Current Research

Anthropometric and Psychosocial Changes in Obese Adolescents Enrolled in a Weight Management Program

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ABSTRACT

Objective To determine short- and long-term effects of the Bright Bodies Weight Management Program on obese adolescents and to further observe if a diet or nondiet approach is more successful.

Design Twenty-five obese adolescents completed a 1-year, comprehensive weight-management program and returned for a 2-year follow-up. Adolescents were 11 to 16 years old (17 female, eight male) with mixed ethnic backgrounds. Although the program emphasizes a nondiet approach, eight children requested a structured meal plan (diet approach), while 17 were taught to make better food choices (nondiet approach). Body mass index (BMI) *z* score, body fat percent, and self-concept were measured at 0, 1, and 2 years. Outcomes were analyzed for the entire group and by diet method groups.

Statistical Analysis Changes in outcome variables were evaluated using covariance pattern models for repeated measures.

Results At 1 year, the entire group (N=25) demonstrated a decrease in BMI *z* score ($P<.001$) and body fat percent ($P<.001$), while self-concept scores increased ($P<.001$). At 2 years, the decrease in BMI *z* score was still significant ($P=.004$) and body fat percent and self-concept scores remained improved, although not significant compared to baseline ($P=.15$ and $P=.10$, respectively). When comparing dietary approaches, the dieting group (n=8) tended to show favorable results short-term for BMI *z* score at year 1 ($P=.11$), but by year 2, the nondieting group (n=17) further improved BMI *z* score ($P=.006$), while the dieting group reverted toward baseline.

Conclusions The Bright Bodies Weight Management Program was successful at decreasing BMI *z* scores both short and long term. In a separate analysis, dieting showed more superior short-term results, but a nondiet approach demonstrated improved long-term results.

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The prevalence of obesity in children and adolescents in the United States has increased dramatically and continuously over the last 4 decades (1,2). Almost 25% of children and adolescents are currently overweight with a body mass index (BMI) >95th percentile for age and sex (3,4). Forty percent of children who are obese at age 7 become obese adolescents, and 75% of adolescents who are obese become obese adults (5). Overweight and obesity in childhood and adolescence is associated with hypertension (6-8), hyperlipidemia and hypertriglyceridemia (9), elevated liver enzymes (10), and increased plasma insulin levels (9,11,12). Impaired glucose tolerance and type 2 diabetes is increasing in youth in the United States, with up to 40% of new cases of diabetes in youth diagnosed as type 2 diabetes (13,14). Furthermore, this population is at greater risk for psychosocial dysfunction, respiratory disease, and orthopedic complications (6,15).

Treatment of obesity in children and adolescents includes nutrition education, exercise, and behavioral modification, which, ideally, includes a family member (16,17). Comprehensive weight-management programs using these approaches have demonstrated short-term efficacy, but to date few studies have demonstrated long-term success (16). Epstein and colleagues have reported

on long-term reductions in obesity in preschool children and preadolescents using the traffic-light diet in a comprehensive treatment modality (18). However, research in adolescent obesity treatment is less frequently examined and published long-term success in adolescent weight management is lacking (19). Consequently, there is little known about which dietary methods are successful in achieving weight loss and maintenance in obese adolescents.

Dieting is thought to be ineffective and harmful, and there are longstanding beliefs that it may cause obesity (20). Several studies reported that use of standard meal plans during the reducing phase of weight loss programs had short-term efficacy (20-23). Using a structured meal plan with children and adolescents may have adverse effects on self-esteem and constitute risk behaviors for development of obesity by encouraging denial of hunger cues, discontinuation of eating while still hungry, and skipping meals (24-26). Furthermore, dieting may result in eating binges once food is available and in psychological manifestations, such as food preoccupation (27). Conversely, a nonrestrictive approach better preserves lean tissue in obese adolescents (28), a factor closely associated with basal metabolic rate. This more liberal method is also reported to be better tolerated and, therefore, more realistic for long-term weight management (28). Although scant scientific data such as this currently exist to support a nondieting approach for weight management in obese adolescents, a nondieting approach of an educational process that involves learning better food choices and moderate portion sizes may prove to be more beneficial long-term. Thus, the major aims of this study were to (a) determine the long-term effectiveness of the Bright Bodies Weight Management Program and (b) examine whether a relationship exists between type of diet method utilized and improved short- and long-term anthropometric and psychosocial outcomes in obese adolescents.

METHODS

Setting and Sample

Subjects were recruited from the pediatric weight management clinic at Yale New Haven Hospital between September 1999 and September 2000.

The dietitian screened the adolescents to determine if they had a BMI ≥95th percentile for age and sex. Other inclusion criteria included any English-speaking youth 11 to 16 years old who assented and whose parent or primary caregiver consented to their participation. Youths were excluded if they had a major health or psychological condition, were concurrently using pharmacological medications for weight management, or were involved in a concurrent weight management program. Each subject identified a family member to participate in the study with him or her, and these included fathers, mothers, and grandparents. The only inclusion criterion for family members was that they were able to speak and read in English and lived with the subject. Thirty-three subjects who met criteria were invited to participate and 33 subjects agreed to do so (no refusals). The study was approved by the Yale University School of Medicine Human Investigation Committee and the General Clinical Research Center Advisory Committee.

Procedures

Anthropometric and psychosocial data were collected at baseline and at 1- and 2-year follow-up. After the subject completed the initial nutrition education classes using a nondiet approach, a written meal plan was provided if they requested more direction and structure. Ten of the 33 subjects preferred a more structured method and this established the two diet-method subgroups, comparing a diet approach using a structured meal plan (SMP group) with a nondiet approach in which the adolescents were educated to make better food choices (BFC group). Each adolescent's motivation level was assessed by week 2 using a questionnaire (scale numbered 1 through 10; 1=unmotivated and 10=extremely motivated) from the *Smart Moves Workbook*, a nutrition and behavior modification curriculum currently being developed for overweight children and adolescents.

In an effort to control for variables associated with weight management success, the 10 subjects who requested a structured meal plan were matched for sex and motivational level with 10 who made better food choices.

After year 1, subjects were asked to attend monthly maintenance classes. Twenty-four percent of the subjects (n=8) dropped out of the study between years 1 and 2 (between months 17 and 20). Six subjects (within the BFC group) moved and left no forwarding address and despite mailing two letters to their old addresses, there was no reply. Two of the subjects (within the SMP group) reported that they "gained all of their weight back and felt too embarrassed to return."

Weight Management Program

The Bright Bodies Weight Management Program included nutrition education, exercise, and behavioral modification. Each week adolescents attended two 30-minute exercise sessions and one 45-minute nutrition or behavior modification class with adolescents of a similar age group. There were four levels (each 12 weeks)—Beginner, Intermediate I, Intermediate II, and Advanced—which each adolescent completed. After 1 year, maintenance classes were offered monthly and were support-group style. Normally, maintenance is suggested when the member reaches a healthful weight that he or she decides on with the help of a dietitian or physician. This may involve 2 or more years of active participation in the program before maintenance is started, because many of the adolescents we help are quite overweight. For purposes of this study, however, we stopped active participation after 1 year and asked the children to return monthly to mimic a maintenance phase of the program.

Nutrition Education Component

The nutrition curriculum used a nondiet, better food choices approach, and was provided for 45 minutes weekly by a registered dietitian for six of the 12-week sessions. Parents or primary caregivers attended the nutrition education classes with their adolescents. Classes began in a support-group style in which members discussed upcoming challenges with peers who assisted in problem-solving. The nondiet, better food choices approach included education regarding low-fat, nutrient-

dense food choices, moderate portion sizes, and hunger and fullness. Nutrition education classes included label reading, balancing meals, portion sizes, making better food choices, recipe modification, and healthful snacks. The *Smart Moves Workbook* provided a foundation for all class topics.

After the adolescents completed 36 weeks and were at the advanced level, they were encouraged to pair with other members to mentor and support their peers. Thirty of the 33 (91%) subjects participated in the mentorship. Most adolescents (84%) chose to help children in the 8-to 10-year-old group (younger children were not part of the study). Adolescents provided their "buddy" with their home phone number and met with them briefly once per week for 12 weeks and then monthly at their own maintenance visit.

Diet Method Subgroups

Structured Meal Plan. A written meal plan of appropriate caloric level was provided after the initial nutrition education classes were completed if requested by caregiver and adolescent. *The American Diabetes Association and American Dietetic Association Exchange Lists for Meal Planning* (29) was used by the dietitian as a foundation to develop a simplified plan. Ten adolescents participated in the structured meal plan group. To demonstrate compliance and comprehension of the meal plan, the SMP group filled out simplified food intake sheets three times weekly (2 weekdays, 1 weekend day), which involved checking off the food group/serving used per meal, and returned the sheets to the dietitian each week. Sheets were scored 0, 1, or 2 and then averaged (0=poor compliance, 2=high compliance). The dietitian met with the adolescent and caregiver when poor compliance occurred, to be sure there was no confusion regarding the meal plan. Average score of each SMP adolescent was greater than 1. No formal data analysis of individual nutrients was performed.

Better Food Choices. In contrast, adolescents who did not utilize a structured meal plan comprised the BFC group (n=23). These adolescents continued with a nondiet approach, which is the philosophy of the Bright Bodies program.

Exercise Component

Exercise sessions were 2 days a week for 30 minutes with an exercise physiologist. Adolescents exercised with peers of similar age; parents did not exercise. A ratio of one exercise physiologist was maintained for every six adolescents. Adolescents chose the form of exercise they felt most comfortable engaging in (cardiovascular equipment or dance routines). Equipment included stationary bicycles, treadmills, rowing machines, Biodex ergometers (Biodex, Shirley, NY), and stair-steppers. All sessions included a 5-minute warm-up and cool-down. A Polar heart rate monitor (Polar USA, Dartmouth, MA) was worn consistently, which was targeted at 65% to 80% of their estimated maximum heart rate. The Borg's Perceived Exertion Chart (30) was used to monitor exertion. Adolescents were encouraged to exercise 3 additional days at home per week and decrease sedentary behaviors.

Behavioral Modification Component

The behavioral modification curriculum used a problem-solving approach and was provided for 45 minutes weekly by a dietitian or social worker for six of the 12-week sessions. Adolescents attended these classes without their parents or caregivers so that they felt free to participate in straightforward discussion. Parents/caregivers attended their own classes offered by a nurse practitioner when their adolescents were in the behavioral modification classes, which provided an opportunity for them to discuss challenges regarding working with their adolescents in making healthful behavior change and to learn parent modeling.

The goals of the behavioral modification component were to help the adolescents replace negative behaviors with positive, healthful behaviors, while improving overall self-image. The dietitian or social worker taught self-monitoring, stimulus control, cognitive behavioral strategies, stress management, and contingency management (self and class rewards) using corresponding topics found in the *Smart Moves Workbook*.

ANTHROPOMETRIC MEASUREMENT

BMI and BMI *z* Score

Adolescents were weighed weekly or every other week, depending on their preference. Parents were encouraged to be weighed as well, to further promote a family approach. A stadiometer, calibrated in ⅛-cm intervals, was used to determine height. Weight was measured in socks with no shoes in kilograms to the nearest tenth using a Detecto Scale (model CN20, Detecto, a division of Cardinal Scale Manufacturing Co, Webb City, MO), zeroed and calibrated before each weight. BMI was calculated as kg/m^2 (31). BMI *z* scores, which reflect the standard deviation score for the age- and sex-appropriate BMI distribution, were calculated as well (31). The adolescent's last weekly weight at the end of year 1 was used to calculate the mean BMI/BMI *z* score, while their last monthly weight was used for mean calculations at the end of year 2.

Body Fat Percentage

The Tanita Body Fat Analyzer (TBF 300, Tanita Corporation of America, Inc, Arlington Heights, IL) determined the percent body fat of each adolescent and tracked their progress. The Tanita uses a leg-to-leg bioelectrical impedance method to estimate body fat percentage, and has been found to have a high correlation ($r=0.89$, $P<.001$) with dual-energy x-ray absorptiometry in children (32). Body fat percentages were obtained monthly. One-year mean body fat percentages were derived from values obtained from the last month of the active program (month 12) and 2-year mean calculations were derived from the values obtained at the last month of the maintenance program (month 24).

Psychosocial Measurement

Self-concept was measured using the Piers-Harris Children's Self-Concept Scale I (33). The Piers-Harris Children's Self-Concept Scale I is based on the individual's own perceptions, has a third-grade reading level, and is

Table. Baseline characteristics of children enrolled in the Bright Bodies Weight Management Program

Characteristic	Entire group (N=25, 8 male, 17 female)	Diet Therapy Subgroups	
		SMP[a] (n=8, 2 male)	BFC[b] (n=17, 6 male)
Race or ethnic group			
Non-Hispanic white	15	8	7
Non-Hispanic black	7	0	7
Hispanic	3	0	3
	← *mean±standard error of mean* →		
Age (y)	13.5±0.3	13.3±0.6	13.6±0.3
Weight (kg)	109.6±6.9	89.9±11.6	118.9±7.7
Height (cm)	164.1±1.7	161.6±2.1	165.3±2.3
BMI[c]	40.1±2.0	33.9±3.4	43.0±2.2*
BMI *z* score	2.5±0.1	2.2±0.2	2.6±0.1*
Body fat (%)	45.8±1.2	43.0±1.6	47.1±1.6
Self-concept (total score)	54.4±2.3	56.1±2.8	53.5±3.1
Motivational level (1-10)	7.72±0.3	8.6±0.4	7.3±0.4*

[a]SMP=Structured Meal Plan group.
[b]BFC=Better Food Choices group.
[c]BMI=body mass index; calculated as kg/m^2.
*$P<.05$.

appropriate for children and adolescents aged 7 to 18. The scale is self-administered and contains 80 yes-or-no questions with a score ranging from 0 to 80. The Piers-Harris Children's Self-Concept Scale I provides a total score that reflects overall self-concept and six subscales:

1. behavioral adjustment;
2. freedom from anxiety;
3. happiness/satisfaction;
4. intellectual/school status;
5. physical appearance/attributes;
6. popularity.

For this study, a total score was measured at baseline, 1 year, and 2 years, and means were reported. Internal consistency coefficients on the total score with children and adolescents ranges from 0.88 to 0.93 and test-retest reliability from 0.69 to 0.96 (33). Total score increases as the child's self-concept improves.

Demographics

Demographic data for age, sex, and ethnicity of the adolescents appear in the Table.

Statistical Analysis

All data were entered in an Access database (Microsoft Corp, Redmond, WA). Baseline characteristics were compared with independent sample t tests and χ^2 analysis, where appropriate. Changes in outcome data were analyzed with repeated measures covariance pattern models using the MIXED procedure in SAS, version 8 (SAS, Cary, NC) (34). Planned contrasts of group differences in changes from 0 to 1 year and 1 to 2 years were evaluated with Bonferroni corrected significance tests. All data are presented as mean±standard error of the mean.

RESULTS

Results represent the completers for the entire group (N=25), of which 17 were from the BFC group and eight from the SMP group. Although our dropouts left the maintenance program between years 1 and 2 (between 17 and 20 months), we will report on completers only (N=25). Of note, data did not change significantly when dropouts were included in year-1 outcomes.

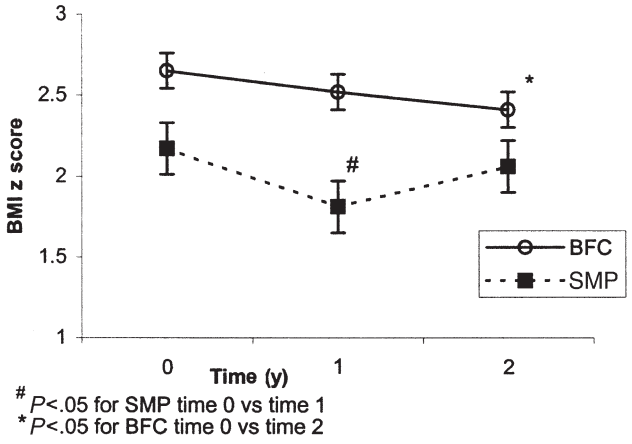
Adolescents were 11 to 16 years old (mean age±standard error, 13.5±0.3, 17 female, 8 male), 60% non-Hispanic white, 28% non-Hispanic black, and 12% Hispanic (Table). In reference to the subgroups, the BFC group had higher baseline mean weight and mean percentage of body fat, and were taller, when compared with the SMP group, but these differences were not statistically significant (Table). The SMP group had a higher income ($P<.05$) when compared with the BFC group.

Primary Aim—Bright Bodies Weight Management Program Results

BMI *z* Scores. At 1 year, the entire group (N=25) showed a decrease in BMI z scores from 2.49±0.10 to 2.30±0.10, $P=.004$ (ie, a 7.7% decrease in BMI z scores after 1 year, which converts to a decrease in absolute BMI from 40.10 to 37.7±2.08, $P\leq.0001$). At 2-year follow-up, the decrease in BMI z score from baseline was maintained (2.29±0.10, $P=.03$), which converts to an absolute BMI decrease to 39.3±2.08, $P\leq.0001$).

Percentage Body Fat

The entire group at 1 year showed a mean percentage body fat decrease from 45.76%±1.65% to 40.79%±1.66%, $P=.002$. At year 2, mean percent body fat was no longer



# $P<.05$ for SMP time 0 vs time 1
* $P<.05$ for BFC time 0 vs time 2

Figure 1. Change in body mass index *z* score after 1 and 2 years. BMI=body mass index; BFC=better food choices diet method group; SMP=structured meal plan diet method group.

significantly different than baseline (42.44%±1.65%, $P=.15$).

Self-Concept Scores

At 1 year, the entire group showed an improvement in mean self-concept scores (higher score indicates improvement) from 54.36±2.43 to 61.60±2.43, $P<.001$. At year 2, scores were not significantly higher than baseline (58.29±2.45, $P=.10$).

Secondary Aim—Comparison of Diet Method Groups

BMI *z* Scores. One-year improvements from baseline tended to be higher in the SMP group but were not significantly different when compared to the BFC group (change in BMI *z* score from baseline to 1 year: SMP=−0.36±0.10, BFC=−0.12±0.07, $P=.11$) [ie, the SMP group had a 16.4% decrease in BMI *z* score in the first year while the BFC group showed a 4.7% decrease]. At 2 years, however, the BFC group demonstrated a further reduction while the SMP group reverted toward baseline (change in BMI *z* score from 1 year to 2 years: SMP=0.24±0.10, BFC=−0.12±0.07, $P=.006$) [ie, by year 2, the SMP showed a 5.1% decrease from baseline in BMI *z* score while the BFC further progressed to a 9.1% decrease (Figure 1)].

It is worth noting that results were similar when the two diet method groups were matched for sex and motivational level: The SMP group's BMI *z* score decreased by −0.36±0.10 at year 1 while the BFC group decreased by −0.14±0.11 ($P=.34$) [ie, the SMP group showed a 17% decrease in BMI *z* score while the BFC decreased their BMI *z* score by only 5% at year 1]. By year 2, however, the SMP group's BMI *z* score attenuated toward baseline while the BFC group continued to improve their BMI *z* score (change in BMI *z* score from 1 year to 2 years: SMP=0.24±0.10, BFC=−0.27±0.11, $P=.004$) [ie, the SMP group showed a 5.1% decrease in BMI *z* score while the BFC showed a 15.1% decrease].

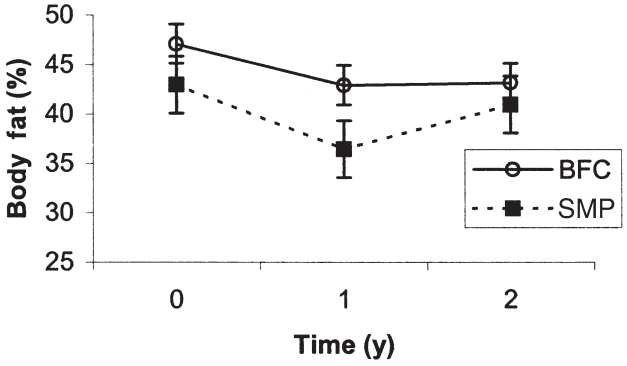


Figure 2. Change in body fat percentage after 1 and 2 years. BFC=better food choices diet method group; SMP=structured meal plan diet method group.

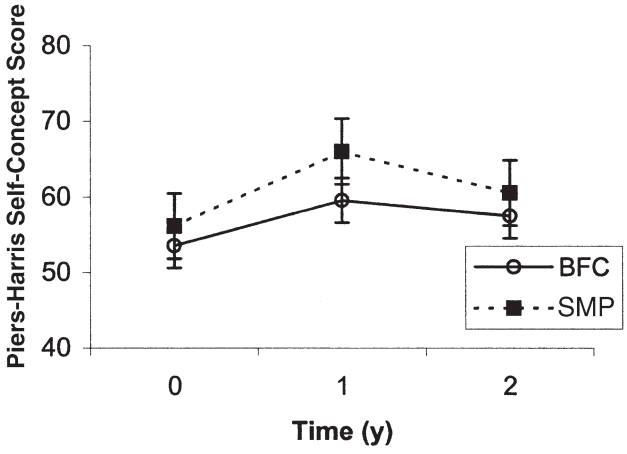


Figure 3. Change in self-concept scores after 1 and 2 years. BFC=better food choices diet method group; SMP=structured meal plan diet method group.

Percentage Body Fat

Changes in percentage body fat did not significantly differ between SMP or BFC groups (SMP=−6.5%±2.5%, BFC=−4.2%±1.7%, $P=.90$ from baseline to 1 year; SMP=−4.5%±2.5%, BFC=−0.23%±1.7%, $P=.34$ from 1 to 2 years) (Figure 2).

Self-Concept Scores

Changes in self-concept scores did not significantly differ between the SMP and BFC groups from baseline to 1 year (6.0±2.1 and 9.9±3.1, $P=.62$, respectively) or from 1 to 2 years (SMP=−5.5±3.1, BFC=−2.2±2.2, $P=.79$) (Figure 3).

DISCUSSION

Results of this observational study demonstrated that the Bright Bodies Weight Management Program brought forth positive, enduring anthropometric results in obese adolescents. Although obesity research is scant in this population, it is crucial to document weight management treatment of adolescents as most of these individuals

continue to be obese into adulthood. This study helps fill a void in the research in adolescent obesity treatment and is particularly important given its long-term nature.

In addition to the study's long duration, another strength was the separate analysis of diet method subgroups, with all other aspects of therapy constant, which offered us insight into the differences in short- and long-term outcomes in the adolescents using better food choices when compared to a structured meal plan. The group utilizing a diet approach tended to have superior outcomes in the short term, but clearly faltered in the long term, while the group utilizing a nondieting approach further progressed in the long term.

In order to maintain the philosophy of the Bright Bodies Weight Management Program, it was necessary to uphold a nondiet approach and provide a structured meal plan only to the adolescents or parents who requested this form of therapy. Our experience taught us to anticipate adolescents or caregivers seeking use of a diet approach at the outset of this project. Indeed, when teaching the nondiet approach, some parents reported that they were "floundering" and needed a more concrete approach. This may be true as learning how to eat healthier takes more time than "following" a diet because it is a process that involves multiple educational sessions. The hallmark of most weight management programs is gaining all weight back—and sometimes more—after a period of time (35). When Toubro and colleagues compared an ad lib, low-fat, high-carbohydrate diet to a fixed energy intake in obese adults, they found less weight regain in the ad lib group at the 1-year follow-up (36). Successful long-term weight management is difficult to achieve in adults and most weight management research in adolescents is short term (18).

This long-term pediatric study suggests that a weight rebound may not occur after weight loss if a nondiet approach is used, as it may teach the skills necessary to maintain weight loss. Skills such as making better food choices, differentiating between hunger and cravings, learning to stop eating when full, preparing food in a low-fat way, decreasing portion sizes, and making changes gradually, may provide a strong foundation for working with adolescents so they can make realistic behavior changes over time.

Field and colleagues recently compared dieting vs nondieting in preadolescents and adolescents and demonstrated that not only was dieting ineffective for weight control, but it promoted weight gain (37). While this study had a large sample size, it was limited to children of nurses enrolled in another national study. The majority of the subjects were white and from middle- to high-socioeconomic backgrounds. The dieting group used self-reported measures, and dietary interventions were neither clearly defined nor used the same dietary interventions. Our study, which represented an ethnic and socioeconomic status mix and utilized a specific diet in the dieting group, also supported the premise that adolescents should not follow restrictive diets.

Although there is high correlation between percent body fat and BMI, our 2-year results in percent body fat did not show significant changes as our BMI *z* scores. Less exercise during the maintenance phase of the program may be an explanation for this. The program promoted exercise during the second year, but did not keep formal records of participants' exercise levels. We also recognize that percent body fat increases normally during adolescence and, unlike the BMI *z* score, which adjusts for age and sex, the percent body fat has no comparable scale for adjustment.

From a developmental perspective, adolescence is a time of identity formation. When tracking self-concept scores, we hoped to capture an improvement that would be maintained even if some weight was regained. At year 1, the group had improved their self-concept significantly, but by year 2 this improvement was no longer significant. Interestingly enough, the SMP group who had regained some weight showed no difference in their change in self-concept scores than the BFC group who continued to decrease BMI *z* score. Treatment was clearly different in year 2, as the members met monthly vs twice per week. The lack of continued improvement in self-concept may be related to less interaction with peers who help us form our identity.

As this was a small-scale, descriptive study and not a randomized, controlled study, our data do not provide definitive evidence that a nondieting approach provides superior long-term outcomes in weight management. Nonetheless, our data suggest that the Bright Bodies Weight Management Program was successful in losing and maintaining weight among obese adolescents and that dieting or the use of a structured meal plan may not promote the best long-term success for weight management in adolescents, but a nondieting approach, such as making better food choices, may be an important dietary intervention to use with adolescents interested in long-term weight loss. A larger randomized follow-up study is currently underway.

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References

1. National Center for Health Statistics. *The Third National Health and Nutrition Examination Survey (NHANES III, 1988-94) reference manuals and reports*. Hyattsville, MD: US Department of Health and Human Services, Public Health Service, Centers for Disease Control; 1996.
2. Troiano RP, Flegal KM, Kuczmarski RJ, Campbell SM, Johnson CL. Overweight prevalence and trends for children and adolescents. The National Health and Nutrition Examination Surveys, 1963 to 1991. *Arch Pediatr Adolesc Med*. 1995;149:1085-1091.
3. Barlow S, Dietz W. Obesity evaluation and treatment: Expert committee recommendations. *Pediatrics*. 1998; 102:E29-E40.
4. Himes J, Dietz W. Guidelines for overweight in adolescent preventive services: Recommendations from an expert committee. *Am J Clin Nutr*. 1994;59:307-316.
5. Kolata G. Obese children: A growing problem. *Science*. 1986;232:20-21.
6. Stallones L, Mueller WH, Christensen BL. Blood pressure, fatness, and fat patterning among USA adolescents from two ethnic groups. *Hypertension*. 1982; 4:483-486.

7. Kotchen JM, Kotchen TA, Gurthrie GP, Cottrill CM, McKean HE. Correlates of adolescent blood pressure at five-year follow-up. *Hypertension*. 1980;2:124-129.
8. Clarke WR, Woolson RF, Lauer RM. Changes in ponderosity and blood pressure in childhood: The Muscatine Study. *Am J Epidemiol*. 1986;124:195-206.
9. Cook S, Weitzman M, Auinger P, Nguyen M, Dietz WH. Prevalence of a metabolic syndrome phenotype in adolescents. *Arch Pediatr Adolesc Med*. 2003;157: 821-827.
10. Strauss RS, Barlow SE, Dietz WH. Prevalence of abnormal serum aminotransferase values in overweight and obese adolescents. *J Pediatr*. 2000;136: 727-733.
11. Attia N, Tamborlane WV, Heptulla R, Maggs D, Grozman A, Sherwin RS, Silver D, Shulman GI, Caprio S. The metabolic syndrome and insulin-like growth factor I regulation in adolescent obesity. *J Clin Endocrinol Metab*. 1998;83:1467-1471.
12. Robinson C, Tamborlane WV, Maggs DG, Enoksson S, Sherwin RS, Silver D, Shulman GI, Caprio S. Effect of insulin on glycerol production in obese adolescents. *Am J Physiol*. 1998;274:E737-E743.
13. Sinha R, Fisch G, Teague B, Tamborlane WV, Banyas B, Allen K, Savoye M, Reiger V, Taksali S, Barbetta G, Sherwin RS, Caprio S. Prevalence of impaired glucose tolerance among children and adolescents with marked obesity. *N Engl J Med*. 2002;346:802-810.
14. Fagot-Campagna A. Emergence of type 2 diabetes mellitus in children: Epidemiological evidence. *J Pediatr Endocrinol Metab*. 2000;13(suppl 6):S1395-S1402.
15. Kiess W, Reich A, Muller G, Meyer K, Galler A, Bennek J, Kratzsch J. Clinical aspects of obesity in childhood and adolescence—Diagnosis, treatment and prevention. *Int J Obes Relat Metab Disord*. 2001; 25(suppl 1):S75-S79.
16. Goldfield GS, Raynor HA, Epstein LH. Treatment of pediatric obesity. In: Wadden TA, Stunkard AJ, eds. *Handbook of Obesity Treatment*. New York, NY: Guilford Press; 2002:532-555.
17. Quinzi D. Obesity in children. *Adv Nurse Pract*. 1999; 7:46-50.
18. Epstein LH, McCurley J, Wing RR, Valoski A. Five-year follow-up of family-based behavioral treatments for childhood obesity. *J Consult Clin Psychol*. 1990; 58:661-664.
19. Jelalian E, Saelens BE. Empirically supported treatments in pediatric psychology: Pediatric obesity. *J Pediatr Psychol*. 1999;24:249-250.
20. Foster GD, McGuckin BG. Nondieting approaches: Principles, practices, and evidence. In: Wadden TA, Stunkard AJ, eds. *Handbook of Obesity Treatment*. New York, NY: Guilford Press; 2002:494-512.
21. Epstein LH, Wing RR, Penner B, Kress MJ. Effects of diet and controlled exercise on weight loss in obese children. *J Pediatr*. 1985;107:358-361.
22. Reybrouck T, Vinckx J, Van den Berghe G, Vanderschueren-Lodeweychx M. Exercise therapy and hypocaloric diet in the treatment of obese children and adolescents. *Acta Pediatr Scand*. 1990;79:84-89.
23. Sothern MS, DeSpinasse B, Brown R, Suskind RM, Udall JN Jr, Blecker U. Lipid profiles of obese children and adolescents before and after significant weight loss. *South Med J*. 2000;93:278-283.
24. Satter EM. Internal regulation and the evolution of normal growth as the basis for prevention of obesity in children. *J Am Diet Assoc*. 1996;96:860-864.
25. Satter EM. Childhood obesity demands new approaches. *Obes Health*. 1991;6:42-43.
26. Birch LL, Davison KK. Family environmental factors influencing the developing behavioral controls of food intake and childhood overweight. *Pediatr Clin N Am*. 2001;48:893-907.
27. Polivy J. Psychological consequences of food restriction. *J Am Diet Assoc*. 1996;96:589-596.
28. Amador M, Ramos LT, Morono M, Hermelo MP. Growth rate reduction during energy restriction in obese adolescents. *Exp Clin Endocrinol*. 1990;96:73-82.
29. American Diabetes Association (Alexandria, VA) and American Dietetic Association (Chicago, IL). Exchange Lists for Meal Planning. 1995.
30. Borg GV. Borg's Perceived Exertion Chart. *Med Sci Sports Exerc*. 1982;14:377-387.
31. Kuczmarski RJ, Ogden CL, Grummer-Strawn LM. Centers for Disease Control growth charts. *US Adv Data*. 2000;314:1-27.
32. Nunez C, Rubiano F, Horlick M, Thornton J, Heymsfield SB. Application of leg-to-leg bioimpedance system in children. International Conference Series on Health Promotion, Conference on Childhood Obesity: Partnership for Research and Prevention, Atlanta, GA; International Life Sciences Institute, Washington, DC; 1999:68.
33. Piers EV, Herzberg DS. *Piers-Harris Children's Self-Concept Scale*. 2nd ed. Los Angeles, CA: Western Psychological Services; 2003.
34. Statistical Analysis System. *SAS User's Guide: Statistics*. Cary, NC: SAS Institute; 1988.
35. Perri M, Corsica J. Improving the maintenance of weight loss in the behaviorial treatment of obesity. In: Wadden TA, Stunkard AJ, eds. *Handbook of Obesity Treatment*. New York, NY: Guilford Press; 2002: 357-379.
36. Toubro S, Astrup A. A randomized comparison of diets for maintaining obese subjects' weight after major weight loss: Ad lib, low fat, high carbohydrate diet verses fixed energy intake. *BMJ*. 1997;314:29-34.
37. Field AE, Austin SB, Taylor CB, Malspeis S, Rosner B, Rockett HR, Gillman M, Colditz. GA. Relation between dieting and weight change among preadolescents and adolescents. *Pediatrics*. 2003;112:900-906.