

Impact of Mindfulness-Based Eating Awareness on Diet and Exercise Habits in Adolescents

Abstract

Background: Childhood and adolescent overweight is one of the most important current public health concerns. There is an urgent need to initiate community-based prevention to support healthy eating and physical activity in children. Mindfulness-Based Eating Awareness Training (MB-EAT) is a 12-week manualized intervention developed by Kristeller et al. that uses focused meditation techniques to help obese individuals normalize eating behaviors, and improve exercise and dietary habits.

Objective: To adapt the MB-EAT program to adolescents (MB-EAT-A) and assess the impact of the MB-EAT-A program implemented in a high school setting on self-reported assessment of eating and exercise habits and dietary intake of fat.

Methods: 40 ninth grade adolescents (14 males; 35 African-Americans, 1 Caucasian, 4 Others; mean age 16.2±1.2 yrs; BMI=32.4±9.0, BMI range 19.1 to 58.4) from 6 high school health/physical education classes were randomly assigned to 12-weekly sessions of MB-EAT-A intervention (n=18) or health education control (CTL, n=22). Assessments of eating and exercise habits and dietary fat and caloric content were conducted at pre-test, post-test at 3 mo. immediately following intervention and follow-up, 3 months after intervention ended, with 85% retention at follow up.

Results: At 6 mo. follow-up, the MB-EAT-A group increased days/week of moderate exercise >30 min/day (0.8 vs -0.7 days/week), and intense aerobic exercise >20 min/day (1.4 vs. -0.5 days/week, both $p < .05$) compared to decreases in CTLs. At 6 mo. follow-up the MB-EAT-A group increased number of servings per week of low calorie foods (7.7 vs. -0.05, $p < .02$), foods with no saturated fats (5.1 vs. -0.4, $p < .10$) and low in saturated fats (4.6 vs. -2.7, $p < .02$). At 6 mo. follow-up the MB-EAT-A group increased number of foods with no fat (3.9 vs -0.3, $p < .08$) and low in fat (5.8 vs. -1.4, $p < .02$) compared to decreases in CTLs. Weight gains at follow-up (4.2 vs 6.2 lbs, MB-EAT-A vs CTL) did not differ significantly between the two conditions ($p = .87$). In a sub-sample of 29 African American adolescents, 58% reported, a binge eating problem with most being mild to moderate in severity. Excessively eating on a regular basis and thinking about trying to control eating urges were the most common features present. Binge eating severity did not significantly correlate with anxiety, depression, or self-esteem.

Conclusion: The MB-EAT-A program increased moderate and intense aerobic exercise and improved dietary habits in favor of low calorie and low fat foods in an overweight/obese adolescent sample. The MB-EAT-A program increased moderate and intense aerobic exercise and improved consumption of low calorie and low fat foods in overweight /obese adolescents. The study demonstrated feasibility of conducting the MB-EAT-A program in a high school setting, and good acceptability by the students. The successful implementation of MB-EAT-A points to the potential of school-based mindful eating programs as a means of addressing early onset of obesity in high-risk youth.

Findings were presented to the Society of Behavioral Medicine 29 Annual Meeting and Scientific Sessions, March 26-29, 2008, San Diego, CA [1].

Keywords: Mindfulness-Based Eating Awareness; Diet; Exercise Habits; Overweight; Obese; Childhood obesity; National Health and Nutrition Examination; Body mass index; Non-Hispanic African American; School-based obesity prevention

Abbreviations: BMI: Body Mass Index; AA: African American; MBSR: Mindfulness-Based Stress Reduction program; MB-EAT-A: Mindfulness-Based Eating Awareness Training

Introduction

Childhood obesity is a major health problem in the US. In

2009-2010, the prevalence of obesity (Body mass index, BMI $\geq 95^{\text{th}}$ percentile of the BMI-for-age growth charts) in children and adolescents was estimated at 16.9% [2-4]. Estimates from the 2003-2004 National Health and Nutrition Examination Survey showed that 37% of non-Hispanic African American (AA) adolescents between the ages of 12-19 years are at-risk for

Research Article

Volume 3 Issue 2 - 2016

Vernon A Barnes^{1*} and Jean L. Kristeller²

¹Department of Pediatrics, Augusta University, USA

²Department of Psychology, Indiana State University, USA

*Corresponding author: Vernon A Barnes, Department of Pediatrics, Augusta University, 1120 15th St, Augusta, GA 30912, USA, Email: vbarnes@augusta.edu

Received: January 22, 2016 | Published: February 22, 2016

overweight (BMI for age at or above the sex-specific 85th percentile but less than the 95th percentile) or overweight (BMI for age at or above the sex-specific 95th percentile) [2,5]. This is of concern given the increases among overweight youths in conditions formerly thought of as “adult” conditions, such as type 2 diabetes, hypertension, sleep apnea, asthma, orthopedic problems, and psychological impairment [6,7].

There is general agreement among public health professionals that the major focus of prevention efforts should be on children, including adolescents [8]. Ninety-one studies on school-based obesity prevention interventions have been conducted, with the majority of studies effective in improving health behaviors in the short term [9]. Fifty-five studies have provided strong evidence to support beneficial effects of child obesity prevention programs on BMI [10].

The Mindfulness-Based Stress Reduction program (MBSR) has been utilized in medical centers, hospitals, and clinics around the world for a range of health-related issues [11-13]. Mindfulness-Based Eating Awareness Training (MB-EAT) has been informed by the MBSR program [14]. The rationale for choosing MB-EAT for our study was based on previous and ongoing research with MB-EAT by Kristeller and colleagues [15-17], who found that eating-focused meditation techniques assist obese adults with binge eating problems to normalize their eating behaviors, mood, metabolic regulation, and to increase internalization of control, independent of weight change [18]. Research using programs based on MB-EAT have found positive effects for decreasing binge episodes, improving one’s sense of self-control with regard to eating, and diminishing depressive symptoms [19].

School-based programs designed to reduce weight and improve eating behavior in high-risk adolescents and young adults are virtually non-existent [20-22]. Such cognitive-based programs providing personal experience have been particularly appealing for adolescents [23]. The MB-EAT program utilizes a 12-week manualized intervention [19]. It has also been adapted for use with several other populations, including obese adults with Type-II diabetes [24], individuals who identified restaurant

meals as particularly challenging [25] and as augmented with stress-management components [25,26].

This study adapted the MB-EAT program for adolescents (MB-EAT-A) to address weight loss and eating behavior, and to the requirements of delivering it within a school setting. We hypothesized that the MB-EAT-A program implemented in a high school would also improve exercise habits and dietary intake of fat, in addition to improving control over eating patterns, and reducing the likelihood of weight gain.

Methods

This study was conducted by the Georgia Prevention Institute and approved by the Medical College of Georgia Human Assurance Committee. Adolescent subjects provided written assent and their legal guardians provided written informed consent for study participation after study procedures were fully explained.

Participants

40 ninth grade adolescents (14 males; 35 African-Americans, 1 Caucasian, 4 Others; mean age 16.2±1.2 yrs; BMI=32.4±9.0, BMI range 19.1 to 58.4) from 6 high school health/physical education classes were randomly assigned to 12-weekly sessions of MB-EAT-A intervention (n=18) or health education control (CTL, n=22). All subjects were in enrolled in health education or physical fitness classes at school. The MB-EAT-A group engaged in 50-min sessions at school each week for 3 months (Figure 1). Primary outcome measures were changes in body weight, eating patterns, and eating and exercise behavior from pre-test to post-test at 3 mo. immediately following intervention and follow up at 6 mo. (3 mo. after intervention ended).

Demographic information and anthropometric measurements were collected at school for height (via stadiometer, to nearest 0.25 inch) and weight (via Detecto scale, to nearest 0.25 lb). BMIs [kilograms per meter squared (kg/m²)] were calculated from the subjects’ baseline heights and weights. Heights and weights were measured at each weekly intervention session as well as follow-up.

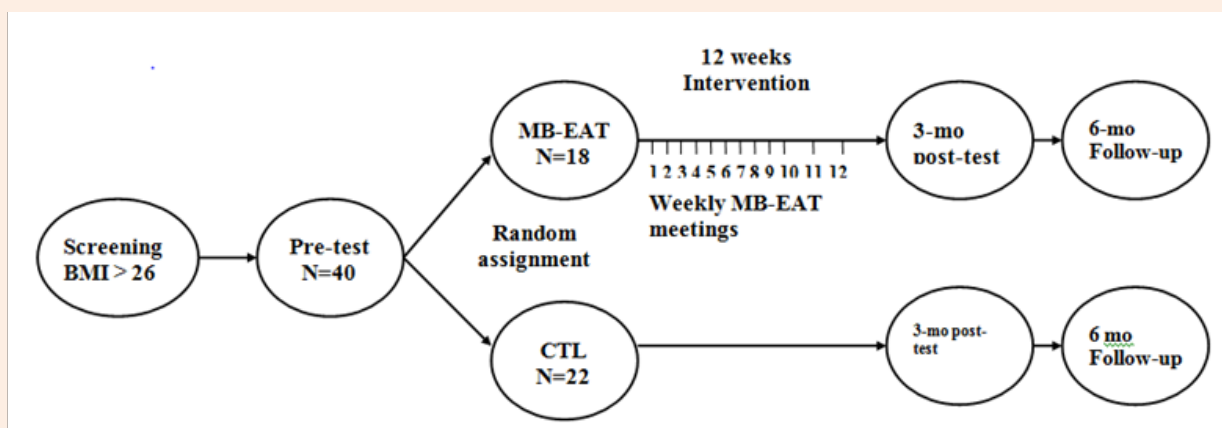


Figure 1: Study Protocol.

Description of MB-EAT-A intervention

The MB-EAT intervention has been adapted for adolescents (MB-EAT-A) to develop skills that are necessary for increasing eating awareness and eating self-regulation [1,28,29]. The MB-EAT-A workshop is a novel approach to the growing problem of stress-related consequences upon physical (e.g., elevated BMI) and emotional health in adolescents. This workshop is intended to address eating awareness identified as a factor most likely to contribute to improving eating-related behavior. For adolescents, the program is designed to foster a flexible change in eating behavior and food choices, provide coping choices such as relaxation skills, and promote a change in physical activity. Kristeller et al. [30] have developed this intervention for adults [30], a protocol-driven 12-session intervention that teaches and reinforces specific skills for managing eating awareness, reducing stress and flexibly improving dietary and exercise patterns. Promising evidence has been obtained in adults about the impact of this program on binge eating, overall eating patterns, and weight loss [18].

The following 12 sessions were adapted from the Kristeller et al. MB-EAT program [19,31]. In the original full MB-EAT program, these sessions lasted 90 minutes. Given the constraints of scheduling within school class periods, each MB-EAT-A session lasted approximately 45 minutes.

Session one contains an introduction to the MB-EAT-A program (Eating for Awareness, Meditation and Mindfulness, the Raisin Meditation). The session begins with instruction in the breathing awareness meditation (BAM) technique, a simple mindfulness technique using the breath as an object of focus. The raisin meditation is taught as the first exercise of Jon Kabat-Zinn's MBSR program [32], and the BAM technique, also borrowed from MBSR, has been used in other school-based studies [33,34]. The BAM technique involves having the individual sit upright in a comfortable position with eyes closed. The technique cultures 'moment-to-moment non-judgmental awareness' while the individual focuses completely on the activity of breathing. Subjects are instructed to focus upon the movements of their diaphragm while breathing in a slow, deep, relaxed manner. Subjects are taught that if they find their attention shifting toward unrelated thoughts, ideas, or images, to simply acknowledge and accept them without making judgments about them and to shift attention back to the breathing.

Session two reinforced the Session one material, added instruction using mini-meditations with mindful eating, a mindful eating practice with cheese and crackers, and addressed avoiding eating high fat food.

Session three is a lesson on hunger awareness, 'Inner and Outer Wisdom', culturing body acceptance, a hunger awareness meditation, a body scan and a healing self touch meditation.

Session four focuses on mindful awareness of taste and taste satiety (using chocolate), awareness of emotion and other triggers for eating, and how to use this awareness to decrease calories.

Session five continues with focus on awareness of satiety-related to, stomach fullness and making food choices. Fullness awareness

and fullness ratings are based on slowly drinking a large amount of water. The food choices practice includes a sweet (cookies) and a salty food (corn chips).

Session six focuses on mindful/non-judgmental calorie reduction and making healthy food choices in cultivating 'Outer Wisdom'. It also includes an introduction to seated yoga, and a 'mindful pot luck' meal option.

Session seven concerns weight loss, using 'outer wisdom' or using knowledge to make wise choices regarding calories and nutrition.

Session eight addresses 'mindful movement', and gives recommendations for increasing physical activity. The lesson focuses on general health/weight loss/physical fitness, including using pedometers, and provides a walking meditation.

Session nine addresses thoughts and emotions, stress, distress, and eating: 'Mindfulness and the Stress Reaction.' Exercises included: 'Eating Triggers Meditation', and 'My Favorite Food Exercise'.

Session ten concerns an understanding of emotional triggers, bringing mindfulness to emotion, conducting a 'chain analysis' of personal over-eating reactions, and an Emotion Meditation.

Session eleven is a lesson on connecting to the higher self and relapse prevention, understanding of 'self' and using it to maintain goals, mindfully choosing and eating snacks, using the KEEP IT OFF, a self-rated assessment of small, manageable changes in eating, and a Wisdom Meditation.

Session twelve is the final meeting. It discusses progress, 'KEEP IT OFFs' and goal setting, and continued meditation practice. It includes a final mindfulness meditation practice and a celebratory mindful snack.

Measures

Subjects completed the following questionnaires at pre-test at 3 months immediately following intervention, and at 3 months after the intervention ended (the 6 month follow-up): (1) Binge Eating Scale (BES; 16 items): measures behavioral manifestations of binge or compulsive overeating, and feelings and cognitions associated with these patterns [35]. (2) Three Factor Eating Questionnaire (TFEQ; 51 items): measures three factors related to cognitions and behaviors associated with eating. These factors include cognitive dietary restraint (conscious control of food intake with concerns about shape and weight), disinhibition (over-consumption of food in response to a variety of stimuli, such as emotional stress, associated with a loss of control on food intake), and susceptibility to hunger (food intake in response to feelings and perceptions of hunger) [36]; and the (3) Basic Assessment System for Children (BASC; 104 items): measures anxiety, attitude to school, depression, attitude to teachers, sensation seeking, social stress, interpersonal relations, relations with parents, and self-esteem. Diet and exercise behavior were measured by a short dietary recall that assesses fat and dietary fiber [37], and the 'Youth Risk Behavior Surveillance', a lifestyle behavior survey that assesses physical activity [38].

All questionnaires were completed in the classroom and data

were entered at the GPI.

Data analysis

Descriptive statistics were used to examine demographic information and anthropometric measurements, as well as questionnaire scores, of the entire sample. Binge eating severity was determined based on the following classification scheme of individual BES total scores: ≤ 7 , none; 8 to 17, mild; 18 to 26, moderate; and, ≥ 27 , severe. Spearman's rho (ρ) coefficients were computed to identify significant associations between binge eating severity, and anthropometric measurements (BMI and BMI z-score) and BASC subscales. Pearson's correlation (r) coefficients were computed to identify significant associations between TFEQ factors and anthropometric measurements. Student's t-tests and chi-square analyses were used to compare demographic information and anthropometric measurements between males and females. We conducted an exploratory *post-hoc* analysis to evaluate binge eating features and related psychopathology from a subset of the sample with a BMI for age at or above the sex-specific 85th percentile. BMI z-scores and percentiles were determined using the *NutStat* module of *Epi Info* (Division of Public Health Surveillance and Informatics, 2003), which uses the 2000 Centers for Disease Control and Prevention Growth Charts for the U.S. as a reference. Mixed model repeated measures ANOVA for body weight and BMI was analyzed with a 2 (group) by 2 (sex) by 3 (time: visits 1, 2, 3) and the questionnaire data was analyzed using a 2 (group) by 2 (sex) by 2 (time: visit 1 and 3) model.

Results

There were no statistically significant differences between the intervention and control condition for baseline characteristics, except for, differences on the Binge Eating Scale approaching significance (Table 1, CL>MB-EAT-A, $p < .06$). The mean \pm SD age was 16.2 ± 1.2 years, and 69% ($n = 20$) were female. The mean (\pm SD) BMI, BMI z-score, and BMI percentile of the entire sample were 35.2 ± 8.4 kg/m², 2.1 ± 0.6 , and 96.8 ± 3.7 , respectively.

Nutritional intake

At six months, the MB-EAT-A group generally showed improvement in dietary/nutritional intake, increasing intake of healthier foods compared to decreases in the control group. These improvements were significant for overall intake of 7.7 more servings per week of lower calorie foods ($p < .02$), and 4.6 more servings of foods with low saturated fat ($p < .02$), and approached significance for servings per week of foods with no saturated fat ($p < .10$).

At 6-mo follow-up, the MB-EAT-A group increased 7.7 servings per week of low calorie foods compared to a slight decrease in CTLs. ($p < .02$, Figure 2). At 6-mo follow-up, the MB-EAT-A group increased 5.1 servings per week of foods with no saturated fat compared to a decrease in CTLs. ($p < .10$). At 6-mo follow-up, the MB-EAT-A group increased 4.6 servings per week of foods with low saturated fat compared to a decrease in CTLs. Change from baseline was $+4.6$ vs. -2.7 at 6-mo ($p < .02$, Figure 3). At 6-mo follow-up, the MB-EAT-A group increased 5.8 servings per week of foods low in fat compared to a decrease in CTLs. Change from baseline was $+5.8$ vs. -1.4 at 6-mo ($p < .02$, Figure 4).

Exercise

At 6-mo follow-up, the MB-EAT-A group increased days/week of aerobic exercise that makes one sweat or breathe hard (e.g., basketball, soccer, running swimming laps, fast bicycling, fast dancing >20 min/day), relative to the control group. Change from baseline was 1.4 vs. -0.5 days/week, at 6-mo ($p < .05$, Figure 5). At 6-mo follow-up, the MB-EAT-A group increased days/week of moderate aerobic exercise >30 min/day that does not make one sweat or breathe hard. Change from baseline was 0.8 vs. -0.7 days/week, ($p < .05$, Figure 6).

Weight changes

At 4 weeks the MB-EAT-A group decreased 0.23 ± 2.0 lbs compared to a slight increase of 0.1 ± 3.1 lbs in the CTL group ($p = ns$). At 1-month follow-up, the MB-EAT-A group gained a mean of 0.74 lbs compared to 0.77 lbs in the CTLs ($p = ns$). Results at 3 months posttest indicate the MB-EAT-A group slightly decreased in weight 0.3 lbs compared to an increase of 0.4 lbs in the CTL group although BMI stayed the same for both groups ($p = ns$, see Table 2). Weight gains (4.2 vs. 6.2 lbs, MB-EAT-A vs. CTL) did not differ between the two conditions at 6 mo. follow-up ($p = .87$).

Eating behavior

Measures of eating behavior were collected from a total of 29 African American (AA) adolescents who were at-risk for overweight, overweight or obese. Data from the TFEQ were incomplete for 1 female adolescent.

Table 3 provides a distribution of responses to the BES, characterizing patterns of overeating, weight and dieting concerns in the sample. While the BES, is not diagnostic of binge eating disorder, it indicates level of concern. For example, on item #8, 72% acknowledge regularly overeating, 38% overeat only once/month, but the rest overeat more frequently. For those who are dieting (item #7), 45% admit to then compulsively overeating once they eat a 'forbidden' food, and only 24% feel they don't spend too much time thinking about controlling their eating (item #14).

The mean (\pm SD) BES total score was 13.0 ± 9.8 . Fifty-eight percent ($n = 17$) were classified as having a binge eating problems. Of these, 31% ($n = 9$) had mild overeating problems, 17% ($n = 5$) had a moderate problem, and 10% ($n = 3$) had a severe problem. Level of severity (none, mild, moderate, or severe) did not correlate with BMI ($\rho = 0.3$, $p = 0.2$) or BMI z-score ($\rho = 0.2$, $p = 0.2$).

Mean (\pm SD) scores of cognitive dietary restraint, disinhibition, and susceptibility to hunger were 8.4 ± 3.2 , 6.2 ± 3.0 , and 5.5 ± 3.3 , respectively. At baseline, BMI negatively correlated with susceptibility to hunger ($r = -0.4$, $p = 0.03$), approached significance with cognitive dietary restraint ($r = 0.4$, $p = 0.07$), but not with disinhibition ($r = 0.08$, $p = 0.7$). BMI z-score negatively correlated with susceptibility to hunger ($r = -0.5$, $p = 0.01$), but did not significantly correlate with either cognitive dietary restraint ($r = 0.3$, $p = 0.2$) or disinhibition ($r = 0.05$, $p = 0.8$). The BES scale positively correlated with disinhibition ($\rho = 0.4$, $p = 0.03$), but did not correlate with cognitive dietary restraint ($\rho = 0.08$, $p = 0.7$) or susceptibility to hunger ($\rho = 0.2$, $p = 0.3$).

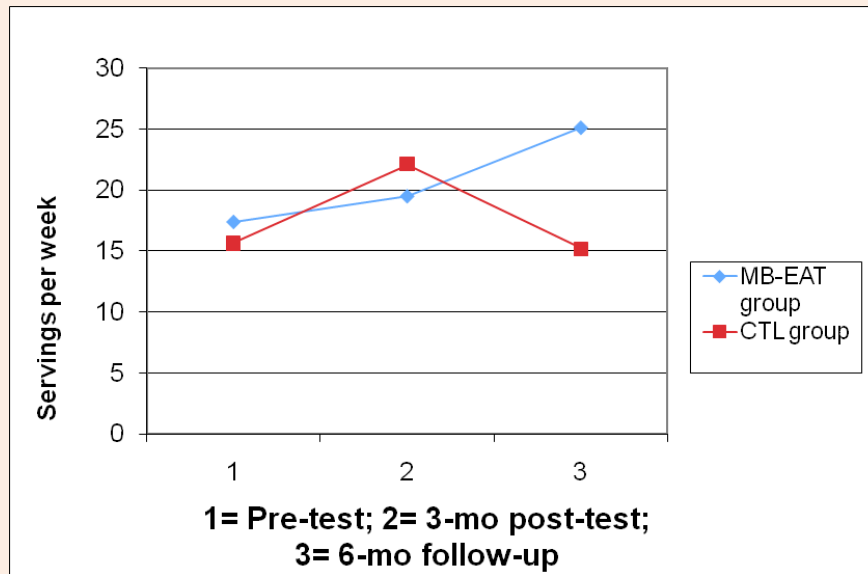


Figure 2: Average Servings per Week of Low-Calorie Foods.

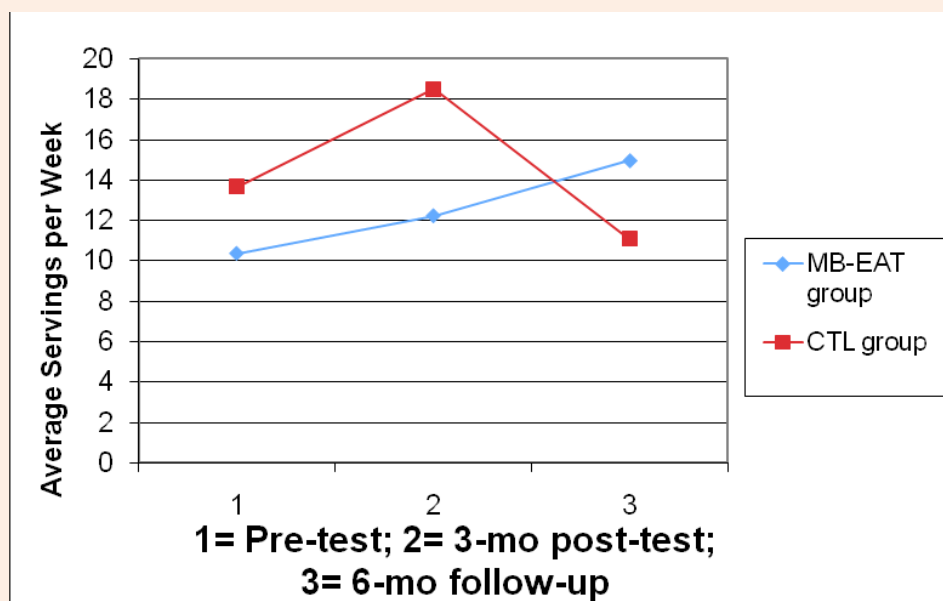


Figure 3: Average Servings per Week of Foods with Low Saturated Fat.

The BES negatively correlated with attitude towards school ($\rho = -0.4$, $p = 0.04$), but not with other BASC subscales, including anxiety ($\rho = 0.2$, $p = 0.4$), depression ($\rho = -0.008$, $p = 1.0$), interpersonal relations ($\rho = 0.2$, $p = 0.2$), and self-esteem ($\rho = -0.2$, $p = 0.4$).

Sex differences in eating behavior

Although males and females showed comparable BMIs (male: 36.8 ± 9.7 kg/m², female: 34.4 ± 8.0 kg/m²; $t = 0.7$, $df = 27$, $p = 0.5$), BMI z-scores were significantly higher in males (2.4 ± 0.6)

compared with females (1.9 ± 0.5 ; $t = 2.1$, $df = 27$, $p = 0.05$). BES total scores were similar between groups (male: 13.4 ± 10.9 , female: 12.8 ± 9.6 ; $t = 0.2$, $df = 27$, $p = 0.9$), as was the distribution of having any binge eating problem, defined as a BES total score ≥ 8 (male: 56%, female: 60%; $\chi^2 = 0.05$, $df = 1$, $p = 0.8$). In males, binge eating severity negatively correlated with self-esteem ($\rho = -0.7$, $p = 0.02$), and positively correlated with interpersonal relations ($\rho = 0.7$, $p = 0.04$). In females, binge eating severity negatively correlated with sensation seeking ($\rho = -0.6$, $p = 0.01$).

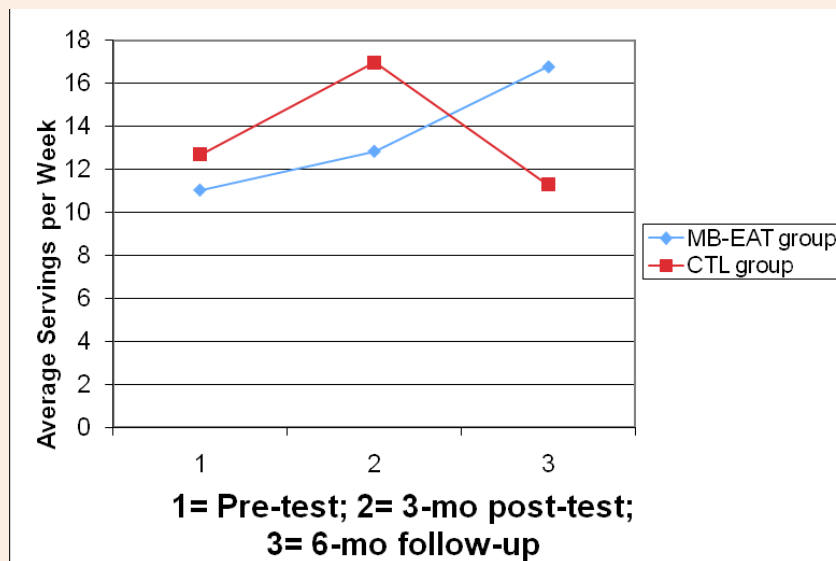


Figure 4: Average Servings per Week of Foods Low in Fat.

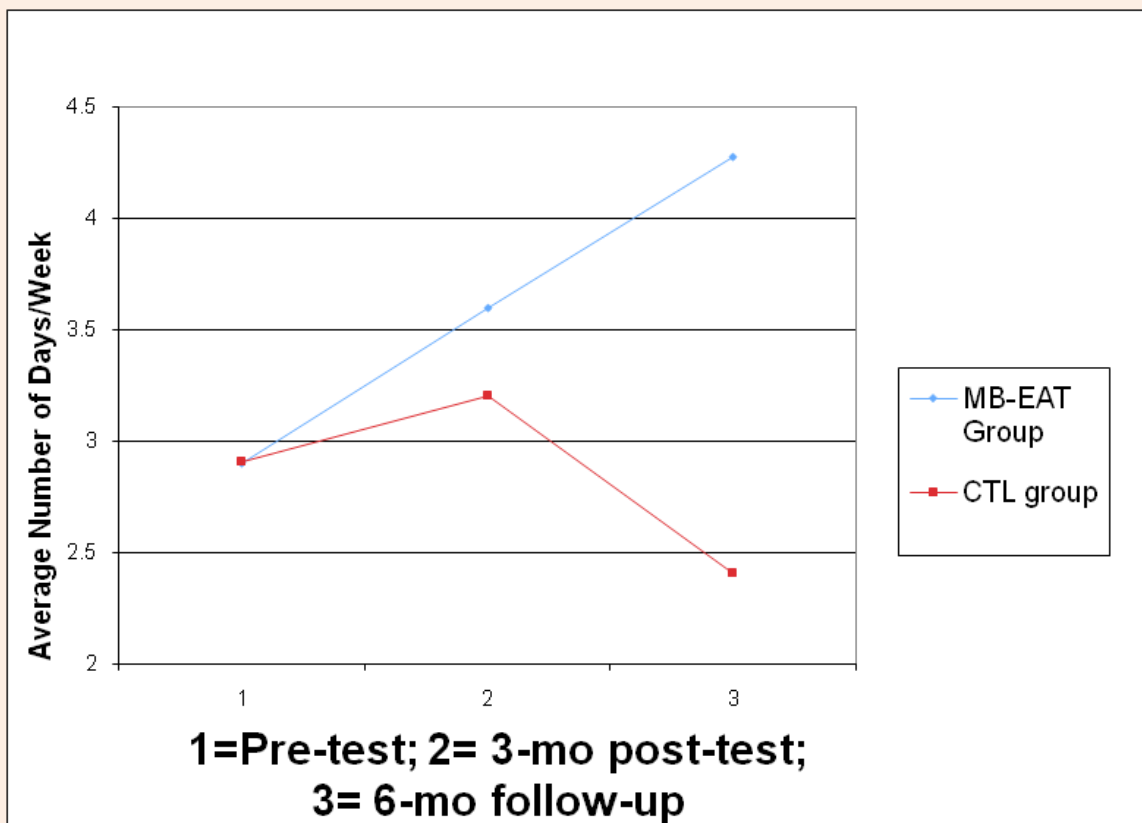


Figure 5: Average Number of Days/Week of Intense Exercise.

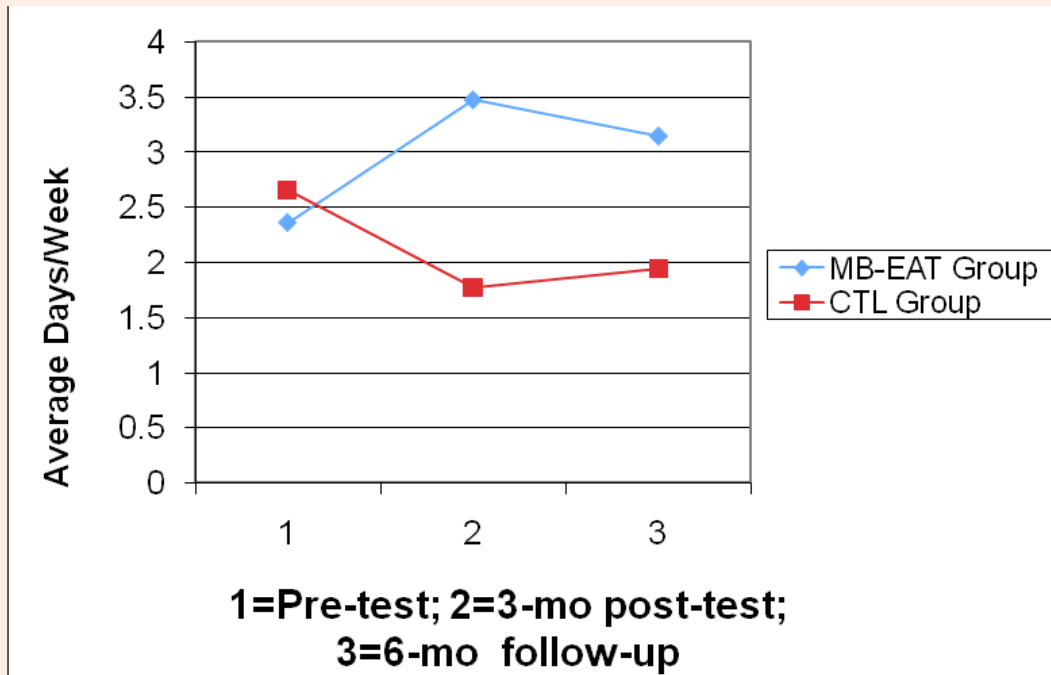


Figure 6: Average Days/Week of Moderate Aerobic Exercise.

Table 1: Descriptive characteristics at pretest.

	MB-EAT-A (n=18; 7M)	CTL (N=22; 7M)	P value
Age (yrs)	16.6±1.0	15.9±1.3	.07
Weight (lb)	210.3±67.7	193.7±59.5	.41
Height (in)*	66.5±3.6	65.0±2.9	.15
BMI	32.9±8.8	32.0±9.4	.74
Anger expression	8.5±8.6	10.6±8.9	.45
Perceived stress	8.3±3.1	8.0±1.4	.65
Binge Eating Scale	9.9±7.2	15.2±2	.06
Cognitive Restraint§	9.2±3.7	6.6±3.0	.02
Disinhibition	5.3±2.4	6.8±3.1	.10
Perceived hunger	5.6±3.0	5.8±3.6	.84

Values are means±SD *M>F, p=.0003 § Increase with age, p<.05.

Table 2: Unadjusted pretest and posttest means.

	MB-EAT-A (n=18; 7M)		CTL (N=22; 7M)	
	Pretest	Posttest	Pretest	Posttest
Weight (lbs)	210.3±67.7	210.2±69.0	193.7±59.5	197.3±59.3
BMI	32.9±8.8	33.0±8.9	32.0±9.4	32.3±9.8
Anger Expression¶	8.5±8.6	11.5±8.5	10.6±8.9	10.6±10.9
Perceived Stress	8.3±3.1	7.7±2.7	8.0±1.4	7.7±2.4
Binge Eating Scale§	9.9±7.2	10.9±7.3	15.2±10.2	10.6±10.9
Cognitive Restraint	9.2±3.7	9.1±4.6	6.6±3.0	6.3±3.0
Disinhibition	5.3±2.4	5.2±2.5	6.8±3.1	5.0±2.5
Perceived Hunger¶	5.6±3.0	3.4±1.8	5.8±3.6	4.8±3.2

Values are means±SD. ¶ ps = .10; § p<.01

Least squared means repeated measures ANOVA group x time values adjusted for age and sample size

Table 3: Distribution of responses to the Binge Eating Scale.

(N=29)	Ratings†‡			
	0	1	2	3
Q1. Feeling self-conscious about appearance/weight	66%	24%	-	10%
Q2. Rapidly eating and feeling uncomfortable afterwards	59%	14%	21%	7%
Q3. Feeling helpless about controlling eating	69%	10%	-	21%
Q4. Having a habit of eating when bored	90%	-	10%	-
Q5. Eating when not physically hungry	38%	41%	10%	10%
Q6. Feeling guilty after overeating	41%	38%	-	21%
Q7. Having loss of control over dieting	55%	-	28%	17%
Q8. Excessively eating on a regular basis	28%	38%	28%	7%
Q9. Having fluctuations in caloric intake	45%	24%	24%	7%
Q10. Having loss of control over urges to eat	59%	28%	7%	7%
Q11. Having a problem stopping eating when full	41%	41%	14%	3%
Q12. Feeling ashamed about overeating when others present	52%	31%	14%	3%
Q13. Eating between meals	72%	-	24%	3%
Q14. Thinking about trying to control eating urges	24%	38%	31%	7%
Q15. Thinking about food	41%	35%	10%	14%
Q16. Knowing when physically hungry and the appropriate amount of food to eat	41%	38%	21%	-

† Binge eating severity: [32]

0 = no problem; 1 = mild; 2 = moderate; 3 = severe

‡ Ratings (i.e., scoring weights) collapsed into 3 or fewer groups on Q1, Q3, Q4, Q7, and Q13.

Only 3 ratings available for Q6 and Q16

Focus group findings

This study involved identification of adaptations in content, format, style of presentation and timing necessary to successfully conduct the MB-EAT-A workshop in a high school setting. This was facilitated by conducting focus groups at follow up in order to obtain feedback from the students regarding workshop content, style of presentation and materials, to help with fine-tuning of the program. Two focus groups were conducted with a subset of the sample (n=15, mean age 16.6±1.0; BMI=32.9±8.8) to assess the MB-EAT-A workshop. Responses highlighted either satisfaction in the program or positive effects on their well-being. Overall benefits cited by the focus groups included weight maintenance, relaxation, improved eating habits and anger control. Suggested

improvements to the program related to improving food and facilities, increasing class size, separate schedule or period for this program and adding an exercise component. Issues disliked included lengthy surveys and missing gym class.

Discussion

The MB-EAT-A program in overweight/obese adolescents improved dietary habits in favor of low calorie and low fat foods, improved consumption of low calorie and low fat foods and increased moderate and intense aerobic exercise. Importantly, a trend was observed whereby the MB-EAT-A group exhibited in a greater decrease in perceived hunger compared to CTLs. The pilot study demonstrated feasibility of conducting the MB-

EAT-A program in a high school setting. To our knowledge this is the first study of applying mindfulness approaches via MB-EAT-A to examine impact upon diet, exercise and eating behavior in adolescents with a wide range of body weights including overweight/obese and those at-risk for development of obesity.

No effects were found, however, on the Binge Eating Scale for the MB-EAT-A group, a measure not only of overeating but also preoccupation with weight and concerns about dieting. One reason for this was the relatively low scores on the BES in the MB-EAT-A group relative to the CTL group. However, it is useful to consider the patterns of overeating that were observed overall. Our findings suggest that a significant percentage of at-risk for overweight, overweight or obese AA adolescents exhibit binge eating features, namely excessively eating on a regular basis and thinking about trying to control eating urges, particularly when they perceive they have violated dietary intentions. Furthermore, there does not seem to be a sex difference with regard to the presence of binge eating in this sample of AA adolescents. Fifty-eight percent of AA adolescents in this study reported binge eating features, with the majority (48%) being mild to moderate in severity. Previous findings have reported prevalence of binge eating among obese youths up to 37% which are lower than our prevalence [39]. Given the considerable morbidity and mortality associated with obesity it was critical to also identify AA youths with sub-clinical features of binge eating [7].

Binge eating features most frequently reported in our sample of AA adolescents are consistent with those reported in other ethnic groups [40]. More than 70% reported some degree of excessive eating, which is likely to lead to weight gain, especially in the absence of compensatory behavior [41,42]. Similarly, 76% reported having thoughts about trying to control eating urges. Because over eating involves a sense of loss of control [43], preoccupation with thoughts on how to manage these eating urges and/or weight changes is likely to occur [44]. Furthermore, feeling helpless about being able to control eating, which was rated as a severe problem in more than 20% of the sample, may reflect maladaptive coping mechanisms. Interventions, such as cognitive behavioral therapy or interpersonal therapy, have been shown to be useful in increasing sense of control and developing appropriate coping skills [45].

Binge eating has been consistently shown to be associated with substantial psychopathology, including depression, anxiety, and low self-esteem [46-48]. In our sample of AA adolescents, binge eating severity did not significantly correlate with such psychopathology, perhaps because absolute prevalence of clinical levels was low. Methodological differences, including sample characteristics and assessment tools, may account for this discrepancy. Alternatively, the degree of psychopathology among overweight adolescents may be independent of binge eating status, as observed in the study by Decaluwe et al. [37]. In this study, greater severity of binge eating was associated with a poorer attitude towards school. One plausible explanation of this particular finding is that adolescents with more severe binge eating and higher BMIs experience a greater degree of weight-based teasing by their peers at schools, which is reflected in their

overall attitude towards school [49,50].

Studies evaluating sex differences in the presence of binge eating features have largely been inconsistent. Some have reported higher rates of binge eating among males [51,52], while some have reported higher rates of binge eating among females [53,54]. Specifically among obese adolescents, males and females may exhibit comparable rates of binge eating [37,55]. This may be applicable across ethnic groups, as the presence of binge eating features was indeed similar across AA adolescent males and females in this study. Binge eating has been shown to be strongly associated with status of overweight among adolescents [47,48,55], and higher rates of binge eating have been observed in AA adolescents compared to white adolescents [52]. A better understanding of the presentation of binge eating in this subset of adolescents may offer the opportunity for ethno-specific early detection and appropriate treatment, thereby improving future health status, psychosocial functioning, and quality of life.

The small sample size from one suburban high school in Southeastern U.S limits the generalizability of our findings and limits statistical power for the analyses. It is unclear whether similar findings would be observed in AA adolescents from another geographic region. With regard to limitations in the methodology, problems of validity and reliability, in assessment of eating and exercise habits, associated with inaccurate assessment, recall bias, and social desirability bias, are well-known [56].

At-risk for overweight, overweight or obese AA adolescents exhibit a variety of features associated with over eating and body awareness concerns. Like other ethnic groups, excessively eating on a regular basis and thinking about trying to control eating urges are among the most common features present in adolescents reporting a binge eating problem. Associated psychopathology may be independent of binge eating status in these adolescents. Multi-site studies of large samples of ethnically diverse adolescents are needed to determine if ethnicity influences the characterization of binge eating features.

These findings demonstrate the potential beneficial impact of the MB-EAT-A upon diet and exercise habits in youth. The successful implementation of the intervention points to the potential of school-based mindfulness-based programs as one means of addressing early onset of obesity in high-risk youth, particularly AAs. Designing interventions and programs to address eating behavior and impact obesity in a high school setting involves giving careful consideration to the nature, timing, intensity and duration of such programs, as well as the cognitive, social, cultural and behavioral factors of the participants. Our approach introduced focused eating awareness training in a school health education setting. The MB-EAT-A program can be further developed to be standardized and protocol-driven; and focused on managing appetite (hunger/satiety/triggers) to promote calorie reduction and energy output increase and thereby foster weight loss.

We have determined that such a school-based obesity treatment and prevention program is feasible. The next step will be to establish effectiveness necessary for its eventual wide

scale implementation. Although some school-based prevention programs have been shown to be highly cost-effective [57], resources to fund school-based prevention programs are limited. Programs that promote intrinsic motivation and peer support may hold particular promise [58,59]. However, the optimal way to motivate adolescents for making diet, exercise, and other behavioral changes for improving weight and health is still unknown [60]. With increased concerns regarding obesity rates among adolescents and a rapid rise in Type II diabetes, policy makers may consider expanding school-based prevention programs, as part of a comprehensive prevention initiative in order to help reduce obesity in our society.

Acknowledgment

We thank Dr. C. Larke, superintendent, and the principal, Mr. Jessie Chambers, teachers and staff at Glenn Hills High School in Augusta, GA for their assistance and cooperation in providing the facilities for this study. Dr. Christian Lemmon, Dr. Nick Patel and Maribeth Johnson assisted with data analysis. Research assistants who helped with data collection and/or management were Amanda Stevens and Dr. V. Pradeep Shenbagarajan. The healing self-touch exercise was developed by Sasha Loring, MS, MEd at Duke Integrative Medicine. This study was supported by Medical College of Georgia Grant PSRP00006.

References

- Barnes VA, Kristeller J, Shenbagarajan VP (2008) Impact of Mindfulness-Based Eating Awareness Therapy on adolescents diet and exercise habits. *Ann Behav Med* 35: s46.
- Ogden CL, Carroll MD, Kit BK, Flegal KM (2012) Prevalence of obesity and trends in body mass index among US children and adolescents, 1999-2011. *JAMA* 307(5): 483-490.
- Dehghan M, Akhtar-Danesh N, Merchant AT (2005) Childhood obesity, prevalence and prevention. *Nutr J* 4: 24.
- Flegal KM (2005) Epidemiologic aspects of overweight and obesity in the United States. *Physiol Behav* 86(5): 599-602.
- Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, et al. (2006) Prevalence of overweight and obesity in the United States, 1999-2004. *JAMA* 295(13): 1549-1555.
- Franks PW, Hanson RL, Knowler WC, Sievers ML, Bennett PH, et al. (2010) Childhood obesity, other cardiovascular risk factors, and premature death. *N Engl J Med* 362(6): 485-493.
- Must A, Strauss RS (1999) Risks and consequences of childhood and adolescent obesity. *Int J Obes Relat Metab Disord* 23(Suppl 2): S2-S11.
- White House Task Force (2010) Solving the Problem of Childhood Obesity Within a Generation: White House Task Force Report on Childhood Obesity Report to the President. Washington, DC, USA.
- Whittemore R, Chao A, Popick R, Grey M (2013) School-based internet obesity prevention programs for adolescents: a systematic literature review. *Yale J Biol Med* 86(1): 49-62.
- Waters E, de Silva-Sanigorski A, Hall BJ, Brown T, Campbell KJ, et al. (2011) Interventions for preventing obesity in children. *Cochrane Database Syst Rev* CD001871.
- Bishop SR (2002) What do we really know about mindfulness-based stress reduction? *Psychosom Med* 64(1): 71-83.
- Smith JE, Richardson J, Hoffman C, Pilkington K (2005) Mindfulness-Based Stress Reduction as supportive therapy in cancer care: systematic review. *J Adv Nurs* 52(3): 315-327.
- Grossman P, Niemann L, Schmidt S, Walach H (2004) Mindfulness-based stress reduction and health benefits. A meta-analysis. *J Psychosom Res* 57(1): 35-43.
- Kristeller JL, Baer RA, Quillian-Wolever RE (2006) Mindfulness-based approaches to eating disorders. In: Baer RA (eds.), *Mindfulness-based Treatment Approaches*. Elsevier, San Diego, California.
- Kristeller JL, Wolever RQ (2006) MB-EAT-A (Mindfulness -Based Eating Awareness Therapy): Theory, research and practice. *Ann Behav Med* 31: S002.
- Best JL, Quillian-Wolever RE, Sheets VL (2006) Mindfulness-based intervention for BED enhances post-prandial glucose metabolism independent of weight change. *Ann Behav Med* 31: S143.
- Kristeller JL, Quillian-Wolever RE (2003) Mindfulness meditation and obesity: Re-regulating food intake. *Ann Behav Med* 25: S033.
- Kristeller JL, Hallett BC (1999) Effects of a meditation-based intervention in the treatment of binge eating. *Journal of Health Psychology* 4: 357-363.
- Kristeller JL, Wolever RQ (2011) Mindfulness-based eating awareness training for treating binge eating disorder: the conceptual foundation. *Eat Disord* 19(1): 49-61.
- Baranowski T, Cullen KW, Nicklas T, Thompson D, Baranowski J (2002) School-based obesity prevention: A blueprint for taming the epidemic. *Am J Health Behav* 26(6): 486-493.
- Resnicow K (1993) School-based obesity prevention: Population versus high-risk interventions. *Ann N Y Acad Sci* 699: 154-166.
- Resnicow K, Robinson TN (1997) School-based cardiovascular disease prevention studies: review and synthesis. *Annals of Epidemiology* 7(7): S14-S31.
- Dryfoos JG (1993) Preventing substance use: rethinking strategies. *Am J Public Health* 83(6): 793-795.
- Miller CK, Kristeller JL, Headings A, Nagaraja H (2014) Comparison of a Mindful Eating Intervention to a Diabetes Self-Management Intervention among Adults with Type 2 Diabetes: A Randomized Controlled Trial. *Health Educ Behav* 41(2): 145-154.
- Timmerman GM, Brown A (2012) The effect of a mindful restaurant eating intervention on weight management in women. *J Nutr Educ Behav* 44(1): 22-28.
- Daubenmier J, Kristeller J, Hecht FM, Nicole Maninger, Margaret Kuwata, et al. (2011) Mindfulness intervention for stress eating to reduce cortisol and abdominal fat among overweight and obese women: An exploratory randomized controlled study. *Journal of Obesity* 2011(2011): 1-13.
- Daubenmier JJ, Weidner G, Sumner MD, Mendell N, Merritt-Worden T, et al. (2007) The contribution of changes in diet, exercise, and stress management to changes in coronary risk in women and men in the multisite cardiac lifestyle intervention program. *Ann Behav Med* 33(1): 57-68.
- Barnes VA, Patel NC, Lemmon CR (2008) Binge eating in a suburban sample of overweight African American adolescents. Paper presented at: Society of Behavioral Medicine, San Diego, California.
- Barnes VA, Shenbagarajan VP, Kristeller J (2007) Effect of mindfulness-based eating awareness therapy on body weight and eating behavior in African American adolescents. Paper presented at:

- Society of Behavioral Medicine 2007 Annual Meeting, Washington, USA.
30. Kristeller JL, Hallett CB (1999) An exploratory study of a meditation-based intervention for binge eating disorder. *J Health Psychol* 4(3): 357-363.
 31. Kristeller JL, Wolever RQ, Sheets V (2013) Mindfulness-Based Eating Awareness Training (MB-EAT) for Binge Eating: A Randomized Clinical Trial. *Mindfulness* 5(3): 282-297.
 32. Kabat-Zinn J, (1990) Full Catastrophe Living: Using the Wisdom of your Body and Mind to Face Stress, Pain and Illness. The Program of the Stress Reduction Clinic at the University of Massachusetts Medical Center, New York, Delta.
 33. Barnes VA, Davis HC, Murzynowski JB, Treiber FA (2004) Impact of meditation on resting and ambulatory blood pressure and heart rate in youth. *Psychosom Med* 66(6): 909-914.
 34. Barnes VA, Pendergrast RA, Harshfield GA, Treiber FA (2008) Impact of meditation on ambulatory blood pressure and sodium handling in prehypertensive African American adolescents. *Ethn Dis* 18(1): 1-5.
 35. Gormally J, Black S, Daston S, David R (1982) The assessment of binge eating severity among obese persons. *Addictive Behaviors* 7(1): 47-55.
 36. Stunkard AJ, Messick S (1985) The three-factor eating questionnaire to measure dietary restraint, disinhibition and hunger. *J Psychosom Res* 29(1): 71-83.
 37. Kristal AR, Shattuck A, Henry HJ, Fowler AS (1990) Rapid assessment of dietary intake of fat, fiber, and saturated fat: Validity of an instrument suitable for community intervention research and nutritional surveillance. *American Journal of Health Promotion* 4(4): 288-295.
 38. Kristal AR, Shattuck A, Henry HJ, Fowler AS (1990) Rapid assessment of dietary intake of fat, fiber, and saturated fat: Validity of an instrument suitable for community intervention research and nutritional surveillance. *American Journal of Health Promotion* 4(4): 288-295.
 39. Kann L, Kinchen SA, Williams BI, Ross JG, Lowry R, et al. (1998) Youth risk behavior surveillance-United States, 1997. Morbidity and mortality weekly report. Surveillance summaries: MMWR/Centers for Disease Control 47(3): 1-89.
 40. Decaluwe V, Braet C, Fairburn CG (2003) Binge eating in obese children and adolescents. *Int J Eat Disord* 33(1): 78-84.
 41. Marcus MD, Kalarchian MA (2003) Binge eating in children and adolescents. *Int J Eat Disord* 34(Suppl): S47-57.
 42. Stice E, Cameron RP, Killen JD, Hayward C, Taylor CB (1999) Naturalistic weight-reduction efforts prospectively predict growth in relative weight and onset of obesity among female adolescents. *J Consult Clin Psychol* 67(6): 967-974.
 43. Stice E, Presnell K, Spangler D (2002) Risk factors for binge eating onset in adolescent girls: a 2-year prospective investigation. *Health Psychol* 21: 131-138.
 44. Tanofsky-Kraff M, Yanovski SZ, Wilfley DE, Marmarosh C, Morgan CM (2004) Eating-disordered behaviors, body fat, and psychopathology in overweight and normal-weight children. *J Consult Clin Psychol* 72(1): 53-61.
 45. Neumark-Sztainer D, Story M, Hannan PJ, Perry CL, Irving LM (2002) Weight-related concerns and behaviors among overweight and nonoverweight adolescents: implications for preventing weight-related disorders. *Arch Pediatr Adolesc Med* 156(2): 171-178.
 46. Brownley KA, Berkman ND, Sedway JA, Lohr KN, Bulik CM (2007) Binge eating disorder treatment: a systematic review of randomized controlled trials. *Int J Eat Disord* 40(4): 337-348.
 47. Doyle AC, le Grange D, Goldschmidt A, Wilfley DE (2007) Psychosocial and physical impairment in overweight adolescents at high risk for eating disorders. *Obesity (Silver Spring)* 15(1): 145-154.
 48. Glasofer DR, Tanofsky-Kraff M, Eddy KT, Yanovski SZ, Theim KR, et al. (2007) Binge eating in overweight treatment-seeking adolescents. *J Pediatr Psychol* 32(1): 95-105.
 49. Gruzca RA, Przybeck TR, Cloninger CR (2007) Prevalence and correlates of binge eating disorder in a community sample. *Compr Psychiatry* 48(2): 124-131.
 50. Eddy KT, Tanofsky M, Brenner TH, Herzog DB, Brown TA, et al. (2007) Eating disorder pathology among overweight treatment-seeking youth: clinical correlates and cross-sectional risk modeling. *Behav Res Ther* 45(10): 2360-2371.
 51. Haines J, Neumark-Sztainer D, Eisenberg ME, Hannan PJ (2006) Weight teasing and disordered eating behaviors in adolescents: longitudinal findings from Project EAT (Eating Among Teens). *Pediatrics* 117(2): e209-215.
 52. Childress AC, Brewerton TD, Hodges EL, Jarrell MP (1993) The Kids' Eating Disorders Survey (KEDS): a study of middle school students. *J Am Acad Child Adolesc Psychiatry* 32(4): 843-850.
 53. Johnson WG, Rohan KJ, Kirk A (2002) Prevalence and correlates of binge eating in white and African American adolescents. *Eat Behav* 3(2): 179-189.
 54. Croll J, Neumark-Sztainer D, Story M, Ireland M (2002) Prevalence and risk and protective factors related to disordered eating behaviors among adolescents: relationship to gender and ethnicity. *J Adolesc Health* 31(2): 166-175.
 55. Field AE, Camargo CA, Taylor CB, Berkey CS, Frazier AL, et al. (1999) Overweight, weight concerns, and bulimic behaviors among girls and boys. *J Am Acad Child Adolesc Psychiatry* 38(6): 754-760.
 56. Mindell JS, Coombs N, Stamatakis E. (2014) Measuring physical activity in children and adolescents for dietary surveys: practicalities, problems and pitfalls. *Proc Nutr Soc.* 73(2): 218-225.
 57. Dahlberg LL, Potter LB (2001) Youth violence. Developmental pathways and prevention challenges. *Am J Prev Med* 20(1 Suppl): 3-14.
 58. Jensen CD, Duraccio KM, Hunsaker S.L, Rancourt D, Kuhl, ES, et al. (2014). A qualitative study of successful adolescent and young adult weight losers: Implications for weight control intervention. *Childhood Obesity.* 10(6): 482-490.
 59. Kulik NL, Fisher EB, Ward DS, Ennett ST, Bowling JM, et al. (2014) Peer support enhanced social support in adolescent females during weight loss. *Am J Health Behav.* 38(5): 789-800.
 60. Owens S, Galloway R. (2014) Childhood obesity and the metabolic syndrome. *Curr Atheroscler Rep.* 16(9): 436.