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Lori L. Candela

University of Nevada, Las Vegas, lori.candela@unlv.edu

Antonio P. Gutierrez

University of Nevada, Las Vegas

Janet S. Dufek

University of Nevada, Las Vegas, janet.dufek@unlv.edu

LeAnn G. Putney

University of Nevada, Las Vegas, leann.putney@unlv.edu

John A. Mercer

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Research Article

Modifying the Diabetes Prevention Program to Adolescents in a School Setting: A Feasibility Study

**Lori L. Candela,¹ Antonio P. Gutierrez,¹ Janet S. Dufek,²
LeAnn G. Putney,³ and John A. Mercer²**

¹ School of Nursing, University of Nevada, 4505 Maryland Parkway, P.O. Box 453018, Las Vegas, NV 89154-3018, USA

² Department of Kinesiology, University of Nevada, Las Vegas, NV 89154, USA

³ Department of Educational Psychology, University of Nevada, Las Vegas, NV 89154, USA

Correspondence should be addressed to Lori L. Candela, lori.candela@unlv.edu

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The growing epidemic of overweight children has led to a higher prevalence of youth being diagnosed with diabetes, particularly type 2 diabetes. The current study modified the Diabetes Prevention Program (DPP) for use with 7th–10th graders in a school setting. The DPP is an evidence-based lifestyle intervention program that has been translated successfully in various adult settings. Yet the feasibility of modifying the DPP for use with middle and high school students has not been documented. A multidisciplinary university research team collaborated with a local charter school to include a modified DPP as part of the curriculum for one semester. Pre- and posttests included food knowledge, health locus of control, BMI, and performance on the 12-minute Cooper walk/run test. Findings suggest tentatively that the modified DPP was successful at increasing food knowledge and awareness of more rigorous physical activity as well as their association to improved health outcomes. Equally as important, results demonstrate that it is feasible to conduct interventions targeting healthy weight among adolescents in school-based settings by incorporating them in the curriculum.

1. Introduction

Pediatric obesity has already emerged as a 21st century global epidemic. Even more startling is how fast the epidemic has grown in America. Between 1980 and 2000, the number of overweight children tripled [1]. Among 6 and 17 years old, 36% are currently overweight, and 13% of those are considered obese [2]. Among the many physical, psychological, and social consequences of being an overweight or obese child is the development of type 2 diabetes (T2DM). Today, 30–50% of children are being diagnosed with T2DM, and nearly all are overweight [3]. T2DM in children will likely overtake type 1 diagnoses within the next 10–20 years [4].

The continued surge in the numbers of overweight children and adolescents has prompted multiple types of prevention programs. Groups such as the American Dietetic Association urge both family and school-based programs [5]. However, the school setting has become the focus of

many interventions as most children attend for a significant number of hours and days per year [6].

In 2008, Kropski et al. reported a review of experimental and quasiexperimental school-based obesity programs published between 1990 and 2005 [7]. They noted much variation in the types of interventions including a nutrition component, physical activity component, or both. A significant difference was noted in 12 of the studies in physical activity, sedentary behavior, and/or dietary intake. However, the authors noted that the small number of studies was a limitation and called for more methodologically rigorous studies to be conducted [7]. The HEALTHY study was conducted across multiple school sites over a 3-year period. Targeting 6th through 8th graders, the study focused on educational, behavioral, and physical activity interventions. Additionally, factors at the school level affecting the nutrition and health of students as well as family involvement were integral components in the study [8]. The results of the

study did not show differences between the intervention and control groups with regard to overweight and obesity prevalence. The lack of significant results in school-based programs targeting overweight and obese children provides a strong rationale to explore other interventions.

The Diabetes Prevention Program (DPP) is an evidence-based intensive lifestyle intervention aimed at preventing or delaying the onset of type 2 diabetes [9–11]. The study focused on educational modules aimed at healthy eating, physical activity, and individual coaching support. Since that time, the DPP has been translated to several adult community-based settings with positive results [12–14]. The DPP modification was preferable to the HEALHTY study procedures, as it could be readily incorporated into the existing school curriculum. Moreover, it included evaluative measures that could be easily performed by school nurses and teachers as opposed to researchers.

Although several intervention programs regarding healthy eating and physical activity have been used with children in various community-based settings, the DPP has not yet been examined for its effectiveness to be used with young people, specifically adolescents in a school-based setting. The DPP study was conducted with adults at very high risk of developing diabetes. However, the lifestyle intervention content centered on healthy eating and physical activity. This is foundational information for any individual in preventing potential chronic conditions, such as diabetes in the future. Therefore, the following question guided this feasibility study: do students who participate in the DPP curriculum differ on selected cognitive and physical measures versus students who do not participate in the DPP curriculum?

We predicted—based on previous research administering the DPP curriculum to adult populations—that the adolescents in the DPP curriculum group (intervention) would vary on the cognitive and physical measures when compared to students receiving only traditional instruction. More specifically, we postulated that students exposed to the DPP curriculum would exhibit lower BMI and higher food knowledge at posttest than students in the traditional curriculum (comparison group). Moreover, we predicted that students in the DPP curriculum would outperform those in the comparison group on the Cooper test and that they would evince more internal (as opposed to external) health locus of control than the comparison students at posttest (see below for an explanation of these measures). Adolescents were chosen as they are typically more autonomous. The eating and activity patterns they develop during this time may persist as they grow older [15].

2. Methods and Procedures

2.1. Participants. Participants for this study included 115 middle and high school students enrolled in grades 7 ($n = 30$), 8 ($n = 39$), 9 ($n = 22$), and 10 ($n = 24$) in an at-risk, ethnically diverse charter school between the ages of 12 to 17 years ($M = 14.17$, $SD = 1.35$). The charter school was located in a large school district in a metropolitan area

in the southwestern United States. This particular school was selected because of its demographic characteristics. The school's administrator informed the research team that approximately 50% of the students were overweight, prompting the collaboration with the school. The ethnic breakdown of participants was 11 African American; 1 Asian American; 21 Caucasian; 64 Hispanic; 16 other; 2 who refused to report their ethnicity. There were 65 male and 48 female participants as well as two who did not report their gender. Four participants reported being diagnosed with T2DM ranging from 5 to 48 months from the completion of the demographic questionnaire. These participants were omitted from any subsequent analyses to avoid potential confounds. In regards to their family history, 17 participants reported having either a parent or sibling with diabetes.

2.2. Procedures. Upon receiving approval from the university's institutional review board, the research team arranged an initial planning meeting with the school's administration. The school's administrator was immensely supportive and agreed to assist the research team through whatever means possible. At the advice of administration, the research team decided to abandon random assignment of participants to the DPP intervention and comparison groups in order to maintain intact grade levels, as all students remain with their grade level cohort throughout the school day. This obviated potential contamination effects from intervention to comparison groups. Grades 7–10 were selected to participate in the study. In an effort to cut across both middle and high schools, one grade each from middle and high schools was selected to be in the intervention (grades 7 and 9) and comparison (grades 8 and 10) groups. Several mailings were attempted to solicit parental permission because at-large information sessions geared towards providing additional information to parents were unsuccessful due to lack of attendance. Participants signed assent forms at school during regularly scheduled class sessions.

The first and second authors, who have experience in curriculum development and instruction, prepared the 10 DPP curriculum sessions prior to the commencement of any research activities. The original 16 DPP sessions were collapsed to 10 for greater efficiency of instruction. The DPP curriculum was meticulously reviewed and modified to ascertain that all content was appropriate for an adolescent population. Before instruction, the entire DPP curriculum was vetted by school administration and the teachers who agreed to provide instructional time for the sessions to further validate the content. Once all pertinent approvals were obtained, the first and second authors administered the DPP curriculum sessions to participants in grades 7 and 9 (see DPP curriculum below for an explanation). Participants in the comparison group (grades 8 and 10) received their traditional curriculum. All participants completed the cognitive and physical measures (see Section 3) before the administration of the DPP curriculum to the intervention group to establish a baseline. Finally, at the end of the 10-week DPP curriculum, participants once again completed the cognitive and physical assessments.

2.3. DPP Intervention. The purpose of the DPP intervention was to educate and motivate 7th and 9th grade students to achieve the following goals: (1) increasing knowledge of food and nutrition; (2) developing healthier eating habits; (3) participation in additional and more rigorous physical activity; (4) empowering students through motivation (e.g., commitment to goals, understanding social cues, eliminating negative thoughts and feelings, etc.); (5) setting and monitoring the progress of healthy weight goals. Sociocultural theory guided the development of the 10 learning sessions. In particular, the researchers considered the cultural mix and developmental age of students in creating a learning environment that drew upon individual experiences as well as social interaction with each other [16]. The curriculum was delivered over a 10-week period during a regularly scheduled class, each session lasting no more than 45 minutes. Sessions involved a combination of lecture and interactive activities, and some incorporated the use of technology (e.g., i-Clickers, PowerPoint). Appendix A contains the sequence of the original DPP curriculum juxtaposed against our modifications to it for the purposes of this study; Appendix B contains a sample lesson plan for one of the lessons.

2.4. Materials: Cognitive. The food knowledge questionnaire (FKQ) was adapted from an unpiloted measure propagated by the United States Department of Agriculture [17]. For the purposes of this study, items from the FKQ that were deemed as too complex for adolescents were modified to maximize conceptual understanding. For instance, terms such as hypertension and osteoporosis were changed to high blood pressure and weakening of the bones, respectively. The final FKQ used for this study included 76 items that assessed participants' factual knowledge of nutrition and health, such as understanding of the food pyramid, appropriate serving sizes, and unhealthy dietary habits and their associated health effects. Sample items include "which health problems are associated with being overweight?"; "looking at the table below, match each nutrient with the food group that is considered a high source of the nutrient"; "based on your food knowledge, which of the following choices has more fat?" Because this instrument assessed participants' declarative knowledge of nutrition and health, responses were coded as either 1 (correct) or 0 (incorrect). Subsequently, participants' correct responses were summed, yielding a continuous food knowledge score between 0 and 76. Internal consistency for this measure using Cronbach's alpha was adequate, $\alpha = .77$ (pretest $\alpha = .78$; posttest $\alpha = .75$).

Participants' health locus of control was measured using the multidimensional health locus of control (MHLC) scales [18]. For this study, form A of the instrument was used, which included all three subscales: chance, internal, and powerful others. Participants responded on a 6-point Likert scale ranging from "strongly disagree" (1), "moderately disagree" (2), "slightly disagree" (3), "slightly agree" (4), "moderately agree" (5), to "strongly agree" (6). For each scale, scores were obtained by simply summing participants' responses for the items comprising each scale. In essence,

participants' scores on each scale ranged from 6 to 36. The MHLC scales were intended to be interpreted independently; hence, there is no overall MHLC score. Sample items included "no matter what I do, if I am going to get sick, i will get sick" (chance); "i am in control of my health" (internal); "my family has a lot to do with my becoming sick or staying healthy" (powerful others). The reliability of each scale was acceptable, with the exception being the powerful others scale at posttest: Internal, $\alpha = .65$ (pretest $\alpha = .60$; posttest $\alpha = .70$); Chance, $\alpha = .63$ (pretest $\alpha = .61$; posttest $\alpha = .64$); and Powerful Others, $\alpha = .61$ (pretest $\alpha = .69$; posttest $\alpha = .52$). While these internal consistency reliability coefficients are adequate, they are by no means ideal because they are relatively low. This suggests that participants' responses were not consistent, which yielded a great deal of measurement error.

The Nelson and Narens Model of Metacognition is a cognitive model that specifies that information gathering precedes behavior change which is represented as the individual exerting control over his or her environment [19, 20]. From this perspective, knowledge would be considered an antecedent to any dietary or physical activity behavior change. Although locus of control is considered a more stable characteristic of the individual, it is potentially amenable to change with the introduction of new knowledge [19, 20].

2.5. Materials: Physical. In addition to cognitive paper-and-pencil surveys, the research team collected physical measures at both pretest and posttest, including the 12-minute Cooper walk/run test, height, and weight. Subsequently, age, gender, height, and weight were utilized to calculate each students' body mass index (BMI), and BMI percentile [per the Center of Disease Control and Prevention (CDC) guidelines for children and adolescents]. Student height/weight was measured twice at pre- and post-sessions using a healthometer digital medical scale: 500 KL (Health o meter Professional) by a registered nurse with extensive experience in assessing anthropometric measures. The 12-minute Cooper walk/run test [21] is a validated assessment that measured the distance students traveled around the 60 feet \times 30 feet gymnasium at the school in 12 minutes. Interventions targeting physical fitness improvement as measured by changes in the Cooper walk/run test have been noted in the literature [22].

Numbers were placed strategically throughout the gym to more accurately and easily measure the distance students traveled in 12 minutes; additionally, markers were placed every 3 feet to further increase ease and accuracy of measurement. Before any physical measures were collected, students were given letter-size papers (one in front and one in back) to place around their shoulders with their unique participant number. Next, the class was divided so that one half proceeded to the private screening area in which height and weight data were collected, while the other half proceeded to the Cooper. The same researchers read the same instructions to all participants for each physical measure so as to avoid potential researcher bias. All physical assessments took place during a regularly scheduled physical education period at the school's gymnasium.

After data collection at both pretest and posttest, the distance students traveled in 12 minutes during the Cooper test, initially measured in feet, was converted to miles to facilitate data analysis and interpretation. Furthermore, height (measured in inches) and weight (measured in pounds) were utilized to calculate the BMI and BMI percentile of each participant per the guidelines established by the CDC [23]. Only results from the Cooper walk/run test (in miles) and BMI were selected from among the physical assessments to be included in the analyses to obviate singularity and multicollinearity problems, as some of the measures (e.g., height, weight, BMI, and BMI percentile) were very highly correlated. BMI was selected as an outcome measure because it accounted for students' age, gender, weight, and height.

2.6. Data Analysis. Descriptive statistics and zero-order correlations were conducted for selected cognitive and physical measures at both pretest and posttest. To answer the proposed research question, we conducted several mixed-model analyses of variance (ANOVAs). All data were screened for univariate and multivariate outliers using box plots and Mahalanobis Distance, respectively, according to the procedures outlined by Tabachnick and Fidell [24] prior to any data analysis. Furthermore, data were tested for univariate and multivariate assumptions, including normality, homogeneity of variance, homogeneity of variance-covariance matrices, and multicollinearity. Five cases had incomplete data. These cases were omitted from analyses in order to maintain consistent group sizes across all analyses. All requisite assumptions were met, and thus, data analyses proceeded accordingly with the remaining 115 cases. All statistical analyses were conducted using the IBM Statistical Package for the Social Sciences (SPSS) version 17.

3. Results

Table 1 contains the means and standard deviations of the cognitive and physical measures. Tables 2 and 3 contain the zero-order correlations for the cognitive and physical assessments, respectively.

Mixed between/within ANOVAs were conducted with the type of instruction (DPP intervention, traditional instruction) serving as the between-subjects factor and measurement point (pretest, posttest) serving as the within-subjects factor. In the first analysis, the cognitive measures (food knowledge and the three scales of the MHLC) were individually entered as dependent variables. Cohen's [25] criteria were utilized to evaluate the magnitude of effect sizes in which .10 is small; .25 is moderate; $\geq .40$ is large.

3.1. Food Knowledge. The food knowledge \times time (pretest/posttest) interaction was not statistically significant, $P > .05$. The between-subjects main effect was not statistically significant, $P = .45$. However, the differences in food knowledge scores between pretest and posttest was significant, $F_{(1,112)} = 5.13$, $P < .05$, $\eta^2 = .04$. Students had higher scores at posttest when compared to their baseline performance (see Table 1 for means). To better observe

TABLE 1: Descriptive statistics of pretest and posttest cognitive and physical measures.

Variable ^a	Pretest		Posttest	
	M	SD	M	SD
Cognitive				
Food knowledge	41.96	9.58	43.41	8.28
Internal ^b	24.04	5.50	22.90	6.71
Chance ^b	18.46	5.68	17.46	6.02
Powerful others ^b	20.36	6.09	18.70	5.95
Physical				
Cooper ^c	0.73	0.21	0.69	0.20
BMI	24.62	6.32	24.25	5.90
BMI percentile	72.86	26.73	71.35	26.88
Height ^d	63.84	3.79	64.33	3.83
Weight ^e	143.74	44.42	144.67	42.80

^a $N = 115$.

^bMultidimensional health locus of control (MDHLC) scales.

^cIn miles.

^dIn inches.

^eIn pounds.

TABLE 2: Zero-order correlations between pretest and posttest cognitive measures.

Variable ^a	1	2	3	4
(1) Food knowledge	—	.00	.11	-.07
(2) Chance	-.05	—	.32 ^c	.58 ^c
(3) Internal	.23 ^b	.24 ^b	—	.39 ^c
(4) Powerful others	-.06	.51 ^c	.36 ^c	—

^aCorrelations ($N = 115$) above the diagonal are from pretest data, whereas correlations below the diagonal are from posttest data.

^b $P < .05$ (two tailed).

^c $P < .01$ (two tailed).

TABLE 3: Zero-order correlations between pretest and posttest physical measures.

Variable ^a	1	2	3	4	5
(1) Cooper	—	-.33 ^c	-.25 ^c	.04	-.26 ^c
(2) BMI	-.31 ^c	—	.76 ^c	.28 ^c	.92 ^c
(3) BMI percentile	-.19 ^b	.80 ^c	—	.26 ^c	.72 ^c
(4) Height	.09	.25 ^c	.23 ^b	—	.59 ^c
(5) Weight	-.21 ^b	.92 ^c	.74 ^c	.59 ^c	—

^aCorrelations ($N = 115$) above the diagonal are from pretest data, whereas correlations below the diagonal are from posttest data.

^b $P < .05$ (two tailed).

^c $P < .01$ (two tailed).

these differences, we used grade level as the between-subjects factor instead of the type of instruction. The results indicated that the significant differences in food knowledge score were found among the 7th grade students (pretest: $M = 41.93$, $SD = 7.26$; posttest: $M = 43.93$, $SD = 6.24$), whereas the differences among 8th, 9th, and 10th grade students did not reach significance at the $P < .05$ level.

3.2. Health Locus of Control. The health locus of control \times time (pretest/posttest) interaction was not statistically significant, $P > .05$. The internal and chance scores did not reach significance for the between-subjects or within-subjects factor, all P values $>.05$. However, the powerful others scores reached significance for the within-subjects factor, $F_{(1,103)} = 5.71$, $P < .05$, $\eta^2 = .05$. Students demonstrated a lower mean score on the powerful others scale at posttest (see Table 1 for means). To further examine these results, we used grade level as the between-subjects factor, as outlined above. The results demonstrated that significant differences were found in 7th (pretest: $M = 21.84$, $SD = 6.16$; posttest: $M = 20.40$, $SD = 6.66$) and 9th (pretest: $M = 20.33$, $SD = 4.96$; posttest: $M = 17.95$, $SD = 6.03$) grade students, whereas the differences among 8th and 10th grade students was not significant at the $P < .05$ level.

3.3. Physical Activity. In regards to differences in Cooper performance, the distance \times time (pretest/posttest) interaction was not statistically significant, $P > .05$. Students traveled longer distances at pretest than posttest (see Table 1 for means), $F_{(1,108)} = 5.28$, $P < .05$, $\eta^2 = .05$. The type of instruction main effect was significant also, $F_{(1,108)} = 7.81$, $P < .01$, $\eta^2 = .08$, indicating that the DPP intervention group (pretest: $M = 0.79$, $SD = 0.20$; posttest: $M = 0.74$, $SD = 0.20$) outperformed the comparison group (pretest: $M = 0.68$, $SD = 0.20$; posttest: $M = 0.65$, $SD = 0.20$) at both pretest and posttest.

3.4. BMI. The BMI \times time (pretest/posttest) interaction was not statistically significant, $P > .05$. The between-subjects main effect for BMI was not significant, $P > .05$, although the DPP intervention group exhibited lower overall BMI than the comparison group at posttest. The time difference between BMI at pretest and posttest was statistically significant, $F_{(1,108)} = 5.22$, $P < .05$, $\eta^2 = .05$. Students manifested a lower mean BMI at posttest than pretest (see Table 1 for means).

4. Discussion

This DPP intervention study has demonstrated, tentatively, that instruction specifically tailored to adolescents has the potential to influence their dietary knowledge. Along with more thorough experimental studies utilizing multiple schools, increased knowledge of healthier dietary habits has the potential of promoting behavior change in the form of more rigorous physical activity and healthier eating habits.

Students exposed to the DPP curriculum demonstrated gains in food knowledge from baseline to posttest, although this effect was manifested by 7th grade students only, not those in 9th grade. This trend persisted in other areas as well, as 7th grade students demonstrated greater motivation to actively participate in the DPP curriculum than their 9th grade peers. For instance, most of the 7th grade students readily adopted weight, healthier dietary habits, and more rigorous physical activity goals at the beginning of the study, whereas their 9th grade peers were less willing to

cooperate in this regard. Some of this increased motivation and commitment, however, could be explained by the 7th grade instructor, Mr. C, who himself adopted weight loss goals to inculcate increased participation in his students.

The 9th grade students may have been more concerned with other aspects of their lives to remain committed and motivated in the DPP curriculum. During adolescence—especially as children transition from middle school to high school—motivational beliefs [26] and commitment to learning tend to wane. Zimmerman posited that adolescents' motivation suffers because other activities and situations (e.g., dating, forming social bonds, employment, etc.) supersede academic achievement and learning in their lives [26]. In addition, research has found that students' perceived sense of belongingness to particular contexts such as academic settings (e.g., schools, classrooms, and specific teachers) leads to positive outcomes, including a desire and commitment to learn [27]. Anderman asserted that individuals' sense of belongingness is a basic psychological need that they strive perennially to meet [27]. It may very well be that, unlike 7th grade students, 9th grade students may no longer be as ready and willing to please their teachers because their sense of belonging is satisfied by their peers as well as other external factors cogently articulated by Zimmerman [26]. This, in turn, may have undermined their motivation, commitment, and resolve to successfully adopt the lessons of the DPP curriculum.

Although 7th grade students' food knowledge gain was relatively modest, these results are encouraging. Lobstein et al. cogently argued that the rate of overweight and obesity is alarmingly high among 6- and 17-year-old children [2]. By increasing their food knowledge, adolescents are well equipped to make better choices in terms of diet. The reality of the sample of adolescents in this study and many others like them is that frozen, prepackaged food and snacks as well as fast food comprise the daily meal menu far too often. This is evidenced by the finding from the U.S. Department of Agriculture that 94% of teenagers consume low-quality diets [28]. Therefore, knowledge of healthier eating, combined with healthier eating, weight, and more rigorous physical activity goals, addresses the call of Lobstein and colleagues [2] to reduce the overweight and obesity rates among adolescents.

Health locus of control has profound repercussions on how individuals cope with and process matters relating to health and illness [18, 29], and hence, it significantly impacts how adolescents react to the DPP curriculum. While locus of control has been considered a more stable characteristic of individuals, research has demonstrated that knowledge may be an effective antecedent to behavior change and attributes such as locus of control [19, 20]. Adolescents with more internal health locus of control tend to be more receptive and amenable to the cognitive and behavioral changes of the type the DPP curriculum necessitates. In terms of health locus of control, the DPP intervention group—both 7th and 9th grade students—indicated that they do not consider the negative influences of their family and peers when reflecting about matters of health and illness, whereas the comparison group adolescents were more prone to external influences.

This is particularly meaningful for the large portion of minorities in this group, such as Hispanics, whose parents and grandparents may share a more fatalistic and deterministic view of health locus of control [30]. Noteworthy is the fact that neither the intervention nor the comparison group differed significantly on the internal scale. This would have given us some indication that the adolescents considered their own beliefs preeminent when reflecting on health and illness. This is ideal because individuals who have an internal health locus of control feel more empowered, and thus, more efficacious in attempting to cope with illness and disease [18, 29]. In spite of this, the DPP curriculum has the potential to decrease reliance on chance and external health locus of control factors among adolescents, which in turn increases the likelihood that the intervention will be successful in the long term. Through sustained, long-term efforts, researchers and practitioners can tip the balance for overweight and obese adolescents at risk of developing T2DM.

Type of instruction promoted engagement in more rigorous physical activity as well. Adolescents in the intervention group outperformed the comparison group on the Cooper test, although adolescents in both groups traveled a longer distance at baseline. However, this effect could have been due more to contextual factors than the lack of success of the DPP curriculum, as the physical posttests were scheduled during the week prior to final exams. It is difficult, at best, for adolescents to feel motivated about exercising when exams are looming closely. Knight-Abowitz summed the attitude of teenagers towards school activities as bored and disengaged [31]. Moreover, adolescents in some of the grades performed the physical posttest immediately after their lunch or recess. This may or may not have had an adverse effect on their performance on the Cooper test due to fatigue. Nevertheless, the results demonstrate that the DPP curriculum encourages students to engage in more sustained rigorous physical activity through educational and motivational activities.

Despite the fact that the DPP curriculum was intensive at school, the lack of statistically significant changes in BMI between and within groups could be explained by insufficient family involvement, particularly parental. Studies have indicated that conflict is common between adolescents and their parents, with an associated decline in closeness and time spent together [32]. We made several attempts to elicit parental involvement in the DPP intervention so as to maximize effects, but our attempts were futile, which is not wholly unexpected given the demographics of the school. With so many parents unable to speak, read, or write in English, it becomes a challenge to inspire them to participate, even though many of them may acknowledge the importance of healthy weight, more rigorous physical activity, and healthier eating habits, not to mention socioeconomic and other reasons that may discourage many parents from participating. It is known that low-income children, such as represented in the school under study, are more likely to be living with a single working parent which may adversely affect opportunities to be involved with any school activities [33]. We strongly believe that if greater parental/familial involvement would have been secured, the results pertaining

to behavior change and weight would have been different for the DPP intervention group.

4.1. Implications. This feasibility study has several implications that will be helpful in conducting further research. These include fostering a university-school collaboration and using a multifaceted design. Elements common to community-based participatory research (CBPR) and collaboration theory [34, 35] were helpful in actualizing this research collaboration. In particular, the need for mutual respect, trust, and flexibility has been essential for both researchers and the charter school. This was evidenced in our study in which the timeframe from our first meeting to the actual commencement of the study was 18 months. Recommendations to others considering a research collaboration in community schools include initial meetings to determine the needs and priorities of the community partner, establishing a means for regular, frequent communication, determining clearly delineated roles and expectations in the beginning and upfront, developing realistic timelines, and forming flexible attitudes towards the issues that are certain to arise.

Future research should consider the feasibility of further modifying the DPP content down to elementary school age groups. High school and middle school students have high levels of disengagement that is less present in elementary school students [36] and determining methods to engage families in the program. Also important is the need to consider multiple strategies for intervention programs, such as learning content, physical activity programs, attention to school food choices, and inclusion of families. Future studies conducted using mixed methods designs could be very helpful in capturing qualitative data as a way to further understand adolescent perceptions of nutrition, physical activity, and health. Finally, experimental studies in which schools are selected randomly to receive the intervention would go a long way in minimizing contamination and the influence of confounding variables.

4.2. Limitations. We acknowledge several limitations in the conduct of the study that may have prevented more robust results from emerging, particularly in regards to the effectiveness of the DPP curriculum among middle and high school adolescents. The lack of abundant significant results and larger effect sizes could be attributed in part to measurement error, as the food knowledge measure did not perform as well as expected. Future research using this measure should include the use of factor analysis to ascertain whether the food knowledge questionnaire has multiple factors rather than a single principal component, as this may contribute to measurement error if items are not loading on the appropriate factors, if at all. In fact, researchers should consider designing a more construct-pure and direct measure of food knowledge in the future and pilot test and validate it. Additionally, the MHLC scales, although previously validated, exhibited relatively poor internal consistency at both data collection points. Perhaps researchers wishing to examine the DPP curriculum in younger populations would be better served to seek stronger,

TABLE 4: DPP lesson plan: session no. 8 (40 minutes).

Topic	Content notes	Teaching method	Learning activities	Time on task
8. Problem solving	Problems, problems, and more problems!!!	Interactive lecture PPT	Problems are a natural part of life, but they can be solved and avoided in the future	20 minutes
	Emphasize that problems are an absolute part of life		Learn and apply the five steps to solving a problem in meeting their health goals	
	7 steps to effective problem solving:		Understand that behavior is interconnected (behavior) chain	
	Describe the problem in detail (behavior chains)		If one solution to a problem does not work, they can try an alternate solution	
	Brainstorm (reflect and clearly think about the behavior chain that led to the problem)		Formulate positive plans of action to solve problems they encounter in meeting their health goals	
	Come up with several potential solutions		Learn the basic components of a good plan of action	
	Pick one option to try out (choose the one i.e. most likely to work)		Learn how to evaluate the effectiveness of an action plan	
15. You can manage stress	Make a positive action plan, one that is carefully prepared	Interactive lecture PPT	Review fictitious problem and apply the five problem solving steps, including evaluation	15 minutes
	Try out the action plan		Develop a unique action plan for actual problems	
	Evaluate its effectiveness			
	Stress		Students will learn what stress is	
	What is stress?		Students will discuss how stress applies to their lives	
	What kinds of things make you feel stressed?		Review ways to prevent stress	
	What is it like when you are stressed?		What to do when you cannot avoid stress	
Wrap up	What can stress do to your health?	General information	Explain how the lifestyle intervention program can cause stress	5 minutes
	Ways to prevent stress			
	Continue to keep track of weight, healthier eating, and physical activity goals			
	Put your action plan into action			
	Try managing your stress			

more psychometrically sound measures of food knowledge and health locus of control in future research endeavors that are specifically tailored to younger populations. Finally, the Cooper test of physical fitness was administered in groups rather than individually due to the short time span because of standardized and other testing schedules. Consequently, the competitive nature of the testing context may have unduly influenced some students to overachieve.

In regards to the DPP curriculum, the nature of the study may have undermined the results. For instance, students were not randomly selected and assigned to the intervention or comparison group. Additionally, preexisting personal characteristics of the adolescents may have biased or contaminated the study, hence, the need for random assignment. Because the research team was advised by school

administration to include both middle school and high school students, the two groups may not be as readily comparable as if they had been in the same grade level. Furthermore, DPP curriculum sessions for 7th and 9th grade students were all administered during different classes because of the need to accommodate standardized testing schedules, and thus, the influence of different instructors may have been a potential confound, as some instructors were more enthusiastic and supportive of the DPP curriculum than others. Finally, in spite of our best efforts, parental participation and support, which is critical for the instilment and consolidation of healthier dietary and exercise habits at home, was virtually nonexistent. Therefore, we strongly recommend that future research implements more robust experimental controls, perhaps via a true

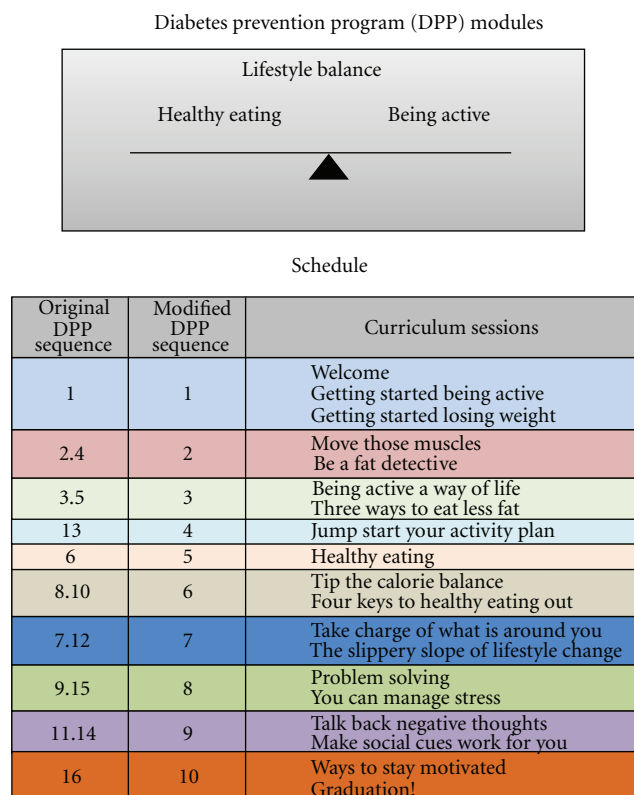


FIGURE 1

experimental design. Additionally, researchers should make more concerted efforts to secure parental/familial involvement in future studies. More research is needed, however, to corroborate our tentative findings, particularly as they pertain to younger populations, with stronger experimental and statistical controls. As Kropski et al. [7] exhorted, interventions aimed at reducing obesity in children and adolescents need to be more consistent and methodologically rigorous.

5. Conclusion

While the results of this study are mixed and inconclusive, we believe that they tentatively demonstrate the feasibility of employing the modified DPP curriculum in adolescent populations in school-based settings. Because the needs of children and adolescents differ from those of adults, more research should be centered around adolescents and even younger children. As children and adolescents spend more and more time at school, as they lead an increasingly sedentary lifestyle, and as they increase their unhealthy snack and fast food intake, the need for interventions such as the modified DPP curriculum presented here will become more pressing. Therefore, we welcome, and even challenge, researchers to improve upon our work of transforming the DPP curriculum into a successful intervention for children and adolescents alike through multischool, true experimental designs.

Appendices

A. Appendix A

See Figure 1.

B. Appendix B

See Table 4.

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