-behavioral treatment with aerobic exercise (CBT + EXER). The secondary hypothesis was that adolescents who received CBT + PEAT would demonstrate greater improvement in self-concept and social functioning than adolescents who received CBT + EXER.

Methods

Participants

The 76 study participants were recruited from advertisements in local newspapers between January 2000 and January 2002. Figure 1 provides a flowchart outlining the process by which participants were enrolled. A total of 407 families were screened by telephone. Of these, 225 met eligibility requirements: between 20 and 80% overweight as defined by BMI (kg/m^2), adolescent age between 13 and 16 years, one parent able to participate with adolescent, and English speaking. Potential participants were excluded if they met criteria for a major psychiatric disorder at the time of evaluation, were taking medications that might impact weight loss, had medical comorbidities that would impact participation in the diet and physical activity prescription, or were already enrolled in counseling or a weight loss program. Those who appeared eligible were then scheduled for assessment, after which they completed a 2-week diet record as part of a 'run-in' period.

Design

The study protocol was approved by the institutional review boards at Rhode Island Hospital and The Miriam Hospital. Written informed consent was obtained from parents and assent from adolescents. Participants were enrolled into the study by one of two research assistants. A total of 76 participants were randomly assigned to either CBT + PEAT or CBT + EXER. Once all participants completed their baseline assessment and diet record run-in, they were eligible for treatment. An urn randomization procedure,[33] with percent overweight and gender as covariates, was used to assign adolescents to treatment condition. Randomization was conducted by the study coordinator. Participants were informed of treatment condition 2 days prior to the first intervention meeting. The study initially included a third treatment arm, standard care, which involved three individual meetings with a nutritionist. This condition was discontinued due to patient and parent concerns with treatment acceptability and associated significant difficulties with retention. Results from this treatment condition are not reported here. No adverse events or untoward side effects occurred in either the CBT + PEAT or the CBT + EXER group during the intervention. Unless otherwise noted, all measures were collected at baseline, at 4 months following randomization (immediately following the 16-week intervention), and at 10 months following randomization.

Intervention

Common treatment components. Both group-based interventions included 16 weekly sessions, with parents and adolescents attending separate concurrent meetings, followed by 4 monthly maintenance sessions. Adolescents were prescribed a balanced deficit diet (1400–1600 calories) based on the dietary exchange system and asked to gradually increase physical activity to a minimum of 30 min daily for 5 days a week. In addition to weekly meetings, adolescents attended bi-weekly dyad meetings with the participating parent. Each week, participants who completed behavioral goals and demonstrated a minimum 1/2 pound (0.23 kg)

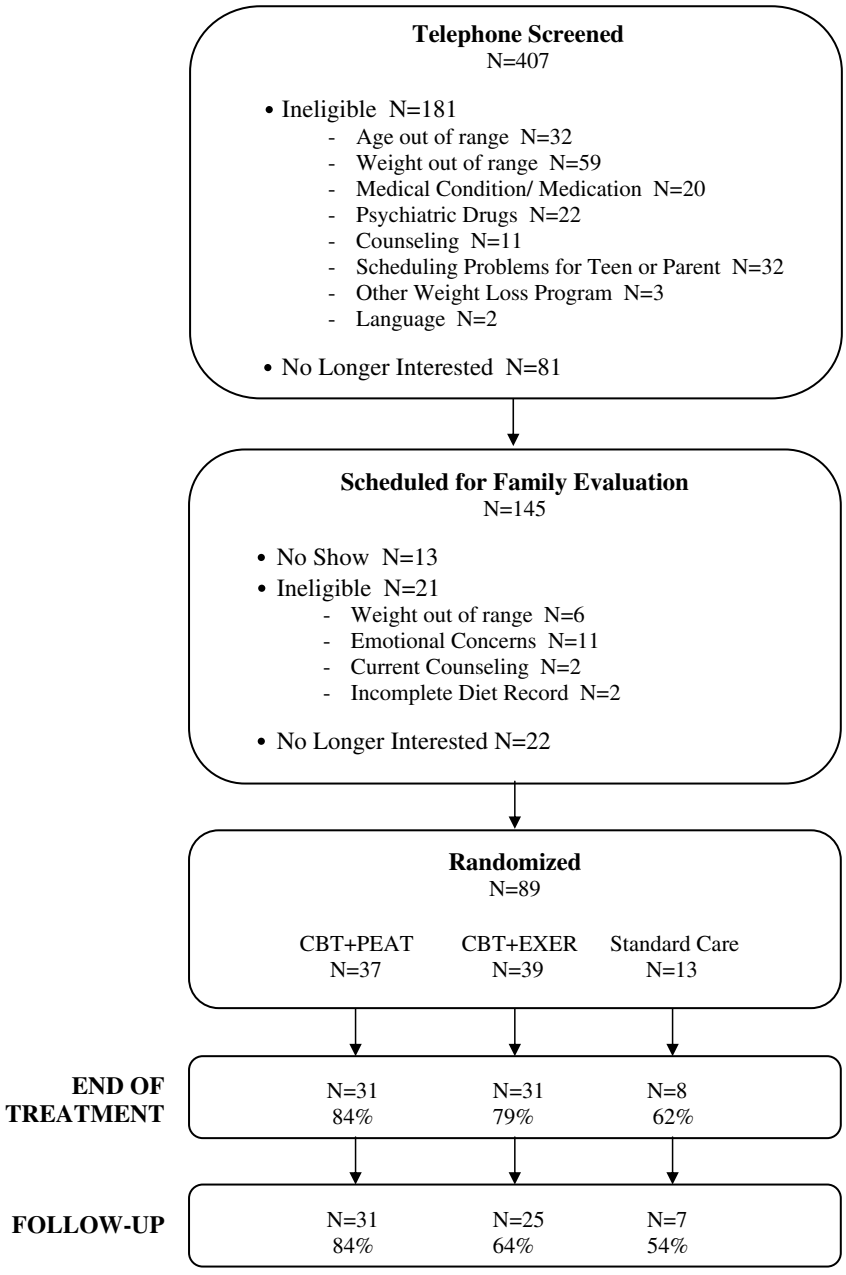

Figure 1 Participant enrollment.

weight loss – considered an objective measure of success-were entered into a raffle for a small prize.

Cognitive-behavioral weight loss intervention was standard across both group conditions and was modeled on child and adult weight control programs.[34,35] Treatment groups were conducted by doctoral level psychologists with experience in adolescent weight management. Behavioral topics included self-monitoring, motivation for weight loss, goal setting, the importance of physical activity, implementation of stimulus control strategies, use of parent–teen contracts to support nutrition and physical activity goals, social influences on diet and exercise, the relationship between stress and eating, and relapse prevention. Nutrition topics included presentation of the exchange system, portion control, dining out, dietary fat, and healthy snack choices, and were presented by a dietitian.

The parent meetings for both treatment conditions included didactic content that paralleled that presented to adolescents. In addition, parents were provided guidance regarding implementing change at a family level and supporting positive eating and physical activity habits in their adolescents.

In addition to the 60-min group meeting, all adolescents participated in 30 min of on-site physical activity supervised by either an exercise physiologist or physical therapist. The goal of the brief exercise session was for adolescents to achieve a target heart rate of 40–60% above resting for a minimum of 20 min.

Unique treatment components. In addition to the CBT intervention discussed above, adolescents participated weekly in either an additional session of supervised physical activity or a session of the peer-based intervention, both held separately from the above-described 60-min meeting.

Aerobic exercise. Activities for the supervised exercise intervention included use of treadmills, stationary bicycles, and brisk walking within the hospital setting. Each session included a 10-min warm-up period, 30 min of physical activity, and a 20-min wrap-up period that consisted of 'cool down' and review of weekly physical activity goals.

Peer-enhanced adventure therapy. The peer-based activity session consisted of an initial 'warm-up' activity that included physical activity, followed by the primary challenge for the group, processing of the activity, and establishing weekly personal goals. Group activities consisted of both physical and mental challenges that were aimed at development of social skills, problem-solving abilities, and self-confidence. For example, one activity required that group members work in teams to lead each other through a maze. The goal of each activity was to increase individual self-confidence while developing trust among group members. Sessions were structured sequentially to target increasingly challenging activities. The final challenge consisted of two half-days at an area ropes course, including both 'low' and 'high' elements. An example of a high element is a log placed between two trees approximately 25 ft above the ground. In teams of two, adolescents were challenged to climb to the height of the log and help each other walk across a short distance to a landing. Participants wore appropriate safety equipment, including a safety harness attached to a belay rope system and a helmet.

Measures

Anthropometric variables. Weight was obtained on a balance beam scale in street clothes without shoes. Height was obtained with a stadiometer. Height and weight were used to calculate BMI (kg/m^2), as well as percent overweight with reference to age and gender.

Psychosocial variables. Psychosocial constructs were selected to evaluate hypothesized intervention-related differences. Dimensions of self-concept, social support, and perceived rejection in peer relationships were expected to improve through involvement with the peer-enhanced adventure therapy intervention. Self-concept was evaluated using the self-perception profile for adolescents (SPPA).[36] The SPPA is a self-report measure of adolescents' perceptions of competence in eight specific domains. Internal consistency for individual subscales ranges from 0.74 to 0.92 and factor analysis indicates identification of a unique factor for each of the eight subscales.[36] Dimensions of physical appearance, close friendship, athletic competence, social acceptance, romantic appeal, and global self-worth were included in the current study. The children's physical self-perception profile (CPSPP)[37] was used to provide an additional assessment of self-concept related to physical appearance. Social support was measured using the social support scale for children and adolescents (SSSCA).[38] The authors report adequate reliability and validity for dimensions of social support from parents, classmates, teachers, and close friends.[38] Finally, peer rejection was assessed with the Peer Experiences Questionnaire (PEQ),[39] which has high internal consistency (α 0.80–0.90).

Data analysis plan

The study was powered ($B = 0.80$) to detect a 3.4 kg difference in weight loss between conditions at the end of treatment, assuming a two-tailed analysis with alpha set at 0.05 and a standard deviation of 4.8 kg. The effect size and variance estimates were based on our previous pilot work. The primary analysis was a mixed factor analysis of variance (ANOVA) on those who completed treatment ($N = 62$); treatment condition was the between-subjects factor and time was the repeated measure. Primary outcomes were changes in absolute weight and BMI from baseline to end of treatment and 10 months from randomization. Intent to treat analyses (ITT) were conducted for outcomes of absolute weight loss and change in BMI, including all participants randomized to one of the two group treatment conditions ($N = 76$) and assuming return to baseline weight for non-completers. Given the relative lack of literature regarding weight loss outcomes for adolescents, we elected to adopt a conservative approach for imputing missing values.

Multivariate analysis of variance (MANOVA) on completers was used to examine change in dimensions of self-concept and social function from baseline to end of treatment. Significant MANOVA findings were followed by univariate ANOVA and, where appropriate, planned comparisons, to determine which dimensions were sensitive to change. First-order correlations were conducted to evaluate relationship between change in weight status and change in psychosocial measures from baseline to 4 months.

Results

Sample characteristics

Demographic and weight data for participants are included in Table 1. The sample was primarily Caucasian (79%) and of middle socioeconomic status based on Hollingshead,[40]

Table 1 Mean baseline sample characteristics of participants

	Total sample (n = *76)*	*CBT+EXER* (n = *39)*	*CBT+PEAT* (n = *37)*
Age (mos)	174.08 (11.19)	176.36 (11.97)	171.68 (9.91)
Weight (kg)	86.41 (12.40)	86.44 (13.69)	85.75 (10.92)
Height (cm)	162.79 (7.32)	162.20 (8.10)	163.42 (6.38)
BMI[a]	32.48 (3.07)	32.79 (3.16)	32.15 (2.99)
Hollingshead score	44.85 (10.94)	42.32 (12.17)	47.60 (8.78)
Percent overweight[b]	60.56 (15.17)	61.42 (15.86)	59.64 (14.55)
Binge eating score	12.22 (7.60)	12.62 (7.37)	11.81 (7.91)
Parental BMI	32.33 (8.47)	31.25 (7.21)	33.50 (9.63)

Note. Values enclosed in parentheses represent standard deviations. *Note.* Weight and height for one participant and parent randomized to PEAT was unavailable. No significant differences were found between treatment groups. [a]BMI, Body Mass Index, is calculated as weight in kilograms divided by the square of height in meters. [b]Percent overweight is calculated as actual BMI divided by 50th percentile BMI for age and gender.

71% were female subjects, 29% were male subjects, and the average age was 14.51 years. There were no significant differences between the two groups on percent overweight, BMI, or any of the other baseline variables.

Attendance

Of the 76 participants randomized to group interventions, 62 completed the 4-month assessment (82%) and 56 completed the 10-month assessment (74%). Of the 14 participants who did not complete the 4-month evaluation, six dropped out of treatment within the first six sessions and the remaining eight dropped out between sessions 7 and 14. The primary reason cited for discontinuing study involvement was the time commitment involved in study participation. Participants who discontinued treatment did not differ from completers with regard to baseline age or socioeconomic status. There was a significant difference in baseline BMI, with noncompleters being heavier than completers. Participants randomized to CBT + EXER attended an average of 73.5% of treatment sessions, while those randomized to CBT + PEAT attended an average of 78.5% of sessions. There were no differences in attendance at treatment or assessment sessions by treatment condition.

Weight loss data

A repeated measures ANOVA was conducted to evaluate changes in absolute weight through the end of treatment and 10 months from randomization. Participants in both treatment conditions demonstrated significant weight loss over time, $F = 29.06$, $df = 2, 53$, $P < 0.01$. The group by time interaction was non significant, $F = 1.32$, $df = 2, 53$. Participants in the CBT + PEAT condition lost an average of 5.31 kg (s.d. = 5.61) during the active intervention, compared to an average weight loss of 3.20 kg (s.d. = 3.61) for completers of the CBT + EXER condition. At the 10-month evaluation, participants randomized to CBT + PEAT demonstrated an average weight loss of 3.40 kg from baseline (s.d. = 8.16), while those assigned to CBT + EXER had an average weight loss of 0.67 kg (s.d. = 5.50) from baseline. Planned comparisons using Bonferroni tests indicated that difference in weight status over time was accounted for by a significant decrease from start to end of treatment ($P < 0.01$) as well as a significant increase from end of treatment to 10 months from randomization ($P < 0.01$).

Changes in BMI, which account for decreases in weight as well as increases in height, were also examined. As with absolute weight loss, there was a significant reduction in BMI over time, $F = 30.90$, $df = 2, 53$, $P < 0.01$. The interaction between group and time was not significant for BMI, $F = 1.10$, $df = 2, 53$, $P = 0.34$. Planned comparisons indicated a significant decrease in BMI from baseline to end of treatment, $P < 0.01$, and baseline to 10 months from randomization, $P < 01$. Decreases in BMI at end of treatment and 10 months are presented in Figure 2. The figure also includes findings for ITT analyses for BMI, to be discussed below.

Treatment groups were also compared on the percentage of participants able to achieve a minimum weight loss of 4.5 kg (10 pounds). Although the differences were not significant at the 4-month evaluation (48% of participants randomized to CBT + PEAT demonstrated a weight loss of at least 10 pounds compared to 32% randomized to CBT + EXER, $\chi^2 = 1.68$, $P = 0.15$), there was a significant difference at 10 months. At the 10-month evaluation, 35% in the CBT + PEAT condition maintained a weight loss of 4.5 kg or more compared to 12% in the CBT + EXER condition, $\chi^2 = 4.07$, $P < 0.05$ (see Figure 3a).

Groups were compared on participants achieving 5 and 10% weight losses at end of treatment and 10-month evaluation. There were no significant differences in participants achieving a 5% weight loss at end of treatment (CBT + PEAT = 48% vs CBT + EXER = 32%, $\chi^2 = 1.68$, $P = 0.20$) or 10 months from randomization (CBT + PEAT = 32% vs CBT + EXER = 20%, $\chi^2 = 1.06$, $P = 0.30$). Likewise, there was no significant difference in participants achieving a 10% weight loss at end of treatment, CBT + PEAT = 26% vs CBT + EXER = 10%, $\chi^2 = 2.73$, $P = 0.10$. There was a significant difference in participants achieving a 10% weight loss 10 months from randomization, with 23% of participants assigned to CBT + PEAT and 4% of

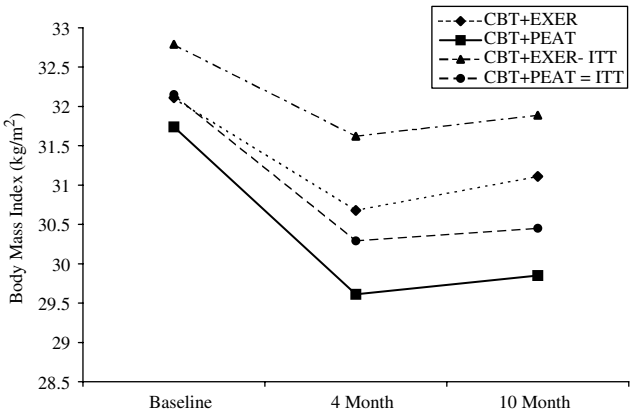

Figure 2 BMI (kg/m^2) at baseline and 4-month and 10-month evaluations.

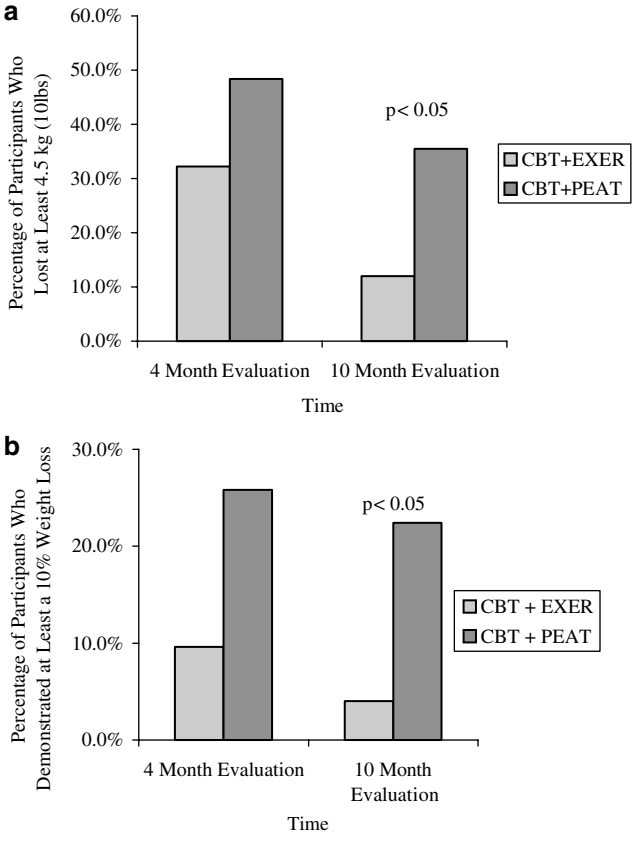

Figure 3 Percentage of participants with minimum 4.5 kg (10 pounds) weight loss and minimum 10% weight loss at 4-month and 10-month evaluations.

participants assigned to CBT + EXER achieving this goal, $\chi^2 = 3.90$, $P < 0.05$ (see Figure 3b).

ITT analyses replicated the pattern of findings with regard to absolute weight loss and changes in BMI for completers. Specifically, significant weight loss was observed in both treatment conditions over time, F = 33.25, df = 2, 72, $P < 0.01$, and the interaction between time and condition was nonsignificant, F = 1.81, df = 2, 72, $P = 0.17$. Planned comparisons using Bonferroni tests indicated significant weight loss from baseline to end of treatment, $P < 0.01$ and baseline to 10 months from randomization, $P < 0.05$, with a significant gain between end of treatment and follow-up, $P < 0.01$. Likewise, both groups demonstrated a significant decrease in BMI over time, F = 35.72, df = 2, 72, $P < 0.01$, with no significant interaction, F = 1.65, df = 2, 72, $P = 0.20$. Planned comparisons indicated a significant reduction in BMI from baseline to 4-month, $P < 0.01$, and 10-month evaluations, $P < 0.01$. ITT findings for BMI are presented with results for completers in Figure 2.

To explore the effect of age on weight loss, the group was divided into younger (under 14.75 years of age) and older (over 14.75 years of age) adolescents. This age split was chosen because it is the midpoint at study entry (13.0 to 16.5 years). Analysis of absolute weight loss indicated a significant time by age by group interaction, F = 3.20, df = 2, 51, $P < 0.05$. The group by age interaction is presented in Figure 4. As seen in the figure, older adolescents randomized to the CBT + PEAT condition demonstrated more than four times the weight loss of older adolescents assigned to the CBT + EXER condition at the end of treatment ($M = -7.86$ kg vs $M = -1.72$ kg). Older adolescents assigned to CBT + PEAT maintained a weight loss of 5.87 kg at 10 month follow-up, while those assigned to CBT + EXER demonstrated a gain of 0.42 kg from baseline.

Psychosocial outcomes

A MANOVA was conducted on the measures of self-concept (global self-concept, physical appearance, athletic competence, close friend, and social acceptance subscales from the SPPC and the Physical Self-Worth Scale) at baseline, end of treatment, and 10 months from randomization. The overall analysis was significant for time, F = 6.385, df = 12, 39,

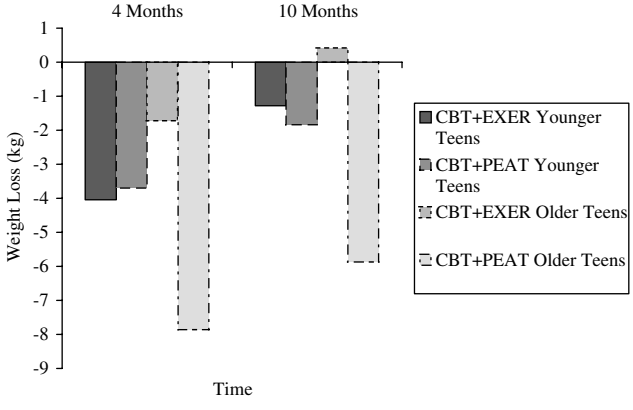

Figure 4 Weight loss by age and treatment condition.

$P<0.01$. The time × group interaction was nonsignificant, $F=1.81$, $df=12, 39$, $P<0.08$. Univariate tests indicated that adolescents randomized to both treatment conditions demonstrated significant improvements on dimensions of global self-concept, $F=4.96$, $df=2, 100$ $P<0.01$, physical appearance, $F=30.33$, $df=2, 100$, $P<0.01$, and physical self-worth, $F=16.67$, $df=2, 100$, $P<0.01$, across time. Significant increases on measures of physical appearance and physical self-worth were observed from baseline to end of treatment, $P<0.01$, and maintained at 10-month evaluation, $P<0.01$. For the dimension of global self-worth, the significant difference over time was accounted for by increase from baseline to 10-month evaluation, $P<0.01$.

A mulitivariate ANOVA including the four subscales of the SSCA, as well as measures of peer rejection and loneliness, was conducted to evaluate changes in social functioning following intervention. Neither the time, $F=1.908$, $df=12, 39$, $P=0.06$, nor the time × group interaction was significant, $F=1.032$, $df=12, 39$, $P=0.44$, indicating no significant improvements over time.

Relationship between change in psychosocial variables and weight loss

Correlations were conducted to evaluate the relationship between absolute weight loss and changes in self-concept and social function during the intervention. Analyses were conducted within treatment condition to examine potential differences in the relationship between variables by group. For adolescents assigned to CBT + PEAT, end of treatment weight loss was associated with improvement in self-reported physical appearance, $r=-0.508$, $P<0.01$. There were no significant relationships observed between weight loss and psychosocial measures for adolescents assigned to the CBT + EXER condition.

Attendance, treatment satisfaction, and weight loss

There was an association between percent of treatment sessions attended and weight loss, such that higher attendance was related to greater decrease in weight at both end of treatment ($r=-0.29$, $P<0.05$) and 10-month evaluation ($r=-0.379$, $P<0.01$). Treatment groups were also compared on their ratings of treatment satisfaction following the 16-week intervention. Adolescents who received the peer enhanced intervention reported significantly higher overall treatment satisfaction ($M=4.56$) than did those who received the additional exercise component ($M=3.89$), $F=8.13$, $df=1, 53$, $P<0.01$.

Parents of adolescents in the CBT + EXER group ($M=4.68$) did not differ from parents of adolescents in the CBT + PEAT group ($M=4.81$) on an overall measure of treatment satisfaction, $F=0.528$, $df=1, 52$, $P=0.47$.

Discussion

Several findings from the current study suggest the potential benefit of adding a novel intervention to cognitive-behavioral weight management treatment for overweight adolescents. A greater percentage of adolescents randomized to the CBT + PEAT condition demonstrated a minimum 10 pound (4.5 kg) weight loss at the 10-month evaluation, suggesting that the intervention may have been advantageous with regard to maintenance of weight loss. The average 5.5 kg weight loss demonstrated by adolescents randomized to the CBT + PEAT intervention at the end of treatment exceeds that observed in a number of previous behavioral weight control trials with this age group.[15–18] Additionally, CBT + PEAT appeared particularly effective for the older adolescents in our sample. Older adolescents randomized to the peer intervention lost more than 7 kg compared to less than 2 kg for those in the CBT + EXER condition. Thus, the experiential learning offered through this treatment may be particularly beneficial to adolescents who are slightly more sophisticated with regard to cognitive and emotional development. This is also consistent with developmental theory, suggesting that peers may be the most influential during 'middle adolescence', which corresponds to our older adolescent group.[26]

Participants in both treatment conditions demonstrated significant improvements in self-concept. However, hypotheses regarding the unique impact of adventure therapy on psychosocial variables were not confirmed. Both treatment groups demonstrated significant improvements in global self-concept and physical self-worth. Other adolescent weight control interventions have reported improvements in self-esteem associated with participation in a weight management program,[41] suggesting that these changes may be related to participation in a program rather than specifics of the peer intervention. With regard to social functioning, our measures may not have been sensitive enough to detect changes over time or potential differences between the groups. Alternatively, the advantage for the CBT + PEAT condition may be conveyed through processes other than social support and self-worth. We measured social support rather than adolescent functioning in social relationships. A more direct measure of social skills may have yielded different results. The finding of greater treatment satisfaction in adolescents randomized to CBT + PEAT may reflect greater investment in the intervention, which potentially impacted adherence to other program components such as diet and exercise.

Very few changes in psychosocial measures were related to weight loss at end of treatment. While adolescents assigned to both treatment conditions demonstrated improvement in self-concept, there was minimal association between improvements on these dimensions and weight loss. An earlier review paper notes a similar lack of relationship between improvement in self-esteem and weight loss in several adolescent weight loss studies.[42] Given that

treatment tends to be offered in a group setting, one possible explication for these findings is that improvement in self-concept is fostered by participation in a program with adolescents confronting similar challenges. This may be particularly salient for adolescents experiencing social isolation. Improved self-concept related to physical appearance was related to treatment outcome only for adolescents who received the CBT + PEAT intervention. This finding suggests that self-perception related to physical appearance may be an important treatment component for adolescents assigned to this peer-based intervention. Consistent with findings from a number of adult weight control interventions,[43] attendance at group sessions was significantly related to weight loss. This highlights the importance of identifying strategies for increasing attendance in adolescent weight control trials.

There are several limitations that potentially impact interpretation of the current findings. First, the anticipated effect size may have overestimated differences between groups given the comprehensive behavioral intervention received by participants in both groups. Second, noncompleters were heavier than completers at study entry. However, there were no baseline differences between treatment groups in BMI and there was no difference in attrition between the two conditions. We did not include measures of calorie intake or dietary composition following enrollment into the study. Consequently, we are unable to evaluate the relationship between adherence to the dietary prescription and weight loss. A further limitation was the absence of a measure of body composition. As this was a pilot study, our primary objective was to evaluate differences between groups at the end of treatment, with a relatively brief follow-up period. Information regarding long-term maintenance of weight loss is clearly a critical issue for future studies. Finally, we opted to discontinue the 'standard care' (i.e., nutritional counseling) treatment arm due to significant concerns related to participant retention and treatment satisfaction. Consequently, we are unable to offer a direct comparison of behavioral group treatment to nutritional counseling alone.

A number of directions for future research focused on adolescent weight management interventions are suggested. One direction is identification of potential mechanisms for enhancing the effectiveness of the peer intervention. For example, early identification of an adolescent group leader, who might serve as a peer facilitator could be incorporated into this model and may lead to increased benefits. Another possibility is increasing the continuity between the behavioral component and the peer-enhanced component of the intervention. This could be accomplished by introducing common staff or reviewing weight related goals in the context of the peer intervention.

Another area for future investigation relates to the marked variability in treatment outcome across participants. Findings from this pilot study suggest that age is one significant contributor. Additional research is needed with larger randomized samples to examine this age effect. Defining other sources of variability in treatment outcome is key to understanding which adolescents are likely to benefit from a particular treatment and to identifying variables that can be targeted for intervention. Finally, the current intervention was intensive, requiring considerable investment on the part of adolescents and parents. Future studies in the area of adolescent weight management could also focus on innovative settings for the delivery of interventions to potentially decrease the burden on families.

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