Published in final edited form as:

Eat Behav. 2010 December ; 11(4): 217–222. doi:10.1016/j.eatbeh.2010.05.001.

Early Patterns of Food Intake in an Adolescent Weight Loss Trial as Predictors of BMI Change

Chantelle N. Hart, Ph.D.^a, Elissa Jelalian, Ph.D.^{a,b}, Hollie A. Raynor, Ph.D., R.D.^a, Robyn Mehlenbeck, Ph.D.^b, Elizabeth E. Lloyd-Richardson, Ph.D.^a, Jamie Kaplan, B.A.^c, Katherine Flynn-O'Brien, B.A.^c, and Rena R. Wing, Ph.D.^a

^aWeight Control & Diabetes Research Center, The Miriam Hospital and the Warren Alpert Medical School of Brown University, 196 Richmond Street, Providence, RI 02903, USA; Chantelle_Hart@brown.edu; Elissa_Jelalian@brown.edu; hraynor@utk.edu; erichardson@lifespan.org; rwing@lifespan.org.

^bBradley Hasbro Research Center, Rhode Island Hospital and the Warren Alpert Medical School of Brown University, CORO West, Suite 240, 1 Hoppin Street, Providence, RI 02903, USA; rmehlenbeck@lifespan.org

^cBehavioral Medicine, The Miriam Hospital, Coro West, Suite 240, 1 Hoppin Street, Providence, RI 02903, USA

Abstract

Purpose—To determine whether baseline intake or initial changes in intake of fruits (F), vegetables (V), snack foods (SF), and reduced-calorie snack foods (RCSF) during standard behavioral weight loss treatment predict BMI reductions among overweight adolescents. Given conflicting messages between child and adult weight loss interventions, the role of RCSF in adolescent weight control was of particular interest.

Methods—Seventy-two adolescents, 13–16 years old, participating in a 16-week behavioral weight loss trial with diet records at baseline and 4 weeks were included. Height and weight were measured at 0 and 16 weeks. Frequency of intake of F, V, SF, and RCSF were obtained from 7-day food records at 0 and 4 weeks.

Results—Male gender, higher initial frequency of intake of V and increased frequency of intake of F and RCSF over the first 4 weeks of treatment accounted for 43% of the variance in BMI reduction at 16 weeks ($p < .001$).

Conclusions—Early changes in eating habits, including increased frequency of intake of F and RCSF may promote greater adolescent BMI reductions.

Keywords

Obesity; Standard Behavioral Weight Loss Treatment; Eating Habits; Fruit; Vegetables; Snack Foods

© 2010 Elsevier Ltd. All rights reserved.

Address for Correspondence: Chantelle Hart, Ph.D., Weight Control & Diabetes Research Center, The Miriam Hospital, 196 Richmond Street, Providence, RI 02903, USA; Chantelle_Hart@brown.edu; Phone: 401-793-9727; Fax: 401-793-8944.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

1. Introduction

Pediatric obesity has been labeled an epidemic (Wang & Dietz, 2002) with 34% of adolescents 12-19 years old considered to be overweight or at risk for overweight in the United States (Ogden, Carroll, & Flegal, 2008). While there is empirical evidence to support the effectiveness of weight loss treatment for children (Epstein, 2003; Jelalian & Saelens, 1999) and adults (Curioni & Lourenço, 2005; Norris et al., 2005) there is less empirical evidence for effective behavioral treatment programs for adolescents. Furthermore, weight loss trials with adolescents demonstrate considerable variability in terms of treatment outcomes (Berkowitz et al., 2003; Jelalian et al., 2008; Sondike et al., 2003). Thus, there is a great need to evaluate the effectiveness of behavioral weight loss programs for adolescents, particularly with regard to key behavioral changes that produce better treatment outcomes.

One potentially important variable in predicting weight loss outcomes is early treatment response (i.e., making changes at the start of treatment to promote early weight loss). Research with adult populations consistently shows that individuals who lose more weight initially in standard behavioral weight loss programs are more likely to continue to lose weight to promote better treatment outcome (Wing & Phelan, 2003). A recent study conducted with adolescents enrolled in a standard behavioral weight loss program also found that weight loss during the first four weeks of treatment was positively associated with subsequent weight loss (Jelalian et al., 2008). Thus, it may be particularly important to identify which behavioral changes initiated by adolescents early in a weight loss program are associated with positive treatment outcomes.

One of the core components of standard behavioral weight loss interventions involves dietary prescription to produce a healthy, calorie-reduced diet. Participants are commonly asked to change the quality of their diet, oftentimes through an increase in fruits (F) and vegetables (V) and decrease in foods high in fat and sugar content such as snack foods. The importance of enhancing the quality of the diet to produce weight loss is particularly salient during adolescence. Research consistently shows that the quality of adolescents' diets has declined over the past 2-3 decades (Jahns, Siega-Riz & Popkin, 2001; Nielsen, Siega-Riz, & Popkin, 2002) with recent estimates of food intake documenting that adolescents do not meet a number of current dietary recommendations (Briefel & Johnson, 2004; Cavadini, Siega-Riz, & Popkin, 2000; Kant, 2003; Sanchez et al., 2007). For example, one large study using 24-hour dietary recall interviews found that 88% of adolescents interviewed did not meet current recommendations for five servings of F and V daily (Sanchez et al., 2007). Moreover, adolescents who were overweight or obese were at increased risk for not meeting recommendations. An additional study similarly found that adolescents consumed only 1.4 servings of F and 3.3 servings of V daily with potatoes accounting for half of the servings of V and fruit juices accounting for a large percentage of F consumed (Cavadini et al., 2000). In contrast, data from the National Health and Nutrition Examination Survey (NHANES), 1988 to 1994, showed that low nutrient dense foods, including snack foods (SF) (e.g., desserts, salty snack foods, sweeteners/sweetened drinks), account for approximately 1/3 of children's and adolescents' daily energy intake (Kant, 2003). Thus, given the poor quality of adolescents' diets, adherence to common dietary recommendations as part of a weight loss program may pose some challenges. However, if adolescents are able to increase F and V while they decrease their intake of SF, they may experience considerable benefits in terms of weight loss.

While standard behavioral weight loss interventions with children and adults are fairly consistent in terms of their recommendations regarding consumption of F, V and SF, they diverge in their stance on modified foods or reduced calorie snack foods (RCSF) (i.e., reduced calorie, lower fat versions of food/beverages higher in energy density) and the role these foods should play in promoting weight loss. Evidence-based pediatric obesity interventions

discourage the consumption of reduced calorie alternatives because they do not support changes in eating habits during childhood (Epstein & Squires, 1988). The rationale is that RCSF are designed to imitate the taste of their higher calorie counterparts, and thus promote preferences towards these tastes. RCSF are therefore discouraged in an attempt to change eating habits towards healthier alternatives such as F and V. In contrast, interventions with adults typically encourage consumption of RCSF, and in fact, there is some evidence for a protective effect of eating RCSF for weight management in adults (Blackburn et al., 1997; Raben et al., 2000). Given the increasing availability of RCSF, the divergence in pediatric and adult behavioral treatment programs regarding the utility of RCSF to promote weight loss, and the increased ability of adolescents to make independent decisions regarding snack consumption, it is important to evaluate the potential utility of these foods in promoting weight loss within the context of a behavioral weight loss program. To our knowledge, no studies have evaluated the potential role of RCSF in promoting weight loss in adolescents.

The purpose of the present study is therefore to determine whether adolescent eating behaviors are associated with BMI change over the course of a 16-week behavioral weight loss program. Specifically, the present study assesses the effect of both baseline and early changes (i.e., over the first 4 weeks of treatment) in the reported frequency of consumption of F, V, SF, and RCSF on BMI change over the course of active treatment. It was hypothesized that increased frequency with which adolescents reported consuming F, V, and RCSF as well as decreased frequency with which adolescents reported consuming SF over the first four weeks of treatment would be associated with reduction in BMI at the end of a 16-week adolescent weight loss trial.

2. Methods

2.1. Participants

Participants were recruited from pediatrician offices and advertisements in local newspapers. Inclusion criteria were: between 13 and 16 years of age, parent or guardian available for participation in intervention, between 30 and 90% overweight with reference to age- and gender-specific BMI (Kuczmarski et al., 2000), able to speak and read English, and no dietary or physical activity restrictions. Participants in the present study represent a subsample of 118 adolescents enrolled in a 16-week behavioral weight loss program. One hundred (85%) adolescents completed the treatment program. Of these 100 adolescents, 72 (72%) completed 7-day diet records at baseline and 4-weeks into treatment and were therefore included in the present analyses. To be considered complete, at least four of seven days of dietary data needed to be documented. Those who completed dietary data did not differ significantly from the entire sample on age, race/ethnicity, or baseline percent overweight. They also did not differ from treatment completers (but without completed dietary data) on age, race/ethnicity or percent overweight at baseline. However, they were more likely to be female ($\chi^2 = 4.50$, $p = .03$), have better attendance, $t(39.61) = -3.02$, $p = .004$, and demonstrate greater BMI reductions, $t(99) = 3.52$, $p = .001$, over the 16-week active treatment program than those participants who completed treatment, but did not have completed dietary data. Table 1 provides demographic information on participants included in the present analyses. Briefly, adolescents were primarily Non-Hispanic White (75%) and female (73.6%). They ranged in age from 13-16 years old ($M = 14.21$, $SD = 0.88$) at the start of treatment. Mean body mass index (BMI) at the start of treatment was 30.99 ($SD = 3.33$); mean percent overweight was 59.74 (17.28).

2.2. Procedures

The Institutional Review Board where the study was conducted approved all procedures. Families were recruited into the study with advertisements and referrals from area pediatricians. Families attended an initial assessment to determine eligibility and to obtain written informed consent from parents and assent from adolescents. Participants were then

randomly assigned to one of two group treatment conditions: cognitive behavioral treatment with peer-enhanced skills training (CBT+PEAT) or cognitive behavioral treatment with aerobic exercise (CBT+EXER). Both groups attended twice weekly group sessions (i.e., one behavioral group session and one activity session) over 16 weeks. Height and weight were obtained at baseline and at the end of the 16-week treatment. Adolescents completed diet records at baseline and 4-weeks.

2.2.1. Intervention—Adolescents in both treatment conditions received a standardized, group-based cognitive behavioral weight loss intervention (Jelalian, Lloyd-Richardson et al., under review). The intervention was a larger trial of a previously described weight loss intervention for adolescents (Jelalian, Mehlenbeck et al., 2006). Briefly, parents and adolescents attended separate concurrent meetings. Adolescents received a prescription for a balanced, calorie-reduced diet (1400-1600 calories) and gradual increase in physical activity to a minimum of 30 minutes/day of aerobic activity 5 days per week. To achieve the 1400-1600 daily calorie goal, from the start of treatment, adolescents were encouraged to eat a balanced diet of evenly distributed meals throughout the day (i.e., breakfast, lunch, dinner & snacks). Adolescents were provided with dietary education on nutrient composition across food groups and were encouraged to increase F and V and decrease unhealthy snack foods as a means of reaching their calorie goal. Adolescents were advised that eating foods with higher nutritional value (i.e., F and V) was wiser in terms of health benefits and enhancing satiety, but were also taught that if they were to consume snack foods, lower calorie and lower fat versions were better choices than those high in calories and fat. Behavioral topics addressed in groups included self-monitoring, motivation for weight loss, goal setting, stimulus control strategies, social influences on diet and exercise, stress and eating, and relapse prevention. Parent sessions focused on similar content as well as guidance regarding family level implementation of eating and activity changes.

Treatment groups differed in the activity sessions that accompanied the standard cognitive behavioral intervention. Adolescents randomized to CBT+EXER participated in supervised weekly physical activity sessions that focused on cardiovascular fitness. Adolescents randomized to CBT+PEAT participated in weekly activity sessions based on the principles of Outward Bound and geared to facilitate group cohesion and self-efficacy. More detailed description of intervention components upon which the present study was based can be found in Jelalian, Mehlenbeck et al. (2006) and Jelalian, Lloyd-Richardson et al. (under review).

2.3. Measures

2.3.1. Demographic Variables—Basic demographic information was collected from all participants. Due to their potential association with weight loss outcomes, of particular interest in the present study are adolescent race/ethnicity, age, and gender.

2.3.2. Body Mass Index (BMI)—BMI was calculated as weight (kg)/height (m²) at baseline and at the end of the 16-week treatment. Weight was obtained on a balance beam scale and height was calculated using a stadiometer. Adolescents were dressed in their undergarments, hospital gowns and without shoes for measurements. The primary variable of interest in the present study is BMI change over the 16-week intervention.

2.3.3. Food Intake—Food intake was measured using 7-day self-reported food records, shown to be valid assessments of food intake in children (Domel et al. 1994). Adolescents were trained on recording dietary intake and provided with measuring cups and scales to weigh and measure food items. Adolescents were asked to record all consumed foods over a 7-day period, including a brief description of the food items, amount, calories, and fat (g) consumed. Food records at baseline and 4 weeks into treatment were coded for the number of F, V, SF, and

RCSF. Using procedures similar to those employed in a previous study with adolescent weight loss participants (Saelens & McGrath, 2003), food intake in each category was defined as the number of entries in the food journal for each food item, irrespective of serving size. This was done to minimize adolescents' inaccuracies in reporting portion sizes (Livingstone, Robson, & Wallace, 2004), and to maximize reliability of food intake variables. Only whole fruits and vegetables (i.e., no juices) were included in the present analyses; potatoes were not included in the count for vegetables given that potatoes are primarily eaten as french fries in adolescents' diets (Cavadini et al., 2000; Krebs-Smith et al., 1996). Snack foods were defined as foods within the following food groups containing greater than 25% calories from fat: a) bread, cereal, rice, pasta food group: baked goods such as cakes, cookies, doughnuts, muffins, pastries, pies, scones, and sweet rolls and biscuits; granola/snack bars; high-fat crackers; and flavored popcorn; b) milk, yogurt, and cheese food group: flavored dairy drinks, frozen dairy-based desserts, ice cream, ice milk, and pudding; and c) fats, oils, and sweets: candy, chips and salty snacks, chocolate, flavored iced teas, frozen desserts, gelatin desserts, punch, sherbet, and soft drinks. If a SF was reported to be consumed as a primary meal (i.e., doughnut for breakfast) it was not included in the count for SF. RCSF were defined as reduced calorie versions of the above SF. Examples of RCSF include beverages (e.g., diet soda, crystal light), and foods (e.g., baked chips, low-calorie pudding and ice cream, 100 calorie packs). Two independent reviewers coded food journals. Inter-rater reliability for food records at baseline and four weeks were determined using intraclass correlation coefficients (ICCs). ICCs for food ratings at both time points ranged from .98-.99, which is considered to be excellent reliability.

2.4. Data Analysis

Data were analyzed using the Statistical Package for the Social Sciences version 14.0 (SPSS 14.0). Preliminary analyses were run between demographic variables and the main outcome variable, change in BMI, to determine potential covariates for the primary analyses. Repeated measures analysis of variance (ANOVA) were also run to assess for changes in eating behaviors over the first 4 weeks of treatment. Given that baseline BMI was significantly associated with BMI change over the course of active treatment (data presented below), all analyses with change in BMI as the dependent variable control for baseline BMI. Furthermore, although treatment condition was not significantly associated with treatment outcome, it was also controlled for in subsequent analyses given that adolescents participated in 1 of 2 distinct activity interventions. Thus, partial correlations controlling for group treatment condition and baseline BMI were run between independent variables (i.e., self-reported initial frequency of intake of F, V, SF and RCSF as well as initial changes in frequency of intake of these foods) and the dependent variable, change in BMI. A hierarchical linear regression, with baseline BMI, gender, and group treatment condition entered in the first two steps, was run to determine the relative contribution of independent variables in predicting BMI change over the course of the 16-week treatment. Because change in food intake over the first four weeks of treatment was of primary interest, significant changes in food intake were entered into the last step of the regression analysis. A significance level of $p < .10$ was used to determine variable entry into the regression. Finally, in an attempt to better understand the association between changes in eating behaviors over the first four weeks, weight loss over the first four weeks, and subsequent weight loss, post-hoc analyses (i.e., partial correlations controlling for treatment condition) were run.

3. Results

On average, adolescents lost 4.47 (4.31) kg and grew 0.92 (1.01) cm over the course of the 16-week treatment. This corresponded to an average BMI decrease of 1.98 (1.54) kg/m² and decrease in percent overweight of 11.96 (8.07). Adolescent BMI at baseline was associated with BMI change over the 16-week treatment ($r = -.31$, $p = .009$) with adolescents with higher

initial BMI exhibiting greater BMI changes. Gender was marginally associated with BMI change, $t(70) = 1.69$, $p = .096$, with males evidencing a larger decrease in BMI than females. Participant age, treatment condition, and race/ethnicity were not associated with changes in BMI over the 16-week treatment.

3.1. Self-Reported Eating Behaviors at Baseline and Over the First Four Weeks

Table 2 shows the frequency with which adolescents reported consuming F, V, SF, and RCSF at baseline and 4-weeks into treatment. As can be seen in the table, at baseline, the frequency with which adolescents reported consuming SF was relatively high in comparison to F, V, and RCSF. By 4 weeks into treatment, adolescents were reporting more comparable frequency of intake across each category. Furthermore, adolescents reported significantly decreasing the frequency of SF consumed, $F(1,71) = 38.56$, $p < .001$, and also reported significantly increasing the frequency of RCSF consumed, $F(1,71) = 4.41$, $p = .04$, over the first 4 weeks of treatment. Changes in frequency of consumption of F and V over the first 4 weeks were not significant.

3.2. Baseline Food Intake, Early Changes in Food Intake and BMI Change

Partial correlations (controlling for baseline BMI and treatment condition) among baseline food intake, early changes in food intake and BMI change can be found in Table 3. All variables that were at least marginally ($p < .10$) associated with BMI change (i.e., gender, baseline V intake, change in F intake and change in RCSF intake) were entered into a regression equation. Hierarchical linear regression was run to determine the relative contribution of independent variables in predicting adolescent BMI reduction over time. As can be seen in Table 4, the final model accounted for 43% of the variance in BMI change over the 16-week behavioral treatment program. Significant predictors of greater reductions in BMI included male gender, greater reported frequency of vegetable consumption at baseline, greater increases in reported frequency of F consumption over the first 4 weeks of treatment, and greater increases in reported frequency of RCSF consumption over the first 4 weeks of treatment. Baseline BMI and treatment condition did not significantly predict changes in BMI.

3.3. Post-Hoc Analyses Regarding Eating Behaviors and Weight Change Over the First Four Weeks of Treatment

Partial correlations controlling for baseline BMI and treatment condition were run to determine whether baseline eating behaviors and change in eating behaviors over the first four weeks of treatment were associated with weight loss over the first 4 weeks of treatment. Only change in RCSF over the first 4 weeks was associated with weight loss over the first 4 weeks ($r = -.27$, $p = .02$); baseline eating behaviors as well as change in F, V, and SF over the first four weeks were not associated with 4-week weight losses. Weight loss over the first 4 weeks of treatment was not associated with subsequent weight loss (i.e., weeks 5-16) ($r = -.06$, NS).

4. Discussion

Findings show that early changes in eating behaviors during a weight loss trial for adolescents were associated with better weight-related outcomes. Strikingly, the combination of male gender, baseline frequency of vegetable consumption and changes in eating habits (i.e., increased F and RCSF intake) during the first 4 weeks of treatment accounted for 43% of the variance in BMI reductions over the 16-week treatment evidenced in this adolescent sample. Furthermore, study findings suggest that in addition to promoting intake of nutrient-rich foods such as F, discussing the potential utility of RCSF as an adjunct to F and V may be an effective approach for adolescents.

Findings from this study regarding RCSF may seem at odds with recommendations made for pediatric weight loss, which historically discourage RCSF as part of weight loss trials (Epstein

& Squires, 1988). However, adolescence marks a different developmental timeframe during which there is increased independence in food choices (Lindsay et al., 2006). For example, adolescents are more likely to purchase food items from corner stores, and to eat out at fast food restaurants than are children (Bowman et al., 2004). In these situations, a reduced fat snack item may represent a more reasonable alternative. Thus, although it may be quite relevant to discourage RCSF in children, the realities of adolescent life (i.e., increased opportunities to make food purchases) may suggest that in addition to encouraging intake of nutrient-dense foods, discussion of healthier alternatives to SF such as RCSF may be appropriate.

In fact, research supports the potential utility of RCSF in promoting healthy weight and increasing the overall diet quality. Based on existing evidence, the American Dietetic Association (ADA) released a position paper on fat replacers, which states that when used in moderation, use of low calorie, reduced fat foods may aid in decreasing dietary energy and fat intake (ADA, 2005). This position is backed by empirical evidence. Data from the Growing Up Today Study found some protective effects for consumption of reduced fat snack foods (e.g., lower fat/nonfat versions of common snack foods) for males in preventing weight gain (Field et al., 2004). Furthermore, analyses from the Continuing Survey of Food Intake by Individuals (CSFII) that specifically assessed intake of foods for which there are regular and modified-fat versions showed that children and adults who included lower fat foods (including snack foods) in their diet were more likely to meet dietary guidelines for fat and saturated fat, and generally displayed higher key nutrient intakes than did individuals who ate higher fat versions of these foods (Sigman-Grant, Warland, & Hsieh, 2003). Given that adolescents' diets are rich in SF and that RCSF may be beneficial for weight management it may be important to not only promote intake of F and V, but also RCSF to enhance adolescents' weight loss efforts.

In addition to RCSF, the frequency with which adolescents reported eating vegetables at baseline and increases in F over the 1st 4 weeks significantly predicted larger decreases in adolescent BMI. In the present sample, higher frequency of vegetable intake at baseline may reflect a healthier diet from the start as well as increased preference for healthier food items. This may have made it easier for adolescents to adopt the healthier eating patterns endorsed by the study and which ultimately resulted in weight loss. Findings regarding changes in F intake are interesting given that adolescents as a whole did not report significantly increasing the number of F that they ate over the first four weeks of treatment. Even though this change may not have been significant, adolescents did report increasing the frequency of F intake over this time period. It is possible that indicating on a food diary that you are eating F more frequently is a sign that you are adopting a healthier diet, which may be associated with greater BMI reductions. Nonetheless, these findings are encouraging given that reported increases in F were associated with greater BMI reduction. However, despite these positive changes evidenced for F, it is important to note that the reported frequency with which adolescents consumed F and vegetables remained quite low even at four weeks into active treatment.

Surprisingly, although frequency of intake of SF significantly decreased over the course of the 1st 4 weeks, these changes were not associated with changes in weight. This may be an artifact of response bias such that adolescents were less apt to report SF intake during treatment. However, this finding is consistent with results from the Growing Up Today Study, in which no relationship was found between SF and annual BMI z-score change over the 2-year study period in children 9-14 years old (Field et al., 2004). Regardless, given the negative association between consumption of SF and attainment of essential micronutrient needs (Frary, Johnson & Wang, 2004), approaches that promote a combination of decreasing SF and increasing fruits, vegetables, and RCSF should ultimately lead to healthier diets.

Overall, study findings are consistent with adult studies, which have shown that early treatment response is a significant predictor of weight loss outcome (Wing & Phelan, 2003; Stotland & Larocque, 2005). However, they diverge from previous work with adults as well as a recent trial with adolescents (Jelalian et al., 2008) in that weight loss over the first 4 weeks was not associated with subsequent weight loss. Findings from the present study suggest that establishment of healthier eating behaviors rather than weight loss per se is a significant predictor of changes in adolescents' weight status. This underscores the importance of enhancing efforts to engage adolescents in making changes in eating behaviors early in treatment as a means of producing better weight loss outcomes.

The present study should be considered in light of some limitations. First, the sample was relatively small ($N = 72$) and consisted of a subsample of adolescents from a larger study who completed diet records at baseline and 4 weeks into treatment. Therefore, they may not be a true representation of all study participants and may represent a select sample of adolescents who were more adherent to treatment recommendations. Second, the findings are based on self-report of food consumption and included data reported at two time points with 7-day food journals. Social desirability and thus potential inaccuracies in completing food journals (i.e., not documenting all SF consumed) may threaten the reliability and validity of findings. However, the high number of SF reported by adolescents in this study lends credibility to the present findings. Furthermore, report from only two weeks of food consumption, particularly if adolescents did not record on all 7 days, may not represent adolescents' typical eating behaviors. Future investigations may benefit from larger sample sizes, use of innovative technology to better assess food intake, and repeated measures of food intake throughout treatment to better assess the influence of changes in eating on weight loss outcome. Finally, global ratings of food intake (i.e., counts of the number of times adolescents documented eating a certain food) were used rather than more specific quantification of the amount of food consumed. This was done to enhance confidence in reliability and validity of self-reported food intake used in our prediction model. Future studies would benefit from more detailed assessment of food consumption.

Conclusions

Early changes in eating behavior predict weight loss success in a sample of adolescents who are overweight. Of particular benefit for adolescents within this sample was a pre-established habit of eating vegetables more frequently as well as increases in frequency of intake in both F and RCSF. While the promotion of F and V is a consistent message delivered as part of standard behavioral weight loss treatment, an adjunct message that may be beneficial for adolescents is to increase the number of RCSF to replace SF in achieving weight loss goals.

References

- American Dietetic Association. Position of the American Dietetic Association: Fat replacers. *Journal of the American Dietetic Association* 2005;105:266–75. [PubMed: 15668687]
- Berkowitz RI, Wadden TA, Tershakovec AM, Cronquist JL. Behavior therapy and sibutramine for the treatment of adolescent obesity: A randomized controlled trial. *Journal of the American Medical Association* 2003;298:1805–1812. [PubMed: 12684359]
- Blackburn GL, Kandors BS, Lavin PT, Keller SD, Whatley J. The effect of aspartame as part of a multidisciplinary weight-control program on short-and long-term control of body weight. *The American Journal of Clinical Nutrition* 1997;65:409–18. [PubMed: 9022524]
- Bowman SA, Gortmaker SL, Ebbeling CB, Pereira MA, Ludwig DS. Effects of fast-food consumption on energy intake and diet quality among children in a national household survey. *Pediatrics* 2004;113:112–8. [PubMed: 14702458]

- Briefel RR, Johnson CL. Secular trends in dietary intake in the United States. *Annual Review of Nutrition* 2004;24:401–431.
- Cavadini C, Siega-Riz AM, Popkin BM. US adolescent food intake trends from 1965 to 1996. *Archives of Disease in Childhood* 2000;83:18–24. [PubMed: 10868993]
- Curioni CC, Lourenço PM. Long-term weight loss after diet and exercise: A systematic review. *International Journal of Obesity* 2005;29:1168–1174. [PubMed: 15925949]
- Epstein, LH. Development of evidence-based treatments for pediatric obesity. In: Kazdin, AE.; Weisz, JR., editors. *Evidence-Based Psychotherapies for Children and Adolescents*. The Guilford Press; NY: 2003. p. 374–388.
- Epstein, LH.; Squires, S. *The stoplight diet for children*. Little, Brown, & Company; Boston: 1988.
- Field AE, Austin SB, Gillman MW, Rosner B, Rockett HR, Colditz GA. Snack food intake does not predict weight change among children and adolescents. *International Journal of Obesity* 2004;28:1210–1216. [PubMed: 15314623]
- Frary CD, Johnson RK, Wang MQ. Children and adolescents' choices of foods and beverages high in added sugars are associated with intakes of key nutrients and food groups. *Journal of Adolescent Health* 2004;34:56–63. [PubMed: 14706406]
- Jahns L, Siega-Riz AM, Popkin BM. The increasing prevalence of snacking among US children from 1977 to 1996. *The Journal of Pediatrics* 2001;138:493–498. [PubMed: 11295711]
- Jelalian E, Hart CN, Mehlenbeck RS, Lloyd-Richardson EE, Kaplan JD, Flynn-O'Brien KT, et al. Predictors of attrition and weight loss in an adolescent weight control program. *Obesity* 2008;16:1318–1323. [PubMed: 18356834]
- Jelalian E, Mehlenbeck R, Richardson E, Birmaher V, Wing RR. "Adventure therapy" combined with cognitive behavioral treatment for overweight adolescents. *International Journal of Obesity* 2006;30:31–39. [PubMed: 16158087]
- Jelalian E, Saelens BE. Empirically supported treatments in pediatric psychology: Pediatric obesity. *Journal of Pediatric Psychology* 1999;24:223–248. [PubMed: 10379137]
- Kant AK. Reported consumption of low-nutrient-density foods by American children and adolescents: Nutritional and health correlates, NHANES III, 1988 to 1994. *Archives of Pediatrics and Adolescent Medicine* 2003;157:789–796. [PubMed: 12912785]
- Krebs-Smith SM, Cook A, Subar AF, Cleveland L, Frday J, Kahle LL. Fruit and vegetable intakes of children and adolescents in the United States. *Archives of Pediatrics and Adolescent Medicine* 1996;150:81–86. [PubMed: 8542012]
- Kuczmariski, RJ.; Ogden, CL.; Grummer-Strawn, LM. *CDC growth charts: United States*. National Center for Health Statistics; Hyattsville, MD: 2000.
- Lindsay AC, Susner KM, Kim J, Gortmaker S. The role of parents in preventing childhood obesity. *The Future of Children* 2006;16:169–86. [PubMed: 16532663]
- Livingstone MBE, Robson PJ, Wallace JMW. Issues in dietary intake assessment of children and adolescents. *British Journal of Nutrition* 2004;92:S213–S222. [PubMed: 15522159]
- Nielsen SJ, Siega-Riz AM, Popkin BM. Trends in energy intake in US between 1977 and 1996: Similar shifts seen across age groups. *Obesity Research* 2002;10:370–378. [PubMed: 12006636]
- Norris SL, Zhang X, Avenell A, Gregg E, Schmid CH, Lau J. Long-term non-pharmacological weight loss interventions for adults with prediabetes. *Cochrane Database of Systematic Reviews*. 2005;(Issue 2) Art. No.: CD005270. DOI:10.1002/14651858.CD005270.
- Ogden CL, Carroll MD, Flegal KM. High body mass index for age among US children and adolescents, 2003–2006. *Journal of the American Medical Association* 2008;299:2401–2405. [PubMed: 18505949]
- Raben A, Vasilaras TH, Møller AC, Astrup A. Sucrose compared with artificial sweeteners: Different effects on ad libitum food intake and body weight after 10 wk of supplementation in overweight subjects. *The American Journal of Clinical Nutrition* 2002;76:721–729. [PubMed: 12324283]
- Saelens BE, McGrath AM. Self-monitoring adherence and adolescent weight control efficacy. *Children's Health Care* 2003;32:137–52.
- Sanchez A, Norman GJ, Sallis JF, Calfas KJ, Cella J, Patrick K. Patterns and correlates of physical activity and nutrition behaviors in adolescents. *American Journal of Preventive Medicine* 2007;32:124–130. [PubMed: 17197153]

- Sigman-Grant M, Warland R, Hsieh G. Selected lower-fat foods positively impact nutrient quality in diets of free-living Americans. *Journal of the American Dietetic Association* 2003;103:570–6. [PubMed: 12728214]
- Sondike SB, Copperman N, Jacobson MS. Effects of low-carbohydrate diet on weight loss and cardiovascular risk factor in overweight adolescents. *Journal of Pediatrics* 2003;142:225–227. [PubMed: 12640363]
- Stotland SC, Larocque M. Early treatment response as a predictor of ongoing weight loss in obesity treatment. *British Journal of Health Psychology* 2005;10:601–14. [PubMed: 16238868]
- Wang G, Dietz WH. Economic burden of obesity in youths aged 6 to 17 years: 1979-1999. *Pediatrics*. 2002 109 from <http://www.pediatrics.org/cgi/content/full/109/5/e81>.
- Wing, RR.; Phelan, S. *Obesity: Mechanisms and Clinical Management*. Lippincott, Williams, & Wilkins; Philadelphia: 2003. Behavioral treatment of obesity: Strategies to improve outcome and predictors of success. 2003

Table 1

Demographic Characteristics of the Study Sample (N = 72).

Variable	
Age in Years [Mean (SD)]	14.21 (0.88)
Gender [N (%)]	
Male	19 (26.4)
Female	53 (73.6)
Race [N (%)]	
African American	10 (13.9)
Caucasian	57 (79.2)
Other	5 (6.9)
Ethnicity [N (%)]	
Hispanic	3 (4.2)
Non-Hispanic	69 (95.8)

Table 2

Changes in Adolescent-Reported Frequency of Weekly Food Intake Over the First Four Weeks of Weight Loss Treatment (N = 72).

	Baseline	4-Weeks into Treatment	Change from Baseline to 4-Weeks
Fruits			
Mean	3.60	4.30	0.69
SD	4.10	3.78	4.63
Range	0-22.00	0-16.00	-14.0-14.0
Vegetables			
Mean	6.46	6.09	-0.36
SD	5.33	5.34	4.42
Range	0-23.00	0-27.00	-10.00-14.80
Snack Foods/Drinks (SF)			
Mean	10.89	6.45	-4.44***
SD	6.86	4.25	6.06
Range	0-30.00	0-17.50	-28.00-6.50
Reduced-Calorie Snack Food/Drinks (RCSF)			
Mean	2.70	3.50	0.81*
SD	3.92	4.15	3.27
Range	0-15.00	0-18.00	-8.67-10.00

*
p < .05

***
p < .001

Table 3

Partial Correlations Among Study Variables (N = 72).^a

	1	2	3	4	5	6	7	8	9
1. BL-4 MO BMI Change	---								
2. BL Vegetable Intake	0.40***	---							
3. BL Fruit Intake	0.10	0.26*	---						
4. BL SF Intake	-0.17	-0.11	-0.15	---					
5. BL RCSF Intake	-0.17	0.33**	-0.00	-0.11	---				
6. BL-4WK Change Vegetable Intake	0.17	-0.41***	-0.17	0.17	-.12	---			
7. BL-4WK Change Fruit Intake	-0.31**	0.13	-0.62***	0.15	0.11	0.06	---		
8. BL-4WK Change SF Intake	0.14	0.03	0.08	-0.78***	0.08	-0.09	-0.10	---	
9. BL-4WK Change RCSF	-0.21	-0.09	0.07	0.07	-0.33**	0.04	-0.03	0.01	-

^a All correlations control for baseline BMI and treatment condition

* p < .05

** p < .01

*** p < .001

Table 4
Hierarchical Linear Regression Predicting Change in BMI Over the 16-Week Behavioral Treatment (N = 72).

	B	SE B	β	R ²	ΔR^2
Step 1				0.12*	
Gender	0.95	0.34	0.27**		
Baseline BMI	-0.09	0.05	-0.19		
Step 2				0.12*	.01
Treatment Condition	0.07	0.29	0.02		
Step 3				0.29***	0.17***
Baseline Vegetables	-0.80	0.19	-0.40***		
Step 4				0.43***	0.14***
Change Fruit	-0.75	0.23	-0.32**		
Change RCSF	-0.70	0.31	-0.21*		

* p < .05
** p < .01
*** p < .001