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A Comparison Between a Comprehensive Wellness-Based After-School Program and a Traditional YMCA After-School Program on Measures of Physical Fitness, Health-Related, and Executive Cognitive Function Variables in Minority Elementary School Children.

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Many intervention and prevention programs targeting physical activity and fitness in children and adolescents have been effective, however, few have targeted changes in physical fitness, health-related variables, and cognitive executive function in a single study. The purpose of this study was to compare the Translational Health in Nutrition and Kinesiology (THINK), a comprehensive wellness based after-school program, to a traditional YMCA after-school program on measures of physical fitness, health-related variables, and executive cognitive function in a group of 102 elementary school, minority children (mean age= 9.2 years) following a 10-week intervention period. This study was based on a quasi-experimental nonequivalent control group design. A series of two way mixed design ANOVA analyses were used to predict effects on physical fitness, health-related, and executive cognitive function measures by time and group. When a significant main effect was found, Sidak pairwise comparisons were performed to establish where differences were found. Significant interactions were found for all physical fitness ($p<0.01$) and health-related ($p<0.01$) variables. The THINK group showed improvements in all physical fitness ($p<0.01$) and health-related ($p<0.01$) variables post-testing, while the traditional YMCA

group showed either no change or significant decreases. Furthermore, a significant interaction was found for average reaction time ($p<0.01$) with the THINK group showing significant increases ($p<0.01$) while the traditional YMCA evidenced no improvements post-testing. Although no statistically significant interactions were observed for percent accuracy ($p=0.15$), the THINK group evidenced significant improvements ($p<0.01$) while the traditional YMCA showed no changes post-testing. Our findings showed that a comprehensive after-school program, THINK, was more effective in improving physical fitness, health-related, and executive cognitive variables compared to a traditional YMCA program. This lends support for establishing programs with a comprehensive approach to improve outcomes that may have positive effects on physical fitness, health, and academic performance in children.

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Chapter 1

Introduction

Research has shown that regular participation in physical activity plays a dominant role in the prevention and treatment of chronic diseases such as metabolic syndrome, cardiovascular disease, and Type II diabetes (Center for Disease Control and Prevention [CDC], 2009; Hallal, 2006; Sothern, 1999, Warburton, 2006). In addition to positive health benefits, physical activity has been shown to have favorable effects on cognitive function (Hillman 2004, 2008, 2010, 2012; Gunstad, 2007, 2008), self-esteem and self-efficacy (DeBate, 2009; Ortega, 2008), as well as academic performance (Castelli, 2007; Sibely, 2003).

Unfortunately, nationwide, less than one-third of children between the ages of six and 17 engage in vigorous physical activity, defined as activities lasting at least 20-minutes that make the child sweat and breathe hard (Robert Wood Johnson Foundation [RWJF], 2008). Less than 30% of children in the United States meet the physical activity recommendations of at least 60-minutes of moderate to vigorous activity on five or more days per week (CDC, 2009; United States Department of Health and Human Services [USDHHS], National Center for Chronic Disease Prevention and Health Promotion [NCCDPHP], 2008). Additionally, significantly fewer students in Miami-Dade County meet the national recommendations for physical activity participation (CDC, 2009; USDHHS, 2008).

Not surprisingly, 34% of children and adolescents nationwide have been reported to fail their standardized President's challenge physical fitness tests (NIHCM, 2008). Research supports a significant inverse relationship between aerobic fitness levels and cardiovascular disease risk factors, which may track into adulthood, emphasizing the need to encourage healthy lifestyle behaviors as early as possible in children. This may be particularly relevant for minority youth who demonstrate low physical activity and fitness levels throughout their childhood and adolescent years (Burton & VanHeest, 2007; Sallis et al., 2000). Research has illustrated that in both Hispanic and African-American children, as physical activity and fitness increases, the prevalence of overweight and obesity status decreases (Atintas, 2008; Sharma, 2009; Swallen, 2005; Ogden et al., 2010). Overweight and obesity show the highest prevalence rates in minority children of Hispanic and African-American backgrounds (CDC, 2012; Freedman, 2006). Thus, it would be particularly important to improve physical activity and fitness levels in these populations.

Although many intervention and prevention programs targeting physical activity and fitness in children and adolescents have been shown to be effective, few have incorporated a combination of activities focusing upon the development of physical fitness (McKenzie, 2009, Kropski, 2008; Davis 2007; Sallis, 1997), health-related variables (Gortmaker, 2012) , and executive cognitive function (Kamijo, 2011) in a single study.

Executive cognitive function refers to a subset of goal-directed processes that encompass the selection, scheduling, inhibitory control, and coordination of computational processes (Hillman, 2009). These processes are involved in perception, memory, attention, behavioral inhibition, verbal reasoning, and monitoring of actions. Measures of executive cognitive function are extensively used by researchers as a proxy of overall cognitive ability. Growing evidence suggests that executive cognitive function may be inversely associated to obesity in childhood (Agranat-Meged et al., 2005; Davison, 2000; Gunstad, 2008, 2009), adulthood (Cserjesi, 2009; Gunstad, 2007), and in the elderly (Elias, 2003; Gunstad, 2010).

A cross-sectional study conducted with 212 minority children at the University of Miami showed that executive cognitive function was inversely related to central obesity and positively related to physical fitness. Thus, children who had lower central fat distribution and greater aerobic fitness on the two-minute walk test exhibited faster reaction times on the executive cognitive function task (Mantilla, 2014). In another study of preadolescent children, seven to nine years-old, the relationship between weight status and cognition was analyzed using a comprehensive assessment of cognitive function, academic achievement, and measures of adiposity. Body mass index (BMI) and fat mass measured via Dual-energy X-ray absorptiometry were negatively associated with cognitive function reinforcing the inverse relationship between BMI and fat mass with cognitive performance. Higher BMI and fat mass were also correlated with lower academic achievement (Kamijo, 2012). The results of studies indicating that lower adiposity and higher fitness levels are associated with better health status and cognitive performance in children, highlight the need to provide children opportunities to lead more physically active lives.

The present study evaluated the effects of the Translational Health in Nutrition and Kinesiology (THINK) after-school program on: physical fitness (cardiovascular, strength, motor skills, power, and flexibility), health-related variables (body composition, central obesity), and executive cognitive function (percent accuracy, average reaction time) in children. The THINK program (intervention) was compared to a traditional

YMCA after-school program (control), using the Sports, Play, and Active Recreation for Kids (SPARK) (McKenzie 2009; Sallis 1997) as the fitness curriculum, to determine differences between groups in these factors over the 10-week intervention period. The SPARK curriculum has been used in school-based physical education classes (Cardon, 2009; Sallis et al., 1993) and after-school (Cardon, 2009; McKenzie, 2009) settings to target changes in physical activity in children. SPARK is widely used as the primary physical fitness curriculum by the YMCA in their traditional after-school programs throughout Miami-Dade County.

Investigators hypothesized that the THINK after-school program would result in significant improvements in physical fitness (Gortmarker, 2012; Edwards, 2011; McKenzie, 2009; Wong et al, 2009; Stice 2006), health-related variables (Edwards, 2011; Freedman, 2005; Caballero et al. 2003), and/or executive cognitive function (Mantilla, 2014; Kamijo, 2011; Gunstad, 2008; Hillman, 2008) across the 10-week intervention and these changes would be significantly greater than any resulting from the traditional YMCA after-school program.

Chapter 2

Methods

Changes in measures of physical fitness, health-related fitness, and executive cognitive function for the THINK after-school program and a traditional YMCA after-school program were compared following a 10-week intervention period (Figure 1). Evaluation occurred at two time points: 1) prior to the after-school program and 2) following the completion of the after-school program. This study used a quasi-experimental nonequivalent control group design (Gay, Mills, & Airasian, 2009). A timeframe of 10 weeks was chosen for the intervention to examine the effects of the program. Other studies have reported significant changes in physical fitness variables following a seven to 10-week period (Edwards, 2011; Kamijo, 2011; Flodmark, 2006 McMurray, 2002; Rodgers, 2001)

Sample and Recruitment

A total of 105 healthy children (eight to 12 years old) were recruited from YMCA sites throughout Miami-Dade County (THINK n=51, YMCA n=54) (Table 1.). Potential subjects and their parents were informed of the study by YMCA staff through contact letters and flyers. From a total 60 YMCA locations, two sites were selected based on demographic information provided by the YMCA. These sites were matched by socioeconomic status (SES) and race/ethnicity. The site designated as the control had funding to support the traditional YMCA program including the SPARK fitness curriculum. The designated intervention site did not have funding for the tradtional program and had outdoor free play as their fitness component. The scheduling components at each site, with the exeception of the educational curriculum, were the same. During the study, THINK was used as the fitness curriculum in the intervention site while the control site retained SPARK. Within the two sites, the sample of students was selected based on the inclusion and exclusion criteria (Figure. 1).

Inclusion criteria consisted of meeting the age requirements (eight to 12 years-old), being enrolled in a YMCA program, and being able to participate in physical activity. Exclusion criteria included metabolic, cardiovascular, neuromuscular and psychological disorders, and medications that would interfere with testing results. Based on aforementioned criteria there were no subjects excluded from this study. A total of 51 children participated in the THINK program, while 54 were in the YMCA program. A Chi-square analysis showed no statistical differences between the THINK and traditional YMCA groups by age, gender, or race/ethnicity (Table 1.).

Table 1. A comparison of participant demographics between THINK and Traditional YMCA groups using Chi-square analysis

Demographic Variables	**THINK (n=51)**	**Traditional YMCA (n=54)**	**Total (n=105)**
Age (mean years; SD)	9.22(1.00)	9.21(1.07)	9.22(1.03)
Gender			
Boys (*n*)	30	30	60
Girls (*n*)	21	24	45
Race/Ethnicity			
White Hispanic or Latino (%)	88.2	85.2	86.7
White Non- Hispanic or Latino (%)	7.8	7.4	7.6
Black Non- Hispanic or Latino (%)	4.0	7.4	5.7

Notes: **SD: Standard deviation. THINK: Translational Health in Nutrition and Kinesiology.**
($\chi(1) = 0.70$, $p = 0.87$) for group by age; ($\chi(1) = 0.19$, $p = 0.67$) for group by gender; ($\chi(1) = 0.35$, $p = 0.84$) for group by race/ethnicity.

All procedures were approved by the University of Miami Subcommittee for the Use and Protection of Human Subjects in conjunction with the YMCA. The YMCA provided an agreement letter consenting full support of the study. Parents were provided with information packets regarding project details including requirements, benefits, incentives, a parental consent form, and child assent form. Once consented, parents received a health questionnaire regarding their children. The questionnaire was required prior to the pre-test and post-test data collection. All children enrolled in the project received a report of their fitness, body composition, and executive cognitive function.

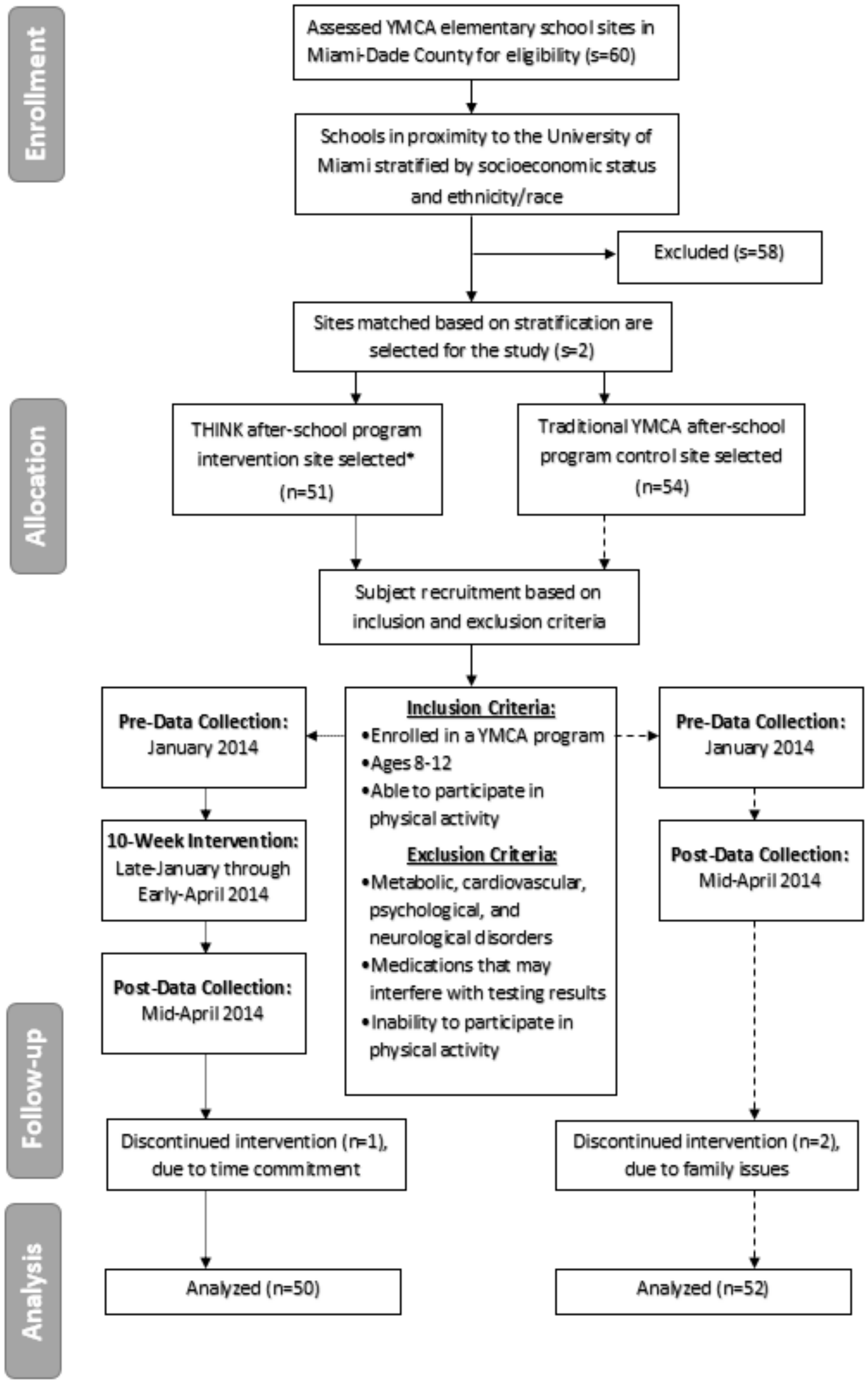

Figure 1. Consolidated Standards of Reporting Trials flowchart.
Notes: *Intervention site selected based on proximity to the University of Miami. s= number of sites; n= number of children.

THINK and YMCA Program Structure

The THINK program provided an interactive curriculum based on experimental learning through the use of technology to enhance knowledge. Hands-on health and wellness activities, daily fitness sessions, weekly lessons, laboratories, and cooking sessions were offered. These sessions were provided by a doctoral student, as well as masters and undergraduate students in exercise physiology with the supervision of YMCA staff. To improve fitness, a wide selection of developmentally appropriate and multiculturally sensitive activities were provided as indicated in the 2000 and 2004 National Association for Sport and Physical Education manuals. The daily fitness sessions of 60 minutes were designed to facilitate a fun environment for the purposes of promoting learning and physical activity. Curriculum components called THINK Brain Games were integrated during the activity and fitness sessions. These components were task oriented, requiring logic and team building skills to stimulate cognitive function and enhance learning through movement. Weekly educational periods such as lessons, laboratory, and cooking sessions were provided for a duration of 60 minutes each. The total contact time per week for the THINK program was approximately eight hours: five hours of physical fitness and 3 hours of education. All program components incorporated weekly themes, facilitated with technology, focusing upon anatomy, physiology, health, and nutrition. The THINK program had weekly goals for fitness and curriculum knowledge. The control group received a traditional YMCA after-school program provided by YMCA staff. This YMCA program was based on the SPARK curriculum which provided daily physical activity for a duration of 60 minutes. The traditional physical fitness sessions encompassed sports and games to increase movement and team play with no specific fitness goals. This group did not receive lessons, laboratories, or cooking sessions. The total contact time per week for the traditional program was approximately five hours of physical fitness.

Measures

All data were collected on the YMCA sites where the interventions occurred under the supervision of YMCA staff. The research team from the University of Miami administered all tests. A total of 35 exercise physiology undergraduate and graduate students underwent a two-week intensive training program. Throughout the training, students were taught to establish uniform assessment and data collection procedures. In early January 2014, prior to preliminary data collection, the research staff was reassembled to review standard testing protocols, maintain uniformity in measurements of dependent variables, and establish test/re-test reliability of all measures. To minimize measurement error, all evaluations were conducted by the same researchers pre- and post-testing. The data collection sessions lasted between two and three hours.

A modified health questionnaire was used to collect information regarding: each child's academic status, general health, family socioeconomic status, and contact information (Institute of Medicine [IOM], 2013).

Physical Fitness Measures

The National Institute of Medicine (NIH) Toolbox two-minute Walk Endurance Test was used to measure aerobic fitness (NIH, 2012).. This test was adapted from the American Thoracic Society's six-minute walk test protocol. A 50 ft course was used for the test.

A Jamar plus handgrip dynamometer (Sammons Preston, Bolingbrook, IL) was used to measure grip strength. Participants were seated in a chair with the elbow bent at a 90-degree angle and wrist in neutral position as the arm was positioned against the trunk. Each participant squeezed the dynamometer as hard as possible for a count of three. The dynamometer provided a digital reading of force in pounds. Subjects completed a practice trial followed by two test trials with the highest value recorded for each hand (NIH, 2012).

The one-minute curl-up test was used to measure abdominal strength and endurance. This was done by recording the maximum number of curl-ups performed in one-min until the subject could no longer perform the curl-up in proper form (The President's Challenge, 2013).

The wall squat test was used to assess the child's lower body strength and endurance, specifically for the quadriceps muscle group (Welk, 2008). Each participant began with their back against the wall, feet flat on the ground, and 90 deg angles at the hip and knee joints. The subject then held this position as long as possible. The test started when the subject assumed the proper position and ended when the subject could not maintain the position in proper form.

A vertical jump test utilizing a Vertec (Vertec, Knoxville, TN) was completed to assess lower body power (Sargent, 1921). The vertical jump distance was recorded by measuring the difference between the standing reach and the height reached at the end of the highest vertical jump. Three trials were completed and the highest value was recorded.

The 30-foot shuttle run is a standard test used to measure motor skills and agility (The President's Challenge, 2013). The child was asked to run from a starting cone to a second cone placed 30 feet away as fast as possible. There were two wooden blocks (approximate size of 2" x 2" x 4") aligned with the second cone. Each child was required to pick-up the blocks (one at time) and return them to the starting cone as soon as possible. Scores were recorded to the nearest tenth of a second using a handheld stop watch (Osolo, China) (President's Challenge, 2013).

A sit-and-reach box (Flexer-tester, Novel Product Inc., USA) was used to assess lower body flexibility (lower back and hamstrings). Participants removed their shoes and sat on the floor with their knee joints in full extension and soles of the feet placed flat against the end of the box. With hands placed on top of each other, palms down, and legs held flat, the participant reached along the measuring line as far as possible. After three practice reaches, the fourth reach was required to be held for three seconds while the distance was recorded (The President's Challenge, 2013).

Health-Related Measures

Health-related variables included: BMI, body fat percentage, sagittal abdominal height (SAH), and waist circumference. Body composition was measured using the Inbody-520 multi-frequency bioimpedance analyzer (Biospace, Beverly Hills, CA), which assesses body composition by measuring the speed at which electrical currents of different frequencies travel through different body tissues (Inbody, 2006). Information recorded included: body weight, percent body fat, and BMI. Height (centimeters) was measured using a Weigh Beam Eye-Level physicians' scale (DETECTO, Webb City, MO, USA). The SAH was used as predictor of visceral abdominal fat (Sampio, 2007;

Riserus, 2004). A portable anthropometer (Lafayette Instrument Company, Lafayette, IN) was used to measure SAH and was placed at the level of the iliac crest (L_{4-5}) while the subject was laying on an examination table. The caliper arm was positioned to touch the abdomen slightly but without compression as the distance between this point and the examination table was measured to the nearest 0.1 cm after a normal expiration (Sampio, 2007; Riserus, 2004). Waist circumference was used to indicate central obesity by placing a Gulick spring loaded measuring tape (Dunlee, Aurora, IL) midway between the caudal part of the lateral costal arch and the iliac crest (WHO, 2008). Measurements were recorded in centimeters while in a standing position with feet shoulder width apart.

Executive Cognitive Measure

A computer-based, executive cognitive test, a flanker task, was used to assess executive cognitive function. The flanker task is used to measure a subject's capacity for motor inhibition. In this paradigm, a subject must respond to a target stimulus with either the right or left hand. One classical setup is to use an arrow pointing to the left or right as a target. Therefore if the participant sees "<", they respond with their left hand and if the participant sees ">", they respond with their right hand. The target is flanked by identical symbols that are either aligned with the target (congruent trial, "<<<<<" or ">>>>>") or point in the opposite direction (incongruent trial, <<><< or >><>>) (Eriksen, 1979). The design was modeled after Hillman et al (2006), who used a modified flanker task for children eight to 12 years-old. The visual angles were 1.1° vertical, 8.7° horizontal. The subject was seated ~50 cm from the test screen. The cognitive battery provided average reaction time and percent accuracy. This battery has been used to evaluate executive cognitive function in elementary school children (Mantilla 2013; Hillman 2009, 2005).

Statistical Analysis

All data were analyzed using SPSS 19 Software (IBM, Armonk, New York, USA). Statistical analyses was limited to those students who completed pretest and post-test sessions. In the case of missing data, the participant was excluded from the statistical analysis.

A power analysis using G-Power 3.1.7 (Stony Brook University, Stony Brook, NY) indicated that a total sample size of 74 subjects was required for the test of the overall ANOVA repeated measures, within factors model in order to ensure 80% power. To be conservative, a small effect size (.15) was chosen (Cohen, 1977), significance was set a priori at alpha .05, power (1-β prob) was 0.8, the number of groups was two (THINK and YMCA), number of measures was three (physical fitness, health-related variables, and cognitive function), correlation among repeated measures was 0.5, and nonsphericity correction was one (de Heer, 2011; Kamijo, 2011; Davis, 2007; Thomas, 2006; Kedler, 2005).

A series of 14 separate two-way mixed design ANOVA's, 2 time points (pre- time 1, post -time 2) x 2 (Group: YMCA, THINK) were conducted to examine changes within groups and differences between groups over time following the intervention period.

Sphericity was assumed with two time points (pre and post). For all dependent variables, quantile-quantile (q-q) plots were examined by groups, which showed that all dependent variables were normally distributed. The assumption of homogeneity of error variance by groups was checked. When a significant main effect was found, pairwise comparisons were conducted to establish where differences were found. Sidak adjustments were selected since they are less stringent than Bonferoni and better able to detect differences reducing the likelihood of committing a Type II error. Significance was set a priori at alpha ≤ 0.05.

Chapter 3

Results

This study compared the effects of a comprehensive wellness based program, THINK, to a traditional YMCA after-school program on physical fitness, health-related, and executive cognitive function variables. The study sample initially began with 105 children (THINK=51, YMCA= 54). At the conclusion of the study there were 102 children (THINK=50, YMCA= 52).

Physical Fitness Variables

No significant differences at baseline were observed between the THINK and YMCA group in physical fitness variables. As shown in Table 2, there were significant group by time interactions for the two-minute walk (F(1, 100)= 11.3, $p< 0.001$, $\eta^2 p= 0.10$). The interaction occurred because distance covered for the THINK group was significantly greater ($M_{diff}= 60.30$, $p<0.001$) than the traditional YMCA group ($M_{diff}= -0.08$, $p= 0.99$). A significant interaction was found for both right-handgrip (F(1, 100)= 45.82, $p< 0.01$, $\eta^2 p= 0.31$) and left-handgrip strength ((F(1, 100)= 63.31, $p< 0.001$, $\eta^2 p= 0.39$). This was identified as significant increases in both right-handgrip ($M_{diff}= 4.48$, $p<0.001$) and left-handgrip strength ($M_{diff}= 4.54$, $p<0.001$) were found in the THINK group while significant decreases were observed in the traditional YMCA group's right-handgrip ($M_{diff}= -1.62$, $p= 0.01$) and left-handgrip strength ($M_{diff}= -1.27$, $p= 0.02$). A significant interaction was found for the one-minute curl-ups (F(1, 100)= 122.3, $p< 0.001$, $\eta^2 p= 0.55$) with the THINK group performing a significantly greater number of curl-ups ($M_{diff}= 26.6$, $p<0.001$) while the traditional YMCA group evidenced a significant decrease in the number of curl-ups performed post-testing ($M_{diff}= -5.1$, $p=$

0.01). A significant interaction was found for the wall-sit test ($F(1, 100)= 16.17$, $p< 0.001$, $\eta^2 p= 0.14$) with the THINK group performing the wall-sit for significantly longer period of time ($M_{diff}= 220.94$, $p<0.001$) while the traditional YMCA group showed no change in wall-sit time post-testing ($M_{diff}= 7.1$, $p=0.9$). A significant interaction was found for vertical jump height ($F(1, 100)= 42.8$, $p< 0.01$, $\eta^2 p= 0.30$). This occurred due to the fact that vertical jump height increased for the THINK group ($M_{diff}= 5.68$, $p<0.001$) while the traditional YMCA showed no change post-testing ($M_{diff}= -0.9$, $p= 0.2$). A significant interaction was found for the shuttle run ($F(1, 100)= 17.72$, $p< 0.01$, $\eta^2 p= 0.15$) with the THINK group showing significant improvements in time ($M_{diff}= -1.62$, $p<0.001$) while the traditional YMCA showed no time change post-testing ($M_{diff}= -0.31$, $p= 0.16$). A significant interaction was found for the sit-and-reach ($F(1, 100)= 53.2$, $p< 0.01$, $\eta^2 p= 0.35$) with the THINK program showing significant increases in flexibility ($M_{diff}= 2.87$, $p<0.001$) while the traditional YMCA group showed significant decreases post-testing ($M_{diff}= -1.9$, $p<0.001$).

Table 2. A comparison of physical fitness variables (mean and SD) between the THINK and traditional YMCA after-school program following a 10-week period.

	THINK (n=50)		**Traditional YMCA (n=52)**				
Physical Fitness Variables	**Pre Evaluation** (mean ± SD)	**Post Evaluation** (mean ± SD)	**Pre Evaluation** (mean ± SD)	**Post Evaluation** (mean ± SD)	***F***	***df,df***	***p***
Two-minute Walk (ft)†	642.3(80.0)	702.6(113.2)*	682.5(58.9)	682.5 (65.0)	11.26	1,100	< 0.001
Right-Handgrip (lbs)†	15.22(4.76)	19.70(4.47)*	18.71(3.78)	17.10(3.78)*	45.82	1,100	< 0.001
Left-Handgrip (lbs)†	14.22(4.56)	18.76(4.37)*	17.46(3.62)	16.19(3.87)*	63.31	1,100	< 0.001
One-minute Curl-ups (#)†	31.5(10.3)	58.0(18.1)*	41.0(13.6)	35.8(14.4)*	122.32	1,100	< 0.001
Wall sit (min:sec)†	46.45(18.90)	267.40(22.17)*	55.21(29.63)	62.27(20.29)	16.17	1,100	< 0.001
Vertical jump (# flags)†	14.2(6.6)	19.8(6.1)*	19.2(6.0)	18.3(5.1)	42.75	1,100	< 0.001
Shuttle run (sec)†	14.61(1.85)	12.99(1.43)*	13.17(1.32)	12.86(1.64)	17.72	1,100	< 0.001
Sit-and-reach (cm) †	24.4(6.4)	27.3(6.9)*	29.7(7.2)	27.5(6.9)*	53.21	1,100	< 0.001

Notes: **F interactions reported for a two-way mixed design ANOVA. SD: Standard deviation. df: Degrees of freedom. THINK: Translational Health in Nutrition and Kinesiology. *Significantly different than pre evaluation, p≤0.05; †Significant between group differences, p≤0.05**

Health-Related Variables

No significant differences were observed at baseline between the THINK and YMCA group in health-related variables. As shown in Table 3, there were significant group by time interactions for BMI ($F(1, 100)= 3.94$, $p= 0.05$, $\eta^2p= 0.04$) with the THINK group showing significant decreases ($M_{diff}= -0.71$, $p<0.01$) while the traditional YMCA showed no change post-testing ($M_{diff}= -0.02$, $p= 0.95$). A significant interaction occurred for percent body fat ($F(1, 100)= 31.94$, $p< 0.001$, $\eta^2p= 0.24$) with the THINK group showing significant decreases ($M_{diff}= -3.22$, $p<0.001$) while the traditional YMCA evidenced no change post testing ($M_{diff}= 0.64$, $p=0.19$). A significant interaction was found for sagittal abdominal height ($F(1, 100)= 34.5$, $p< 0.001$, $\eta^2p= 0.26$) with the THINK group showing significant decreases ($M_{diff}= -3.47$, $p<0.001$) while the traditional YMCA group showed no changes post-testing ($M_{diff}= -0.40$, $p= 0.92$). A significant interaction was found for waist circumference ($F(1, 100)= 14.7$, $p< 0.001$, $\eta^2p= 0.13$) with the THINK group showing significant decreases ($M_{diff}= -3.41$, $p<0.01$) while the traditional YMCA group showed a significant increase post-testing ($M_{diff}= 2.3$, $p= 0.03$).

Table 3. A comparison of health-related variables (mean and SD) between the THINK and traditional YMCA after-school program following a 10-week period.

	THINK (n=50)		**Traditional YMCA (n=52)**				
Health-Related Variables	**Pre Evaluation** (mean ± SD)	**Post Evaluation** (mean ± SD)	**Pre Evaluation** (mean ± SD)	**Post Evaluation** (mean ± SD)	***F***	***df,df***	***p***
Body mass index (m^2/kg) †	18.71(3.00)	17.99(2.88)*	20.14(4.93)	20.13(4.27)	3.94	1,100	0.05
Body fat (%) †	21.66(7.24)	18.44(7.78)*	23.99(10.75)	24.63(11.09	31.94	1,100	< 0.001
Sagittal abdominal height (cm) †	14.4(4.1)	10.9(1.6)*	13.2(2.2)	13.1(2.0)	34.50	1,100	< 0.001
Waist Circumference (cm) †	66.4(8.3)	63.0(8.3)*	66.3(10.1)	68.6(14.0)*	14.67	1,100	< 0.001

Notes: **F interactions reported for a two-way mixed design ANOVA. SD: Standard deviation. df: Degrees of freedom. THINK: Translational Health in Nutrition and Kinesiology. *Significantly different than pre evaluation, p≤0.05; †Significant between group differences, p≤0.05**

Executive Cognitive Function Variables

No significant differences were observed at baseline between the THINK and YMCA group in executive cognitive function variables. As shown in Table 4, there was a significant group by time interaction for average reaction time ($F(1, 100)= 16.20$, $p<0.001$, $\eta^2 p= 0.14$) with the THINK group showing significant improvements in average reaction time ($M_{diff}= -160.90$, $p<0.001$) while the traditional YMCA group showed no change post-testing ($M_{diff}= -36.99$, $p= 0.09$). There was no significant interaction for percent accuracy ($F(1, 100)= 2.24$, $p= 0.15$, $\eta^2 p= 0.02$), however, the THINK group showed significant improvements in percent accuracy ($M_{diff}= 0.06$, $p<0.001$) while the traditional YMCA group showed no changes post-testing ($M_{diff}= 0.03$, $p= 0.08$).

Table 4. A comparison of executive cognitive function variables (mean and SD) between the THINK and Traditional YMCA after-school program following a 10-week period.

	THINK (n=50)		Traditional YMCA (n=52)				
Cognitive Executive Function Variables	**Pre Evaluation** (mean ± SD)	**Post Evaluation** (mean ± SD)	**Pre Evaluation** (mean ± SD)	**Post Evaluation** (mean ± SD)	***F***	***df,df***	***p***
Accuracy (%)	0.90(0.12)	0.96(0.04)*	0.92(0.06)	0.94(0.07)	2.24	1,100	0.15
Average Reaction Time (ms) †	688.58(202.83)	527.68(120.18)*	641.48(153.47)	604.49(102.07)	16.20	1,100	<0.001

Notes: **F interactions reported for a two-way mixed design ANOVA. SD: Standard deviation. df: Degrees of freedom. THINK: Translational Health in Nutrition and Kinesiology. *Significantly different than pre evaluation, p≤0.05; †Significant between group differences, p≤0.05**

Chapter 4

Discussion

The purpose of this study was to evaluate the comparative effects of 10 weeks of the comprehensive THINK after-school program and traditional YMCA program on: physical fitness, health-related variables, and executive cognitive function in minority children. The THINK intervention was designed to engage students by promoting physical activity while asking questions that encourage creative thinking and problem solving. The program introduced a series of health-related themes incorporating technology during fitness and laboratory sessions to enhance learning. Applied experiences demonstrating healthier lifestyle habits were accomplished through gardening, cooking, and daily exercise. Parental involvement was also used to strengthen community links that reinforced the application of positive lifestyle activities. In contrast, the traditional YMCA program included physical activities, outdoor games, and play consistent with the SPARK curriculum although no supplemental health curriculum or parental involvement was incorporated. The SPARK is a commonly used curriculum designed to engage children through games and outdoor play. Numerous studies have shown that SPARK increases physical activity in children during physical education periods (McKenzie, 2009; McKenzie, 1997; Sallis, 1997) and after-school programs (McKenzie, 2009, Sallis et al., 2000). The traditional YMCA program focused upon increasing physical activity levels, but not necessarily fitness and wellness experiences.

As a result of the intervention, children in the comprehensive THINK group evidenced greater improvements in dependent variables including aerobic fitness, muscular strength, muscular power, flexibility, body composition, fat patterning, and cognitive function compared to the traditional YMCA. Gains in aerobic fitness have been positively related to cardiovascular health (Parrett, 2011; Sloan, 2009; Strong, 1999), health-related quality of life (Sloan, 2009), and the prevention of chronic diseases (Blair, 1996) across the lifespan. Aerobically fit children and adolescents have a reduced risk of cardiovascular disease and chronic diseases (Kvaavik, 2009; Blair, 1996) later in life. Grip strength (Sayer, 2006) and abdominal strength (Ross & Pate, 1987) have been linked to longevity and improved quality of life. Agility (Hammet, 1992; Payne & Isaacs, 1987), lower body strength (Sharma & Tomar, 2005; Kraemer & Fleck, 2004; Faigenbaum & Westcott, 2000), lower body power (Faigenbaum & Westcott, 2000), and flexibility (Sharma & Tomar, 2005) have all been associated with positive growth and development in children and adolescents. Given the fact that 34% of students have been found to fail their physical fitness tests and perform worse than adults on measures of aerobic fitness (NIHCM, 2008), it is essential to provide programs that can positively influence all areas of physical fitness.

It is unclear as to why a decrease and/or no change in several physical fitness variables were observed following the traditional YMCA program. The SPARK curriculum used for the YMCA's fitness sessions matched the volume of physical fitness training used in previous studies showing significant improvements in physical fitness and health (Cardon, 2009; McKenzie, 2008; Sallis, 1997). However, the lack of a structured educational component and fitness driven curriculum may have contributed to the shortfall in improvements by the YMCA group. Most studies incorporating SPARK as their fitness curriculum have evaluated changes after three months or longer and thus the shorter duration of this study may have contributed to the lack of positive changes in the YMCA group.

Health-related variables are also strategic to cardiovascular health (Freedman, 2007; Freedman, 2005) and improved quality of life (Sayer, 2006). Both waist circumference (WHO, 2008; Taylor, 2000) and sagittal abdominal height (Riserus, 2004; Gustat, 2000; Sjostrom, 1991) are indicators of central adiposity and can be used as predictors of cardiovascular disease (Freedman, 2007; Gustat, 2000), type II diabetes mellitus (Freedman, 2005, Lobstein, 2004; Freedman, 1987), and metabolic syndrome (Daniels, 2005; Weiss, 2004) throughout the lifespan. Children who have greater waist circumference and elevated BMIs are at greater risk of developing these disorders which may track into adulthood. Furthermore, African-American and Hispanic-Latino children and adolescents evidence the highest rates of obesity, cardiovascular disease, type II diabetes mellitus, and metabolic syndrome (CDC, 2012; Freedman 2005). As a result of the THINK program, a 24% reduction in sagittal abdominal height, 15% reduction in total body fat, and 4-5% reductions in waist circumference and BMI respectively, were observed. The lack of improvement and decline in some of the health-related variables in the YMCA group may have been a result of their unstructured and unplanned fitness sessions. The SPARK curriculum used for the YMCA's fitness sessions focused more on physical activity and enjoyment of play while lessons were selected at random by the counselors. Conversely, the THINK program's fitness component was structured, planned in advanced, and goal oriented towards improving specific physical fitness attributes. This assured that children stayed on task and were working towards specific fitness goals. The strong emphasis on physical fitness in the THINK group may have contributed to the improvements in health-related variables.

Growing evidence suggests that brain health and cognitive function play a vital role in shaping health behaviors (Hillman, 2008), intelligence (Burkhalter, 2011; Hillman, 2008; Campos, 1996), and academic performance (Burkhalter, 2011; Datar, 2006; Datar, 2004) in children and adolescents. Mature cognition is characterized by abilities such as: storing information, mental manipulation of information, acting on the basis of choice rather than impulse, exercising self-control by resisting inappropriate behaviors, and quickly and flexibly adapting to changing situations (Davidson, 2006). Furthermore, cognitive function may work synergistically with physical fitness and health-related variables. Previous studies have shown an inverse relationship between fat distribution and cognitive function and a positive relationship between aerobic fitness and cognitive function (Mantilla, 2013; Kamijo, 2012; Burkhalter, 2011; Hillman, 2008; Castelli, 2007; Colcombe 2004). Findings have also suggested that fit elementary school children exhibit greater allocation of attention and memory in comparison to their less fit classmates (Kramer & Hillman 2006).

The THINK group exhibited faster reaction to the stimulus and a higher percentage of correct responses in the cognitive task showing better executive cognitive performance. These positive changes may have resulted from different components within the THINK curriculum incorporating brain fit sessions, which used activities such as solving puzzles or completing math problems during physical activity. Engagement in the classroom and laboratory sessions prompting problem-solving strategies, may have also contributed to the improvements in executive cognitive function. The YMCA group did not incorporate advanced motor learning and used only skill-related tasks (dribbling basketballs) to improve motor skills. Furthermore, motor learning was only part of the YMCA's fitness sessions while THINK incorporated motor learning into all aspects of the program. Advanced motor skill development, along with gains in physical fitness, may have attributed to the positive outcomes in executive cognitive function in THINK in comparison to the YMCA. As shown in previous studies, improvements in cognitive performance, physical fitness, and health-related variables may have had a synergistic effect in the THINK group, which in turn, may improve overall health, academics, and lifestyle habits (Kamijo, 2012; Burkhalter, 2011; Hillman, 2008).

Several limitations may have influenced our results. Since researchers collaborated with the YMCA to evaluate a program ongoing in the field, a quasi-experimental design was chosen rather than a randomized trial. The sites were selected based on criteria related to socioeconomic status, race/ethnicity, and geographic location by the YMCA. The intervention site was only chosen if no other program was active. The lack of randomization could be accompanied by residual confounding factors that may have biased the results. However, researchers worked with YMCA leadership to identify sites with similar characteristics within each area. Furthermore, the intervention was only 10 weeks long and a more extended duration may have had a greater impact on the dependent variables in both groups. Despite the limited duration of intervention, significant findings were observed in the THINK group as a result of the program.

The traditional YMCA program experienced high staff turnover, whereas the THINK program maintained all staff throughout the intervention. Staff turnover is a significant barrier to program implementation and remains a challenge to promoting health in after-school programs. The differences in staff turnover rates may have contributed to the results observed between the two groups. Additionally, there were four drop outs during the program. One subject dropped out of the THINK group due to injury and three subjects dropped out of the YMCA group for personal reasons. However, retention rates in the THINK (98%) and YMCA (96%) programs were both very high. In general, the short duration of the study, the lack of a structured educational components, and the lack of a fitness driven and motor learning component in the traditional YMCA program may have contributed to the shortfall in outcome variables in comparison to the comprehensive THINK program.

This study shows that a comprehensive after-school program rooted in scientific concepts using activities that parallel real life experiences and structured to promote specific fitness goals, can result in dramatic changes in physical fitness, health-related variables, and executive cognitive function. To our knowledge, these findings are the first to demonstrate increases in all three areas, physical fitness, health-related variables and executive functioning in one study. Furthermore, these results can be generalized to minority elementary school children since 87% of participants were Hispanic and 6% were African-American.

Chapter 5

Conclusion

A comprehensive program such as THINK which targets improvements in physical fitness, the acquisition of cognitive and motor learning skills, positive lifestyle behaviors, and wellness education has the potential to improve physical fitness, health-related variables, and cognitive function in youth thus, positively influencing their current and future well-being.

Recommendations for the Future

It is recommended that future programs focus on physical fitness variables and motor learning skills integrated with cognitive learning and the promotion of positive lifestyle behaviors, to improve the health and well being of our nation's youth. Future studies should also focus on the chronic effects of comprehensive programs such as the THINK, throughout the school year, with appropriate follow-up post intervention to assess retention and sustainability of the program.

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