Annals of Case Reports & Reviews

Research Article

doi: 10.39127/2574-5747/ACRR:1000180.
Perry AC, et al. Annal Cas Rep Rev: ACRR-180.

A Community-Based Summer Program Designed to Improve Physical and Psychosocial Health

(Running Title: A Community-Based Summer Program)

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Citation: Perry AC, Velasquez C, Mirandah S, Cruz N, Lee D (2020) A Community-Based Summer Program Designed to Improve Physical and Psychosocial Health. Annal Cas Rep Rev: ACRR-180.

Received Date: 24th November, 2020; **Accepted Date:** 28th November, 2020; **Published Date:** 05th December, 2020

Abstract

Background: *Evidence shows that adiposity rises and physical activity and fitness levels decline in youth during the summer months. The present study examined the effects of a novel translational health in nutrition and kinesiology (THINK) summer program on health-related variables including physical fitness and nutrition habits, social-emotional learning (SEL), and Science, Technology, Engineering, and Math (STEM) education.*
Methods: *A total of 36 underserved adolescents (mean age = 12 years) were randomly recruited from the Miami-Dade County Public School system to attend a free 6-week THINK Summer Program for rising 6th-8th graders.*
Results: *Anthropometric data revealed significant decreases in BMI z scores ($p<0.05$) and increases in lean body mass ($p<0.01$) with improvements in cardiorespiratory fitness ($p<0.001$), agility ($p<0.001$), flexibility ($p<0.001$) and power ($p<0.05$) for the entire sample. SEL improved for the entire sample ($p<0.01$) with no changes found in STEM learning. Attendees with a BMI > 85th % showed improvements in food habits ($p<0.05$).*
Conclusion: *Results showed innovative programs emphasizing nutrition and movement sciences can improve physical and psychosocial health in middle school adolescents during the summer.*

Keywords: *Physical fitness, kinesiology, social-emotional learning, nutrition habits, minority adolescents.*

Introduction

According to recent estimates, 31.8% of youth in the United States are either overweight or obese [1]. Evidence suggests that poor diet and sedentary lifestyle behaviors resulting in reduced physical fitness levels contribute to obesity and its' associated co-morbidities including cardiovascular disease, type 2 diabetes, cancer, and premature death [2,3]. Unhealthy eating behaviors [4] and low cardiorespiratory fitness levels [5] also track longitudinally into adulthood further exacerbating the current disease burden in the United States. The most precipitous drop in physical activity levels occurs as children transition from elementary to middle school [6,7] yet this also signifies a period when youth are starting to gain more autonomy making their own food selections, physical activity choices, and personal health decisions. Since pre-adolescence reflects a period of significant growth and maturation before personal lifestyle behaviors become ingrained and established, this may provide the perfect opportunity to initiate preventive strategies to promote positive healthy lifestyle behaviors in the long term.

Although many public schools have cut back on their requirements for physical and health education, it is during the summer months when students are most vulnerable to physical inactivity and weight gain. Studies have shown physical activity levels stagnate [8] or decline [9,10] during the summer. This is especially true for Latino and Black youth, particularly girls, who possess the highest rates of overweight and obesity [1] and more unfavorable markers of cardiometabolic health [11]. Carrel [9] noted decreases in cardiorespiratory fitness and increases in insulin and adiposity in youth during the summer when compared to the school year. Using pedometers, Fu [12] found reduced physical activity levels and lower cardiorespiratory fitness after summer in a group of lower income predominately Latino children. Von Hippel [13] documented unhealthy weight gain during the summer which accrued during a 3-year period with Latino and Black children showing the greatest risk.

Despite this vulnerable time period, several programs have shown improvements in physical activity, body mass index (BMI), and selected physical fitness components in minority youth [14-16]. Others have shown participants fail to meet national guidelines for physical activity participation [17,18]. According to the "structured day hypothesis", attending classes, recess, lunch, and physical education classes at designated times reduces screen time, snacking, and other unhealthy behaviors [19].

The inclusion of social-emotional learning (SEL) has also been shown to be a critical factor in improving positive behavioral outcomes in youth [20,21]. SEL is the process by which youth aquire and effectively apply the attitudes, knowledge, and skills necessary to set and achieve positive goals, make responsible decisions, regulate negative emotions, and develop supportive social networks [22]. Therefore, summer programs providing health-related activities, innovative experiences that include SEL and structure, may have the most potential for increasing physical fitness and positive lifestyle behaviors in youth.

Few summer programs have used health-related themes in nutrition and kinesiology rooted in science, technology, engineering, and math (STEM). We know of no programs featuring hands-on clinical or laboratory skills integrated with health-related themes that are supported by fitness/sport activities. Thus, summer may be the perfect opportunity to incorporate structure using novel experiences to help youth learn more about their bodies and the importance of their health by staying active. In the present study, a translational health in nutrition and kinesiology (THINK) summer program was developed for underserved middle school adolescents to improve personal health (nutrition habits and physical fitness), STEM education, and SEL.

Methods

Design and Recruitment

A pre-test post-test within group study design was conducted. The program reflected a collaborative effort between a local community organization and a major university. Participants were recruited through Weekly Briefings sent to principals of all Miami-Dade County Public Schools (M-DCPS) regarding free summer programs available to rising 6th-8th grade students. The study was approved by the Institutional Review Board for Use of Human Subjects in accordance with university guidelines (Protocol ID: 20190472, approved 06/04/2019). A total of 49 students representing 21 different schools from the M-DCPS system were initially recruited for the THINK summer program. Four students never attended, two dropouts occurred due to dislike of the physical nature of the program, and two more students left for vacation during the middle of the program. Therefore, 41 students completed the 6-week program. Another five students were absent on the final day of post-testing leaving 36 students available to complete baseline and post-testing evaluations.

Study Protocol

Attendance was taken daily during the program which ran Monday-Thursday 10:00 AM-4:00 PM for six hours per day. All parents were required to complete a standard medical questionnaire describing their child's medical history status and any current physical and/or mental health concerns. All measurements were conducted on site at the University of Miami Laboratory of Clinical and Applied Physiology.

Trained research assistants majoring in exercise physiology served as counselors and conducted all measurements after receiving a 2-week training workshop on program content and standardization of testing procedures to ensure accuracy and reliability of data collection. Assistants supervised physical fitness drills and sport activities during the course of the program. The same investigators performed baseline and post-testing data to ensure consistency and reliability of measurements, however, they were blinded to pre-test values.

Intervention

The intervention was divided into four main segments: academic (nutrition and kinesiology), STEM laboratories, fitness skills/sport activities, and SEL. Academics and fitness/sports skills were included every day while both SEL and STEM activities were offered 3 days/week during the 6-week program.

The introduction of health-related themes differed from the traditional pedagogical approach in that investigators used an "active learning" paradigm that engaged students with the materials presented, encouraged participation in class, and fostered group collaborative work [23]. Research shows enhanced learning using this model since it empowers learners to better apply and translate information provided [24]. Each health-related theme facilitated a greater understanding of concepts in nutrition and exercise physiology along with information reviewing the physiological benefits of an active, healthy lifestyle.

Laboratory experiences followed with reinforced educational themes enabling youth to learn more about their bodies from a science-based perspective. This included use of pedometers to learn how many steps are in one mile, goniometers to teach flexibility, dynamometers for measuring strength, Douglas bag and flow meters to teach respiratory function, and pressure cuffs for blood pressure and heart rate measurements. Students were also exposed to anatomical models of muscles and bones during anatomy lessons. Understanding of materials were assessed using games, such as "Simon Says" where students had to point to the correct bone (ulna, femur, acromion process) or muscle (deltoid, biceps, gastrocnemius) to stay in the game.

The physical activity component emphasized motor skill acquisition that reinforced laboratory experiences and health-related themes. Team relays and games were integrated with educational materials. For example, following a nutrition unit, students had to sprint to a supermarket bag, randomly select a grocery item, then sprint back to the MyPlate poster and place the item under the correct food group. Points were awarded to the fastest team with the most accurate placement of supermarket items.

The SEL component included several modules throughout the program centered around helping youth learn how to adopt a growth mindset, establish and achieve positive goals, regulate emotions to attain favorable results, understand personality tendencies to overcome challenges, and achieve a positive interface within their communities. These modules were delivered in both large and small group formats that enabled students to actively engage with their peers and counselors in conducting applied, hands-on activities that prompted shared learning.

The curriculum included learning experiences within the larger framework of the Social Cognitive Theory [25] to promote self-efficacy, improve cognitive-perceptual factors, and perceived benefits of an active fit lifestyle. The THINK summer program prepared adolescents for perceived barriers by providing interactive educational, clinical, and movement experiences that stimulated learning and physical activity in a positive, receptive environment.

Measurements

Questionnaires and Scales. SEL was measured by the Positive Youth Development Inventory (PDYI), a 58- item questionnaire measuring five subscales of youth development: character, competence, confidence, connection, and contribution [26]. The PDYI has been shown to provide a valid reliable estimate of positive youth development with Cronbach's alpha = 0.92 [26]. The Middle/High School Attitudes STEM survey used exploratory factor analysis to assess construct validity to measure student attitudes toward STEM education. Information on critical thinking, communication, and collaboration, referred to as 21st Century Skills were added to the questionnaire with sampling conducted on 9,081 students in 6th-12th grades [27]. Reliability of all constructs used in the development of the questionnaire was $r = 0.83$. The Adolescent Food Habits Checklist (AFHC) encompassed a 23- item checklist used to assess dietary intake. It included dietary decisions in which adolescents possessed more personal dietary control such as avoidance of calorically dense foods, choosing low-fat alternatives, selecting fruits and vegetables, and avoidance of snacking. The AFHC had a high internal reliability with Cronbach's alpha = 0.82 and test retest reliability at $r = 0.90$ [28].

Physical Measurements

Anthropometry. Height and weight were measured using a wall mounted stadiometer and digital scale (Conair Corporation, Stamford CT, USA). BMI was computed using weight (kg) divided by height (m^2). BMI percentiles were calculated based upon age and gender for average weight (< 85%), overweight/obese (≥ 85%), and obese only (> 95%) participants using Centers for Disease Control and Prevention guidelines. Body fat was measured using multi-frequency segmental bioelectrical impedance analysis using the InBody 570 machine (Seoul, South Korea) which has been shown to correlate with the DEXA machine to compute body composition in adolescents [29].

Physical Fitness. Upper body strength was measured by having participants squeeze a Jamar hydraulic hand held dynamometer as hard as possible using the dominant hand (JA Preston Corporation, Clifton, NJ, USA) according to procedures outlined by the American Society of Hand Therapists [30]. Cardiorespiratory fitness was measured using the Pacer test which has been shown to be a valid measure of cardio-respiratory endurance [31]. Abdominal muscular endurance was measured by having participants perform as many sit-ups as possible in one minute using the protocol developed by the President's Council on Physical Fitness and Sports [32]. Lower body power was measured via the VertecTM Jump Training System (Sports Imports, Hilliard OH, USA) using a static start jump in which the adolescent's standing height with the arm stretched overhead was subtracted from their maximum standing jump height after performing a squat countermovement [33]. For lower back and hamstring flexibility, participants were instructed to move a lever as far forward as possible while seated with their outstretched legs abutting a Sit-and-Reach Box (Acuflex I, Novel Products Inc, Rocktown, IL, USA) [34]. Agility was measured using a shuttle run test in which participants were required to run as quickly as possible between two parallel lines 9.14 meters apart after picking up two foam blocks (5.08 cm x 5.08 cm x 10.16 cm) according to procedures by the Presidents Council on Physical Fitness and Sports [32].

Statistical Analysis

All data were analyzed using an SPSS statistical package (version 24, IBM SPSS Inc, USA). Group means ± standard error of the mean (SE) were calculated for physical fitness characteristics, STEM, SEL, and nutrition habits. Data was initially screened for normality of distribution by calculating skewness and kurtosis, with values ± 2.00 deemed normal. No outliers were identified. A paired sample t-test was performed to determine significant differences between baseline and post-testing measurements on all outcome measures at the completion of the program. Associations among all variables were analyzed using bivariate correlations (r values) conducted for the entire sample, by BMI percentile (< or ≥ or 85%), and by gender.

Results

Age and demographic information are presented in table 1. The average age of participants was 12 years. Latino adolescents comprised the greatest number of participants at 69.4%, followed by Black at 16.7%, Asian at 8.3%, and White at 5.6% adolescents. The sample also featured an even split by gender with 18 boys and 18 girls in each group.

Characteristics (*n*=36)	Values
Age (years)	12
Race/Ethnicity (%)	
Latino	69.4
Black	16.7
Asian	8.3
White	5.6
Gender (%)	
Boys	50
Girls	50

Table 1: Participant characteristics at baseline.

Shown in table 2 are the anthropometric data of participants at baseline and post intervention. Although BMI scores did not change, BMI *z* scores went down (t = 2.33, p<0.05), while both total body weight (t = -5.04, p<0.001) and lean body mass (t = -3.40, p<0.01) significantly increased. No significant changes were found in any other anthropometric variables following the program.

	Baseline (*n*=36)	Post-Testing (*n*=36)	P value [b]
Height (cm) [a]	157.43 ± .67	158.01 ± .58	0.45
Weight (kg) [a]	55.65 ± 5.39	56.57 ± 5.38	<0.001
BMI (kg/m^2) [a]	22.63 ± .84	22.51 ± .82	0.52
BMI *z* score [a]	.04 ± .17	-.06 ± .16	<0.05
Body Fat (%) [a]	28.61 ± 1.71	27.97 ± 1.68	0.14
Lean Body Mass (kg) [a]	38.79 ± 2.99	39.77 ± 3.01	<0.01

Note. SE = Standard Error.
[a] Mean ± SE
[b] Paired sample t-test

Table 2: Anthropometric characteristics at baseline and post-testing.

Reported in table 3 are the physical fitness and SEL mean scores at baseline and post-testing. For the entire sample, cardiorespiratory fitness (t = -4.69, p<0.001), agility, (t = 4.94, p<0.001), flexibility (t = -4.24, p<0.001), power (t = -2.36, p<0.05), and SEL improved (t =-3.23, p<0.01). Upon further analysis, it was shown that in those < the 85th% for BMI, aforementioned variables improved with the exception of power and SEL. For participants ≥85th % for BMI, the same variables improved as for the entire sample. For boys only, the same variables improved with the exception of power and SEL. For girls, the same variables improved as for the entire sample with the exception of power. Not included in this table are the results for STEM learning, which showed no significant improvements following the program (t = -0.92, p=0.36).

	Baseline [a]	Post-Testing [a]	P value [b]
Total Sample (*n*=36)			
Cardiorespiratory Fitness [c]	20.89±2.14	23.69±2.21	<0.001
Strength (kg)	10.30±1.35	10.35±1.35	0.899
Agility (sec)	12.69±0.21	12.05±0.25	<0.001
Flexibility (cm)	26.00±1.37	28.65±1.26	<0.001
Power (cm)	38.15±0.96	44.30±1.32	<0.05
Muscular Endurance [d]	29.17±2.17	26.33±1.60	0.148

SEL [e]	3.27±0.05	3.35±0.05	<0.01
BMI <85th Percentile (*n*=20)			
Cardiorespiratory Fitness [c]	25.65±3.00	27.90±3.09	<0.05
Strength (kg)	10.2±1.94	10.29±2.21	0.835
Agility (sec)	12.20±0.25	11.52±0.33	<0.01
Flexibility (cm)	23.63±1.99	26.06±1.87	<0.01
Power (cm)	41.12±1.65	48.49±2.28	0.158
Muscular Endurance [d]	28.56±3.11	26.88±2.27	0.472
SEL [e]	3.27±0.07	3.31±0.07	0.249
BMI ≥85th Percentile (*n*=16)			
Cardiorespiratory Fitness [c]	14.94±2.34	18.44±2.67	<0.001
Strength (kg)	10.42±1.95	10.42±1.49	1.00
Agility (sec)	13.21±0.31	12.61±0.31	<0.01
Flexibility (cm)	28.71±1.66	31.61±1.32	<0.05
Power (cm)	34.98±0.85	39.80±1.17	<0.01
Muscular Endurance [d]	29.86±3.11	25.71±2.33	0.217
SEL [e]	3.26±0.07	3.41±0.08	<0.01
Boys (*n*=18)			
Cardiorespiratory Fitness [c]	24.44±3.71	27.83±3.87	<0.05
Strength (kg)	11.12±2.21	10.8±2.26	0.546
Agility (sec)	12.49±0.34	11.86±0.35	<0.01
Flexibility (cm)	24.29±1.81	26.85±1.73	<0.05
Power (cm)	42.37±1.56	45.06±1.43	0.159
Muscular Endurance [d]	24.94±1.67	25.06±1.71	0.958
SEL [e]	3.19±0.08	3.27±0.08	0.121
Girls (*n*=18)			
Cardiorespiratory Fitness [c]	17.33±1.89	19.56±1.76	<0.05
Strength (kg)	9.23±0.94	9.75±0.97	0.265
Agility (sec)	12.93±0.22	12.27±0.34	<0.01
Flexibility (cm)	28.23±2.02	31.00±1.70	<0.01
Power (cm)	33.02±0.69	43.38±2.42	0.070
Muscular Endurance [d]	34.69±4.11	28.00±2.97	0.051
SEL [e]	3.34±0.06	3.44±0.07	<0.01

Note. SEL = Social-Emotional Learning, SE = Standard Error
[a] Mean ± SE
[b] Paired sample t-test.
[c] Number of laps completed.
[d] Number of sit-ups completed in one minute.
[e] Total score.

Table 3: Physical fitness and SEL values at baseline and post-testing.

Table 4 presents the relationships between body composition and physical fitness. For the entire sample, body fat was inversely related to cardiorespiratory fitness, (r = -0.69, p<0.001) and persisted in those < and ≥ the 85th% for BMI (r = -0.71 and -0.73 respectively, p<0.01 for both), in boys (r = -0.84, p=0.001), and in girls (r = -0.50, p<0.05). Larger and slower times on the agility test was positively correlated with % body fat for the entire sample (r = 0.60, p<0.001) and persisted in those < 85th % (r = 0.50, p<0.05), and in boys (r = 0.63, p<0.01). Body fat was also inversely related to grip strength in those ≥ 85th % for BMI (r = -0.80, p<0.01) yet postively related to flexibility for the entire sample (r =0.38, p<0.05). Power was inversely correlated with adiposity for the entire sample (r = -0.43, p<0.05), in those < 85th% for BMI (r = -0.51, p<0.05), and in boys (r = -0.62, p<0.01). Lean body mass was correlated with cardiorespiratory fitness in those < 85th % and ≥ 85th% for BMI (r = 0.45 and r = 0.52 respectively, p<0.05 for both), with grip strength for the entire sample (r = 0.75, p<0.001), in those with a BMI < 85th% (r = 0.87, p<0.001) and ≥ 85th% (r = 0.74, p<0.01), and in boys (r = 0.82, p<0.001). Greater lean body mass was inversely related to lower (faster) times on the agility test scores in those ≥ 85th% for their BMI (r = -0.63, p<0.05). Greater lean body mass also translated into greater power with higher scores on the vertical jump test evidenced in those with a BMI ≥ 85th % (r = 0.80, p<0.001), and in boys (r = 0.61, p<0.05).

		Cardiorespiratory Fitness		Strength		Agility		Power		Flexibility	
		R	**P value**	***r***	**P value**	***r***	**P value**	***r***	**P value**	***r***	**P value**
Total Sample (*n*=36)	Body Fat (%)	-0.69	<0.001	-0.29	0.114	0.60	<0.001	-0.43	<0.05	0.38	<0.05
	Lean Body Mass (kg)	0.22	0.194	0.75	<0.001	-0.25	0.180	0.32	0.076	0.36	0.053
<85th Percentile (*n*=20)	Body Fat (%)	-0.71	<0.001	-0.38	0.140	0.50	<0.05	-0.51	<0.05	0.21	0.419
	Lean Body Mass (kg)	0.45	<0.05	0.87	<0.001	-0.44	0.085	0.38	0.144	0.24	0.368
≥85th Percentile (*n*=16)	Body Fat (%)	-0.73	<0.01	-0.80	<0.01	0.51	0.052	-0.34	0.213	-0.05	0.853
	Lean Body Mass (kg)	0.52	<0.05	0.74	<0.01	-0.63	<0.05	0.80	<0.001	0.15	0.608
Boys (*n*=18)	Body Fat (%)	-0.84	0.001	-0.36	0.149	0.63	<0.01	-0.62	<0.01	0.29	0.257
	Lean Body Mass (kg)	0.36	0.152	0.82	<0.001	-0.36	0.162	0.61	<0.05	0.40	0.118
Girls (*n*=18)	Body Fat (%)	-0.50	<0.05	-0.03	0.919	0.52	0.055	-0.30	0.288	0.50	0.079
	Lean Body Mass (kg)	-0.40	0.096	0.26	0.376	0.01	0.965	0.03	0.903	0.65	0.016
Note. r = correlation coefficient.											

Table 4: Relationship between physical fitness and anthropometric measures at post-testing.

Shown in table 5 are changes in the AFHC follwing the program. Although a 12% improvement in the AFHC was observed following the program, it failed to reach statistical significance. However, in participants whose BMI ≥85th %, there was a significant improvement in food habits (t = -2.69, p<0.05). There were no other changes in food habits in any other subsample of participants. Not presented in table form was the significant relationships between AFHC and SEL for the entire sample (r = 0.41, p<0.05) and the positive relationship between sugar intake and adiposity found for the entire sample (r = 0.33, p<0.05).

Category	Food Habits Baseline [a]	Food Habits Post-Testing [a]	% increase [b]	P value [c]
Total Sample (*n*=36)	11.414	12.736	12%	0.064
BMI < 85th Percentile (*n*=20)	11.495	12.075	5%	0.581
BMI ≥ 85th Percentile (*n*=16)	11.313	13.563	20%	<0.05
Boys (*n*=18)	10.972	12.639	15%	0.078
Girls (*n*=18)	11.856	12.833	8%	0.376

Note. [a] Mean ± SE. The Adolescent Food Habits Checklist provides a maximum of 23 points with the higher score indicating more positive eating behaviors.
[b] Values are rounded off to whole numbers.
[c] Paired-sample t-test.

Table 5: Adolescent food habits checklist at baseline and post-testing.

Discussion

The THINK program was a unique summer study using hands-on laboratory experiences integrated with health-related themes in nutrition and kinesiology to enhance the promotion of active lifestyle behaviors. Physical fitness and included after sport activities were to provide motor skill acquisition and team play while. SEL helped participants to adopt a positive growth mindset in a supportive environment. The study reflected a community-university partnership designed to create a culture of health and fitness that was racially/ethnically sensitive to all participants.

We found significant decreases in BMI *z* scores that were balanced by an increase in lean body mass with no changes in adiposity levels. This is especially important during the summer months when declines in fitness and gains in weight and BMI have been reported to occur more frequently in minority youth [12,13]. Moreno and colleagues [35] noted increases in BMI *z* scores every summer since 1st grade in children 6-11 years and these patterns were more pronounced in those who were overweight, obese, and Latino. Obesity and its' associated co-morbidities track well into adulthood and disproportionately affect Latino and Black children [36]. The burden of obesity among Latinos and Black minorities has been a critical health issue having long term implications. With almost 70% of participants being Latino and almost 95% of attendees being of color, deceased BMI *z* scores along with positive gains in lean body mass were very promising.

Gains in several physical fitness measures including cardiorespiratory fitness, agility, flexibility, and power were observed for the entire sample. Furthermore, in those whose BMI ≥ 85th%, aerobic fitness increased 23.4%, power increased 13.8%, flexibility increased 10.1%, and agility increased 8.3%. Globally, fitness levels have been reported to be declining for years [37] therefore, gains in several health-related fitness variables are particularly compelling. In a 6-week fitness summer camp for predominantly minority youth, adolescents evidenced declines in BMI and waist circumference along with improvements in calisthenic exercises, however, no standard measures of cardiorespiratory fitness levels were evaluated [16]. In a 2-week residential camp of primarily obese Latino children, significant body weight and adiposity losses were observed, however, no changes in cardiorespiratory fitness were found, most likely, due to the short program length [14]. Even longer- term programs conducted across 1-1.5 years in primarily Mexican [38] and African American youth [18], failed to show increases in physical activity levels and cardiorespiratory fitness. We believe the strong emphasis on motor skill acquisition integrating sport activities and fitness skills demanding high energy expenditure may have contributed to gains in several physical fitness variables.

According to the Task Force on Community Preventive Services, gains in physical fitness are associated with reduced adverse medical conditions including ischemic heart disease, type 2 diabetes, hypertension, colon cancer and quality of life [39]. Our findings supported the fact that at post-testing, greater levels of adiposity were inversely related to cardiorespiratory fitness and power, and in those whose BMI ≥ 85th %, lean body mass was positively related to cardiorespiratory fitness, strength, agility, and power. Given the significant relationship between physical fitness and body composition and its impact on physical health, programs of this nature should serve as the cornerstone treatment for the promotion of active, healthy lifestyle behaviors in youth.

It is well known that certain individual personality variables and social characteristics can lead to healthy child behaviors and adolescent development. Therefore, a great deal of time was spent discussing personal values and real life responsibilities, using different case scenarios with role playing to discuss strategies to better handle difficult situations. Significant improvements in SEL were found with those ≥ 85th% for BMI, and girls contributing to the bulk of positive gains. According to experts, obesity and levels of fitness can impact adolescents' psychological outcomes and buffer against the negative effects of low self-esteem and depression [40]. Since participants selected "healthier eating" as a primary goal in their SEL modules, it was not surprising that food habits were positively related to SEL. In agreement with the findings by Wang [14] in her 2-week residential camp, SEL was unrelated to any physical fitness variables. Therefore, psychosocial measures appeared to operate independently of physical performance measures.

Positive lifestyle behaviors should reflect nutritional needs of adolescents especially during a period of accelerated growth. Unfortunately, many adolescents fail to meet dietary recommendations for important nutrients [41] and during the summer break, many eat larger portion sizes with high calories, fewer nutrients, and more energy dense foods [42]. The AFHC addressed areas in which adolescents have some degree of personal control. Attendees demonstrated a 12% improvement in their nutrition behaviors which although not significant, showed a trend in the positive direction. Improvements were driven by the 20% improvement in those with a BMI ≥ 85^{th}% and to a lesser extent, in boys. Compared to non-Hispanic Whites, Latino and African American youth show higher rates of obesity due to increased obesity promoting behaviors such as skipping breakfast, eating less fruits and vegetables, and lower rates of physical activity [43]. Therefore, in a program in which 86% of attendees were Latino and Black, improvements in dietary habits concomitant with increased physical fitness levels are quite positive. Interestingly, nutrition scores were significantly related to SEL for the entire sample. This signifies a positive relationship between psychosocial variables and healthy nutrition habits found in our sample of minority adolescents. When individual nutrient components were analyzed by body composition, sugar intake was the one nutrition variable related to adiposity for the entire sample. Future work is needed to further understand the relationship between specific sub-categories of food habits, body composition, and SEL components in adolescents.

Several limitations were noted in this study. Although 21 schools were represented in the study, 16% of participants dropped out with daily absences noted in those who attended. Even when students attended, several students arrived late or left early for personal reasons which reduced the final number of completed evaluations. Therefore, it would be important to recruit a greater number of students who are available to attend the full session for the entire duration of the program. Since there was no control group, it would be worthwhile to compare the THINK program to non-fitness summer programs i.e. music camps, art/painting camps. Moreover, accelerometers that measure physical activity and blood markers that measure insulin and glucose levels would have helped to provide clinical measures of metabolic health. Lastly, since a number of individuals were overweight/obese at baseline, there was the possibility of regression toward the mean.

Conclusion

Despite aforementioned limitations, our study showed that an after innovative summer curriculum featuring health-relates themes rooted in STEM-based laboratory experience and physical activities can improve anthropometric measures, physical fitness variables, and SEL. Nutrition behaviors were improved in students with a BMI ≥ 85%. This group also showed more pronounced improvements in physical fitness and SEL. The study also supported the significant interface between body composition and physical fitness variables that are ultimately linked to better metabolic health later on. Furthermore, the program demonstrated the importance of a strong partnership between a local university and the community in promoting health and fitness. Future research should focus on strategies to enhance long-term implementation and sustainability of the THINK program encompassing a larger number of participants using randomized control trials with greater emphasis on the interface of physical fitness with clinical outcome measures.

Funding

This work was supported by The Children's Trust of Miami-Dade County, Miami, FL [Grant number RFP2018-02 #5742].

Acknowledgements

The authors wish to acknowledge all the undergraduate and graduate students who gave so much of their time and energy in helping to run the program and who served as counselors to our participants. We wish to thank the participating schools for their cooperation in getting the word out about our program. We also wish to thank The Children's Trust for their assistance and help in supporting the implementation of our program.

Conflict of Interest

None declared

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