Effects of a School-based Weight Maintenance Program for Mexican-American Children: Results at 2 Years

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The prevalence of childhood overweight has increased significantly, with the highest rates noted among Mexican Americans. Many negative health outcomes are associated with overweight; thus, there is a need for effective weight-loss interventions tailored to this group. This study evaluated 24-month outcomes of a randomized, controlled trial involving an intensive lifestyle-based weight maintenance program targeting overweight Mexican-American children at a charter school in Houston, Texas. A total of 60 children (33 males, 55%) between the ages of 10 and 14 at or >85th percentile for BMI were recruited. Participants were randomized to an instructor-led intervention (ILI) or a self-help (SH) program, both aimed at modifying eating and physical activity behaviors using behavior modification strategies. Changes in participants' standardized BMI (*z*BMI) were assessed at baseline, 1, and 2 years. Tricep skinfold, total cholesterol, triglycerides, high-density lipoprotein cholesterol, and calculated low-density lipoprotein were assessed at baseline and 1 year. ILI participants showed significantly greater decreases in *z*BMI at 1 and 2 years ($F = 26.8$, $P < 0.001$, $F = 4.1$, $P < 0.05$, respectively) compared to SH controls. ILI participants showed greater improvements in body composition, as measured by tricep skinfold ($F = 9.75$, $P < 0.01$). Children in the ILI condition experienced benefits with respect to total cholesterol ($F = 7.19$, $P < 0.05$) and triglycerides ($F = 4.35$, $P < 0.05$) compared to children in the SH condition. Overall, the school-based intervention resulted in improved weight and clinical outcomes in overweight Mexican-American children, and *z*BMI was maintained over 2 years.

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INTRODUCTION

The prevalence of overweight is higher among Mexican-American children than any other ethnic group (1). These children are at an especially high risk of being overweight or obese as adults (2) and of experiencing health consequences such as insulin-resistance, type 2 diabetes, sleep apnea, gallbladder disease, hypertension, and hyperlipidemia (3–5). Unfortunately, ethnic minority children also are less likely to receive health services (6–8). This disparity points to the need for establishing effective programs available through pre-existing resources in the community to improve the weight status of children who may not otherwise present for treatment.

Interventions demonstrating long-term maintenance of weight loss (e.g., 9–11) are limited, and have typically been obtained in lab-based or clinical settings (9). There is evidence of modest short-term success with behaviorally based therapies combining nutrition education and physical activity components (12–14). However, the rising rate of obesity in children indicates a strong need for translational research that assesses these programs in communities.

Utilizing existing community resources is one way to begin implementing these types of programs. For example, schools provide ready access to children in the community and have numerous advantages for promoting healthy lifestyle modifications, including regular parent and child contact and availability of health-promoting resources such as health education and physical activity classes (15). Despite these assets, there is limited evidence for the effectiveness of weight management programs that take place in the school setting (15–17).

The aim of this study was to investigate whether previously reported 6-month weight and cardiovascular improvements after participation in a weight management program were maintained long-term. Our results at 6 months showed that the children in the treatment condition significantly reduced their *z*BMI compared to those in the control condition (18).

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It was hypothesized that participants in the instructor-led intervention (ILI) would continue to show greater health improvements than those in self-help (SH) at 1- and 2-year follow-up measurements.

METHODS AND PROCEDURES

Participants

A total of 181 children were recruited from a charter school in Houston, Texas that serves an urban student population that is 95% Mexican Americans. Children of any weight classification (e.g., normal, overweight) were eligible to participate and were not differentiated during the intervention. Current study analyses include only overweight and obese participants. The sample included 60 overweight and obese students randomized after baseline measurements, with 40 in treatment and 20 in control. **Figure 1** provides a detailed schematic of the study design and participant flow.

Children were between the ages of 10 and 14 ($M = 12.3$, s.d. = 0.7) and in the 6th or 7th grade. All children self-identified as Mexican American. All participants included in analyses were overweight or obese (i.e., BMI >85th or >95th percentile for age and gender, respectively) according to Centers for Disease Control and Prevention guidelines (19). The ILI condition consisted of 11 overweight and 10 obese boys and 10 overweight and 9 obese girls. The SH condition consisted of 6 overweight and 6 obese boys and 2 overweight and 6 obese girls. Baseline characteristics are presented in **Table 1**. The recruitment, randomization procedures, and sample characteristics have previously been described elsewhere (18). This study was approved by the institutional review board for Human Subjects at Baylor College of Medicine.

Procedure

To insure sufficient power to detect changes in weight parameters, students were recruited in two waves/school years (2004–2005 and 2005–2006). Individuals in each wave or cohort of participants were randomized to either the SH or ILI. No incentives were provided for participation in the study; however, children whose parents consented for them to give blood received $25 at the 6-month data collection and $50 at the 12-month data collection. Because the 2-year measurement was not included in the original design of the study, only height and weight measurements were taken, and participants were not asked to provide additional clinical or body composition measures.

Both the SH and ILI conditions focused on increasing healthy eating and physical activity using behavioral strategies to individualize the plans for the specific needs of the participants. Children in the SH condition used a 12-week parent-guided manual intended to promote child weight loss and long-term maintenance of changes (20). Those randomized to the ILI condition participated in an instructor/trainer-led intervention for 24 weeks of daily (Monday through Friday) sessions. As children were not differentiated by weight class, both the SH and ILI groups included children who were normal weight, overweight, and obese.

The ILI classes were held during the last period of the school day while self-help and nonparticipating children attended study hall in separate rooms to reduce the likelihood of contamination. All children at the school received a snack during this period, though the study staff provided ILI children with peanuts/peanut butter and a fruit or vegetable to enhance satiety and to provide an opportunity for fruit/vegetable consumption. Researchers did not control for the caloric content or nutritional value of the snack provided by the school to the SH students. Allowing the school to provide their own snacks allowed for a comparison of our intervention to a more naturalistic example. None of the students reported having a peanut allergy; thus, none of the students were excluded for this reason.

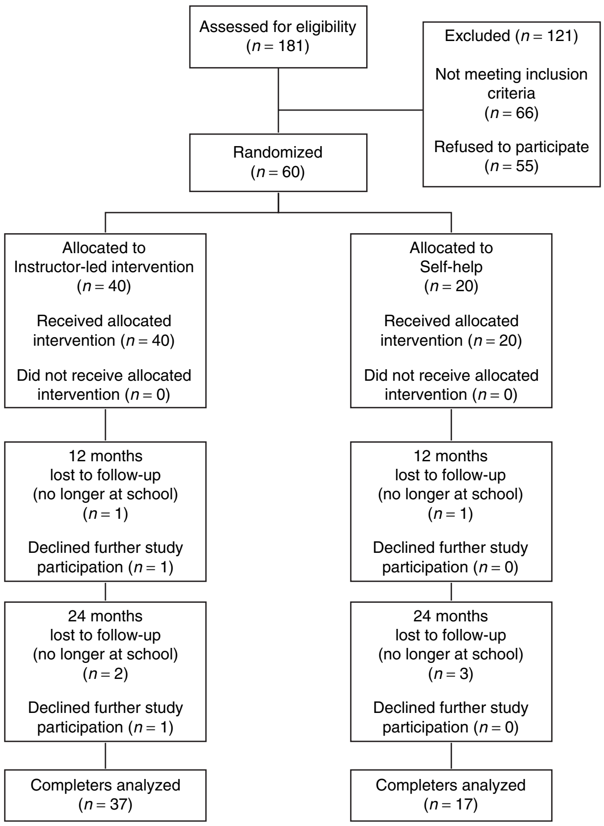

Figure 1 CONSORT diagram.

Table 1 Baseline characteristics of participants by treatment assignment (means ± s.d. or %)

Variable	Instructor-led intervention (*n* = 40)	Self-help (*n* = 20)	*P* value
Age (years)	12.3 ± 0.7	12.5 ± 0.6	0.24
Gender (% female)	47.5	40.0	0.78
Numbers in home	4.5 ± 1.0	4.9 ± 1.4	0.20
BMI (kg/m^2)	25.2 ± 4.4	26.7 ± 5.5	0.27
*z*BMI	1.5 ± 0.6	1.7 ± 0.6	0.33
Height (cm)	152.7 ± 6.6	152.2 ± 8.0	0.77
Weight (kg)	59.0 ± 11.7	62.5 ± 16.3	0.35
Tricep skinfold (mm)	29.1 ± 10.9	27.5 ± 6.2	0.58
Average systolic BP (mm Hg)	111.2 ± 11.8	112.9 ± 18.0	0.67
Average diastolic BP (mm Hg)	69.1 ± 8.9	67.4 ± 11.2	0.51
Total cholesterol (mg/dl)[a]	162.63 ± 26.39	173.13 ± 37.59	0.26
LDL cholesterol (mg/dl)[a]	96.89 ± 25.40	108.79 ± 33.48	0.17
HDL cholesterol (mg/dl)[a]	45.10 ± 9.26	42.78 ± 8.40	0.40
Triglycerides (mg/dl)[a]	103.16 ± 60.94	107.75 ± 56.07	0.80

Because these measurements were not required to participate in the study, the *n* size differs for blood biomarkers.
BP, blood pressure; HDL, high-density lipoprotein; LDL, low-density lipoprotein.
[a]Instructor-led intervention: $N = 32$, self-help: $N = 15$.

The researchers also worked to educate the school on how to provide an environment to support healthy eating and physical activity habits that would benefit all students, not just those in the ILI. For example, the researchers educated the school about healthy snack options and ways to improve school lunch. Physical activity field days were offered to all students. The environmental changes made by the school were not specifically measured. See Johnston *et al.* (18) for the specific content of the interventions.

Measures

Primary outcome measure. Participants' heights and weights were collected at baseline, 1, and 2 years. Weights were obtained using a digital scale with participants wearing light clothing and no footwear. Height was measured using a stadiometer with participants wearing no footwear. BMI was calculated using measured height and weight and was standardized (*z*BMI) using age and gender normative data from the Centers for Disease Control and Prevention (19).

Tricep skinfold. Tricep skinfold thickness was used as a proxy for percent body fat at baseline and 1-year follow-up. All personnel were trained by a senior staff member and were required to match measurements taken by the senior trainer before being allowed to perform the assessment. Two measurements were taken on the right arm with calipers and rounded to the nearest 1 mm. However, a third measurement was taken if there was >2 mm difference between the initial measures. The average of measures taken was used for analyses. Though tricep skinfold thickness is best used in combination with other body composition measures, it provides an adequate approximation of excess body fat in children when used with measures such as standardized BMI (21).

Clinical measures. At baseline and 1-year follow-up, venous blood samples were collected in the morning (0700–0800 hours) following an overnight (>8 h) fast by a trained research nurse or phlebotomist. EDTA-treated whole-blood samples were analyzed for total cholesterol, triglycerides, high-density lipoprotein cholesterol, and calculated low-density lipoprotein cholesterol using an automated analyzer (Hitachi, Tokyo, Japan). Cholesterol analysis was completed in a clinical laboratory at Baylor College of Medicine.

Blood pressure. Blood pressure (BP) was determined using a Dynamap Monitor Pro 100 after participants relaxed for at least 5 min. All BPs were taken in the afternoon. BP was measured and values were interpreted using the methods described by the National High Blood Pressure Education Program Working Group on Hypertension Control in Children and Adolescents (22).

Heart rate measurements. Heart rate was monitored and recorded continuously during each physical activity session via heart rate telemetry (Polar, New York, NY). The physical activity intervention was designed such that participants exercised for 30–35 min per session at an intensity equivalent to 60–85% of age-predicted maximal heart rate. During the course of the intervention, participants accumulated 1,440–1,680 min of exercise at a level which is similar to the minimum recommendation for daily exercise in adults (23).

Statistical analyses

Statistical analyses were performed using SPSS (version 13.0.1; SPSS, Chicago, IL). *T*-tests and χ^2 were conducted to evaluate group differences on baseline characteristics (see **Table 1**) and differences between participants who remained in the study and those who dropped out before the end of the 12-month assessment. A two-group (ILI vs. SH) repeated measures ANOVA was used to evaluate group differences in *z*BMI for baseline, 1- and 2-year outcomes. Repeated measures ANOVA also was used to evaluate group differences for all secondary outcomes at baseline and 1 year for completers only. As recommended by the Consolidated Standards of Reporting guidelines for randomized trials, models were developed for both completers and intention-to-treat using the last observation carried forward method (24). For follow-up analyses, Pearson χ^2-tests were performed to evaluate differences between participants who achieved reduction or maintenance in *z*BMI vs. those who experienced increases.

RESULTS

No differences were found between conditions with respect to baseline demographic or anthropometric variables. In addition, there were no significant differences between completers and noncompleters on baseline demographic variables. Of the 60 participants, 54 (90%) completed baseline, 1-, and 2-year measurements. A subsample of these children (n = 47) consented to provide a blood sample at baseline and 1 year.

Primary outcome

Repeated measures analyses revealed that children in ILI significantly reduced their *z*BMI when compared to children in SH (F = 11.96, P < 0.001, η_p^2 = 0.32) with significant differences in *z*BMI change at 1 and 2 years (F = 26.8, P < 0.001, η_p^2 = 0.32; F = 4.1, P < 0.05, η_p^2 = 0.07, respectively). These results are represented in **Figure 2**. Similar results were observed for BMI (F = 12.62, P < 0.001, η_p^2 = 0.33), weight (F = 9.82, P < 0.001, η_p^2 = 0.28), and percent overweight (F = 9.85, P < 0.001, η_p^2 = 0.33). Using an intention-to-treat model produced similar results for *z*BMI (overall: F = 14.39, P < 0.001, η_p^2 = 0.33; 1 year: F = 29.27, P < 0.001, η_p^2 = 0.33; 2 year: F = 5.42, P < 0.05, η_p^2 = 0.08). See **Table 2** for a listing of results.

Data were analyzed by overweight and obese categories to determine the effectiveness of the intervention for these groups. Additionally, analyses were conducted to assess gender differences. Results indicated that there were no differences in weight change for weight classification (P = 0.13) or gender (P = 0.06).

Evaluation of clinical significance

Based on the statistically significant findings above, we conducted further analyses to evaluate weight changes among

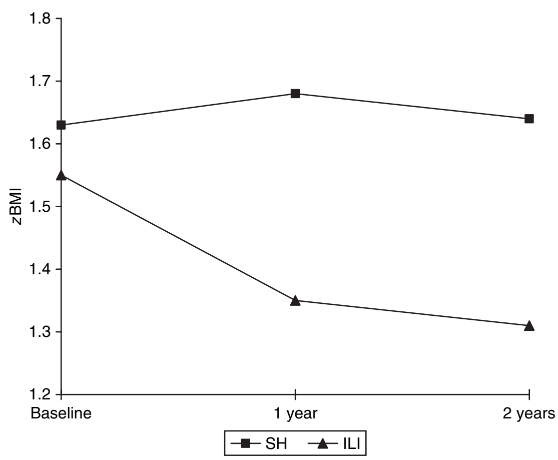

Figure 2 Standardized BMI (*z*BMI) at baseline, 1, and 2 years for completers only. SH, self-help condition; ILI, instructor-led intervention condition.

Table 2 Change in height, weight, zBMI, BMI, percent overweight, BMI percentile, and tricep skinfold by treatment condition for completers and ITT (means ± s.d.)

	Instructor-led intervention		Self-help	
	Completers	ITT	Completers	ITT
Change scores from baseline to 1 year				
Height (cm)	5.2 (±2.5)	5.1 (±2.4)	4.5 (±2.3)	4.3 (±2.3)
Weight (kg)	3.6 (±3.0)***	3.6 (±3.1)***	7.4 (±3.3)	7.4 (±3.2)
*z*BMI	−0.2 (±0.2)***	−0.2 (±0.2)***	0.1 (±0.1)	0.1 (±0.1)
BMI (kg/m²)	−0.2 (±1.1)***	−0.1 (±1.2)***	1.6 (±1.2)	1.6 (±1.1)
% overweight	−5.7 (±6.1)***	−5.5 (±6.2)***	3.4 (±6.0)	3.6 (±6.0)
BMI %ile	−5.8 (±8.1)*	−5.5 (±8.0)*	−0.7 (±2.9)	−0.6 (±2.9)
Tricep skinfold[a]	−7.1 (±6.5)**	−5.6 (±7.1)**	0.0 (±8.13)	0.8 (±7.7)
Change scores from baseline to 2 years				
Height (cm)	9.3 (±5.1)	9.0 (±5.0)	9.4 (±4.9)	8.4 (±5.2)
Weight (kg)	9.5 (±10.3)	9.2 (±10.1)	13.1 (±4.7)	12.1 (±4.9)
*z*BMI	−0.2 (±0.5)*	−0.2 (±0.5)*	0.0 (±0.1)	0.0 (±0.1)
BMI (kg/m²)	0.8 (±3.5)	0.8 (±3.4)	2.2 (±1.4)	2.1 (±1.3)
% overweight	−6.0 (±18.6)	−5.8 (±17.9)	0.7 (±7.2)	1.5 (±7.1)
BMI %ile	−6.7 (±10.9)*	−6.8 (±10.9)*	−1.1 (±3.5)	−0.8 (±3.3)

Significance values indicate differences between instructor-led intervention and self-help. Completers: instructor-led intervention = 37, self-help = 17. ITT: instructor-led intervention = 40, self-help = 20.
ITT, intention-to-treat.
[a]Tricep skinfold was measured only at baseline and 1 year.
$^{*}P < 0.05$. $^{**}P < 0.01$. $^{***}P < 0.001$.

these children. Significantly more children in the ILI condition achieved reduction or maintenance of *z*BMI at 1 year ($\chi^2(1, 54) = 12.70$, $P < 0.01$). As shown in **Figure 3**, >79% of children receiving ILI had *z*BMI reductions at 1 year, and 62% at 2 years. In contrast, the majority of SH children (64% at 1 year and 65% at 2 years) increased their *z*BMI.

Secondary outcomes

All secondary outcomes were measured only at baseline and 1 year. We conducted further analyses to evaluate the impact of weight changes on cardiovascular and metabolic parameters among these children. Children in the ILI significantly reduced their total cholesterol ($F = 7.19$, $P < 0.05$), triglycerides ($F = 4.35$, $P < 0.05$), and tricep skinfold ($F = 9.75$, $P < 0.01$) compared to children in the SH condition at 1 year. Changes in other parameters were not significantly different between groups, including BP (systolic: $F = 2.44$, $P = 0.12$; diastolic: $F = 2.14$, $P = 0.15$), low-density lipoprotein cholesterol ($F = 2.52$, $P = 0.12$), and high-density lipoprotein cholesterol ($F = 0.78$, $P = 0.38$). See **Table 3** for a listing of results. The results of the changes in blood markers should be interpreted with caution as the study was not adequately powered to detect changes in them.

DISCUSSION

Our school-based weight management program resulted in significant improvements in *z*BMI in Mexican-American children at 1 and 2 years compared to those in the SH control condition. A total of 90% of the participants completed the 2-year assessment. A total of 79% of children who participated

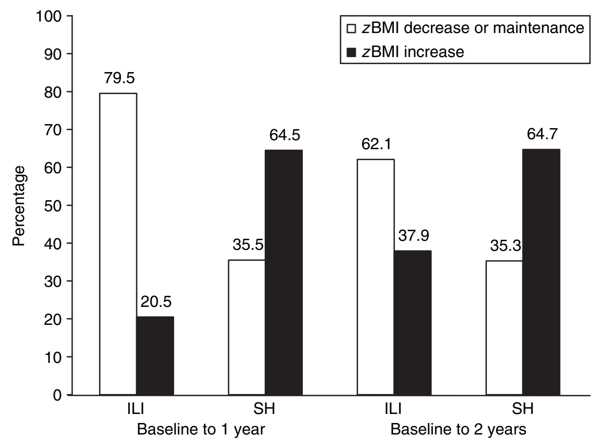

Figure 3 Percentages of Standardized BMI (*z*BMI) changes by condition. SH, self-help condition; ILI, instructor-led intervention condition.

in the ILI had reductions in *z*BMI at 1 year, and the majority maintained this status at 2 years. In terms of clinical significance, the effect sizes for these results decreased from year 1 to year 2. This indicates a decrease in the effect of treatment over time. However, children without treatment demonstrated a tendency to increase *z*BMI over 2 years whereas children in ILI generally decreased *z*BMI.

Though not specifically measured, a number of study-specific methods likely contributed to improvements in *z*BMI for participants in the ILI condition. For example, the university students who served as interventionists generally were viewed

Table 3 Change in cardiovascular parameters by treatment condition for completers and ITT (means ± s.d.)

	Instructor-led intervention		Self-help	
	Completers	ITT	Completers	ITT
Change scores from baseline to 1 year				
Systolic BP (mm Hg)	−4.8 (±12.7)	−3.7 (±11.5)	1.5 (±15.6)	0.1 (±9.2)
Diastolic BP (mm Hg)	−7.2 (±11.46)	−4.2 (±12.0)	−1.7 (±14.7)	−2.9 (±8.2)
Resting heart rate	2.15 (±13.2)	3.4 (±14.5)	−6.5 (±21.6)	1.2 (±8.6)
Total cholesterol (mg/dl)	−18.4 (±18.3)*	−15.4 (±20.8)**	0.6 (±22.2)	4.9 (±22.1)
LDL cholesterol (mg/dl)	−15.7 (±12.4)	−14.0 (±13.1)**	−8.5 (±12.7)	−2.1 (±15.8)
HDL cholesterol (mg/dl)	1.2 (±6.2)	1.1 (±5.9)	3.1 (±4.6)	2.1 (±4.0)
Triglycerides (mg/dl)	−19.2 (±60.2)*	−12.4 (±65.7)	30.2 (±76.9)	24.5 (±69.2)

Significance values indicate differences between instructor-led intervention and self-help. As blood collection was not required for study participation, these results are from a subsample. Completers: instructor-led intervention = 29, self-help = 10. ITT: instructor-led intervention = 32, self-help = 15.
BP, blood pressure; HDL, high-density lipoprotein; ITT, intention-to-treat; LDL, low-density lipoprotein.
$^*P < 0.05$. $^{**}P < 0.01$.

by the participants as role models, and children appeared excited to participate in activities with them. Additionally, the children received consistent positive feedback from these role models for modifying diet and physical activity. Parents also were targeted to receive information the students learned during intervention. Though few parents regularly attended meetings, they responded to flyers and memos sent home in the student notebooks, which suggested that they were aware of the program and the changes students were asked to make. Other strategies, specific to our particular population, also were implemented. For example, children told interventionists that they often skipped school meals and consumed nutrient-poor, high-calorie afternoon snacks available at the school. These unhealthy habits were targeted by providing fruits, vegetables, peanuts, or peanut butter for snacks.

We speculate that the promising results may be attributed to the unique strategies used for involving the overall school and community. We recognize that though we refer to the program as school-based, this setting is not typical. The school has strong ties to the Mexican-American community as well as collaborative family–teacher and student–teacher relationships. Families and school personnel work together to improve the health and education of students, and teachers act as extended family members. Therefore, parents, siblings, extended family members, and teachers were used as valuable sources of support for making healthy lifestyle changes. Utilizing community resources has been shown to be helpful in improving health in minority populations (25).

In addition to weight improvements, children in the ILI also significantly lowered their total cholesterol at 1 year relative to those in the SH condition. Differences were not found for BP, low-density lipoprotein, and high-density lipoprotein; however, these data were only collected on a subsample of participants, many of whom presented with normal values at baseline. These factors combined with the number of participants who consented to give blood decreased statistical power for detecting significant differences over time. Additional research is needed with more participants who present with elevated cardiovascular parameters to detect changes. Research in this area would provide valuable information about the impact of *z*BMI reduction on these physiological markers in children.

Children in the ILI condition showed significant decreases in tricep skinfold thickness compared to children in the SH condition. Although tricep skinfold is an acceptable measure when used in combination with other assessments, it provides little additional information beyond BMI (26). A true measure of body fat (e.g., dual-energy X-ray absorptiometry) would be useful in determining actual changes in body composition. In this study, students in the treatment group displayed a significantly greater decrease in tricep skinfold thickness compared to those in the control condition. However, it is possible that weight loss instead of an actual decrease in body fat was responsible for this difference. Future studies would benefit from implementing more accurate measures of body composition.

The intervention required significant resources to maintain daily contact with our participant population during the initial intensive phase. However, it is important to note that this initial investment resulted in sustained weight loss well beyond the intervention period, a result typically not observed in most obesity intervention studies. Although an evaluation of cost-effectiveness or cost-benefit was not included, the long-term value of making healthy lifestyle changes may offset the cost of behavioral treatment. In theory, helping large groups of children to achieve and sustain healthy weight improvements has substantial potential to be less of an economic burden than the rising costs associated with pediatric overweight and, later, adult obesity (4,27–29).

At this point, the importance of each specific program component (e.g., diet, physical activity, self-monitoring, social support strategies) on the children's *z*BMI is unclear. It is possible that the combination of these elements as a comprehensive treatment package was responsible, but further research is needed to examine the relative impact of each component. Similarly, future studies may evaluate programs of different levels of intensity and include cost–benefit analyses in order to identify treatment and prevention formats that are effective with respect to both weight outcomes and cost.

The current findings indicate that children may benefit from an intensive (i.e., daily) intervention in which established strengths of community settings are recognized and utilized. Each setting is likely to have particular resources that can be utilized to promote weight management. These results are highly encouraging and suggest the benefits of community-based programs to help children achieve healthier lifestyles. However, more empirical evaluations are needed to establish generalizable and cost-effective methods for addressing the current pediatric overweight epidemic.

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DISCLOSURE

The authors declared no conflict of interest.

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