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A True Challenge for Any Superhero

An Evaluation of a Comic Book Obesity Prevention Program

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The purpose of this study was to pilot test the *Comics for Health* program, a theory-based nutrition and physical activity intervention for children. Twelve after-school programs were randomized to either a theory-based (n = 37) or a knowledge-based (n = 34 children) version of the intervention. Pretests, posttests, and 3-month follow-up tests were administered to evaluate the programmatic effects on body mass index percentile, obesity-related behaviors, and constructs of social cognitive theory. Both interventions found significant, yet modest effects for fruit and vegetable consumption ($P < .005$), physical activities ($P < .004$), and water and sugar-free beverage consumption ($P < .001$) and self-efficacy for fruit and vegetable consumption ($P < .015$) and physical activities ($P < .009$). **Key words:** *health behavior, health promotion, obesity, social cognitive theory*

CHILDHOOD OBESITY has tripled in the past 30 years.[1] This is of great concern because of the harmful consequences excess weight can have on numerous body systems. For instance, obesity early in life can lead to neurological, cardiovascular, endocrine, musculoskeletal, renal, gastrointestinal, and pulmonary problems, such as asthma, dyslipidemia, sleep apnea, type 2 diabetes, and hypertension.[2] Obesity has also been shown to have an impact on several determinants of mental health. As reported in the 2009 American Health Association Childhood Obesity Research Summit Report, overweight and obese youth consistently experience greater psychological distress, such as high rates of depression, low reported self-esteem, social marginalization, and negative body image, than their normal-weight peers.[3]

Because of this dramatic increase, the need and interest for effective and innovative health promotion interventions targeting obesity prevention have intensified. One perspective that has gained popularity for use in interventions is the life course theory (LCT), which is a conceptual framework that explains health and disease patterns and disparities, across various groups of people over time.[4] Four key concepts of the LCT include timeline, timing, environment, and equity. *Timeline* purports that healthy

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behaviors develop over the entire life span, and interventions promoting protective behaviors (such as physical activity) and reducing risk factors (such as a diet high in saturated fats) should continuously be implemented to improve and sustain health. *Timing* refers to discrete or sensitive periods across the life span when interventions are especially important. For example, early childhood and pregnancy are both critical periods when the adoption of certain eating patterns can affect an individual's long-term health. The third concept of the LCT is *environment*, which indicates that the physical, social, and economic environments can all play important roles in shaping the health and wellness of populations and the community. Finally, at the core of the LCT, *equity* refers to bringing health equality to all people in the community. This requires researchers to not only identify factors that contribute to health disparities but also address them in health promotion interventions.[4]

The LCT presents a framework that can be utilized for obesity prevention among children. The theoretical framework suggests that multiple intervention strategies are needed (timing) at critical periods in life (elementary-aged children) in environments that can foster health-related behaviors (schools). Interventions should also identify and address causes of health disparities, when appropriate (equity).[4] In recent years, a number of school-based interventions have been implemented, but results from meta-analyses and critical reviews suggest that their effects have been limited.[5-8] This is likely due to the increased emphases schools have on academic areas that are tested by standardized examinations, which often exclude health and physical education.[9] The after-school environment, however, may be an alternative venue for obesity prevention, since many have greater flexibility and often include activities not offered during the school hours or can complement school-based subject matters, such as arts and drama, cultural enrichment, and health education. For example, previous after-school health interventions have included sports that some children may not have an experience in, such as Pilates,[10] soccer (for inner-city youth),[11] and culturally tailored dance routines.[12] Communication also has been used in an after-school program to help children learn aspects of media campaigning, in which they developed refrigerator magnets, a Web site, a commercial, and a rap song to promote healthy behaviors in their family members.[13] Other innovative after-school programs include teaching aspects of theater production[14] and teaching children features of agriculture through developing and maintaining community gardens.[15] The number of children attending after-school programs is also growing. According to the National Center for Education Statistics,[16] almost half (43%) of youth (K-8th grades) now participate in some form of after-school programs.

Health promotion interventions should also be based on theoretical underpinnings. Theories are beneficial for community health programs, since they help researchers discern measurable intervention objectives, provide guidance for intervention strategies, enhance communication between professionals, and improve the possibility of replication for the future, and are generally more effective than intervention not explicitly using a theory.[17,18] A commonly used theory in health promotion is the social cognitive theory (SCT), which posits that human behavior can be explained by reciprocal determinism or a continuous interaction between behavior, personal factors, and the environment. "Behavior" refers to the health behavior, which is being targeted or modified. "Personal factors" refer to cognitions, affects, and biological events. "Environment" refers to social and physical environments.[18] The SCT has been applied for primary prevention to various health behaviors, including prevention of human immunodeficiency virus infection among adolescents,[19] family-planning decision making,[20] smoking cessation,[21] and problem-solving skills among children.[22] The SCT has been particularly successful in obesity prevention. To illustrate, in a recent meta-analysis spanning from 1985 to 2003, authors

reviewed 57 randomized controlled trials designed to favorably affect nutrition and physical activity in children. Among these studies, only 4 showed significant findings, and authors noted that a commonality between the 4 interventions was that they were either implicitly or explicitly based on the SCT.[23] Another review of school-based interventions also cited the SCT as the most widely used theory for obesity-prevention interventions.[24] Constructs of this theory have also been shown to significantly predict behaviors associated with obesity prevention among children. For example, Sharma and colleagues[25] reported that among fifth-grade schoolchildren, self-efficacy was a significant predictor for exercising daily and eating the correct number of fruits and vegetables, self-control was a significant predictor for watching less television daily, and expectations were a significant predictor for drinking 8 glasses of water per day. In another study, using a sample of third-grade children, Resnicow and colleagues[26] reported that the construct of expectations was a significant predictor for fruit and vegetable consumption.

Comic books (or comics) have not been well utilized in health promotion interventions but hold promise as a viable teaching tool, especially among children.[27] Emerging research suggests that comics can serve educational purposes, such as helping younger struggling readers or those of any age who are learning English, by combining pictures and words and giving visual cues as to what the text is explaining.[28] Comics also have a *fun factor* children respond well to, which can attract the interest of reluctant readers and encourage more overall pleasure reading.[29] Comics can also introduce children to more rare or higher-level words and concepts, which, in turn, can enhance their vocabulary. With slightly more of these words than in an average children's book, and 5 times as many than in the average conversation between a child and an adult, consider how many children could learn the 4-syllable words "spec-tac-u-lar" from a Spiderman comic or "in-cred-i-ble" from a Hulk comic.[29] This could easily be applied to health and nutrition, which contain many higher-level concepts that can be difficult to teach children. For example, consider the basics of energy balance, whereby calories are consumed through foods and beverages and expended by basal metabolism and physical activity. Many of these concepts are abstract (eg, calories) or hard to explain (eg, basal metabolism) and could benefit from using comics as a teaching modality. Given the promise comics have as a means of intervention, more research is needed, evaluating their acceptability and usefulness. The purpose of this study was to pilot test the "Comics for Health" intervention, a new comic-book program designed to help children learn and engage in behaviors associated with the prevention of obesity.

METHODS

Participants and after-school programs

Children from 12 mid-western Young Men's Christian Association (YMCA) after-school programs (within the same school district) were recruited for participation in this study. This study used a group randomized controlled design, whereby programs were randomized to either a theory-based or a knowledge-based version of the intervention. All of the children in this study were required to have a signed parental permission form from at least 1 parent and a signed informed assent form to participate. Approval from the institutional review board of the sponsoring university was obtained before data collection began.

INTERVENTIONS (THEORY-BASED AND KNOWLEDGE-BASED)

For this study, it was decided to use an active control group rather than a group of children receiving no intervention. Therefore, children participated in either a theory-based version of the *Comics for Health* intervention or a knowledge-based version. Both

interventions were implemented by the corresponding author of this study and consisted of 4 lessons, each lasting 30 minutes. Lesson topics focused on behaviors identified by the 2005 expert committee regarding the prevention, assessment, and treatment of child and adolescent overweight and obesity[30,31] and included *engaging in no more than 2 hours of screen time per day* (lesson 1), *consuming water and sugar-free drinks instead of sugar-sweetened beverages* (lesson 2), *participating in at least 60 minutes of physical activity per day* (lesson 3), and *consuming 5 servings of fruits and vegetables per day* (lesson 4). For the theory-based intervention, constructs of the SCT, including self-efficacy, expectations, and self-control, were operationalized and targeted. *Self-efficacy* was defined for this study as the children's perceived confidence to engage in key behaviors and overcome barriers to engage in key behaviors; *self-control* was defined as the children's perceived ability to set goals for key behaviors and self-reward themselves upon adequate accomplishment of key behaviors; and expectations comprised a combination of outcome expectations (or belief that a certain outcome will occur as the result of a behavior) and outcome expectancies (or value a certain outcome will have as the result of a behavior).

Pedagogical techniques used to mediate changes in these constructs included (*a*) discrete skills development through instructor modeling and practice, (*b*) use of positive role models, (*c*) role playing to practice learned skills and behaviors and to overcome barriers, (*d*) use of positive and vicarious reinforcement, and (*e*) goal-setting activities. For the knowledge-based intervention, pedagogical techniques were based on only building knowledge regarding healthy eating and physical activity. Examples of how the 2 interventions differed for 1 lesson are shown in Table 1. All other lessons followed the same pattern as presented.

Both interventions culminated with the children creating an original comic book or strip. Activities for making the comic were identical for both programs, in which children were taught basic concepts of storytelling and character development. However, children in the theory-based intervention were asked to develop their comic stories on the health issues covered during the intervention, whereas children in the knowledge-based intervention were not asked to incorporate the health messages.

CHILD EVALUATIONS

Body mass index percentile

Height was measured with a portable stadiometer (Seca 214, Hamburg, Germany) to the nearest 0.1 cm, and weight was measured on an electronic digital scale (Tanita HD 317, Tokyo, Japan) to the nearest 0.1 kg. To minimize bias from incorrect scale readings, the electronic scale was zeroed periodically throughout the study. Body mass index (BMI) percentiles were calculated using the BMI calculator available from the Centers for Disease Control and Prevention at http://apps.nccd.cdc.gov/dnpabmi/Calculator.aspx. Necessary inputs for computing BMI percentile were date of birth, date of measurement, gender, height, and weight. Interpretation of BMI percentile included the following: 95th percentile or more was considered obese, between 85th and 95th percentile was considered overweight, 85th to 5th percentile was considered normal weight, and 5th or less percentile was considered underweight. BMI percentile was measured before the intervention and after a 3-month follow-up period.

Physical activity- and nutrition-related behaviors

Both activity- and nutrition-related behaviors were subjectively measured using a revised version of the School Physical Activity and Nutrition questionnaire, a previously validated instrument containing 5 subscales, each of which measured 1 behavior.[32] The first subscale evaluated fruit and vegetable consumption and consisted of 9 items. Each item evaluated a type of fruit or vegetable as specified by MyPyramid, including *melons*, *berries*, *mixed*

Table 1. A Comparison of Pedagogical Techniques Between the Theory-Based and Knowledge-Based *Comics for Health* Program

	Knowledge-Based	Theory-Based
Lesson 1	Children became familiar with the definition of "screen time." Children identified activities that count toward "screen time." Children identified the appropriate amount of screen time they should have each day	All objectives of the knowledge-based intervention. Children identified and discussed potential outcomes of having too much screen time per day. Children identified and discussed potential barriers of having too much screen time per day, and ways to overcome said barriers. Children practiced talking with parents and friends about having a limited amount of screen time. Children set goals for having a lower amount of screen time.

fruit, and other fruits for "fruit consumption" and *dark green vegetables*, *orange vegetables*, *dried beans or peas*, *starchy vegetables*, and *other vegetables* for "vegetable consumption." The next subscale measured physical activities and consisted of 2 items: 1 for moderate activities and the other for vigorous activities. Next, sedentary activities were measured using 3 items: 1 for watching TV or movies, 1 for time on the computer, and 1 for playing video games. The next subscale evaluated water and sugar-free drink consumption and consisted of 2 items: 1 for water consumption and the other for sugar-free drink consumption. The final subscale evaluated sugar-sweetened beverage consumption and consisted of 1 item. To revalidate the items on this instrument, a panel of 6 experts (5 university professors and 1 director from the YMCA) was asked to establish content validity, face validity, and readability using a 2-round review process. Physical activity and nutrition behaviors were measured immediately before and after the intervention and after a 3-month follow-up period.

Social cognitive theory constructs

To evaluate the constructs of the SCT that were operationalized for the intervention, the "Promoting Healthy Lifestyles" survey was used for each behavior.[25] This survey has been previously evaluated for 2 types of reliability (internal consistency reliability and test-retest reliability) and 3 types of validity (construct, content, and face validity) in a similar sample of schoolchildren.[24] Overall, there were 12 subscales, measuring 3 constructs (self-efficacy, self-control, and expectations), for 4 behaviors: consuming 5 servings of fruits and vegetables, consuming water or sugar-free drinks instead of sugar-sweetened drinks, participating in at least 60 minutes of physical activity per day, and having no more than 2 hours of screen time per day. All items were measured using a 5-point Likert type scale. Responses for all self-efficacy items included (0) not at all sure, (1) slightly sure, (2) moderately sure, (3) very sure, and (4) completely sure. Each self-efficacy scale was measured using 3 items and all subscales ranged from 0 to 12. Items measuring self-control had the same response set, and scales for this construct were measured with 2 items, with each scale ranging from 0 to 8. The final construct, expectations, was measured using the multiplicative score of 4 outcome expectations and outcome expectancies related to each behavior. Responses for outcome expectations included (0) never, (1) hardly ever, (2) sometimes, (3) almost always, and (4) always. Reponses for outcome expectancies included (0) not at all important, (1) slightly important,

(2) moderately important, (3) very important, and (4) extremely important. Each expectation score ranged from 0 to 64. For this study, the Cronbach α was used to confirm internal consistency reliability of each subscale and an a priori critical limit of 0.70 was considered adequate. The SCT constructs were measured immediately before and after the intervention and after a 3-month follow-up period.

Process evaluation

A comprehensive process evaluation was used in this study and has been described in detail elsewhere.[33] In short, both qualitative and quantitative data were collected using surveys, field notes, and open-item questionnaires by the after-school staff, which assessed program fidelity, dose delivered, dose received, reach, recruitment, and context. Results from the process evaluations were used to better interpret the findings presented in this study.

STATISTICAL ANALYSES

To ensure that both the intervention groups were similar at pretest, a comparison of demographic and study variables between both groups was first done, using either a chi-square test (for discrete variables) or univariate ANOVA (for continuous variables). Next, to evaluate the efficacy of the program, univariate repeated-measures ANOVAs with a partial nested design were used. The primary independent variable for this study was the intervention (group). This was a fixed, categorical variable with 2 levels: (1) theory-based group and (2) knowledge-based group. The second independent variable was after-school program (program), which was nested within levels of group variable (the nestee). This was a random quantitative variable with 12 levels (6 programs were randomly assigned to receive the experimental intervention and 6 programs were randomly assigned to receive the comparison intervention). The third independent variable was a within-group variable of time, with 3 levels of measurement at pretest, posttest, and 3 month follow-up test. Therefore, the design used for testing the experimental and comparison interventions was a hierarchical one between and one within repeated-measures design. In calculating the required sample size of children for this study, G*Power was used with the following criteria: an α level of significance ($\alpha = .05$), statistical power ($\beta = .80$), an estimated medium effect size ($f = 0.30$), the number of groups ($n = 2$), the number of measurements ($n = 3$), and an attrition rate of 20%.[34] Based on these criteria, a sample size of at least 34 was needed for each group. All data were analyzed using SAS (version 9.1; SAS Institute, Cary, NC). To evaluate effect size, Cohen's f was calculated as described in Kirk[35] and interpreted as small ($f = 0.10$), medium ($f = 0.25$), and large ($f = 0.40$).

RESULTS

Instrument reliability

To evaluate the Cronbach α for each subscale of the "Promoting Healthy Lifestyles" survey, children from both intervention groups were combined. As presented in Table 2, most subscales met the a priori criteria of $\alpha \geq .70$. Those that were not included were outcome expectations for moderate to vigorous physical activity ($\alpha = .47$), self-control for moderate to vigorous physical activity ($\alpha = .58$), self-control for screen time ($\alpha = .53$), and self-control for sugar-sweetened beverages ($\alpha = .65$).

Initial group equivalency

Across the 12 after-school programs, a total of 71 children ($n = 37$ children for the theory-based group and $n = 34$ children for the knowledge-based group) ranging from 8 to 11 years of age were recruited and included in the final data analysis. At baseline, all demographic and study variables were similar, indicating that there was no need to control for any variable in subsequent analysis. Both groups contained approximately the same mix of boys and girls (theory-based:

Table 2. Summary of the Cronbach α for All Social Cognitive Theory Construct Scales (n = 71)

Social Cognitive Theory Construct With Behavior	Cronbach α
Engaging in at least 60 minutes of physical activity per day	
Outcome expectations	0.47
Outcome expectancies	0.73
Self-efficacy	0.86
Self-control	0.53
Limiting screen time to no more than 2 hours per day	
Outcome expectations	0.69
Outcome expectancies	0.84
Self-efficacy	0.73
Self-control	0.58
Consuming sugar-free drinks instead of sugar-sweetened drinks	
Outcome expectations	0.69
Outcome expectancies	0.79
Self-efficacy	0.75
Self-control	0.65
Consuming 5 servings of fruits and vegetables per day	
Outcome expectations	0.73
Outcome expectancies	0.77
Self-efficacy	0.76
Self-control	0.80

47% boys/53% girls and knowledge-based: 57% boys/43% girls), and both groups consisted mostly of white children (theory-based: 73%; and knowledge-based: 82%), compared with African American (theory-based: 14% and knowledge-based: 6%) and Asian (experimental: 5% and knowledge-based: 12%) children.

Changes in BMI percentile and obesity-related behaviors

Table 3 shows the mean BMI percentile at pretest and follow-up test, and key obesity-related behaviors at pretest, posttest, and follow-up test. No significant differences were found for the interaction (group-by-time) for BMI percentile or any of the behaviors measured in this study. However, significant improvements over time were observed for both groups for fruit and vegetable consumption ($P < .005$), water and sugar-free beverage consumption ($P < .004$), and moderate to vigorous physical activities ($P < .001$). Post hoc analyses indicated that for fruit and vegetables, consumption significantly increased between baseline and posttest and baseline and follow-up test; for water and sugar-free beverages, consumption significantly increased between baseline and posttest and baseline and follow-up test; and for moderate to vigorous physical activity, participation significantly increased from pretest to follow-up test and from posttest to follow-up test. Effect sizes were also generally medium, ranging from 0.20 to 0.31.

Changes in SCT constructs for key obesity-related behaviors

Table 4 shows each SCT construct subscale score at pretest, posttest and follow-up. There were no significant differences found for any of the interaction (group-by-time) variables. However, significant improvements over time were observed for both groups for fruit and vegetable self-efficacy ($P < .015$) and moderate to vigorous physical activity self-efficacy ($P < .009$). Post hoc analyses indicated that for fruit and vegetables, self-efficacy significantly increased between baseline and the posttest, and for moderate to vigorous physical activity, self-efficacy significantly increased from pretest to follow-up. Effect sizes were also small to medium, ranging from 0.17 and 0.19, respectively.

DISCUSSION

This study pilot-tested the *Comics for Health* program on BMI percentile, 4 obesity-related behaviors (consuming 5 servings of fruits and vegetables, consuming water or sugar-free drinks with sugar-sweetened drinks, engaging in at least 60 minutes of physical activity per day, and having no more than 2 hours of screen time per day), and 3 SCT constructs related to each behavior

Table 3. Comparisons of BMI Percentile and Key Obesity-Related Behaviors Between the Experimental and Comparison Groups

Variable	Intervention	Observed Range	Pretest, *M* (SD)	Posttest, *M* (SD)	Follow-up, *M* (SD)	*P*[a]	Effect Size (Cohen's *f*)
BMI percentile	Experimental	9.2 -98.8	60.15 (26.39)	. . .	59.23 (26.31)	0.567	. . .
	Comparison	2.4 -97.3	55.52 (27.96)	. . .	57.26 (27.84)		
Fruit and vegetable[d] consumption (in servings)	Experimental	0-12	3.41 (2.68)[b,c]	4.68 (3.08)[b]	4.62 (3.33)[c]	0.005[d]	0.20
	Comparison	0-12	3.35 (3.17)[b,c]	4.15 (2.97)[b]	4.91 (3.18)[c]		
Sugar-free beverage [d]consumption (in glasses)	Experimental	0-12	3.35 (2.58)[b,c]	4.62 (3.17)[b]	4.21 (2.62)[c]	<0.001[d]	0.31
	Comparison	0-12	4.03 (2.76)[b,c]	5.24 (3.25)[b]	6.06 (3.71)[c]		
Sugar-sweetened beverage consumption (in glasses)	Experimental	0-10	1.36 (2.00)	0.89 (0.98)	0.89 (0.95)	0.358	. . .
	Comparison	0-10	0.94 (1.17)	1.00 (1.54)	1.09 (1.94)		
Moderate to vigorous [d]physical activity, min	Experimental	0-240	69.73 (63.66)[b]	88.38 (68.90)[b,c]	106.21 (64.65)[c]	0.004[d]	0.22
	Comparison	0-240	65.29 (55.01)[b]	69.71 (45.36)[b,c]	100.58 (75.27)[c]		
Screen time, min	Experimental	0-240	116.76 (70.99)	83.51 (70.76)	88.38 (70.69)	0.117	. . .
	Comparison	0-240	83.82 (67.20)	70.59 (57.63)	77.64 (51.23)		

Abbreviation: BMI, body mass index.
[a] *P*-value for main effect.
[b,c] Significant post hoc pair wise comparisons as measured by post hoc analyses.
[d] Significant for main effect over time.

Table 4. Comparisons of All Social Cognitive Theory Constructs for Each Obesity-Related Behavior Between the Experimental and Comparison Groups

Variable	Intervention	Observed Range	Pretest, *M* (SD)	Posttest, *M* (SD)	Follow-up, *M* (SD)	*P*[a]	Effect Size (Cohen's *f*)
Fruit and vegetables							
Self-efficacy[b]	Experimental	0-12	5.89 (3.42)[c]	7.49 (3.19)[c]	6.84 (3.59)	0.015	0.17
	Comparison	0-12	5.42 (3.46)[c]	6.48 (3.82)[c]	5.70 (4.00)		
Self-control	Experimental	0-8	4.70 (2.61)	4.89 (2.49)	4.54 (2.71)	0.637	. . .
	Comparison	0-8	4.00 (2.98)	4.15 (2.77)	3.91 (2.87)		
Expectations	Experimental	0-64	32.72 (21.37)	38.81 (19.46)	37.69 (19.27)	0.164	. . .
	Comparison	0-64	31.33 (18.39)	35.71 (19.52)	31.45 (20.61)		
Sugar-sweetened beverages							
Self-efficacy	Experimental	0-12	7.46 (3.51)	8.38 (2.73)	8.14 (2.94)	0.934	. . .
	Comparison	0-12	7.91 (3.97)	6.55 (3.46)	7.36 (3.82)		
Self-control	Experimental	0-8	4.83 (2.42)	5.42 (2.13)	4.83 (2.56)	0.639	. . .
	Comparison	0-8	4.38 (2.80)	3.75 (2.54)	3.81 (2.96)		
Expectations	Experimental	0-64	28.65 (18.19)	32.68 (20.25)	34.14 (17.66)	0.438	. . .
	Comparison	0-64	31.53 (16.81)	29.68 (20.39)	30.76 (20.00)		
Moderate to vigorous physical activity							
Self-efficacy[b]	Experimental	0-12	4.97 (3.56)[c]	6.68 (3.45)	6.89 (3.23)[c]	0.009	0.19
	Comparison	0-12	4.50 (3.57)[c]	5.26 (3.82)	5.79 (3.93)[c]		
Self-control	Experimental	0-8	4.59 (2.34)	5.27 (2.51)	4.86 (2.39)	0.106	. . .
	Comparison	0-8	3.85 (2.41)	4.24 (2.50	3.76 (2.69)		
Expectations	Experimental	0-64	27.33 (16.93)	30.33 (17.70)	30.06 (16.53)	0.455	. . .
	Comparison	0-64	27.42 (14.43)	28.42 (17.90)	26.52 (17.87)		
Screen time							
Self-efficacy	Experimental	0-12	5.32 (3.57)	6.68 (2.91)	6.51 (3.19)	0.116	. . .
	Comparison	0-12	5.18 (4.10)	5.62 (4.30)	5.68 (3.87)		
Self-control	Experimental	0-8	4.57 (2.62)	5.24 (2.27)	5.14 (2.69)	0.486	. . .
	Comparison	0-8	3.79 (2.76)	3.67 (2.65)	3.79 (2.83)		
Expectations	Experimental	0-64	25.88 (19.92)	30.41 (18.18)	33.24 (19.81)	0.282	. . .
	Comparison	0-64	30.18 (16.91)	29.52 (18.54	26.61 (19.57)		

[a] *P*-value for main effect over time.
[b] *P*-value >0.05 for main effect.
[c] Significant post hoc pair wise comparisons.

(self-efficacy, self-control, and expectations). Children from both groups experienced no changes in BMI percentile. This may have occurred for a few reasons. First, given the brevity of this program, this intervention may not have been intensive enough to affect this variable. The time interval between the first and the follow-up measurements was also not very long and may not have been adequate to demonstrate changes in BMI percentile. To truly impact children's weight status and lose weight, a caloric deficit is needed. Given important environmental cues and the fact that parents are the gatekeepers for providing most of what their children consume and provide opportunities to engage in physical activities, it is likely that this intervention was inadequate and insufficient to overcome these barriers and impact weight. Other studies have shown that it is possible to affect weight with a longer-duration intervention. For example, children enrolled in both the *Kids Living Fit*[36] program and the *Bienestar & CATCH*[37] programs saw a significant decrease in their BMI percentile after participating in a 12-week after-school health program. This does not suggest, however, that any longer duration after-school program can be successful at reducing BMI percentile among children. The *Scouting Nutrition and Activity Program,* an after-school program, was 4 months long, and girls participating in this intervention saw no change in BMI *z*-scores at the end of the study.[38] Similarly, children participating in the 14-week *Tommie Smith Youth Athletic Initiative,*[39] experienced no changes in BMI percentile or percentage of body fat. This difference has also been observed among school-based intervention, and currently, there appears to be conflicting evidence pertaining to the efficacy of brief and longer interventions for obesity prevention. In the meta-analyses by Cook-Cottone and colleagues,[5] it was reported that interventions with a short duration (0-12 weeks) were associated with very small, significant, negative effect on BMI, whereas low to moderate (13-27 weeks), moderate (28-32 weeks), and long (>32 weeks) interventions were associated with small, significant, positive effect on BMI. However, in another meta-analysis by Stice and colleagues,[40] shorter duration intervention (<16 weeks) exhibited a small, yet significant positive effect size for BMI, whereas longer duration interventions (>16 weeks) exhibited no significant effect on BMI. Theoretically, it makes sense that longer interventions allow children a better chance to fully comprehend material being presented and incorporate behavior changes into their lives. However, brief interventions are also advantageous because they can be conducted in a reasonable time frame, which was found to be appealing to the after-school staff members present during this study. This study adds to the evidence that brief interventions do not appear to be adequate to mediate changes in BMI. If this approach is used in the future, a longer intervention period is warranted.

It should also be noted that children in this study had lower rates of obesity and overweight at the time of pretest; while nationally, 16% of children are obese and 31.7% are either overweight or obese, among children in this study, only 6% were obese and 21% either overweight or obese baseline.[1] This may have made it more difficult to find changes in this variable. For example, in a sample of highly overweight children, the potential for BMI percentile to decrease is higher, since children have a greater amount of *excess* weight to lose. In a sample with more normal-weight children, the potential to lose *excess* weight is much lower. It can also be noted that this study was meant to be a primary prevention study. Therefore, these results may, in fact, be positive if this group continues on the same trajectory. The time between measures in this study can be considered a relatively small amount of time, with regard to the prevention of childhood obesity. For a better understanding of whether either group benefited from either program, it would be ideal to monitor their BMI over an extended period of time.

The results also found a significant, yet moderate improvement for reported fruit and vegetable consumption, physical activity engagement, and sugar-sweetened

beverage consumption, and for self-efficacy for fruit and vegetable consumption and physical activity engagement. While these results are promising, improvements were found in both groups, meaning that we cannot conclude that the theory-based intervention was superior to the knowledge-based intervention. These results were disappointing, given that theory-based programs are typically more effective than non–theory-based programs. This also suggests that unlike BMI percentile, nutrition and physical activities can change as a result of brief interventions. This has also been shown in previous studies. For example, children enrolled in the 6-week *Food Fit*[41] program reported significant improvements in various nutrition behaviors, such as fruit and vegetable consumption and using the food label to choose healthier options. Children enrolled in the 4-week *Nutriactive*[42] program also significantly improved in their fitness abilities. However, this still does not explain why the theory-based intervention did not perform better than the knowledge-based intervention. Possibly, the theory was not operationalized adequately to make changes in the key obesity-related behaviors targeted in this study, thus resulting in theory failure. As previously stated, the SCT is a commonly used theory in health education, which posits that human behavior can be explained by reciprocal determinism, or a continuous interaction between behavior, personal factors, and the environment. While the SCT is a useful framework for health promotion interventions, a limitation from using this theory is that it can be difficult to operationalize and use all of the constructs contained within the theory. It was decided to intervene on self-efficacy, self-control, and expectations in order to have a more parsimonious model for evaluation. Knowledge was targeted in this intervention, since it is a necessary factor for behavior change, but it was not evaluated because it was targeted in both the experimental and comparison interventions and assumed that all children had a general knowledge of these health behaviors as evident by the amount of health programs they reported of having participated in the past. Another construct that is greatly needed for behavior change was environment; however, this can be a difficult construct to modify, since children do not generally control their own environments and it can be difficult to intervene with parents.

Finally, only self-efficacy for 2 behaviors increased for children in either group. This was disappointing because previous brief interventions have seen some increases in psychosocial constructs. As previously mentioned, for the 6-week *Food Fit*[41] program, self-efficacy increased for 4 of the 6 targeted behaviors during the intervention, and outcome expectancies increase for 2 of the 6 targeted behaviors. Children enrolled in the 6-week *Nutrition & Media Intervention*[13] reported an increase in motivation but not for self-efficacy. The reliability of the "Promoting Healthy Lifestyles" survey was found to be inadequate for 4 of the 12 subscales, which makes their interpretation difficult and may have led to the null findings. As noted by Pallant,[43] the Cronbach α can be sensitive to scales with fewer items, and in this case these scales had only 2 items. Therefore, these scales were likely not reliable enough to find meaningful differences between the pretest, posttest, and follow-up test. Future health care professionals and researchers should consider lengthening these scales to 3 or 4 items, to follow suit with the other subscales on this instrument that were found to be reliable.

There are some considerable limitations that should be noted from this pilot study, the first being that the dose of the interventions reported in this study was rather brief. Another limitation in this study was that all study variables besides BMI percentile were measured subjectively (or by self-report) and were based on a 1-day recall, which may not be representative of a typical day. Prior to this study, items evaluating activity- and nutrition-related behaviors underwent a validation process, whereby face validity, content validity, and the readability of the scales were established; however, future work should be done

to further improve this instrument, and attempt to establish criterion validity by comparing it to "gold standard" methods, such as using an accelerometer to evaluate the activity scales and using 24-hour recalls or food logs to evaluate the dietary scales. Any inaccuracy in memory or distortions in these self-reports could have impacted the results for this study. The instrument was also lengthy for a child's attention span. At the end of the study, some children complained about the instrument's length, which could have introduced bias if they hurried through it, instead of taking the time to fully read and respond to the items.

CONCLUSIONS

The findings from this study are important for the practice of community health promotion for several reasons. First, this study was designed to be an efficacy study in which we were able to attain trends regarding the impact this approach had on weight status, obesity-related behaviors, and constructs of the SCT. This study also gives us important preliminary findings regarding the feasibility and acceptability of this approach to inform future larger trials. The comic-book approach does appear to be an acceptable intervention medium through which messages can be framed and transmitted to children. Data from process evaluations found that children in this study generally enjoyed making their comic books and wanted more time to fully develop their ideas into stories. Future health care professionals should consider using a similar comic-book approach when targeting this age group.

To expand the dose of this intervention, more than 1 lesson could target each behavior to better develop targeted SCT constructs. If future health care professionals consider spending 1 lesson mediating changes in self-efficacy, 1 lesson on self-control, and 1 lesson on expectations, this would increase the intervention to 12 lessons and give children a longer period to learn different comic-book techniques and further develop their stories. Health educators can operationalize self-efficacy better by taking more time with the intervention methods already used and include other strategies such as taste-testing various fruits and vegetables to reduce barriers such as food neo-phobias, participate in active games where children can have fun being physically active, and have parents participate occasionally to give verbal persuasion and appraisal to ensure that the children feel confident in their abilities. Health educators can operationalize self-control better by taking more time with the intervention methods already used and include other strategies such as helping children set short-term goals, have follow-up discussions with them to talk about their successes and hardships with goals, and discuss contingency plans they can take when they are not meeting their goals. Health educators can operationalize expectations better by taking more time with the intervention methods already used and include other strategies such as taste-testing, include small group activities that help clarify what children perceive as truly important, and have parents participate occasionally to share with their children what they perceive to be important.

Finally, it is well understood that education alone is usually not sufficient to mediate behavior change, and future health educators should consider including additional environmental or policy efforts with this program. As previously mentioned, the LCT provides a sound framework for either expanding this intervention or incorporating it into other health-promoting programs and services. As Halfon and Hochstein[44] reported, this is not to say that multiple intervention strategies will always result in better health outcomes. Rather, by introducing several health-promoting opportunities and risk-reduction services earlier in life, the chances for a healthier life greatly improve, which will ultimately transfer to future generations.

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