Effects of a Cognitive-Behavioral Therapy-Based Immersion Obesity Treatment Program for Adolescents on Weight, Fitness, and Cardiovascular Risk Factors: A Pilot Study

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Abstract

Background: Comprehensive, residential treatment for severe obesity in adolescents may be an alternative to bariatric surgery and more efficacious than outpatient treatment. The aim of this study was to evaluate the effects of a long-term cognitive-behavioral therapy-based immersion obesity treatment program for adolescents.

Methods: Twelve obese adolescents with BMIs above the 95th percentile completed a 14- to 18-week multicomponent intervention.

Results: We observed significant improvements in BMI z-score, waist circumference, mile run time, and blood lipids.

Conclusion: This study suggests that the tested program may be effective, at least in the short term; a randomized, controlled trial to further assess this model is warranted.

Introduction

Although prevalence of obesity among children and adolescents in the United States has leveled off in recent years, obesity at or above the 97th percentile has continued to rise.^{1,2} Bariatric surgery may be effective,^{3,4} but is not without risk. Outpatient interventions are safe, but generally produce only modest reductions in BMI.^{5,6} An alternative treatment approach is intensive, multidisciplinary treatment in a residential facility, sometimes called “immersion treatment.”⁷ Although this approach shows promise, there are few studies describing the impact of such programs. The aim of this pilot study was to assess the effects of a cognitive-behavioral therapy (CBT)-based immersion treatment program for obese adolescents on BMI, physical fitness, blood pressure, and serum lipid concentrations.

Methods

We used a pre/post design to evaluate the effects of this program. Participants were all adolescents who enrolled in the program in either the spring or fall of 2011. A BMI of at least the 89th percentile for age and gender was required for enrollment. The intervention took place at Mindstream Academy in South Carolina⁸ and was approximately 14 or 18 weeks in duration for the fall and spring semesters, respectively. Key intervention components included programs in behavioral counseling, food and nutrition, exercise, and academics. All meals and snacks were provided as a combination of plated meals with “free” salad bar, at a calorie level determined by baseline weight (1400, 1600, or 1800 kcal/day). All snacks were provided separately from meals. The breakdown of the meals and snacks were

Table 1. Expected Daily Caloric Deficit Induced by These Calorie Targets

Variable	Deficiency
Boys 11–13 years and 150–200 lbs	400–1200 kcal/day
Boys 14–18 years and 150–200 lbs	800–1800 kcal/day
Boys 11–13 years and 200–250 lbs	200–1000 kcal/day
Boys 14–18 years and 200–250 lbs	600–1600 kcal/day
Boys 11–13 years and 250 lbs plus	0–800 kcal/day
Boys 14–18 years and 250 lbs plus	400–1400 kcal/day
Girls 11–13 years and 150–200 lbs	400–800 kcal/day
Girls 14–18 years and 150–200 lbs	400–1000 kcal/day
Girls 11–13 years and 200–250 lbs	200–600 kcal/day
Girls 14–18 years and 200–250 lbs	200–800 kcal/day
Girls 11–13 years and 250 lbs plus	0–400 kcal/day
Girls 14–18 years and 250 lbs plus	0–600 kcal/day

as follows: breakfast, morning snack, lunch with salad bar, afternoon snack, dinner with salad bar, and evening snack.

The weight ranges and corresponding daily caloric targets were as follows: 150–200 lbs received 1400 kcal/day, 200–250 lbs received 1600 kcal/day, and 250 lbs plus received 1800 kcal/day. Maintenance was determined by individual students' healthy body weight for gender and age. The expected daily caloric deficit induced by these

calorie targets are provided in Table 1. The macronutrient content of the diet was 45–55% of kcal from carbohydrates, 20–25% from protein, and 15–20% from fat. Nutrition, gardening, and culinary courses were provided at a combined minimum of 3 hours per week.

The physical training (two classes of 1 hour each for 5 days and one class of 1 hour/day) protocol included a combination of long-term cardiovascular exercise (*i.e.*, keeping heart rates up for an extended period of time, *i.e.*, hour-long class) and high-intensity interval training. Students participate in multiple phases (1–4) of high-volume interval training. During phases 1 and 2 of the program, students exercised with target heart rate (HR) range of 50–60% and 60–75% maximum heart rate, respectively, for 90 minutes three times per week. During phases 3 and 4, athletes exercised at the target HR values of 70–85% and 80–95% for 90 minutes three times per week, with a single additional session for 60 minutes each week. Using an HR monitor with chest strap, each athlete's workload was constantly assessed in association with HR.

Components of the behavioral counseling program included CBT,⁹ equine-assisted psychotherapy, and neurobiofeedback techniques. Finally, an accredited online academic home school curriculum was provided, along with one-on-one tutoring and support from classroom teachers, to ensure that students could stay on their current schooling timeline.

Outcome measures included BMI z-scores (weight was measured using a Healthometer professional model 349klx digital scale), waist circumference, blood pressure (measured using a manual sphygmomanometer), fasting blood

Table 2. Baseline Characteristics and Results

Variable	Baseline (Mean±SD)	Δ (Mean±SD)	p value
Age	15.2±1.3	—	—
Weight (kg)	104.4±15.1	−20.1±7.7	<0.01
BMI-for-age z-score	2.3±0.3	−0.5±0.3	<0.01
BMI-for-age percentile	98.7±1.2	−3.3±3.0	<0.01
Percent overweight	87.3±26.0	−35.4±9.8	<0.01
Waist circumference (cm)	40.8±3.2	−7.4±2.2	<0.01
Total cholesterol (mg/dL)	144.3±21.2	−8.6±14.6	0.07
Triglycerides (mg/dL)	87.2±50.9	−17.6±47.4	0.23
HDL (mg/dL)	45.7±11.3	6.6±5.5	<0.01
LDL (mg/dL)	81.8±17.8	−7.9±10.9	0.03
Non-HDL (mg/dL)	98.7±20.6	−15.2±15.1	<0.01
Systolic blood pressure (mmHg)	117.0±9.4	−2.2±12.0	0.56
Diastolic blood pressure (mmHg)	69.3±7.1	1.3±5.8	0.48
Mile time (minutes)	21.3±6.0	−7.6±3.3	<0.01

HDL, high-density lipoprotein; LDL, low-density lipoprotein; SD, standard deviation.

lipid concentrations (total cholesterol, low-density lipoprotein [LDL], high-density lipoprotein [HDL], non-HDL, and triglycerides), and mile time. All anthropometric measures were taken before breakfast, at the same locations on the body (where relevant), by the same person, with the participant wearing the same clothes. BMI *z*-scores and percentiles were determined using 2000 CDC growth charts for gender and age.¹⁰ The time to run or walk 1 mile was measured in minutes and seconds using the same 1-mile route.

Paired *t*-tests were used to assess change from baseline values of all outcome measures among participants. Statistical significance was set at two-tailed $\alpha < 0.05$. Data were analyzed using SAS software for WINDOWS (version 9.3; SAS Institute Inc., Cary, NC).

Results

All students enrolled in the immersion program during the study period were included in the study—a total of 12 participants (11 female, 1 male). The average age of participants was 15.2 years (range, 13–17). Of the 12 participants, 7 were non-Hispanic white. The remaining 5 were Hispanic, non-Hispanic black, Native American, mixed race, and “other.” Five participants had BMIs that fell between the 95th and 99th percentiles for age and gender, and 7 had BMIs that were above the 99th percentile. All characteristics of the study sample are presented in Table 2. Results are expressed as means $\pm$ standard deviation (SD) in text and tables. Mean weight loss was 20.1 kg (SD = 7.7; $p < 0.01$). There were significant improvements from baseline in BMI *z*-score (-0.5 ± 0.3 ; $p < 0.01$), percent overweight (-35.4 ± 9.8 ; $p < 0.01$), and waist circumference (-7.4 ± 2.2 ; $p < 0.01$). Mile time was significantly reduced ($p < 0.01$). Concentrations of LDL and non-HDL cholesterol decreased ($p = 0.03$ and $p < 0.01$, respectively), whereas HDL increased significantly ($p < 0.01$). Although there were decreases in total cholesterol, triglycerides, systolic blood pressure, and diastolic blood pressure, they did not reach significance ($p > 0.05$).

Discussion

In the present study, our data suggest that short-term CBT-based immersion treatment for obese adolescents may be effective in reducing BMI *z*-score and percent overweight, increase physical fitness, and improve serum lipid concentrations. Percent overweight decreased by a mean of 35.4 in our study. This finding compares favorably to those reported in Kelly and Kirschenbaum’s 2011 review of immersion treatment programs for obesity in children and adolescents.⁷ Mean change in percent overweight for all 22 interventions included was -23.9 , but varied from -3.0 to -58.0 . Intervention duration also varied considerably, from 10 days to 10 months.

Strengths of this study include an intervention that is sufficiently intensive to induce changes in outcome

measures, a relatively long intervention duration, and incorporation of CBT. Both long duration and CBT have been associated with greater success in immersion programs.⁷ We also evaluated changes in blood pressure and lipid profile, measures that have not typically been reported on by previous studies. Limitations of this study include uncontrolled study design, small sample size, and nonrandom selection of the study sample. The study sample is not representative of the larger population of obese adolescents. All but 1 of the participants were female, and all self-selected into the study by enrolling in the program. Therefore, participants may have been more motivated than nonparticipants and may have come from households that could afford to pay for the cost of the treatment. We also were not able to formally assess participants’ weight status after leaving the residential program.

The results of this study provide preliminary evidence that a CBT-based immersion treatment program for obesity in adolescents may be effective, while allowing for uninterrupted academic progress. Future research should include assessment of the durability of weight loss and health improvements, objective measures of effects in family members, and a direct comparison to alternative approaches, including bariatric surgery, in the context of a controlled trial.

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Author Disclosure Statement

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