Behavioral Weight Control Treatment with Supervised Exercise or Peer-Enhanced Adventure for Overweight Adolescents

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Objective To evaluate the efficacy of behavioral weight control intervention with a peer-enhanced activity intervention versus structured aerobic exercise in decreasing body mass index (BMI) and z-BMI in overweight adolescents.

Study design Participants were randomized to 1 of 2 group-based treatment conditions: (1) cognitive behavioral treatment with peer-enhanced adventure therapy or (2) cognitive behavioral weight control treatment with supervised aerobic exercise. Participants included 118 overweight adolescents, ages 13 to 16 years, and a primary caregiver. Changes in BMI, standardized BMI, percent over BMI, and waist circumference were examined.

Results Analysis of variance on the basis of intent-to-treat indicated significant decreases in all weight change outcomes at the end of treatment, with significant decreases maintained at the 12-month follow-up. No differences in treatment conditions were observed. Secondary analyses indicated that adherence with attendance and completion of weekly diet records contributed significantly to reductions in BMI.

Conclusions A cognitive behavioral weight control intervention combined with supervised aerobic exercise or peer-enhanced adventure therapy is equally effective in short-term reduction of BMI and z-BMI in overweight adolescents. Adherence, as measured with session attendance and self-monitoring, is a key dimension of weight change. *(J Pediatr 2010;157:923-8)*.

Overweight children and adolescents face a multitude of medical and psychosocial challenges, including type two diabetes mellitus, significant impairments in quality of life,[1,2] self-concept,[3] and relations with peers.[4] Comprehensive weight control interventions, including dietary and physical activity prescription with cognitive-behavioral treatment (CBT), have been found effective with school-age children.[5,6] Fewer lifestyle weight control interventions have been conducted with adolescents, although they do show promise in decreasing adolescent obesity rates.[7,8] Novel intervention approaches for weight loss in adolescents are needed.

One promising adjunct to CBT for adolescent weight control involves peer-based "adventure therapy." Intervention on the basis of adventure therapy is designed to increase self-confidence and support within the peer group and develop a greater level of physical agility, constructs that have been found to relate to increased levels of physical activity in adolescents.[9] In a previously reported randomized trial evaluating the efficacy of group-based CBT plus a peer-based physical activity intervention compared with CBT plus supervised exercise for overweight adolescents, we noted an average reduction of 1.75 body mass index (BMI) units across both intervention conditions.[10] Although there was no significant difference in the two treatments, a greater percentage of adolescents receiving peer-based intervention maintained an absolute weight loss ≥10 pounds at 10-month follow-up.

The objectives of this study were to evaluate the efficacy of this same peer intervention in a second study with a larger sample size and to evaluate the role of treatment adherence on weight-related outcomes. The peer intervention, "adventure therapy," is based on the principles of Outward Bound and was expected to affect weight status through a positive effect on self-concept. It was hypothesized that adolescents randomized to CBT with peer enhanced adventure therapy (CBT+PEAT) would demonstrate greater reduction in BMI and z-BMI than adolescents randomized to CBT with exercise (CBT+EXER). It was also hypothesized that adolescents randomized to CBT+PEAT would demonstrate greater improvements in self-concept than adolescents randomized to CBT+EXER. Finally, treatment adherence, as reflected by session attendance and completion of diet records, was

ANOVA	Analysis of variance
BMI	Body mass index
CBT	Cognitive-behavioral treatment
CBT+EXER	Cognitive-behavioral treatment with exercise
CBT+PEAT	Cognitive-behavioral treatment with peer-enhanced adventure therapy
MANOVA	Multivariate analysis of variance
MVPA	Moderate to vigorous physical activity

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Supported by the National Institute of Diabetes and Digestive and Kidney Diseases (grant R01DK062916 to E.J.) and the National Institutes of Health and the National Heart, Lung, and Blood Institute (grant K23HL069987 to E.L-R).

Registered at www.ClinicalTrials.gov, Clinical Trial #: NCT00285558.

 10.1016/j.jpeds.2010.05.047

expected to be positively associated with weight-related outcomes across treatment conditions.

Methods

A total of 118 overweight adolescents were randomized to treatment (Figure; available at www.jpeds.com). Participants were recruited from local newspaper advertisements and referrals from area pediatricians. Eligibility requirements included age between 13 and 16 years, between 30% and 90% overweight as defined with reference to median BMI for age and sex, at least one parent available to participate, and English speaking. Adolescents were excluded when they met the criteria for a major psychiatric disorder, were already enrolled in a weight loss program, or had a condition that prevented them from following the diet or physical activity prescription. Participants were offered monetary compensation for completing initial and follow-up evaluations. Dyads were reimbursed a total of $50 at the initial evaluation, $75 for completing the end of treatment evaluation, and $100 for the 1-year follow-up. The study protocol was approved by the hospital institutional review board. Parents of all participants provided written informed consent, and adolescents provided assent. Baseline data were collected between August 2003 and May 2006.

Adolescents and their parents were randomized to 1 of 2 treatment conditions, occurring in 6 cohorts, CBT+EXER or CBT+PEAT. Participants were randomized after completing the baseline assessment battery and a 1-week dietary record run-in period. An urn randomization procedure[11] with percent over BMI (dichotomized as high versus low) and sex (male versus female) as covariates was used to assign adolescents to treatment condition. Urn randomization assigns participants in a given subgroup to intervention conditions, but systematically biases the randomization in favor of balance in the intervention conditions. Although urn randomization reduces the probability of imbalance in groups and is less susceptible to experimenter bias, it may introduce the risk of violating assumptions of population models in analyses.[12]

Assessment of anthropometric and psychosocial measures was obtained at baseline, end of the 16-week intervention (end-of-treatment), and 12 months after randomization (12-month follow-up).

Common Treatment Components

Both group-based interventions included 16 one-hour weekly sessions, with parents and adolescents attending separate concurrent meetings, followed by 4 biweekly maintenance sessions. Adolescents were prescribed a balanced deficit diet (1400-1600 calories) and asked to gradually increase physical activity to an ideal of 60 minutes on most days of the week. Treatment groups consisted of didactic material and educational activities illustrating a range of behavioral topics (eg, self-monitoring, motivation for weight loss, goal setting, stimulus control, and relapse prevention). Treatment groups were led by master- and doctoral-level psychologists with experience in adolescent weight management and a registered dietician. The content of co-occurring parent meetings paralleled that for adolescents. Parents were also provided guidance on implementing family-level change and supporting positive eating and physical activity habits in their adolescents.

After completion of the 20 group sessions, periodic (ie, bimonthly) activities were scheduled to encourage continued participant involvement with the study through the end of 12 months. Activities were offered to adolescents in both treatment conditions at separate times and included events such as apple picking, bowling, and miniature golf.

In addition to the CBT intervention aforementioned, adolescents participated in additional weekly activity sessions.

Aerobic Exercise

Activities for the supervised exercise intervention included use of treadmills, stationary bicycles, and other aerobic activities selected by participants, including dance videos and brisk walking within the clinic setting. The format for each session followed the same sequence, beginning with a brief warm-up period, progressing to approximately 35 minutes of sustained physical activity, and ending with a wrap-up period consisting 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 activity goals. Similar to Outward Bound adventure therapy, group activities consisted of both physical and mental challenges that were aimed at development of social skills, problem-solving abilities, and self-confidence. A more detailed description of the adventure therapy component is provided elsewhere.[10]

Anthropometric Variables

Trained research assistants obtained each participant's weight and height. Weight was measured on a balance beam scale in hospital gown without shoes. Height was measured with a stadiometer (Perspective Enterprises, Portage, Michigan). Height and weight were used to calculate BMI (kg/m^2), standardized BMI score (z-BMI), and percent over BMI. The latter is defined as an adolescent's percent >50th percentile BMI for age and sex and is calculated as: ([teen BMI – BMI at 50th percentile for age and sex]/BMI at 50th percentile) x 100. Percent over BMI has demonstrated some advantage in sensitivity to changes in BMI across a range of overweight[13] and is easily interpreted. Waist circumference was assessed with participant wearing hospital gown, measuring horizontally from the right iliac crest around the abdomen at the umbilicus.

Self-Monitoring

Adolescent participants were asked to maintain weekly records to monitor daily dietary intake and physical activity.

Self-monitoring records included food consumed, preparation, and portion size, calorie estimates, fat grams, and time of day for each item recorded. Number of minutes engaged in daily physical activity was also recorded. Of primary interest was the number of weekly self-monitoring records completed.

Physical Activity

Participation in physical activity was assessed at baseline and end of treatment by using the ACTIVITYGRAM.[14] Adolescents were prompted to provide information on 3 days of physical activity, including 1 weekend and 2 weekdays through a computer-assisted assessment. Information was obtained for participation in various activities in 30-minute increments throughout the day. Because our primary interest was in voluntary activity, we include here only activity that occurred in the hour immediately before school (allowing for adolescents who may be choosing to walk to school) and the 8 hours between the end of the school day and 11:00 PM during weekdays. The variable of primary interest was amount of time spent in moderate to vigorous physical activity (MVPA). The ACTIVITYGRAM has demonstrated reliability[15] and validity.[16]

Self-perception

The Self-Perception Profile for Adolescents[17] is a widely used self-report measure of adolescents' perceptions of competence in 8 specific domains. Dimensions of physical appearance, close friendship, athletic competence, social acceptance, and global self-worth were included in this study. Internal consistency for the individual subscales ranges from 0.74 to 0.92, and factor analysis indicates identification of a unique factor for each of the 8 subscales.[17] Additional assessment of physical self-worth was obtained through a brief scale, the Physical Self-Perception Profile for Children.[18, 19]

Data Analysis

Primary outcomes were examined by using mixed factor analysis of variance (ANOVA) conducted with all randomized participants (intent to treat; n = 118), with treatment condition as the between subjects factor and time (baseline, end of treatment, and 12 months) as the repeated measure. The study was powered to detect significant differences in percent overweight between the treatment conditions. With an anticipated number of 120, power was 0.82 to detect a difference as small as 5.4% in percent overweight between the groups or approximately one-third SD. Intent-to-treat analyses assumed return to baseline values for non-completers. Secondary analyses included mixed factor ANOVA on participants available through the 12-month evaluation (completers; n = 93). Because of the divergence of perspectives on appropriate measurement of change in weight status in pediatric samples,[13] multiple outcomes were evaluated, including absolute weight, absolute BMI, z-BMI, and percent over BMI. Changes in waist circumference were also examined. Mixed factor ANOVA also was conducted to evaluate changes in MVPA from baseline to end of treatment. Multivariate analysis of variance (MANOVA) on completers was conducted on dimensions of self-concept from the Self-Perception Profile for Adolescents and the Physical Self-Worth Scale to examine changes in dimensions of self-concept with time. Because of the theoretical relationship in subscales, MANOVA was conducted first to decrease the risk of type I error and account for the correlation among dependent variables. Significant MANOVA findings were followed by univariate ANOVA. First-order correlations and hierarchical regression analyses were conducted to evaluate the contribution of attendance and completion of diet records to BMI change.

Results

Participant demographic and baseline weight status data are presented in Table I. There were no significant differences in adolescents randomized to the two treatment conditions on baseline variables of BMI, percent over BMI, or demographics.

One hundred of the 118 participants (85%) randomized to treatment conditions completed the end-of-treatment assessment, and 93 participants (79%) were available for 12-month follow-up. Participants in both treatment conditions who completed the 12-month evaluation did not differ in the number of treatment sessions attended, with participants randomized to CBT+PEAT and CBT+EXER attending an average of 83% of sessions.

Participants were compared on a number of weight-status measures including absolute weight, BMI, z-BMI, percent over BMI, and waist circumference to evaluate treatment outcomes. A summary of findings for intent-to-treat analysis is presented in Table II. Results for all outcome measures and for both intent-to-treat and completer analyses converged in demonstrating significant reductions with time, with no significant group by time interactions observed. Intent-to-treat analyses indicated significant decreases in BMI ($P < .01$), z-BMI ($P < .01$), percent over BMI ($P < .01$), and waist circumference ($P < .01$). The same pattern of results

Table I. Sample baseline characteristics

	Total sample (n = 118)	CBT+EXER (n = 56)	CBT+PEAT (n = 62)
Age (months)	171.92 (12.19)	170.23 (11.1)	173.44 (12.99)
Sex	Female = 68%	Female = 69%	Female = 66%
Race			
Caucasian	92 (76%)	46 (82.1%)	46 (72.2%)
African-American	16 (13.6%)	6 (10.7%)	10 (16.1%)
Other/Multiracial	10 (8.3%)	4 (7.1%)	6 (9.7%)
Ethnicity			
Non-Latino	107 (90.7%)	52 (92.9%)	55 (88.7%)
Latino	11 (9.3%)	4 (7.1%)	7 (11.3%)
Weight (lb)	187.39 (30.91)	187.78 (31.17)	187.04 (30.91)
Height (in)	64.66 (3.24)	64.79 (3.27)	64.54 (3.27)
BMI	31.41 (3.33)	31.33 (3.1)	31.49 (3.55)
z-BMI	1.62 (.38)	1.64 (.41)	1.63 (.40)
Percent over BMI	161.22 (16.79)	162.12 (18.34)	161.21 (17.80)
Waist circumference	103.51 (9.39)	103.04 (9.20)	103.94 (9.61)

Table II. Intent to treat analyses for weight-related outcomes (n = 118)

	CBT+PEAT			CBT+EXER		
	Baseline	End of Tx	12 month	Baseline	End of Tx	12 month
Absolute weight	187.04 (30.91)	179.73* (30.57)	183.67† (29.45)	187.78 (31.17)	181.69* (32.31)	187.74† (34.82)
BMI	31.49 (3.54)	29.99* (3.78)	30.31†, ‡ (3.91)	31.33 (3.10)	30.02* (3.41)	30.58†, ‡ (3.77)
z-BMI	1.63 (.40)	1.42* (.47)	1.46‡ (.50)	1.61 (.35)	1.45* (.46)	1.50‡ (.52)
Percent overBMI	161.21 (17.80)	151.85* (18.77)	151.45‡ (19.56)	161.23 (15.75)	152.77* (17.10)	153.53‡ (18.16)
Waist circumference	103.94 (9.61)	100.99* (10.62)	101.14‡ (10.66)	103.04 (9.20)	100.16* (10.36)	101.18‡ (10.72)

*$P < .01$ baseline to end of treatment.
†$P < .01$ end of treatment to 12 months.
‡$P < .01$ baseline to 12 months.

was observed in completer analyses, with significant reductions with time in each measure of weight status. Follow-up analyses indicated that significant changes in BMI, percent over BMI, z-BMI, and waist circumference were accounted for primarily by reductions from baseline to end of treatment. Although significant increases in BMI and z-BMI were observed between end of treatment and 12-months, the follow-up values continued to be significantly reduced from baseline.

Mixed factor analysis of variance was conducted on average daily minutes of MVPA during the 3-day period. There were no significant changes in the amount of MVPA reported with time ($F[1,85] = 0.66$) and no significant time by group interaction ($F[1,85] = 0.15$).

Adolescents randomized to both treatment conditions demonstrated significant improvements in self-concept with time ($P < .01$), with no significant differences observed between groups. Univariate tests indicated significant improvements on dimensions of global self-concept ($P < .05$), physical appearance ($P < .01$), social acceptance ($P < .01$), and physical self-worth ($P < .01$). Follow-up tests indicated that improvements on dimensions of global self-concept, physical appearance, and physical self-worth occurred during active treatment and were maintained at 12-month follow-up, and changes in social acceptance were observed only through the end of treatment. Improvements in global self-worth and physical appearance-related self-worth were both related to significant reductions in BMI at the end of treatment (r = –0.25 and r = –0.28, respectively).

Table III. Hierarchical linear regression analysis predicting body mass index change at 16 weeks

Predictor	β	t	R^2
Step 1			0.01
Group	0.107	1.06	
Step 2			0.01
Age at start of program	0.04	0.35	
Sex	0.03	–0.27	
Ethnicity	–0.03	–0.29	
Step 3			0.02
Baseline BMI	–0.07	–0.64	
Step 4			0.28
% diet records completed	–0.36*	–3.40	
% group sessions attended	–0.24†	–2.38	

*$P < .01$.
†$P < .05$.

Analyses were conducted to determine the extent to which measures of treatment adherence, including attendance and completion of self-monitoring logs, were related to weight outcomes for completers. Percent of group sessions attended and records completed were highly correlated (r = 0.69, $P < .01$). The relationship between end of treatment BMI reduction and number of weekly records completed was significant across the sample (r = –0.41, $P < .01$). This relationship held for participants assigned to CBT+EXER (r = –0.53, $P < .01$) aand participants randomized to CBT+PEAT (r = –0.37, $P < .01$). Evaluating predictors of BMI change at end of treatment, adherence was added as a final step in hierarchical regression analyses, after group status, demographic variables, and baseline BMI. Adherence was the only significant step in the model, with total $R^2 = 0.28$ (Table III).

Discussion

BMI reductions in this study were comparable with those observed in a small 10- week trial comparing CBT with a control condition in overweight adolescents[8] and to findings based on prescription of a reduced glycemic index diet for obese adolescents.[20] A lifestyle intervention that reported superior outcomes with adolescents required greater weekly time commitment with a longer active intervention phase.[21] Thus, this study adds to an increasing body of evidence demonstrating significant short-term changes in weight status in adolescent samples associated with lifestyle interventions. Moreover, the findings are consistent with a recent review suggesting that integrated interventions that include attention to diet, physical activity, and behavioral treatment are promising weight control interventions and superior to no treatment.[22]

Although participation in weekly supervised activity was a key component of both treatment conditions, neither group of adolescents increased their participation in leisure time MVPA after the intervention. These findings suggest that participating in structured activity as a component of treatment did not result in adolescents electing increased involvement in physical activity on their own. Although planning for physical activity involvement outside of and after the intervention was a treatment focus, it appears that these efforts were not effective. Because assessment of physical activity was conducted at the end of the intervention, it is possible that an increase in activity during treatment was not

captured. Regardless, it is critical for future research to identify strategies for generalizing adolescent physical activity involvement beyond the scope of intervention.

Findings related to self-concept mirror those observed for weight status. Despite one treatment condition (CTB+PEAT) being designed to address the construct of self-concept, results indicate that adolescents randomized to both treatment conditions demonstrated significant improvements on dimensions of global self-concept, physical appearance, and physical self-worth. Furthermore, these differences were observed at the completion of active treatment and maintained at 12-month follow-up. It is possible that the structure of the group-supervised exercise sessions in CBT+EXER served to unknowingly facilitate informal processes of group cohesion and support in the participating teens. Additionally, improvements in global self-worth and physical appearance related self-worth during the course of treatment were related to greater reductions in BMI. Although these data do not allow for interpretation of directionality, they clearly support previous studies indicating a relationship between weight status changes and improvement in self-concept.[23]

Weekly attendance and completion of diet records contributed significantly to BMI reduction during the course of the active intervention, above and beyond demographic variables and baseline BMI. These findings are consistent with other pediatric studies documenting a relationship between weight loss and self-monitoring in pediatric samples.[24-26] The measure of dietary recording included here focused on whether a diet record was completed, without assessment of accuracy, suggesting that the process of recording may be in and of itself beneficial to adolescents. This is consistent with recent pediatric weight control interventions demonstrating a relationship between frequency of self-monitoring and change in weight-related outcomes.[25]

Taken together, these findings suggest that self-monitoring of diet and physical activity is key to weight control outcomes for adolescents. This research also indicates that there is considerable room for improvement in enhancing the frequency with which adolescents monitor diet and physical activity. Future weight control interventions with adolescents would be well focused on identifying innovative strategies to enhance self-monitoring.

A number of limitations need to be considered when interpreting findings from this study. First, the study did not include a no-treatment control group, and length of follow-up is limited to 12 months. Second, measures used are limited in a couple of ways. Although we included a measure of self-reported physical activity, the study would have benefited from a more objective assessment of physical activity (ie, accelerometer) and assessment at 12-month follow-up. There are additional challenges to measuring physical activity in adolescents, including aiming to better understand the seasonal variations in physical activity. Finally, the measure of adherence was limited, involving assessment only of quantity of monitoring records completed, and not quality of recording.

A number of directions are suggested for future research efforts. First, our findings highlight the potential usefulness of novel approaches for both increasing physical activity and enhancing adherence to key behavioral strategies, such as self-monitoring. A second direction is the need for studies that examine the extent to which subgroups of adolescents may respond better to one or another intervention. Finally, of high importance is translating key components of behavioral weight control interventions for implementation in "real world" settings, moving to effectiveness studies that can serve to inform clinical practice.[27] ■

The authors would like to thank Holly Favell Gray, Donald Morse, and Patrick Cozzolino for their tremendous dedication and tireless efforts on this study.

Submitted for publication Aug 11, 2009; last revision received Mar 26, 2010; accepted May 26, 2010.

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50 Years Ago in *THE JOURNAL OF PEDIATRICS*

Idiopathic Respiratory Distress Syndrome of the Newborn: An International Exploration

Rudolph AJ, Smith CA. *J Pediatr* 1960;57:905-21

A group of distinguished pediatricians and pathologists met on the evening of July 21, 1959 at the ninth International Congress of Pediatrics in Montreal to discuss respiratory distress in infants. The goal was to decide on a name for what we now call respiratory distress syndrome (RDS). The group included Virginia Apgar, Peter Auld, Mary Ellen Avery, Kurt Benirschke, Peter Gruenwald, L. Stanley James, Peter Tizard, Robert Usher, and 28 others. Clement Smith led the open discussion, and Arnold Rudolph transcribed the discussion for *The Journal of Pediatrics*. Avery and Mead[1] had just reported the association of decreased surfactant with RDS, and although the discussants were aware of that seminal report, they did not consider it in the discussion. The clinicians clearly stated that they could not predict which infant would have hyaline membranes, pneumonia, or intraventricular hemorrhage on autopsy. The pathologists were perplexed as to what features were diagnostic—hyaline membranes, atelectasis, or bronchiolar dilation—and how much of each needed to be present to make a diagnosis. They did recognize that infants who died soon after birth seldom had hyaline membranes, and that such red herrings occurred in other diseases as well. The clinicians variously called what we now term the expiratory grunt of RDS as crying expiration, a little cry, groaning, or moaning. There was a vote on the source of this sound, and all thought it came from the larynx. Issues discussed were whether asphyxia preceded RDS, the neurologic signs of RDS, and whether RDS could occur in term infants. The final discussion was on what to name this disorder, with the final 3 contenders being idiopathic respiratory distress of the newborn, pulmonary syndrome of the newborn, and hyaline membrane syndrome. Of the 34 listed as present, Dr Rudolph recorded 22 votes, with 15 for idiopathic respiratory distress of the newborn. I assume that there was an attrition of 12 participants because of the late hour of the vote.

This transcript reflects the remarkable uncertainties regarding lung immaturity in the newborn in 1960. Surprisingly, chest radiology was mentioned, but was not considered central to the clinical diagnosis. Even today, the diagnosis of RDS based on clinical signs and radiology remains imprecise. A brisk clinical response to surfactant treatment is perhaps the most useful recent addition to making the diagnosis.

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10.1016/j.jpeds.2010.05.050

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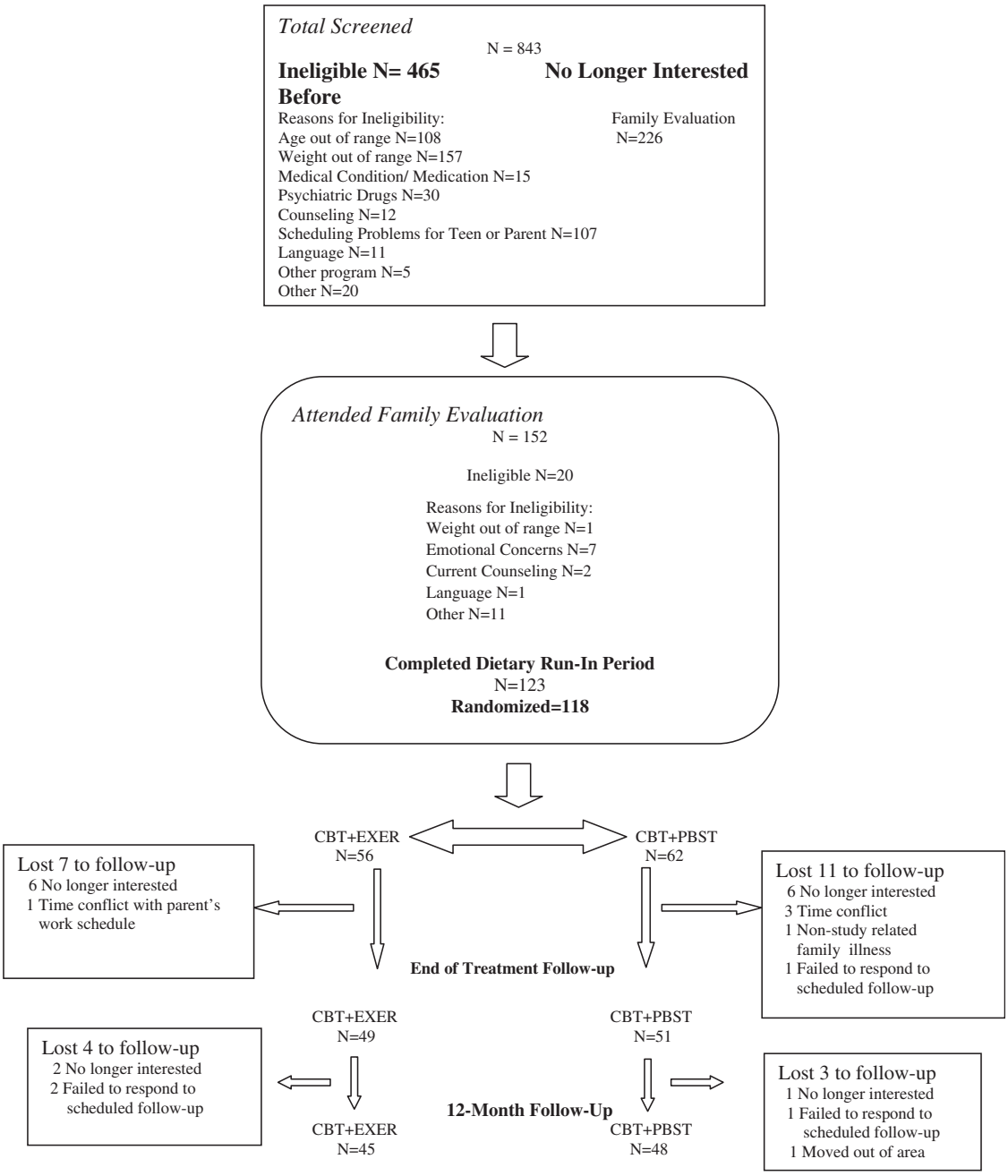

Figure. Consort diagram.