RELATIONSHIPS AMONG PHYSICAL SELF-CONCEPT, PHYSICAL ACTIVITY AND PHYSICAL FITNESS IN THREE DIFFERENT PARTICIPANT GROUPS

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DEDICATION

I would like to dedicate this degree to my family. I would not have been able to accomplish this without the support of my loving wife Elizabeth, and my two beautiful children who have been a blessing throughout the entire process. I also dedicated this degree to my parents, Beverly and Wayne as they have always been supportive of me; and instilled in me a sense of pride to constantly persevere despite constant challenges.

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ABSTRACT

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RELATIONSHIPS AMONG PHYSICAL SELF-CONCEPT, PHYSICAL ACTIVITY AND PHYSICAL FITNESS IN THREE DIFFERENCE PARTICIPANT GROUPS

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The overarching goals of this dissertation were accomplished in three distinct studies. The design of the first study is a descriptive study to determine in young adults the relationships among physical fitness, activity and self-concept; lower extremity strength and power; and physical self-concept. The correlations between the maximal aerobic physical performance measure and the Endurance and Activity subdomains of the PSDQ-S were moderately strong at r = 0.60 and r = 0.54, respectively. Low but significant relationships were found between VO2 max and the Sport subdomain (r = .35). Another significant and moderately strong correlation was found between the seated row and the Activity subdomain for the 3-RM/BW% (r = 0.64). The Strength subdomain measure significantly correlated with the 3-RM/BW% for the seated row (r = 0.35) and chest press (r = 0.43). The ACT and SP subdomains both demonstrated the greatest number of significant correlations with the strength physical performance measures. ACT demonstrated weak to moderate correlations with chest press (r = 0.40), seated row (r = 0.61), and QUAD180 (r = 0.34) SP was correlated with chest press (r = 0.40), seated row

(r = 0.39), leg press (r = 0.33), and QUAD180 (r = 0.35.) For Global PSC and SE, only the quadriceps isokinetic measures yielded moderate but significant relationships (r = 0.33 and r = 0.37 for 60 and 180 degrees per second speeds, respectively).

This study provided insight on the relationships between perceived competencies in the various domains of physical self-concept and objective measures of physical fitness. The Activity and Sport subdomains of physical self-concept were the best self-reported measures of physical fitness, while the seated row measure represented the best objective measure for overall physical fitness.

The design of the second study was a case series consisting of three subjects. Baseline measures of physical self-concept, muscular and cardiovascular endurance, and physical activity levels were collected within 1 month of the conclusion of a previous research study that involved the same subjects for this study that received a 12-week supervised aerobic and resistance training program. These outcome measures were compared at the conclusion of the intervention to assess levels of effectiveness and compliance with the unsupervised home exercise program. The mean values of all the factors of the PSDQ-S were lower for all three subjects in this case report as compared to a reference population of 986 high school students from Australia. The two global factors of self-esteem and overall physical self-concept for two of the three subjects were lower than the reference group.

The three subjects showed small decrements in muscular strength and cardiovascular endurance at baseline of the unsupervised study despite a washout period that ranged from 3-10 weeks between from the supervised intervention. Two subjects essentially maintained their VO2 max while the third subject had a large improvement (25%) at the conclusion of the unsupervised program from baseline. At the conclusion of the unsupervised program, only subject came close to meeting the Federal Physical Activity recommendations. The other two subjects lacked almost 400 minutes per week of recommended moderate to vigorous physical activity. The low self-reported physical activity levels for two of the subjects would suggest a much smaller expected change in aerobic capacity and muscle force generation than what actually occurred, thus a discrepancy existed between the self-reported physical activity and the physical fitness measures.

The third study utilized a quasi-experimental design. The subjects were women referred to an Exercise and Education group (Ex + Ed); the comparison group were women who received a Diet-only (Diet) intervention. Education about proper diet and activity levels were provided to all participants. The Diet group received monthly education from their physician and a health educator. The Ex + Ed group received education from physical therapists and dieticians as part of their group intervention. Seventy-seven women enrolled in the Ex + Ed intervention and completed the baseline assessments. Twenty-three women completed the assessments at the conclusion of the 12-week intervention, resulting in a 71.1% attrition rate. At baseline, there were no differences in body weight between the women in Ex + Ed and Diet interventions. The women in the Diet group were significantly younger, had fewer co-morbidities and

tended to be of Hispanic ethnicity. The ethnic make-up of the women in the Ex + Ed group was predominately African-American. The results of the 2 x 2 mixed model ANOVA revealed a significant group x time interaction ($p = .02$). The Diet group had a mean decrease in body weight of approximately 2.31 kg as compared to the Ex + Ed group with a mean decrease of 0.43 kg. Post hoc analysis with alpha set at .025 revealed a significant within-participants' effect for weight loss at the conclusion of the Diet intervention ($p < .001$). For the participants in the Ex + Ed intervention, significant improvements were made in the distance walked in six minutes and isometric load lifted for the squat and grip strength averages of both sides. The self-reported measures of physical self-concept and moderate PA improved significantly from baseline. Similar to previous studies, weight loss can be achieved easier by controlling caloric intake versus increasing caloric expenditure with exercise. Despite the absence of weight loss, improvements in physical fitness and physical self-perceptions can occur for obese women from low socio-economic backgrounds.

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CHAPTER I

INTRODUCTION

BACKGROUND

Lack of physical activity is a major problem in the modern western society. In the United States, less than half of adults aged 18 to 64 years old met the recommended 2008 Physical Activity Guidelines set forth by Centers for Disease Control and Prevention (CDC) (http: //www.cdc.gov/ physicalactivity/data/facts.html). In the year 2010, less than 30 percent of adolescent schoolchildren met the CDC's physical activity requirement of 60 minutes per day of moderate to vigorous intense physical activity (http://www.cdc.gov/physicalactivity/data/facts.html). While the prevalence rates of individuals who engage in some form of physical activity have declined over the past 15-20 years in the United States, the rate of adulthood obesity has increased to a 2008 prevalence rate of 34%; this is a 19% increase from the year 1980 (Ogden, Carroll et al. 2012). The prevalence rates of childhood obesity have climbed from 5.5% measured during the years 1976-1980 to 16.9% at years 2007-2008 (Ogden, Carroll et al. 2012). The rising rates of obesity are linked to reduced physical activity, one of many factors that contribute to this problem.

For many, the ability to begin and sustain a physical activity or exercise regimen is difficult. Physical self-concept is an often-overlooked factor regarding problems with the initiation and maintenance of a physical activity program. It is a multi-dimensional construct that allows individuals to examine their own levels of physical performance, function and attractiveness based on the previous experiences and environmental surroundings in which they often find themselves (Marsh, Martin et al. 2010). Previous research has pointed to the physical self-concept domain being an important factor to consider when examining potential reasons why individuals either do not start or fail to maintain physical activity programs (Amesberger, Finkenzeller et al. 2011, Cumming, Standage et al. 2011).

Physical self-concept has a variable effect on physical activity participation based on an individual’s age, race, gender and physical activity level amongst others (Annesi, Whitaker 2010). Conversely, physical activity has an effect on physical self-concept that is also affected by the characteristics of the individual; thus, a bi-directional relationship exists between physical activity and physical self-concept (Bouchard 2000). A study on 48 obese men randomized to a supervised aerobic exercise and instruction group or an instruction group only examined aerobic fitness and physical self-concept using the Tennessee Self Concept Scale (Short, DiCarlo et al. 1984). They found that men who participated in the supervised aerobic training group had an approximate threefold increase in their aerobic capacity as compared to the instruction only group. Both groups had an increase in four components of physical self-concept, but the physical self and self-satisfaction subscales had a more dramatic increase in the conditioning group.

Another study examined the relationships between physical self-concept and physical fitness and the effects of gender on elderly individuals who received a 12-week guided skiing intervention (Amesberger, Finkenzeller et al. 2011). They found relationships among aerobic capacity, lower extremity power and strength and components of physical self-concept such as sports proficiency, endurance, strength and global physical self. They also found gender differences in the psychological effects of the intervention. Males tend to relate improvements in lower extremity strength and power to improved perceptions of sports proficiency and global physical self, whereas females tend to relate improvements in aerobic capacity to improved sports proficiency and global physical self.

Studies that involve obese adults utilizing exercise with and without nutritional and/or behavioral support highlight some interesting relationships with physical self-concept. One study compared the effects of a 20-week weight loss program for African American and Caucasian women who were obese (Annesi 2007). The program consisted of monthly instruction on use of cardiovascular machines and six nutritional educational sessions over the 20-week period. The subjects were instructed to increase their exercise program components to three times per week for 30 minutes with a perceived exertion rating level of 12-14. Measures of self-concept, body satisfaction and exercise self-efficacy were measured in addition to bodyweight changes. He found that the weight loss was significant for both groups, but the Caucasian women lost significantly more weight than their African-American counterparts did. He found that body satisfaction, exercise self-efficacy and physical self-concept combined to predict body weight for both groups.

The relationships that psychological factors have on physiological measures such as muscular strength, aerobic capacity and weight loss are important considerations for the design and implementation of effective weight loss programs for individuals across a wide array of demographic factors and physical activity levels. It has been shown in previous studies that an individual's personal attributes such as gender, ethnicity, age and previous physical activity levels can mediate the relationships between physical self-concept, physical fitness, and levels of physical activity engagement. Therefore, it is important to examine if relationships exist between these psychological factors and physiological measures across several populations such as adolescent obese Latinos, young adults with an array of self-reported physical activity levels and women who are obese patients receiving healthcare at a publically funded healthcare institution. As evident in the previously cited studies, the physical self-concept and physical fitness components have reciprocal effects on each other. The diverse effects that physical self-concept has on components of physical fitness across different populations may be important considerations that healthcare professionals must take into account when they design of physical fitness programs that can be adopted and adhered to on a regular and long term basis.

PURPOSE

The overarching goal of the three-study research project is to assess the relationships among physical self-concept, levels of physical activity engagement and measures of physical fitness in participant groups with varying ages and conditions. The goal will be accomplished through three distinct studies: 1) a descriptive study correlating physical self-concept, activity and physical fitness in healthy young adults; 2) a case series of obese Hispanic adolescents undertaking 12 weeks of supervised exercise followed by 12 weeks of unsupervised exercise to increase fitness; and 3) an intervention study to assess weight loss, physical self-concept and fitness gains in obese adult women that received one of two treatment regimens.

STUDY ONE

Are There Relationships between Physical Fitness and Self Esteem in Young Adults?

The design of the first study is a descriptive study to determine if: 1) correlations exists among levels of muscular/cardiovascular fitness, physical self-concept, and physical activity engagement.

Specific Aims and Hypotheses

The aim of the first study is to determine in young adults the relationships among physical fitness, activity and self-concept; lower extremity strength and power; and physical self-concept. The hypothesis is young adults will display significant and moderately strong positive correlations among: 1) physical activity engagement, physical self-concept and muscular/cardiovascular fitness levels.

Subjects

For this study, the subjects were 30 adults aged 18-30 years old that had no reported illness or physical ailments, recruited from the Texas Woman's University Houston campus and surrounding areas. Recruitment was conducted with a recruitment script and recruitment flyers that were handed to interested persons.

Instrumentation

The ParvoMedics True One® metabolic cart assessed maximal aerobic capacity via a graded aerobic exercise test. The Biodex System 3 isokinetic dynamometer assessed quadriceps muscle strength as well as selected weight machines (Quantum Fitness®) that tested three-repetition maximum (3-RM) strength for seated chest press, leg press and seated row press that was according to a standard protocol(Baechle, Earle et al. 2000). The Physical Self-Description Questionnaire-Short Form (PSDQ-S) (Appendix A) (Marsh, Martin et al. 2010) was the self-reported instrument that evaluated levels of physical self-concept. The International Physical Activity Questionnaire (IPAQ) (Appendix B) was used to quantify the frequency, intensity and duration of physical activity engagement.

Procedures

All subjects for this study had their height, weight, and BMI data collected before the physical fitness tests to allow for the normalization of physical performance measures relative to their body dimensions. Self-report questionnaires (IPAQ and PSDQ-S) and a five-minute warm up on treadmill were conducted prior to the physical fitness tests. All subjects had an approximate 10-minute rest period between each physical fitness test.

Isotonic upper and lower body 3 RM strength were tested on the leg press, seated row and seated chess press. Isokinetic quadriceps muscle strength testing then occurred with use of the Biodex System 3 Dynamometer at angular velocities set at 60 and 180 degrees per second, followed by the graded aerobic exercise test (Bruce Protocol)(Noonan, Dean 2000, American College of Sports Medicine, Thompson et al. 2010). The goal was for the subject to perform the graded aerobic exercise test until one or more of the test termination criteria set forth by the American College of Sports Medicine (ACSM) occurs(American College of Sports Medicine, Thompson et al. 2010).

Data Analysis

The Pearson Product Moment and Spearman rank correlation coefficients were used to analyze the data to determine if significant relationships existed among physical self-concept, levels of physical activity engagement and levels of muscular/cardiovascular fitness with alpha set at .05.

STUDY TWO

<u>Can an Unsupervised Home Exercise Program Maintain the Aerobic and Strength Gains Achieved During a 12-week Supervised Program for Obese Hispanic Adolescents?</u>

The design of the second study is a case series. Baseline measures of physical self-concept, muscular and cardiovascular endurance, and physical activity levels were collected within 10 weeks from the conclusion of a previous research study that involved the same subjects for the present study. The physical fitness and self-reported physical activity outcome measures were compared at the conclusion of the intervention to respectively assess levels of effectiveness and compliance with the unsupervised home exercise program.

Specific Aims and Hypotheses

The aims of the second study are to compare the before and after results of the 12-week unsupervised physical fitness program for adolescents who are obese and Hispanic: the average weekly number of minutes spent doing moderate and vigorous physical activity, muscular strength, and cardiovascular fitness and the levels of physical self-concept. The hypotheses are that the participants would: engage in at least 60 minutes of moderate to vigorous physical activity every day; maintain or increase muscular strength and cardiovascular fitness compared to baseline.

Subjects

This study utilized as subjects adolescents that were Hispanic, post-pubertal, and obese, who had completed a 12-week research study conducted by this author and Agneta Sunehag MD, PhD at the Baylor College of Medicine and Texas Children's Hospital. The inclusion criteria were: completion of thrice weekly supervised resistance and aerobic exercise sessions for a duration of 12 weeks as part of the previously mentioned research study; being of Hispanic descent; obese (BMI ≥ 30 kg/m^2 or 95th percentile or greater for gender and age) and post pubertal (Tanner IV-V). The subjects recruited were the four individuals in the Sunehag and Brewer pilot study, and three of the four subjects agreed to participate in the study. Recruitment of the subjects was conducted by approaching their parents/guardians with the purpose, requirements and background for the study with use of a script. Once interest was expressed, an informed consent and assent forms were issued to the parent/guardian and potential subjects, respectively.

Instrumentation

Instruments used in this study involved machines to quantify components of physical fitness and self-report questionnaires to assess levels of physical self-concept and physical activity. The Biodex System 3 Isokinetic Dynamometer and the Parvomedics TrueOne® metabolic cart were used to measure quadriceps/hamstrings muscle strength (angular velocity set at 60 degrees per sec) and a graded aerobic exercise test assessed maximal aerobic capacity (Modified Bruce protocol), respectively (American College of Sports Medicine, Thompson et al. 2010). The 3-RM strength tests conducted as described in Study 1.The Physical Self-Description Questionnaire - Short form (PSDQ-S) was used to quantify the levels of physical self-concept.

Procedures

The following procedures commenced 6, 10 and 3 weeks after the conclusion of the previously described research study for subjects 1, 2 and 3, respectively. All subjects had their height, weight, and BMI data collected before the physical fitness tests to allow for the normalization of physical performance measures relative to their body dimensions. The participants also completed self-report questionnaires (IPAQ, PSDQ-S) and a five-minute warm up on treadmill prior to the physical fitness tests. All subjects had an approximate 10-minute rest period between each physical fitness test. This study began with the 3-RM strength tests followed by the lower extremity strength tests using the Biodex System 3 Isokinetic Dynamometer set at 60 degrees per second followed by the graded aerobic exercise test using the Modified Bruce Protocol. These test procedures were repeated three months later to determine if the unsupervised exercise intervention changed fitness, daily physical activity and/or physical self-concept levels. After the tests concluded at the first session, the subjects were instructed in a twice-weekly resistance exercise program that used adjustable Sports Cords that were provided to them. The subjects were instructed to maintain the same independent aerobic exercise program they performed in the previous research study at intensities equal to 50-70% or 70-85% of their predicted maximum heart rate (220-age) for at least 40 minutes and 20 minutes, respectively, 5 days per week on the days they did not execute the resistance training program. Physical activity education included an eight-minute video produced by the CDC: http//www.cdc.gov/HealthyYouth physicalactivity/video.htm and instructions on how to take their pulse rate for 30 seconds then multiply by two to achieve their heart rate per minute to monitor their exercise intensity while they performed the aerobic exercises. The subjects were given an exercise log to keep a record of their entire exercise program over the 12-week period. Levels of compliance were assessed by calculating the total number of minutes of moderate and vigorously intense physical activities completed per week as reported from the IPAQ.

Data Analysis

For the second study, percent differences were calculated and graphic analysis were utilized for each subject to compare pre and post-intervention levels of physical self-concept, physical activity levels, and muscular/cardiovascular fitness.

STUDY THREE

The Effects of a Group Exercise Program in the Weight Management of the Obese Patient in a Publicly Funded Healthcare System

The third study utilized a quasi-experimental design. The subjects were women referred to an Exercise and Education group (Ex + Ed); the comparison group were women who received a Diet-only (Diet) intervention. Education about proper diet and activity levels were provided to all participants. The Diet group received monthly education from their physician and a health educator. The Ex + Ed group received education from physical therapists and dieticians as part of their group intervention.

Specific Aims and Hypotheses

The primary aim of the third study is to determine for obese women that seeking a weight loss intervention that would be in an Ex + Ed or Diet intervention, which participants would have the greatest weight loss. The hypothesis was both the Ex + Ed and Diet groups would experience weight loss, but the Diet group would have significantly more weight loss than the Ex + Ed group. The rationale for the hypothesized direction of the weight loss effect that favored the Diet group was based on a review of previous studies that documented the effect of weight loss interventions (Miller, Koceja et al. 1997). The secondary aim of this study is to determine if there is a significant difference in levels of muscular/cardiovascular fitness and physical self-concept for participants in the Ex + Ed group at the conclusion of this intervention. The hypothesis was there would be an increase in levels of muscular/cardiovascular fitness and physical self-concept for individuals in the Ex + Ed group.

Subjects

This study recruited 77 women that were obese (BMI ≥ 30 kg/m$^{2)}$, sedentary (less than 75 minutes of moderate and less than 35 minutes of vigorous physical activity per week as reported on the IPAQ) and between the ages of 18-70 years old. These subjects were referred to the Ex + Ed group at a publicly funded healthcare system where they were assigned to a designated tester that performed all the initial and subsequent outcome measure tests. Twenty-three of the participants in the Ex + Ed group completed the 12 week intervention. The subjects for the comparison group (Diet) were comprised of 25 women that were selected as a sample of convenience via review of electronic medical records from a healthcare personnel not involved in this study. Selection of these subjects was based on completion of at least 3 months of the Diet-only intervention with baseline and 3 month anthropometric data that was documented in the electronic medical record. This group fit the same inclusion criteria as the subjects in the aforementioned group. Subjects for the Ex + Ed group were excluded if they had any physical impairment that could diminish the effects of the exercise intervention, reported unstable cardiovascular or metabolic disease, or reported pregnancy.

Instrumentation

A combination of self-report questionnaires and machines quantified the outcome measures used for this study. Stationery (BTE Simulator II™) and hand-grip (Jamar®)

dynamometry were used to measure isometric extremity and grip strength, respectively. The six-minute walk test was used to measure functional walking endurance as a reliable and valid measure of cardiovascular endurance (ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories 2002, Cahalin, Mathier et al. 1996, de Souza, Faintuch et al. 2009). The Physical Self-Worth domain of the Physical Self-Perception Profile (PSPP) (Appendix C) was used to measure physical self-esteem. The IPAQ-S (short form) (Appendix D) was used to quantify physical activity engagement.

Procedures

For the third study, each referred subject for the Ex + Ed group received a comprehensive examination by a physical therapist who served as the designated tester. The physical fitness tests were completed after the self-report questionnaires. The IPAQ short form was used to quantify physical activity levels and the Physical Self Perception Profile (PSPP self-worth domain only) was used to measure physical self-concept (Fox and Corbin.1989). Each subjects for this study had their height, weight, and BMI data collected before the physical fitness tests to allow for the normalization of physical performance measures relative to their body dimensions. The designated tester administered all study-related assessments for the intervention groups immediately before and at the conclusion of the 12 week intervention.

The exercise sessions followed a 30 – 40 minute circuit-training format. Every participant performed the same exercise type regardless of level, but the exercise difficulty was varied based on differences in individual physical fitness. All participants were encouraged to fill out physical activity and food logs that tracked the daily frequency, duration and intensity of the physical activities performed and types of foods consumed. The subjects were encouraged to accumulate at least 150 minutes per week of moderate to vigorous physical activities as per ACSM guidelines (that were in addition to the 60 – 80 minutes of moderate to vigorous physical activities performed during the group exercise sessions).

Data Analysis

Comparisons between the Ex + Ed and Diet groups for the third study utilized a factorial design with group as the between factor and time as the repeated factor with body weight as the primary outcome measure. This data was analyzed using 2 x 2 mixed model ANOVA with the level of significance set at .05. The other outcomes (physical activity levels and muscular and cardiovascular fitness measures) were compared within the Ex + Ed group at the beginning and conclusion of the 12 week intervention using paired t-tests. The level of significance was set at .05 to assess if there were significant changes over time for the variables.

CHAPTER II

REVIEW OF THE LITERATURE

EPIDEMIOLOGY OF OBESITY

Obesity is a national epidemic that threatens the health and well-being of approximately one third of American adults in this country.[1-3] This represents a major public health problem in the United States. Obesity is defined as excess body weight relative to height which defines a body mass index (BMI): body mass (kg)/height (m^2) ≥ 30 kg/m^2.[1,4] Obesity is the second leading cause of preventable death in America with it contributing to the development Type II diabetes, osteoarthritis, cardiovascular diseases and cancers of the breast and digestive system amongst others.[1,2] The U.S. government has given priority to this national public health problem as cited in the Healthy People 2020 with four initiatives that pertain to increasing the percentage of adults and children achieving a healthy weight by 2020.[5]

The obesity prevalence rate increases among certain gender and ethnic groups. The prevalence rates of obesity have climbed significantly for men by approximately 8% from 27.5% to 35.5% for the years 1999-2000 to 2010.[1,6] During that same time period, the prevalence rates for women were higher than men in 1999 with a rate of 33.4%, but this rate did not change significantly at years 2009-2010 with the rate being 35.8% which is essentially the same prevalence rate as men.[1,6] The United States ranks number 11 in the world in the prevalence of obesity.[4]

Middle aged adults from the ages of 40-59 and older adults aged 60 and over had higher prevalence rates of obesity in the years 2009-2010 as compared to individuals 20-39 years.[1,7] Women over the age of 60 had higher obesity rates than any other age and gender cohort with a rate of 42.3% during the years 2009-2010.[1,6] For men, the prevalence rates of obesity did not vary significantly by age.

When prevalence rates are examined by ethnicity, there are striking disparities across race. In the years 2009-2010, Non-Hispanic Blacks had the highest prevalence rates of obesity, with a rate of 49.6%, Hispanics (including Mexican-Americans) at 37.9%, Non-Hispanic Whites at 34.9%.[1,6] Among these groups, Non-Hispanic and Hispanic females have the highest prevalence rates of obesity by gender and ethnicity at 58.6% and 40.7%, respectively.[1,6]

For children between the ages of 2 and 19 years old, the determination of obesity is made via age- and gender-based percentiles for BMI. For children, overweight is defined as a percentile rank that places the child at > 85th but < 95th percentile for BMI based on age and gender; obese is defined as a percentile rank that places the child ≥ 95th percentile for BMI based on age and gender.[8,9] The overall prevalence rate of childhood obesity has increased from 5.0% during the years 1971-1974 to 16.9% during the years 2007-2008 while the rates of adolescent obesity increased during these same time frames from 6.1% to 18.1%.[9] There were significant variations in childhood obesity by ethnicity and gender. Between the years 1988-1994 and 2007-2008 the prevalence rates of obesity showed the steepest increase for non-Hispanic Black girls from 16.3% to 29.2%, followed by Mexican-American boys with rates of 14.1% to 26.8% during those same time periods.[8,10] The prevalence rates increased for each gender by ethnic group between the years 1988-1994 and 2007-2008.[5,6,8,9,10,11]

Examination of the prevalence rates from 2005-2008 challenges the assumption that most obese individuals are from lower socioeconomic backgrounds. When the prevalence rates of obesity are compared by poverty-to-income ratios, which is defined as the amount of household income in relation to that particular family's poverty threshold (based on the number of persons living in the household) for certain populations, the opposite holds true. During the years 2005 – 2008, 15.7 million men who had poverty-to-income ratios greater than 350% above the poverty threshold were obese as compared to 5.1 million obese men who were less than 130% above the poverty threshold.[12] For women, a similar trend was seen during that same time period in which there were 14.2 million women who were classified as obese and had poverty-to-income ratios that were greater than 350% above the poverty threshold as compared to 9.5 million women who were classified obese and had household incomes less than 130% above the poverty threshold.[12]

Overall, there have been significant increases in the rates of obesity across all socioeconomic levels between the years 1998-2004 and 2005-2008. When prevalence rates of obesity are compared across socioeconomic status levels, gender and ethnicity are where significant contrasts can be made. For non-Hispanic Black and Mexican-American men, the rates of obesity decreased as poverty-to-income levels decreased.[12]

For non-Hispanic Black men that resided in households that were greater than 350% above the poverty threshold, their prevalence rate for obesity was 44.5% as compared to 28.5% for men who were less than 130% above the poverty threshold. Similar trends were evident for Mexican–American men with rates of 40.8% and 29.9% for those men who that lived in households that were greater than 350% and below 130% the poverty-to-income ratios, respectively. The trends for non-Hispanic White men remained stable across poverty-to- income ratio levels.[12]

For women across all ethnic backgrounds, the rates of obesity increased as poverty-to-income ratios decreased, with rates at 29.0% and 42.0% for women who were at greater than 350% and below 130% the poverty-to-income ratio, respectively.[12] Women with a minority background did not show the same trend in obesity as men. For minority women, there was no change in prevalence rates of obesity across poverty-to-income levels. The only exception to this trend was for non-Hispanic White women who had a prevalence rate of 29.0% when they had poverty-to-income ratios of greater than 350% as compared to non-Hispanic White women who had poverty-to-income ratios less than 130%.[12]

Obesity rates differed across levels of educational attainment by ethnicity and gender. For men, across all ethnic backgrounds, the general trend was that the rates of obesity increased for each level of educational attainment that was below the completion of a college degree (did not complete high school, high school graduate, and some college).[12] The only significant difference between prevalence rates for obesity across all ethnic backgrounds were between men who graduated from college and those who attended some college (27.4% vs. 36.2% respectively); this same pattern of significance was found for non-Hispanic White men who graduate from college and those who attended some college (27.5% vs. 35.2%). For non-Hispanic Black and Mexican-American men, the prevalence rates actually decreased for those who did not graduate from college, but these differences were non-significant.[2,4,12]

For women across all ethnic backgrounds, a significant trend was found across all levels of educational attainment. Women who were less educated had higher rates of obesity as compared to those who were more educated. Across all ethnic backgrounds, women who were college graduates had a 23.4% prevalence of obesity as compared to 38.4% for those who attended some college, 39.8% for those who graduated from high school and 42.1% for those who did not graduate from high school.[12] This trend of significance persisted across each ethnic group except for non-Hispanic Black women who had significant differences in prevalence rates only between those who graduated from college, with a rate of 42.2%, and those who attended some college, with a rate of 54.3%.[12]

Pathophysiological Manifestations of Obesity

Obesity affects the function of every major organ system of the body. Adipose tissue functions as an endocrine organ and secretes hormones called adipokines.[13,14] Adipokines contributes to the host of metabolic derangements such as insulin resistance, systemic inflammation and altered energy production from stored fatty acids. When adipokines are secreted, they can cause the production of pro-inflammatory mediators such as interleukin 6 and tumor necrosis factor alpha (TNFα) that can reduce the effects of insulin that may lead to hyperglycemia and eventually the development of Type II diabetes.[13,14] Not all adipokines promote adverse metabolic reactions. Leptin and adiponectin are two adipokines that are beneficial in the reduction of inflammation, improving insulin sensitivity, utilization of fatty acids for energy production and regulating hunger.[13,14] Interestingly although these two hormones are secreted by adipose tissue, for individuals who are obese, the circulating levels of these two hormones are reduced, which may be due to exaggerated hormonal regulatory mechanisms such as negative feedback loops to lower the concentrations of the hormone.[13,14]

Evaluation of obesity as a possible etiological factor for the production of metabolic derangements must be considered based on the morphological distribution of adipose tissue. Adipose deposition can occur in just about anywhere in the body, including but not limited to subcutaneous, visceral, hepatic and muscular tissue.[15] The literature has cited that visceral fat distribution, which is the body habitus that is noted by a large waist circumference, is the type that has been implicated as a possible factor in the production of the metabolic derangements noted previously.[13-15]

Mortality rates from all causes and cardiovascular conditions have a positive relationship with waist circumference. Waist circumference or waist to hip ratios are commonly used to denote excessive levels of visceral fat deposition and have been positively correlated with markers of inflammation that include C-reactive protein, IL-6 and TNFα whereas subcutaneous fat in the abdomen, hips and lower extremities does not have the same physiological effects.[13-15]

The maladaptive effects that visceral fat has on the development of systemic inflammation and insulin resistance are not just limited to the development of diabetes but also to micro and macro-vascular disorders that lead to cardiovascular diseases.[16,17] These micro- and macro-vascular changes are due to the increase in levels of pro-inflammatory molecules, vascular cell adhesion proteins and Plasminogen activator inhibitor-1 which all serve to damage the inner lining of small and large blood vessels that lead to the proliferation of white blood cells, cellular adhesions and fibrotic tissue, and the eventual formation of a thrombus.[16,17]

From a kinesiological perspective, obese individuals tend to have an increase in the amount of adipose tissue deposition within muscle tissue between muscle fibers.[15] Like increased fat distribution in other bodily compartments, adipose tissue deposition within muscle has been hypothesized to be due to decreased resting fatty acid utilization via beta oxidation in favor of circulating glucose and glycogen stored in the liver and skeletal muscle. This process called metabolic inflexibility with the accumulation of adipose tissue in skeletal muscle can cause skeletal muscle insulin resistance.[15,16]

In addition, adipose deposition in skeletal muscle has been shown to reduce lower extremity muscle strength, and power for individuals who were obese and had diabetic peripheral neuropathy.[15] In this study, they noted that physical performance levels were lower as compared to age- and gender-matched controls that were not obese and did not have diabetes or peripheral neuropathy. Other studies have noted that obese individuals have decreased physical function, balance reactions and mobility that either place them at higher risk for falls and/or causes more injuries related to a fall when one ensues.[18-20] Obese individuals with chronic low back pain are also more prone to suffer from fear of movement, have higher levels of pain and catastrophizing of their pain and greater self-reported disability as compared to non-obese individuals with chronic low back pain.[21]

Physical Inactivity as a Potential Etiological Factor of Obesity

The factors that contribute to the development of obesity are related to a decrease in energy expenditure and/or an increase in energy consumption that leads to the development of increased body mass.[22,23] Physical activity is one of the main factors examined to prevent and treat the effects of obesity. Physical activity is defined as "bodily movement produced by the skeletal muscles that result in caloric expenditure".[24]

The opportunity to engage in regular bodily movement as a way to perform many of life's daily tasks has been reduced or removed in many cases by more automation and machinery to perform tasks such as stair climbing, lifting and various household chores. Automation, increased screen time viewing a computer or television as well as urban and suburban sprawl in many communities are some of the reasons why physical activity levels have decreased for many people. Since the amount of physical activity as a part of incidental activities of daily living has diminished, for many, the only way to achieve the physical activity needed to promote health must come from physical exercise.

Physical exercise is defined as "physical activity that is planned, structured, repetitive, and results in the improvement or maintenance of one or more facets of physical fitness."[24] While individuals realize that physical exercise is the only way to attain the amount of physical activity necessary to promote health, for certain population groups such as minorities and those individuals from low socioeconomic backgrounds there is a tendency to not engage in healthy physical activities or exercise to promote physical fitness. Physical fitness is defined as "a set of outcomes or traits that relate to the ability to perform physical activity."[24]

While it is important to consider the trends of rising obesity rates in the U.S. as a public health problem, it is just as important to consider the relatively low rates of physical activity to promote health and fitness as another factor involved in the development of the same maladies that are implicated due to obesity. In fact, physical inactivity and lower levels of fitness have been cited as confounders when considering the effects of obesity because many of the ill effects of obesity are related to decreases in physical activity.[25-27] Thus the question must arise, is the increased risk of mortality and morbidity from all causes and cardiovascular diseases due to individuals being obese or is it due to being physically inactive with low levels of physical fitness?

The 2008 Physical Activity Guidelines for Americans from the U.S. Department of Health and Human Services (USDHHS) recommends that all adults attain at least 150 minutes a week of moderate-intensity aerobic physical activity or 75 minutes a week of vigorous-intensity aerobic physical activity or an equivalent combination of moderate- to-vigorous-intense aerobic activity.[25,28] The aerobic activity should be performed in episodes of at least 10 minutes, preferably spread throughout the week. In addition to aerobic activities, the USDHHS recommends that adults should also do muscle-strengthening activities that involve all major muscle groups performed on 2 or more days-per-week.[25,29]

In 2010, approximately 20.7% of the adults who responded to the National Centers for Health Statistics survey met both the aerobic and strengthening guidelines and 49.5% of adults didn't meet the aerobic or strengthening guidelines.[30] The 2010 trend for adults who did not meet either physical activity guidelines increased by age with a rate of 43.1% for adults aged 18-44 years old and 70.3% for adults aged 75 years or older.[30] The rates of non-compliance with both physical activity guidelines were higher for women than men (54.0% vs. 43.8%), with men between the ages of 18-44 having the lowest rates of noncompliance at 37.1%, as compared to women at 49%; women over the age of 75 at 75.3%; men over the age of 75 at 62.8%.[30]

When examined by race, non-Hispanic Whites had the lowest levels of non-compliance at 45% followed by non-Hispanic Blacks with a rate of 58.4% and Hispanics at 60.2%.[30] The steepest differences in rates of non-compliance with both physical activity recommendations were found when education and poverty levels are examined. Individuals with higher levels of educational attainment had the highest rates of compliance with the USDHHS physical activity guidelines for both aerobic and resistance training exercises. In 2010, individuals who attained a bachelor's degree or higher had an age adjusted rate of 30.3% compliance with the recommendations for both aerobic and resistive exercises from the USDHHS. In comparison, the rates were 19.1%, 12.6% and 7.7% for individuals who attained some college, high school diploma (GED), or less than a high school diploma respectively.[30]

The rates of non-compliance by poverty level revealed that individuals who were at 400% or greater than their respective poverty levels had the lowest rates of non-compliance (36.9%), followed by those individuals who were 200%-399% above poverty (50.6%), 100%-199% above poverty (60.6%) and those below poverty (63.9%).[30] When the factors of race and poverty levels were examined together, the differences in non-compliance by race were attenuated. The 2010 rates of non-compliance for individuals who were at 400% or greater than their respective poverty levels by race were 42.5%, 35.2% and 47.7% for Hispanics, non-Hispanic Whites and non-Hispanic Blacks, respectively.[30] At levels below poverty, the rates were 68.6%, 60.5% and 66.9% for Hispanics, non-Hispanic Whites and non-Hispanic Blacks, respectively.[30]

Education and socioeconomic factors play a significant role in the initiation and maintenance of an effective physical activity program. Lack of understanding the importance of regular physical activity in the prevention of disease, few community role models who can promote the beneficial effects of physical exercise and reduced access to health care professionals who can guide individuals in the process of changing lifestyle behaviors are some of the cited reasons why individuals from underserved communities are often inactive compared to others.[31] In their review of evidence based physical activity programs that target underserved populations, Yancey, Ory and Davis[31] noted that socioeconomic and cultural factors can relate to reduced levels of physical activity. Lack of safe neighborhood walking areas, decreased leisure time in lieu of extended paid work hours, and a cultural avoidance of voluntary physical activity due to historical and economic situation were some of the reasons for a lack of physical activity participation by the underserved.[25,31]

For youth from the ages of 6-17 years old, the USDHHS has recommended that all youths obtain at least 60 minutes of moderate- to-vigorous-intensity physical activity each day.[32] These activities must include a combination of aerobic and musculoskeletal strengthening exercises. The Youth Risk Behavioral Risk Survey conducted by the CDC reported a prevalence rate of 28.7% for adolescents in grades 9 through 12 that met the physical activity guidelines in the year 2011.[33] When examined by ethnicity and gender, Hispanic girls had a prevalence rate of 33% as compared to their White counterparts with a rate of 42.6%; for Hispanic boys, the rate was 57.1% as compared to White boys with a rate of 62.1%.[33]

The YRBSS surveys students who are in grades 9 through 12 in public and private schools every two years about health behaviors and patterns. One of the questions asks if they have done at least 60 minutes of aerobic (moderate and vigorous) physical activity at any time during the preceding 7 days. The percentage of students who did achieve the recommended amounts of physical activity on 5 or more days per week in the year 2011 was 49.5%.[33] The prevalence rate for those who did achieve these recommendations was higher for boys (59.9%) than girls (38.5%).[33]

With regards to gender and race, White male students had the highest prevalence rate of compliance with the guidelines (62.1%), followed by Black and Hispanic males at rates of 57.1% each.[33] White female students had the highest rates of compliance (42.6%), followed by Hispanic (33.0%) and Black (31.9%) female students.[33]

The rates of compliance were also higher for younger-age students. When examined by grade and gender, 9th-grade males had the highest rate of compliance (61.0%) with the rate descending at each grade level to 62.3%, 58.5%, and 57.3% for male students in the 10th, 11th and 12th grades, and respectively.[33] For female students, the same trend in compliance with the recommendations was found with 9th-graders who had the highest rates of compliance at (44.5%), followed by 10th, 11th and 12th graders with rates of 40.3%, 35.7% and 32.0% respectively.[33]

The reasons for the rates of non-compliance with physical activity guidelines are multi-factorial. Age plays a central role in the tendency to be physically inactive. A survey conducted in 1997 revealed a 31% decline in the prevalence of vigorous physical activity participation of 3 or more days per week for high school students between the ages of 18 to 21 years as compared to 12 to 13 year olds.[34] The decline in physical activity for these adolescents has been partially explained by a reduction in general self-esteem which is defined as the level of positive or negative feelings about oneself.[35] In addition, the availability of options to be inactive while performing more sedentary activities becomes more available as video games, computers and television competes for their time that would be spent being physically active.

Socioeconomic status, in particular poverty level, appears to confound the relationship between race and physical activity levels.[33,40] Like adults, poverty influences the levels of physical activity participation because often the lack of community resources such as parks, safe areas to walk, lack of neighborhood healthcare providers, and affordable exercise facilities. In addition, for many school based physical activity programs that would be a normal part of physical education (PE) have been reduced or even eliminated due to budgetary reductions and allocation of resources to further more academic pursuits.

Effects of Physical Fitness, Exercise, on Reductions of Metabolic Risk Factors and Morbidity/Mortality

Physical activity and physical fitness are factors that attenuate the relationships between obesity and mortality from all causes and specifically from cardiovascular diseases.[41] Studies have shown that those who were aerobically fit had lower risks of mortality and morbidity at each stratum of waist circumference and BMI.[25,26,26,27] Although it is widely used, BMI is not always the best measure of fatness and thus has a weaker correlation with morbidity and mortality mainly because BMI does not indicate the morphological distributions of fatness both globally and regionally, nor does it account for lean body mass. It appears that those who possess a body habitus of increased abdominal fat distribution or visceral fat are the individuals who tend to have the highest rates of metabolic disorders, cancers and certain cardiovascular conditions. Interesting is that those individuals who were aerobically fit, but had similar waist circumferences as those who were non fit, had lower rates of morbidity and mortality.[25,26]

Individuals with high waist circumferences and high BMIs but who were aerobically fit had lower rates of morbidity and mortality than individuals with low BMIs who were unfit with smaller waist circumferences.[26]

Physical fitness has been shown to be protective against many of these health disorders, and studies show that those individuals with low BMI who were fit still had the lowest rates of morbidity and mortality.[20-22] The conclusion is BMI does affect morbidity and mortality rates, but these relationships are attenuated by physical fitness levels. In studies that use exercise as the prime intervention to combat obesity, the storage of visceral fat is reduced the most in terms of volume as compared to storages for subcutaneous, intramuscular and hepatic fat.[42,43] It appears that this type of fat may be preferentially metabolized to produce energy during times of caloric deprivation whether it is due to increased physical activity or caloric restrictions.[13,14]

Visceral fat has been noted to become oxidized by the beta oxidation process in the mitochondria to catabolize lipids to fatty acids as a fuel source.[13,14,44]

There have been numerous published studies that examine the metabolic effects of exercise with very promising results.[45] An aerobic exercise trial was conducted on obese Hispanic adolescents who were >95th percentile of age and gender based norms for BMI.[43] These adolescents were instructed to not lose weight during the 12-week bi-weekly aerobic exercise program. The researchers noted that aerobic fitness improved and these improvements correlated with increased insulin sensitivity of the hepatic and muscular systems and reductions in systolic blood pressure as well as in hepatic and visceral fat accumulation in children that was independent of weight loss.[43] It is important to note that many of the exercise trials have utilized aerobic exercise as the sole intervention to improve fitness and to assess the relationships with fitness and morbidity and mortality from all causes and cardiovascular diseases. The general consensus is that improvements in cardiovascular fitness have demonstrated inverse relationships with the aforementioned metabolic health indicators.[13,14,25,42,43]

Studies that involve aerobic exercise of varying intensities and volumes for overweight and obese adults revealed that aerobic exercise was an important contributor to the reduction of total abdominal fat by roughly 30%.[44-46] Although the guidelines set for physical activity by the Federal Government call for a combination of moderate-to-vigorous physical activity for at least 150 minutes per week, these guidelines represent the minimal dosage needed to achieve and maintain health. To promote weight loss, such organizations as the American College of Sports Medicine and the American Dietetic Association called for an increased volume of moderate-to-vigorous physical activity (MVPA) by gradually increasing the dose to exceed 150 minutes per week to at least 225 to 420 minutes per week.[25,29,47] These guidelines call for the majority of the physical activity to be aerobic in nature. Aerobic exercise in general increases energy expenditure during the activity itself. Increasing energy expenditure through exercise has been shown to be effective in reducing visceral fat stores, lowering resting systolic and diastolic blood pressure due to increased vagal tone, increasing nitric oxide production and increasing vascular compliance. Aerobic exercise has been shown to morphologically change the serotypes of low density lipoprotein (LDL) particle size from small, which is considered to be more athrogenic, to larger, fluffier types which are less harmful to the vascular system.[48] Despite these benefits of aerobic exercise, this type of exercise does very little to change the resting metabolic rate and, in some cases, the resting metabolic rate may even decrease due to the loss of muscle tissue which is very metabolically active.[47,49] Previous research has shown that the basal metabolic rate accounts for approximately 65-70% of total daily energy expenditures which is significantly higher than the reported 20-30% and 5-10% for energy expenditures that are from physical activity and the thermal effects of digestion, respectively.[50,51,52]

Muscular fitness has not been studied as extensively as aerobic fitness with regards to establishing relationships with morbidity and mortality from all causes and cardiovascular diseases, but a few studies do show promising results. Numerous studies performed on middle aged and elderly adults have shown that grip strength is a valid indicator of general muscular fitness and is significantly correlated with all cause and cardiovascular morbidity and mortality.[53-56] In another study, it appears that individuals who have higher levels of lower extremity strength also have lower levels of premature morbidity and mortality.[53] Since over 50% of the muscle mass is located below the abdominal area, muscular development of the lower extremities can improve basal metabolic rates and increase the levels of testosterone which can foster the increase in muscle mass in regions other than the lower extremities if those areas are engaged in a progressive resistance training program.[57-59] Interventions that use resistance training to ameliorate the effects of obesity and/or maladaptive metabolic profiles have been studied recently as an attractive adjunct or alternative to aerobic exercise.[57-59]

Although resistance training is typically used to improve muscle strength and power, using it to increase lean body mass can also affect weight loss for obese individuals.[57] Increased muscle mass has been shown to contribute positively to resting metabolic rates for individuals who engage in strength training programs.[58,59] Studies using a combination resistance training/diet program were able to produce a 40% reduction in visceral fat which was comparable to an aerobic exercise/diet program with a 39% reduction.[58] Obese Hispanic adolescents, who were not instructed to lose weight or alter their diet, were engaged in a 12-week, bi-weekly resistance training program and experienced hepatic insulin sensitivity that improved and glucose production that decreased due to a reduction in glycogenolysis.[42] They noted visceral, hepatic, and subcutaneous fat stores did not change and thus questioned the prevailing notion that hepatic fat deposition correlates with insulin sensitivity. In addition, these subjects on average gained significant upper and lower body strength as well as approximately 2.5 kg of bodyweight with approximately 80% due to increases in lean body mass. An interesting finding in this study was that, although lean body mass and muscle quality (strength/unit area of muscle mass) improved, peripheral insulin sensitivity did not change.[42] This study noted that previous researchers have found correlations between peripheral insulin sensitivity and lean body mass development which they theorized was due to increased glucose uptake in Type I muscle fibers postulated to occur from enhanced activity of the Glut-4 transporter protein.[42]

In a systematic review, Strasser, Siebert, and Schobersberger[59]noted that a 12-week or greater resistance training program can have an effect of lowering glycosylated hemoglobin (A1c) levels anywhere from 0.5% to 0.8%. A rise in A1c value of 1% has been shown to increase the risk for: mortality due to diabetes by 21%; myocardial infarctions by 14%; microvascular complications by 37%.[59] Besides the effects of resistance training on insulin sensitivity, resistance training has been reported to have a mean six point effect on lowering systolic blood pressure. Strasser et al[59] noted that previous meta-analyses have found that a reduction in systolic blood pressure by at least 3 mmHg has been estimated to reduce coronary heart disease by 5-9%, stroke by 8-14% and all-cause mortality by 4%.[59]

With regards to weight loss, resistance training has been shown to increase lean body mass which has an effect on increasing total energy expenditure, in particular resting metabolic rates. Lean body mass is more metabolically active, and resistance training programs that are intense enough (>70% of one repetition max (1-RM)) to bring about these changes can improve caloric expenditure.[53,60] For obese individuals, resistance training may serve as a useful addition to the more traditional, aerobic based exercise programs that tend to reduce fat and fat free mass due to the catabolic nature of these programs.

Most comprehensive fitness programs aimed at improving general health involve the inclusion of both resistive and aerobic exercise.[60] Guidelines set forth from such agencies as the Centers of Disease Control and Prevention (CDC), ACSM, and USDHHS suggest that fitness programs include both types of exercise to promote healthy lifestyle behaviors.[25,29,32,61] Despite these recommendations, many individuals who do consider themselves "active" do not meet the current guidelines for time spent performing both aerobic and resistive exercises.[33,62,63]

Physical activity levels and the types of physical activities that one engages in tend to vary based on the age, gender and training status of the individual. Gender-based roles and body image perception have been shown to play a role in the amount of physical activity that an individual performs and the types of activities that one enjoys.[64-66] These gender-based perceptions of ideal body images for women include small waist-to-hip ratios and body-fat distribution in the breasts and hips. These beliefs may contribute to the aversion that most women towards certain physical activities due to unsubstantiated fears of becoming "too large" or "too masculine" appearing and to favor aerobic exercises to promote "thinness".[64,65,67] Body image factors also play a role in the participation of certain types of exercises that males choose. In general males, particularly adolescent and young adult males, often view themselves as not achieving the level of muscularity that they should have, whereas women in general often view themselves as carrying more body weight and/or more body-fat than what they should have.[64-66,68,69] Often these perceptions lead to diet and exercise programs that are aerobic in nature with the hopes of losing weight and becoming smaller for women, and resistance/strength training programs for men. As body image plays an important role in the selection of exercise types, other psychological factors such as self-esteem play just as important if not a greater role in the initiation and/or maintenance of a fitness program.[35,70]

Exercise and Weight Loss Programs

For weight loss, the National Heart, Lung and Blood Institute and the American College of Sports Medicine (ACSM) have also found high levels of evidence for the inclusion of both aerobic and resistive types of exercise to promote and maintain weight loss for overweight and obese individuals.[25,29,71] Most of the programs reported in the literature include such treatment modalities as low calorie diets and exercise (aerobic and/or resistance training), as well as behavioral interventions. The settings for these programs usually are in community centers, primary care settings, hospitals, fitness centers and wellness centers, to name a few. These studies have been conducted on a range of populations that span from children to the elderly as well as some that are unisex and others that are coed. Interpreting the results of these studies is often difficult due to the heterogeneity of the attributes of the populations studied (age, gender, socioeconomic status, race), settings in which that the interventions are conducted (wellness vs. primary care facilities), the type of intervention (exercise vs. diet vs. combination) and the outcome measures used (body weight, BMI, waist circumference, etc.).

Hispanic Adolescents: Physical Activity Epidemiology and Interventions Aimed at Increasing Physical Activity Levels

The low levels of physical activities in Hispanic youths have been cited as a serious problem that threatens the health and well-being of this population. Hispanics are the fastest growing minority group in the country with the expected population rate of Hispanics to triple by the year 2050 to approximately 29% of the total U.S. population.[72] Because the prevalence rates of overweight and obesity are high for both Hispanic children and adults, examination of the factors that may contribute to obesity in this group warrants serious consideration. Approximately 30% of Hispanic youths met the recommended 60-minutes per day of moderate to vigorous physical activity guidelines as compared to 37% of non-Hispanic Whites and 31% of non-Hispanic Blacks.[30] Many of these children were overweight or obese.

For adolescent children regardless of race, the CDC 2011 YRBSS revealed trends of decreasing physical activity between the 9th and 12th grades. The prevalence rates of adolescents that met the Federal Physical guidelines of 60 minutes of daily MVPA decreased from 52.9% for 9th graders as compared to 44.8% 12th graders.[33] During this same time period, Hispanic and African-American adolescents had much lower prevalence rates for meeting the Federal physical activity guidelines as compared to their White counterparts with rates of 45.4%, 44.4 and 52.7% respectively.[33]

The 2011 YRBSS demonstrated that the decline in participation rate is particularly worse for girls, dropping from 44.5% in the 9th grade to 32.0% in the 12th grade as compared to boys who had 9th and 12th grade prevalence rates of 61.0% and

57.3%, respectively.[33] The 2011 YRBSS reported prevalence rate of adolescents aged 12 to 17 years that met the Federal physical activity guidelines were 42.6%, 31.9%, and 33.0% for girls who were White, African-American and Hispanic. For boys, the prevalence rate by ethnicity were 62.1%, 57.1% and 57.1% for boys who were White, African-American and Hispanic.[33]

Mulhall, Reis, and Begum[37] sampled 1578 youths from school districts in small to mid-size cities in the Mid-west to understand the attitudes of 12-13 year olds toward exercise and potential factors that may contribute to the engagement of physical activity. They noted that for early adolescent children who were 12-13 years old, regardless of race, there were several factors that were involved in the precipitous decline in physical activity over these years. They noted that for children who were of lower economic levels, (determined by whether they qualified for free or reduced lunch) individual attitudes towards exercise and family fitness activities were significant predictors of physical activity engagement for these children.[37] They found that youths who had a positive attitude towards fitness were more likely to engage in exercise activities, participate in sports and run, jog or walk whereas those with a negative attitude towards fitness engaged in these activities much less. They also noted a decrease in the number of days that they engaged in physical activity when there was no family commitment to exercise as compared to youths that had family members that did exercise 3 or more days per week.

The 2010 Census reported that approximately 32.3% Hispanic children (aged 0-17 years) resided in homes that were considered to be impoverished based on the income to poverty threshold ratios. Living in impoverished areas is associated with crime, along with a lack of safe places to walk and exercise.[31,73-75] For Hispanic youths, attitudes towards their environment are important items to consider when examining their physical activity habits.

Olvera, Smith, Lee, et al[75] examined the perceptions of neighborhood safety with regards to walking and bicycling by sampling Hispanic children (mean age of 10) and their mothers who reside in a low income, inner city neighborhood. They noted that children often perceived their neighborhood as being less dangerous than their mothers did. For children, their most important concerns about walking or bicycling in their neighborhoods were due to strangers and stray dogs being present whereas as their mothers had the most concern about traffic (cars going too fast, excessive amounts of traffic). They used a regression analysis in an attempt to determine if such factors as: excessive traffic, cars traveling fast, the presence of strangers, stray dogs, gangs and lack of crosswalks, traffic signals and insufficient lighting would explain the levels of physical activity in either the children or their mothers. They found that the equations were not statistically significant for explaining MVPA) for either the mothers of their children which is a paradoxical shift from conventional wisdom thinking that those individuals who reside in lower socioeconomic, inner city areas would have less physical activity due to environmental factors. Although the aforementioned study eludes to environmental factors as being less predictive of physical activity levels, it is important to be mindful of the mean age of the children in their study as being younger than adolescents who may perceive their environment differently.

Gordon-Larsen, McMurray, Popkin[63] noted the environment did play more of a factor when examining patterns of physical activity and inactivity for 17,766 adolescent boys and girls (Non-Hispanic white 66.7%, non-Hispanic Black 16.7%, Hispanic 12.7% and Asian 4.0%) with a mean age 15.5 years. Their study utilized an ecological approach by examining environmental determinants of physical activity such as access to and use of available parks and fitness facilities, crime rates, and participation in school PE classes, along with sociodemographic determinants such as ethnicity, household income, education and gender. They found that crime rates, as noted by the number of serious incidents in an adolescent's neighborhood, were significantly associated with decreased physical activity levels that were particularly lower for women than men. The researchers found declining rates of PE participation with age. Twelve year old children had participation rates of 24.7% which declined to 8.3% for 17 year olds that were surveyed in their study for PE participation of at least once per week. Male students were more likely than female students in their study to report PE participation of at least once per week (15.3% vs. 13.7%). They found that age, gender and ethnicity were significant factors for PE participation.[63]

In particular, they found that adolescents who received PE classes 1-4 times per week and those who received PE classes 5 times per week had 44% and 121% respective increases in the odds of participating in moderate to high levels of physical activities. When they examined physical inactivity levels by ethnicity and gender, they found that non-Hispanic Black males and females had the highest rates of physical inactivity. Hispanic males and females were the next highest in terms of physical inactivity.

Previous research studies that examined the effects of interventions designed to increase physical activity in efforts to reduce maladaptive effects on the metabolism, promote physical fitness and reduce obesity have shown promising results. A study done by Byrd-Williams, Belcher, and Spruijt-Metz[38] examined the effects of a 16-week intervention aimed at increasing total physical activity with emphasis on MVPA to reduce measures of adiposity (total fat mass, percent body-fat and visceral fat) on 38 overweight (BMI $\geq 85^{th}$ percentile) Hispanic adolescents. They found that increasing total physical activity by 28% as measured by an accelerometer, not just MVPA, was associated with a 1.3 kg decrease in fat mass and a 0.8% decrease in body-fat after adjusting for pre-intervention adiposity levels. It appears that total physical activity and not just physical activity that is moderate or vigorously intensive is the key to reducing body-fat levels for overweight Hispanic adolescents.

Total physical activity is an important concept to consider for individuals who desire to lose weight by engaging in exercise programs. Often when individuals engage in a weight loss program by reducing energy intake and/or increasing energy expenditure the magnitude of the weight that is lost is adversely affected by behavioral and physiological compensations.[41,76] One behavioral compensation discussed in a paper by

King, Caudwell, Hopkins et al[41] was the voluntary reduction of incidental physical activity required to do every day activities when one engages in a structured exercise program; or the increased caloric intake as one increases his or her physical activity level resulting in a diminished weight loss effect or even weight gain.

Another randomized control trial conducted by Davis, Ventura, Shaibi, et al[77] examined the effects of a diet program that sought to reduce the consumption of added sugars and increase the intake of fiber rich foods along with a twice weekly total body strength training program on 54 overweight Latino adolescents. The comparison groups were diet-only and control. The outcome measures were insulin sensitivity, body composition, adiposity and upper and lower body strength. They found no significant improvements in metabolic risk factors such as insulin sensitivity, body composition or the ratio of glucose to insulin production. They found a small reduction in glucose production for the intervention groups as compared to the controls with the diet-only group showing a greater reduction (18% vs. 6.3%) in glucose production. They noted a significant increase in upper body strength across all three groups, with the diet nutrition and strengthening group having the greatest magnitude of increase. Despite the increases in strength, the subjects in this study did not have the concomitant improvements in metabolic parameters that were present in other studies. The authors noted that the possible reason(s) for the lack of changes in metabolic profiles may be due to insufficient intensity and/or duration of the strength training intervention to manifest favorable metabolic changes. This study also included adolescent females (48% female vs. 52%

male) which the authors stated is a group that may require a longer duration as compared to males involved in a resistance training intervention before favorable metabolic effects such as insulin sensitivity are manifested.

Hasson, Adam, Davis, et al[78] performed a similar randomized control trial as the aforementioned one to improve metabolic markers of inflammation, adiposity and insulin resistance in African-American and Hispanic youths who were obese by randomizing them to a similar diet-only group, diet-plus-strength training group or control group.[78] Compared to the control group, both intervention groups had improved insulin sensitivity but these improvements were seen for the Hispanic cohort only and worsened in the African-American cohort.[78] The diet-plus-strength training group had lower levels of hepatic fat as compared to the diet-only and control groups. In addition the diet and strength groups had significantly lower levels of the inflammatory markers plasminogen activator inhibitor-1 (PAI-1) protein and the adipokine, resistin with African-Americans showing greater improvements in PAI-1 and acute insulin responses to glucose.[78] They found no other effects of the intervention for any other measures of adiposity or inflammation.

There have been several studies that have documented improvements in metabolic profiles and general health without the effects of weight loss. These studies support the emerging paradigm that lack of fitness may be more of an etiological factor that promotes metabolic derangements than just fatness.[17, 22, 75,76,79,80] Van Der Heijden, Toffolo, Manesso, Sauer, Sunehag, et al[43] performed a 12-week, four times per week aerobic exercise program at 70% of VO_2 peak for 30 minutes comparing the effects on healthy Hispanic adolescents that were lean and obese without the effects of weight loss. They found that the both groups significantly increased their VO_2 max (obese: 13 ml O_2/kg/min and lean: 16 ml O_2/kg/min). Only the obese group had a significant reduction in hepatic and visceral fat content while reducing insulin resistance. The fasting insulin levels were reduced by approximately 3.6 μU/ml and the homeostasis model assessment of insulin resistance (HOMAIR) by 0.8. They noted a significant correlation between the reductions in visceral fat and fasting insulin. Their lean counterparts did not exhibit any of these metabolic changes. One other important consideration found in their companion study published in a separate paper was that the aerobic exercise intervention did not increase the basal metabolic rates for either the lean or obese subjects.[81] The aerobic intervention also did not increase fatty acid consumption at rest for the obese subjects but improved the fatty acid consumption for the lean subjects. An important factor to consider when using aerobic exercise for weight loss is that while the exercise is being performed, there is an increased rate of energy expenditure. When individuals undergo weight loss programs, behaviors such as the increased consumption of calories throughout the day or a reduction in incidental physical activity can work synergistically to negatively influence weight loss outcomes.[41] The lack of change seen in fatty acid consumption is an important consideration for individuals who are diabetic or who display early signs of impending diabetes such as insulin resistance.[11, 15, 77, 82]

For individuals who are insulin resistant, there is a lack of metabolic flexibility that occurs when fatty acids become the prime substrate used at low intensity levels of physical activity.[16, 83] In these cases, the substrate of choice becomes exogenous and endogenously produced glucose, but with lack of an adequate insulin response, the levels of both glucose and fatty acids accumulate and produce toxic and deleterious effects on the vascular and nervous systems.[13,14,16,17,83,84]

In another separately published study, these same researchers found that the aerobic training program improved hepatic and peripheral insulin sensitivity for both the lean (19% and 35%, respectively) and obese (23% and 59%, respectively) Hispanic adolescent subjects.[43] They also noted that the glucose production rate decreased significantly for both the lean and obese counterparts (3% and 4% respectively) along with a significantly decreased glycogenolysis (8%) for the obese group. These are important findings because it revealed that moderately intense aerobic exercise for 4 days per week (less than the CDC-recommended amount of 60-minutes per day), without weight loss could play a large role in potentially preventing the onset of diabetes in otherwise healthy, Hispanic adolescents. Although the obese individuals in their study had significantly lower levels of insulin sensitivity than their lean counterparts at baseline, they were able to manifest much larger improvements in hepatic and peripheral insulin sensitivities.

The lack of fatty acid utilization and changes in basal metabolic rates after a 12-week bout of aerobic exercise 4 times per week for obese Hispanic individuals, who tend to have higher levels of insulin resistance and thus reduced levels of metabolic flexibility, has led to the use of the use of resistance training as a potential contributor to improved metabolic fitness.[58-60,78,85] These same researchers examined the utility of a 12-week, bi-weekly total body resistance training program for obese Hispanic adolescents without the effects of weight loss. They found an increase in lean body mass, lower and upper body muscle strength, a 24% increase in fasting hepatic insulin sensitivity and a 12% decrease in glycogenolysis.[42] They did not find any changes in total, visceral, hepatic, or intramyocellular fat content as well as fatty acid oxidation rates. Despite the lack of changes in fat content in any of the major storage sites or fatty acid oxidation, this study did show that resistance training could be a useful adjunct to aerobic training since it does augment favorable changes in insulin sensitivities and has the capacity to develop muscular strength, promote the development of lean body mass which can be beneficial both psychologically for improved body image and physiologically as resistance training may offer similar benefits to aerobic training and which may be better tolerated by obese individuals.[42]

Shaibi, Cruz, Ball, et al[86] found an increase in hepatic insulin sensitivities that was independent of increased lean body mass development for Hispanic adolescents that underwent a 16-week, bi-weekly resistance training program. In a systematic review that examined the effects of resistance training on metabolic fitness in children and adolescents, Benson, Torode, and Fiatarone[85] noted that the effects of resistance training were difficult to assess as often they were utilized in conjunction with aerobic training programs and/or dietary programs that had a weight loss component. The utility of resistance training combined with aerobic and/or dietary changes has been proven useful in the preservation of lean body mass which could allow for the maintenance and/or the improvements in basal metabolic rates. Basal metabolic rates often decline with dietary and activity-based programs that promotes fat loss by reduced caloric intake and increased caloric expenditures. In addition, many of the studies that did include resistance training interventions either in isolation or in combination of other health enhancing modalities were often performed using low to moderate loads at higher volumes than traditional strength training programs. These “circuit training” programs often have a large cardiorespiratory component that may also serve to confound the benefits of strength training on metabolic and anthropometric parameters.

Community and School Based Physical Activity Programs for Hispanic Adolescents

Most published studies that document the effects of interventions to combat obesity were randomized control trials utilizing rigorous laboratory based measures, standardized intervention protocols and selective recruitment of subjects to ensure high levels of internal validity. While these are important for establishing efficacy of exercise based interventions to promote weight loss and/or improved metabolic fitness in obese Hispanic adolescents, it is important to examine more closely health promotion programs that have been conducted with obese Hispanic adolescents to examine the effectiveness of these programs under more “real world” conditions. There is a dearth of published reports that addresses this particular population group, and the reported effects of health promotion efforts to reduce weight and/or improve metabolic fitness in this population are mixed.

Many of these “real world” interventions have taken place in community health centers, YMCAs, and schools with varying results. Smith, Annesi, Walsh, Lennon, and Bell, et al.[87] examined a behaviorally-based treatment to examine if changes in such psychosocial factors such as self-efficacy would increase the levels of self-reported voluntary physical activity and reduce Type 2 diabetic risk factors in 23 obese children between the ages of 11 and 14 (39% Hispanic, 39% African-American, 9% Asian, 4% White, 9% other). They utilized a twice-a-week program designed to promote an increase in self-regulatory efficacy (confidence in using internal psychosocial cues to overcome perceived barriers to engaging in physical activity) and task self-efficacy (feeling of adequacy in performing certain physical tasks, activities or sport). One of their hypotheses was that a program addressing these behavioral components would result in increased physical activity engagement which would in turn result in favorable changes in such Type 2 diabetic risk factors as BMI and cholesterol levels (increased High Density Lipoprotein (HDLs) and decreased Low Density Lipoproteins (LDLs)). Their intervention took place in a physician’s office using small groups (3-5 participants and their parents/guardians) and was led by a dietician and an exercise specialist who used social cognitive based treatments to promote goal setting, mastery and regulatory skills as they engaged in a 45-minute exercise program followed by a 45-60 minute consultation with a dietician. They found a significant increase in the self-reported days of physical activity (at least 60-minutes per day) as well as a reduction in total cholesterol. There were no significant changes in BMI, HDL, LDL cholesterol or glucose/insulin ratios. They also found significant and favorable changes in task self-efficacy which they felt may have contributed to the increase in self-reported physical activity in this group. Both self-efficacy measures contributed to 40% of the variance in the changes in days per week of voluntary physical activity meeting or exceeding 60 minutes per day.

Another study of an intervention designed to promote weight loss and long term weight maintenance for overweight Mexican-American children with an age range of 10 - 14 years conducted at a charter school showed promising results.[88] The intervention was a randomized controlled trial in which 60 children were randomized to an instructor led or self-help program (using a 12-week parent-guided manual) with the aim of increasing physical activity and modifying eating habits based on the specific needs of each participant. The 5-days-per-week instructor-led intervention was 24 weeks and the parent-led, self-guided program was 12 weeks long. They found a significant reduction in BMI z-score/percentile and triceps skinfold thickness at the 1st and 2nd year follow-ups for those who received the instructor led intervention. No change was found for those in the self-help group at either the 1st or 2nd year time points. The metabolic risk factors of total cholesterol and triglycerides showed significant decreases for the participants in the instructor-led intervention from baseline to the 1st year with no changes found in the parent-led, self-help group.

In a separately published report from the same researchers, they also noted an improvement in the quality of life for the individuals who participated in the instructor-led group.[89] They found a significant correlation between a modest amount of weight loss and quality of life for these participants. These studies highlight the importance of guided instruction which appears to be most effective in promoting behavioral changes. The didactic materials require the individual(s) to digest and utilize the information in the self-help manual independently in order to promote process-oriented changes for weight loss. This mode of behavioral change was deemed inferior to the instructor-led method of health promotion. The authors of this study also point out that the school where the intervention took place enjoys collaborative teacher–family and teacher-student relationships with strong ties to the Mexican–American community. The authors speculate that this type of relationship may foster an environment that is successful in the promotion of healthy behaviors in a community setting.

In another school-based intervention that targets Hispanic adolescents, Villalba, Amirehsani, and Lewis[90] performed an intervention utilizing a Health Fair in which nurses and nursing students would guide students through stations that would assess each child's health behaviors and vital signs. They also perform a physical exam. Age-appropriate literature was provided in both English and Spanish for the participants and their parents. The intervention also included a weekly small group meeting led for eight weeks by a school counselor who provided education on healthy behaviors and strategies to improve self-concept. Self-concept is defined as the way we see ourselves in a particular situation, context or domain.[35,91] Additional literature provided information to promote healthy behaviors such as increasing physical activity and reducing sugary beverage consumption was issued during these small group meetings. At the conclusion of the eight week program another health fair was conducted along with another modified Health Assessment Checklist to examine if any changes in behavior were found. A modified Health Assessment Checklist was provided to the participants at both the health fairs. The checklist included demographic information, frequency of doctor/dental visits, heart rate, BMI, and a fingerstick glucose test result. The researchers of this study found that the amount of time spent exercising each week increased significantly along with a reduction in daily sugary beverage consumption. They found no significant change in BMI. A few interesting points can be gleaned from this study. This intervention saw results in self-reported physical activity levels by providing education only and not actual performance of physical activity in a supervised manner. Although reliance on self-report only can limit the interpretative utility of this study, it does show promise for an education-only intervention potentially, impacting physical activity patterns for Hispanic adolescents who are at high risk for diseases associated with physical inactivity.

In another school-based intervention that took place in a predominantly Hispanic Junior High School in New York City, Rosenbaum, Nonas, Weil, et al[92] conducted a 3-4 month randomized controlled trial that consisted of a weekly 45-minute classroom program that taught the participants nutrition education such as reducing portion sizes, sugary beverage consumption and exercise principles in a science class in which the participants were also educated on experimental design, data analyses, diabetes epidemiology and research ethics. They had to complete a research project for their science class at the conclusion of this intervention. The intervention also consisted of thrice weekly exercise classes that were designed to accommodate either gender regardless of body size. They found significant reductions in pre and post levels of BMI, body-fat percentage, the pro-inflammatory cytokine interleukin 6 and the inflammatory marker C - reactive protein along with improvements in insulin sensitivity.

Systematic reviews have revealed that both school and community-based physical activity programs have varying results with regards to improvements in obesity-related parameters.[45,93] BMI is the most widely used index of fatness. Weight management programs incorporating dietary, physical activity and/or behavioral approaches for children and adolescents show modest improvements in BMI, at best. There are several reasons for the lack of robust results in anthropometric measures of fatness and they stem from issues as to whether BMI is the most valid measure of fatness as compared to other measures such as body-fat percentage, skin fold thickness or waist circumference. These systematic reviews often point to difficulty in the interpretation of the effectiveness of these physical activity programs across different trials because of the use of diverse anthropometric outcomes. In addition, the interventions are compared across a wide array of durations, exercise intensities and components of the programs with inconsistent reporting of exercise intensities and individual compliance levels.

Many of these previous studies do not report the effects of physical activity interventions on subsets of individuals based on BMI level, which further adds to the heterogeneity of the studies. Harris, Kuramoto, Schulzer and Retallack[94] pointed out that it is plausible to consider that many of these physical activity programs may have stronger effects for individuals with higher baseline BMI levels than those who present with lower baseline BMI levels, but those with lower baseline BMI levels may comply better with physical activity interventions than those with higher BMIs. Many of these studies also lack a significant number of minority participants which is important due to the high prevalence of obesity and obesity-related complications in the minority population. Since most of the outcome measures utilize self-report for physical activity levels and food intake there is the possibility of respective over and under-reporting of these two important factors that are involved in the reduction of body weight. Previous literature points to disadvantages such as recall and content validity when using self-reported measures, especially when used in studies that involve minority children/adolescents as subjects. Cultural biases and faulty interpretation of these self-reported measures have been shown to affect the responses to questions about lifestyle practices such as food consumption, and physical activity participation.

The link between BMI and physical inactivity is an empirical one. There is strong evidence that there is a negative association between obesity and low physical activity levels but the cause of this relationship is still questionable.[23] Rhetorically, this question is addressed in studies that seek to answer if low physical activity levels result in higher

BMIs or do higher BMIs increase the prevalence of low physical activity levels? Harris, Kuramoto, Schulzer and Retallack[94] in their systematic review suggest that the pathway to obesity in adolescents has not been clearly established. Children and adolescents with high BMI tend to have low physical activity levels, and low physical activity levels contribute to obesity. Prospective studies that examine the effects of diet alterations or physical activity on BMI reduction show that diet alterations may have a more potent effect on reducing BMI than physical activity alone. Thus, programs that combine both modalities are difficult to assess.[95,96]

It appears that many of the reported programs designed to assist children and adolescents in losing weight appear to be beneficial at maintaining their weight. Previous reports from such well-established programs such as Coordinated Approach to Child Health (CATCH) have been shown effective in school and community-based settings by implementing physical activity, healthy diet, behavioral modification and educational programs that have served to reduce the velocity of BMI increases.[97] Unique to the adolescent population is that height increases and body weight stabilization together lead to a decreased BMI.

A systematic review by Dobbins, De Corby, Robeson, Husson, and Tirilis[39] has shown that school-based interventions lack significant evidence to show that they alter lifestyle patterns to reduce television viewing and increase both duration of physical activity and physical activity during leisure time for adolescents. The studies included children and adolescents from a variety of ethnic backgrounds and ages.

Physical Activity Interventions, Physical Fitness, Metabolic Profile Changes and Adolescents

The results of the physical activity interventions appear to be more promising for metabolic and physical fitness measures. The systematic review conducted by Dobbins, De Corby, Robeson, Husson, and Tirilis[39] noted that physical activity interventions may have a small effect on diastolic blood pressure with no change in systolic blood pressure. They surmised that the lack of significant findings may be due to improper randomization that resulted in unequal distribution of confounding variables affecting blood pressure. In addition, the reporting of mean changes in blood pressure obscures the potential benefits that may have taken place for members of high risk groups that may have had significant improvements in blood pressure with physical activity interventions. Another possibility is that favorable changes in blood pressure, particularly diastolic blood pressure, often occur early in these interventions (7-20 weeks), but then level off as time progresses. Most of the interventions that were included in their review that used childrens' and adolescents' blood pressure as the primary outcome lasted 9 months or less. These authors questioned the relevancy of using blood pressure as an outcome measure for children and adolescents because the hallmark of the adolescent period is rapid structural growth. With this growth, the blood pressure will tend to increase, which is a normal physiological adaptation to increases in body size. They also concluded that there is good evidence that school based physical activity interventions are effective at improving maximal oxygen consumption for adolescents but the long term impact of these interventions on VO2 max is still unknown.[39] This promising finding in adults has been discussed by Donnelly, Hill, and Jacobsen, et al[26] who point to fitness and not self-reported physical activity levels or anthropometric indicators of fatness as being a significant predictors in the development of Type 2 diabetes.

Physical Activity Epidemiology, Young Adulthood by Age, Gender, Poverty Level and Mode of Exercise

The period of young adulthood between the ages of 20 to 30 years is hallmarked by a time that continues to follow the trend of reduced physical activity levels that began during the early teen-age years.[98] The American College Health Association has made increasing physical activity levels for students one of their objectives for the year 2020 as described in their Healthy Campus 2020 initiatives.[99] The objective states that it wants to increase the proportion of students who report meeting the current Federal guidelines for aerobic and muscle strengthening activities. The decline in physical activity from adolescence to young adulthood is related to several of the same factors as children and adolescents, namely ethnicity, education levels, physical self-concept and gender.
The CDC Behavioral Risk Factor Surveillance Survey (BRFSS) is a yearly telephone survey that asks questions about each participant's (>18 years of age) lifestyle practices, risk factors and the presence of diseases.[98] In 2011 approximately 51% and 29% of the participants are meeting the Federal guidelines for aerobic and muscle strengthening activities respectively, with only 21% meeting the both guidelines for aerobic and muscle strengthening activity.[61,98]

The year 2011 prevalence rates of individuals between the ages of 18-24 and 25-34 who met the aerobic guidelines were 56.5% and 49.8%, respectively, with the prevalence leveling off at approximately 50% from ages 35 and older.[98] Prevalence rates of individuals between the ages of 18-24 and 25-34 who met the muscle strengthening guidelines was 43.6% and 33.6%, respectively with the prevalence declining at an average rate of 3% for each decade from the ages of 35-44 onwards.[98]

In 2011 gender specific rates of individuals who met the aerobic guidelines were 53% for men and 49.9% for women, while the rates for individuals who met the muscle strengthening guidelines were 33.3% for men and 24.9% for women.[98] Trend data on the prevalence of individuals who met aerobic and muscle strengthening guidelines are unavailable from the BRFSS because 2011 was the first year that the physical activity questions were divided into components that questioned levels of aerobic and muscle strengthening activities separately. The year 2011 prevalence rates of individuals who met the Federal aerobic and muscle strengthening guidelines increased by small to moderate percentages (range: 0.6% to 4%) for both activities as the household income stratum increased from less than $15,000 per year to incomes from $35,00 to $49,999 per year.[98] The largest prevalence increases were seen for both types of physical activities when the household incomes were over $50,000 per year. The prevalence rates increased for aerobic and muscle strengthening activities by 6.9% and 6.2%, respectively, when the houshold incomes increased from between $35,000 and $49,999 per year to over $50,000 per year (see figures below).[98]

Pribis, Burtnack, McKenzie and Thayer[100] examined the trends in physical fitness over a 13-year period among college-age students with a mean baseline age of 21.5 years for men and 21.9 years for women. They found a significant trend towards decreasing VO_2 max for both males and females. He also found that when data were combined for both male and female students, there was a significant inverse correlation between VO_2 max and BMI with 11.1% and 17.1% of the variance in VO_2 max levels explained by BMI. One of the most striking trends found in this study was the fact that when the trends were examined across time and ordinal based classifications of fitness were assigned as poor, fair, fit and excellent, there was a differential decline in physical fitness by gender over the 13-year observation. The men in the study had an increased proportion in the poor category along with a proportion reduction in the fair, fit and excellent physical fitness categories. The women had an increased proportion in the poor category but the proportions fluctuated up and down during the 13 year observation with women having fewer losses from the fair, fit and excellent categories and less individuals moving into the poor category. Overall the decline in physical fitness was greater in men than women.

Factors That Influence Physical Activity Participation in Young Adults by Gender and Ethnicity

A study by Walsh, White, and Greaney[101] formed focus groups with college-aged men attending a university in attempts to understand their perceptions of their weight, diet and physical activity practices aimed towards achieving a healthy lifestyle.[93] They recruited 47 men with a mean age of 20.3 years who were mostly White – non-Hispanic with 60% having BMIs that would classify them as being overweight. He found that 30%

of the men in their study reported being dissatisfied with their weight and that often these individuals would either engage in dietary restraints (restriction of food intake to maintain their weight) or disinhibition (the tendency to overeat due to food or emotional cues). In this study, the researchers were able to identify common themes cited by the participants that were classified as motivators, barriers or enablers to healthy eating and physical activity participation. The motivators for the engagement in physical activity cited by the cohort of men in this study were the desire to improve sports performance, enhance their physical fitness, improve self-esteem, enhance physical attractiveness, improve current and long-term health, be attractive to women, and relax and improve overall state of mind. The enablers of physical activity were to: have a daily plan, use exercise to compensate for overeating, use intrinsic cues as reasons to exercise, set goals to achieve and use team sports or social support to hold them accountable to exercise. The barriers cited by these men for working against their physical activity efforts were: lack of time, other obligations (job, family, etc.), lack of time management, feelings of laziness and having a girlfriend.

Dowda, Ainsworth, Addy, Saunders and Riner[62] performed an ecological analysis of young adults aged 18-30 years old. They sought to determine the magnitude of the relationships among biological, social and demographic factors with levels of MVPA. They noted that this age is often a transition towards new occupational/professional responsibilities as well as the development of committed relationships such as marriage and/or starting a family by having children of their own. The participants of this study were 4152 male and female adults enrolled in the National Health and Nutrition Examination Survey III (NHANES III). They noted that walking was the most popular form of exercise across all ethnic groups studied regardless of gender (non-Hispanic Whites, non-Hispanic Blacks and Mexican-Americans). They noted that gardening was the one of the top five activities for non-Hispanic White men and women as well as Mexican-American men. Jogging/running and weightlifting were among the top five activities for men regardless of ethnicity. For women, their top five choices for physical activities were different from men. Cycling and dancing were in the top five for women regardless of ethnic background. Calisthenics were in the top five activities for both men and women regardless of ethnic background. They noted that men had higher overall levels of MVPA participation than females. When examined by ethnicity, Mexican-American men and women had the lowest MVPA participation, while non-Hispanic Black men and non-Hispanic white women had the highest levels of MVPA participation. Men and women who were not married had higher levels of MVPA participation than those who were married. Overall, for both men and women, those with higher levels of MVPA were unmarried, non-smokers, in better self-reported health, tried to lose weight within the past year of the study and had attended school. Women who were pregnant and lived in the South at the time of the survey had the lowest MVPA participation. The authors used correlational analyses to determine that when the variable age was logarithmically transformed, it was negatively associated with MVPA among men but not women. The more years of education and higher levels of self-reported social support were positively associated with MVPA for both men and women. Women with higher BMIs and larger family sizes had lower levels of MVPA. Interestingly, alcohol consumption was positively associated with MVPA among women. The researchers also noted that among women, higher levels of social support had a positive relationship with MVPA levels. They concluded that many of these social interactions involve alcohol and this may be a reason for this paradoxically positive relationship between alcohol consumption and MVPA.

The researchers used two different multiple regression analyses to determine which variables had the highest associations with MVPA when they interacted with each other to influence levels of MVPA. The first regression model only included demographic variables which found that for men, non-Hispanic Blacks who were not married, with more education were the most active. For women, non-Hispanic Whites, with more education were the most active, while those who were married with large families were the least active. The researchers noted that both models explained 8% and 11% of the variance in MVPA for the male and female participants, respectively. The second analysis included demographic variables plus variables that correlated with MVPA individually. The researchers noted that the coefficient of determination increased by 7% for men when school attendance, weight loss behaviors and social index were included in the equation, as they were all positively associated with MVPA. They noted that age was negatively associated with MVPA for men. For women, when the following variables: good to excellent self-reported health status, attempts to lose weight over the past year, low BMIs, and high levels of social support were added to the equation, the coefficient of determination increased by 10%. Each of the aforementioned variables had a positive association with MVPA. Being employed and living in the South was negatively associated with MVPA levels for women.

The interaction of race and education was added to the regression equation for men. They found that non-Hispanic White and Mexican-American men with more than 12 years education had higher MVPA than men of all other ethnic groups and educational levels, but non-Hispanic Black men had the highest levels of MVPA regardless of education level. The researchers also noted that this subgroup had the lowest employment level, were more likely to be unmarried and had a higher prevalence of school attendance which they surmised allowed for greater time to participate in MVP activities.

Leslie, Fotheringham, Owen and Bauman[102] observed a similar pattern of inactivity by age and gender for young adult Australians between the ages of 18-30 years old. They compiled data from three previously collected self-reported physical activity data sets. They noted that the male participants were more physically active than the female participants and that there was a higher proportion of male participants who met the physical activity guidelines of 30 minutes of moderate physical activity per day, 5 days per week at each age strata (18-19, 20-24 and 25-29 years). The proportion of adults who engaged in physical activity declined significantly with age for both males and female participants, but the female participants declined less in moderate physical activity than the males and were more likely to walk for moderate exercise than men were. The study researchers noted that when men decreased their vigorous physical activity participation, they did not replace it with less physically intense activities like walking. Their conclusion was that health promotion campaigns should be gender specific and employ strategies to have men replace vigorously intense activities with more moderate ones such as bicycling or walking and women should be taught additional activities to compliment the walking activities that they do.

Relationships between Self-Reported Physical Activity and Objective Physical Fitness Measures

It is important to examine the physical fitness trends as they relate to self-reported physical activity and health related measures. Paalanne, Korpelainen, Taimela, et al[103] examined the correlations between muscular fitness measures and self-reported physical activity and inactivity via the number of hours spent watching television. They noted that men were more physically active than women in the group but the amount of time spent watching TV did not vary by gender. He noted that participation level in MVPA was positively correlated with muscular fitness measures of isometric trunk extension and flexion strength and maximal jumping height for both genders. When levels of television viewing (> or < 2 hours) and self-reported physical activity were examined across gender, the females who watched TV > 2 hours performed worse in all muscular fitness tests compared with those who watched TV for less than 2 hours regardless of the self-reported physical activity level. Similarly, the males who reported > 2 hours TV viewing performed significantly worse in the isometric trunk extension and flexion tests than those who reported < 2 hours of television viewing regardless of self-reported physical activity levels. This study revealed a dose-response relationship to muscular fitness and self-reported physical activity levels with self-reported physical activity being an independent predictor of muscular fitness. Television viewing was also an independent predictor of muscular fitness with viewing amounts > 2 hours appearing to have more deleterious effects on muscular fitness for women than men regardless of self-reported activity level.

Gubata, Cowan, Bedno, Urban, and Niebuhr DW[104] examined self-reported physical activity levels and physical fitness levels for young US Army recruits. They issued a self-reported physical activity questionnaire that was based on a subset of physical activity questions from the CDC's YRBSS questionnaire. Their purpose was to determine, based on the response to those questions, whether or not the applicant met the ACSM's guidelines for physical activity. They used two physical fitness tests (modified 5-minute Harvard step test and maximal number of pushups done in 1 minute) that used gender and age-based norms to determine a "pass" or "fail". They found that the odds of passing the physical fitness battery were higher when self-reported physical activity met the ACSM recommendations regardless of age, race, smoking status, gender or body-fat percentage. In addition, they noted that playing on a sports team within the past year and watching television for less than 3 hours per day were associated with a higher likelihood of passing the physical fitness battery. The researchers concluded that the self-reported physical activity questionnaire could serve as either a screening tool to determine which applicants are ready to take the physical fitness battery or which applicants require physical fitness remediation to properly prepare for the physical fitness test battery. They noted that those applicants who fail the step test portion of the battery had been reported to have an increased likelihood of suffering a musculoskeletal injury within the first 90 days of service.

Relationships between Self-Reported Physical Activity, Physical Fitness, Metabolic Profiles and Morbidity/Mortality

Physical activity for young adults has been reported to exert the same health benefits in children and adolescents with regards to the risk reduction of metabolic derangements such as high blood pressure, visceral and hepatic fat accumulation, insulin resistance and dyslipidemia. One important physiological improvement with consistently intense physical activity is the improvement in physical fitness. The literature points to the improvement in metabolic profiles that may not necessarily be derived from merely being self-labeled as “physically active”.[18,23,29,34,41,46,48,57-60,67,71,77,82]

The physiological changes that occur from a regular fitness regimen such as increased muscular strength, improved oxygen consumption, metabolic flexibility (preference for fatty acid utilization at rest), increased cardiac output at rest and with exertion, and improved lactic acid buffering mechanisms may be the mechanisms that serve to alter metabolic profiles and possibly reduce disease risk.

A longitudinal study conducted by Carnethon, Evans, Church, et al[105] examined the associations of physical activity and aerobic fitness with the developmental incidence of hypertension in later years. The study recruited 4618 African-American and White men and women from the ages of 18-30 years old. They noted that lack of sufficient self-reported physical activity was not a significant factor for the later development of hypertension after controlling for race, age, smoking status, HDL, baseline systolic blood pressure, dietary fiber/salt intake, number of drinks per week, alcohol consumption, fasting glucose and BMI. Physical fitness was assessed aerobically using the Balke treadmill protocol and the participants were categorized into sex-specific tertiles (low, medium, high fitness) based on the duration spent on the treadmill. The researchers found that baseline physical fitness was a significant factor in the prediction of incident hypertension after controlling for the aforementioned variables. In particular, those individuals with high levels of physical fitness (treadmill durations >8.8 or >12.2 minutes for women and men, respectively) had lower incidence rates of hypertension as compared to those with lower levels of physical fitness. This inverse association with fitness and hypertension incidence persisted at all levels of physical fitness regardless of race and gender. The researchers found that when self-reported physical activity and physical fitness were used in the same equation to predict the incidence of hypertension, there were no interactions between self-reported physical activity and physical fitness in the prediction of hypertension after controlling for the other confounding variables. Physical activity was a significant factor in the incidence rates of hypertension only at the highest physical fitness levels. It appears from this study that self-reported physical activity is important in the prevention of hypertension only if it manifests in increased physical fitness.

The researchers in this study cited previous reports that suggest that the effects of physical activity upon incident hypertension are mediated by the physiologic changes that occur with a sufficiently intense and consistent program that improves physical fitness, along with the achievement of a more normal BMI and the prevention of insulin resistance. Because physical activity is often obtained by self–report, physical activity as an independent measure of predicting health behaviors may allow for erroneous presumption of health status. Use of self-reported physical activity measures does not truly reflect physical fitness or the metabolic profiles due to inadequacies of self-reported measures alone.

A similar phenomenon with the use of self-reported health measures combined with aerobic fitness tests to predict mortality rates in men was documented by Gander, Lee, et al [27] This study examined the data on mortality rates of 18,488 men who were participants of the Aerobic Center Longitudinal Study collected at the Cooper Clinic in Dallas, TX. The participants were men with an age range of 20-84 years who periodically received a clinical examination, maximal treadmill test and a request to rate their health status (poor, fair, good, excellent) over a 17-year period from 1987–2003. The researchers of this study found that the self-rated health status showed a significant inverse relationship with mortality rates when controlled for age and date of the examination and other confounding variables (BMI, physical activity, smoking, alcohol consumption, abnormal ECG, cancer, cardiovascular disease, diabetes, hypertension and hypercholesterolemia). When aerobic fitness level was added to the equation, the inverse relationship between self-rated health status and mortality rates was not significant. When the relationship between aerobic fitness level and mortality rate was examined, the inverse relationships between them remained strong when all previously mentioned confounding variables were controlled. Although this study used self-rated health and not self-reported physical activity measures, one could surmise that one's perceived physical activity level and physical capabilities would fall within the domain of self-perceived health status and that this report further confirms that physical fitness has a strong relationship with more global health measures that quantify levels of morbidity and mortality.

Ortega, Sanchez-Lopez, Solera-Martinez, Fernandez-Sanchez, Sjostrom, Martinez-Vizcaino, et al[106] found that self-reported physical fitness levels correlated with measured physical fitness tests, cardiovascular disease risk and measures of adiposity. A population of 276 healthy university students from 18-30 years old from a local university in Spain who completed the International Fitness Scale (IFS). This previously validated scale questions overall fitness, as well as subcomponents of cardiorespiratory fitness, muscular strength, speed-agility, and flexibility. Next the subjects' cardiovascular fitness and muscular strength/flexibility were assessed. The 20-meter shuttle run was used to assess cardiovascular fitness; maximal handgrip and standing broad jump were used for upper and lower extremity power, respectively; and the sit and reach test was used to assess overall flexibility. The researchers found a significant difference between individuals with the highest level of self-reported fitness on the IFS, performing better on the 20-meter shuttle run, handgrip, standing long jump and sit and reach tests than individuals in the lowest self-reported fitness levels, when adjusted for age and gender. In addition, they found that self-reported and measured cardiovascular fitness had a significant inverse relationship with adiposity assessed via Dual-energy X-ray absorptiometry (DEXA)) scan. Muscular fitness measures also had an inverse relationship with adiposity measures. They also noted that high levels of measured and self-reported cardiovascular fitness had a significant inverse relationship with cardiovascular disease risk factors assessed via a metabolic syndrome index (standardized z-scores in waist circumference, triglycerides/HDLc ratio, mean arterial pressure, and Homeostasis Model of Assessment - Insulin Resistance (HOMAIR)). For muscular fitness, both the self-reported and measured fitness scores had an inverse association with cardiovascular disease risk when the absolute measures (no correction via bodyweight) were used. This study was similar to the previously described study in that self-reported measures of fitness or health status and not necessarily self-reported physical activity levels could potentially be used in place of or in conjunction with actual fitness measures in large epidemiological studies as indicators of health and fitness.

Kuijer, Gerrits and Reneman[107] performed a research study to examine how well subjects use three different subjective measures to estimate their ability to lift a weight using standard occupational lifts (waist to shoulder, waist to overhead for a one or five repetition maximum (RM)) and true physical performance measures of those lifts to see if these subjective measures could replace the actual physical performance measures. He used 72 healthy males and females with a mean age of 22 years and gave them three different types of questionnaires. One open ended questionnaire, e.g. "how much can you lift" and two close ended questionnaires, e.g., "Can you lift one kilo of sugar from waist to overhead?". The first close ended questionnaire further asked if the participants can lift everyday items ranging from 1 to 40 kg for women and from 1 to 60 kg for men, with 5-kg increments. The second closed ended questionnaire asked the subject to lift a weight that represented about 70% of the maximal weight they were expected to lift based on age group norms and the subject had to estimate what percentage of his or her maximum lift the weight represented. These researchers found that subjective estimations of lifting abilities alone could not replace the actual physical performance lifts. For at least 79% of the participants of their study, when gender and self-reported fitness participation were added to the subjective lifting questionnaires, the prediction of lifting capabilities were within ± 5 kg for the actual lifting capabilities for the waist to shoulder and waist to overhead lifts for the one and five RM. The study highlights the fact that self-reported estimations of lifting capabilities may have some utility in predicting actual lifting capabilities, but only with the inclusion of other pertinent demographic and lifestyle variables that also impact one's actual ability to perform these lifting tasks.

Psychosocial Factors as a Determinant of Physical Activity Levels

Young adulthood represents an important period for most individuals as the transition from more structured periods of physical activity is interspersed with academic, familial and in some cases occupational responsibilities. For many young adults (18-30 years old) who enter college, the rates of physical activity have been shown to continue to decline.[98]

Strong, Parks, Anderson, Winett and Davy[108] have offered the theoretical basis for lifestyle programs that may impact long term health behaviors in young adults. They noted from interviews of 43 male and female college students, with a mean age of 18.3 years, that physical activity levels declined despite the students reporting that they have > 5 hours per day of leisure time. In addition, they reported high feelings of: exercise self-efficacy (e.g., confidence in sticking to an exercise routine); self-regulation (e.g., setting an exercise related goal to run a specified distance); setting exercise related plans (e.g., frequency of exercise per week); enlisting social support (e.g., engaging friends to exercise); and desired outcomes (e.g., health, psychological and social improvements). Physical activity levels vary from individual to individual and are determined by an interaction among environmental, biological and behavioral factors. The role of these determinants and how they impact the levels of physical activity an individual performs are difficult to measure precisely. The literature cites that psycho-social factors can play a huge role as a determinant of physical activity.[35,64-70]

There are many psycho-social factors that have been implicated as possible reasons for the failure for many to adopt and adhere to an exercise regimen. Most health promotion programs that are successful in promoting or altering lifestyle behaviors utilize these factors as theoretical underpinnings for the strategies to affect a change in behavior. These theories range from transtheoretical models of change, social cognitive theories, operant conditioning principles and hierarchical models of self-efficacy as the basis for the design of these health promotional programs.[35,70,73,109-112] Psycho-social variables such as: body image, self-efficacy, body area satisfaction and physical self-concept have been shown to interact with each other in order to produce awareness of one's own physical capabilities and awareness of one's physical self.[35,64,67,70,87,109]

General Self-Concept and Physical Self-Concept Hierarchical Models

Physical self-concept was initially devised in 1976 as being an important psychological construct that is important for one to develop in order to reach the highest levels of self-concept.[35,113,114] The term self-concept is defined as: how the one perceives him or herself. Attainment of high levels of self-concept has been found to be an important factor in the prevention of depression, obesity and engagement in negative behaviors such as violent acts and substance abuse.[65] In order for an individual to develop self-concept, judgments about oneself must be employed and re-employed throughout one's lifetime in order to gain an understanding of how the individual views him or herself in regards to others and their surroundings.

The term self-concept has been used synonymously with self-esteem. Self-esteem is defined as the affective consequences of one's judgment of self-concept as being either negative or positive.[35,70] Basically self-esteem describes how persons feel about themselves after these judgments have been made, processed and realized. For one to achieve the highest sense of self concept or the perceptions of "who I am" in a particular situation or environmental context, there are certain sublevels of self-concept that have to be evaluated, judged, processed and concluded upon in order to reach this highest level of self-concept which is at the apex of this hierarchical model.

Overall self-concept is derived from two lower order constructs, academic and non-academic self-concepts.[35,113] The academic self-concept relates to one's perception of how well one can process, attain and achieve the highest orders of knowledge based on their levels of maturation for such subjects as English, Math, Science and History. Non-academic self-concept can be further subdivided into social self-concept, emotional self-concept and physical self-concept. Physical self-concept uses people's judgments about how they perceive their physical self which is comprised of judgments made about their physical ability and appearance that may influence their behavior in specific situations or environmental contexts.

The Relationship between Physical Self Concept and Physical Activity Level

Physical self-concept (PSC) has been proposed to influence the adoption and adherence of regular physical activity programs. In the realm of health promotion, PSC is an important area of study because levels of PSC tend to change as an individual ages and have been shown to vary across genders, ethnicities and levels of previous physical training. Overall PSC, as defined as individual judgments made about one's physical abilities and appearance, tends to decline as one moves from childhood throughout adolescence and early adulthood, and has been shown to be lower in girls than boys, in general less in African-Americans than Caucasians and less in individuals who do not regularly engage in physical activities.[37,64-66,68,69,109,113-120]

Psychosocial factors such as PSC can serve as a psychological moderator; for example, the effect of advancing age on decreased physical activity can be reduced by higher levels of physical self-concept.[24] Physical self-concept can also serve as a mediator; for example, the effects of maturation on physical activity for adolescent girls can be explained by changed in the sub-domain levels of physical self-concept.[23,24]

The proposed pathway between PSC and physical activity is not a clear one and the literature implies that the relationships between them, as well as with other psycho-social variables such as exercise self-efficacy, appear to be bi-directional; as one engages in more physical activities, physical self-concept increases and as physical self-concept increases one tends to engage in more physical activities.[23] PSC is mediated by other psycho-social variables that are influenced by such factors as maturation.[64,67] As individuals progress from childhood to early adolescence there is a reduction in physical activity which has been partially explained by PSC, but this relationship is mediated by maturation.[64,67]

A study by Cumming, Standage, and Loney, et al[64] was performed to determine if changes in physical self-concept levels of adolescent girls could be explained by maturational changes. They found that the changes in maturation levels (measured by the percentage of current height relative to predicted adult height) affected PSC levels which subsequently related to reduced physical activity. It is important to note that many of the studies that examine the relationships among physical activity, PSC and other sociodemographic variables must be interpreted carefully in the context of causality because many of these studies are cross-sectional in design and the very nature of the phenomena being studied does not allow for a temporal relationship to be established which is necessary to infer causality.[64,66,115,116,120] Thus PSC can be studied as either a moderator or mediator of physical activity participation or as an outcome measure of physical activity interventions.[23] Because of its relationship with physical activity, PSC has also been examined for relationships with physical performance measures that require strength, endurance and agility.[64,80,115,116,121]

Marsh, Martin and Jackson[113] have found via confirmatory factor analyses that PSC is made of 9 individual domains: Activity, Appearance, Body-Fat, Coordination, Endurance, Flexibility, Health, Sport and Strength; and two global scales. Each of these domains has distinct traits of one's physical self that can be evaluated and considered separately in relation to certain physical activities or physical performance measures. Because these domains are distinct, the levels of these domains will also tend to vary between age groups, genders, and the varying types of physical activities that one engages in. These domains can contribute to overall PSC but their contributions are separate and distinct from each other.

The relationship between PSC and age is a bit unclear when these constructs are examined in individuals who are in the adolescent stage of life. Marsh, Martin and Jackson[113, 114] found that PSC does not change during the adolescent period. Two separate studies done by Asci[120] and Caglar[66] using individuals in the late adolescence to early adulthood stage revealed that PSC declines slightly with age and men tend to have significantly higher levels of PSC than women during this transition period. This study did not reveal an interaction between age and gender. The generalizability of the results must be extrapolated carefully because the population consisted of high school and college aged individuals who were from Turkey.

Annesi, Walsh and Smith[118] performed a study that looked at the effects of a 12- or 24-week weight management program on BMI and behavioral patterns that relate to physical activity and nutritional practices in adolescents. One of the purposes of their study was to examine if psychological predictors such as PSC, self-concept and mood would be short term predictors of BMI change for this group. They found that physical activity and PSC levels increased, with BMI reduction being significant only for the 24-week group. Psychological factors such as PSC, overall self-concept and mood accounted for 13% of the variance in BMI change.

One study found that for adolescent females, the effect of maturation on physical activity levels was mediated by sub-domains of PSC.[64] The researchers of this study noted that the sub-domains of sports competence, physical condition, body attractiveness and strength were mediators of the relationships between maturation and physical activity for adolescent females in their study.[67] Specifically, they found an inverse relationship between maturation and sports competence, body attractiveness and physical condition components of PSC. This is consistent with other studies implying that as females advance in age during the adolescent period, physical activity levels decrease. This relationship therefore may be partially explained by effects of the sub-domains of PSC.

Another interesting finding from this study was that maturation levels had an indirect, inverse relationship with physical self-worth, as established via the relationships demonstrated between maturation and the PSC components. This study further highlighted that physical self-worth had a direct positive relationship with physical activity levels. This is an important finding because several other reports have noted that both PSC and physical activity levels typically decline for females from the pre-adolescent to late adolescent-early adult stages of life.[66,69,120]

PSC has been implicated as one of the reasons for this pattern of activity decline. Many of these studies that compare the effect of gender on PSC need to be interpreted carefully as they were often done on subjects from non-U.S. countries and younger children or adolescents who were at the extremes of functional levels, from those who had disabilities to elite level athletes. Schneider, Dunton and Cooper [65] conducted a randomized controlled trial examining the effect of a 9-month school-based physical activity intervention on PSC for sedentary, adolescent females. The intervention group received four supervised exercise and educational sessions per week with an additional day that they were instructed to engage in a physical activity session on their own. Participants in the control group were encouraged to attend their usual PE classes but were not given any additional instruction on how to increase their levels of physical activity. The researchers noted that the main effects of group for the intervention on PSC were not present despite an improvement in cardiovascular fitness and increased vigorous physical activity participation that were not present for the control group. They noted that both the intervention and control groups had a significant main effect for time for PSC sub-domains of sports competence, appearance, strength, global physical self-concept, and overall self-esteem, with no between group differences for BMI and body-fat percentage. The researchers found an interaction between group and change in cardiovascular fitness, namely that the intervention group had a significant increase in global PSC when their cardiovascular fitness improved. Paradoxically for the control group, there were significant increases in global PSC when their cardiovascular fitness did not improve and no changes in global PSC when the cardiovascular fitness increased. For the paradoxical findings the researchers pointed to possible reasons such as that the exercise intervention may not have been intense enough. They pointed to previous studies suggesting that for adolescent females, changes in body-fat are needed to promote improvements in PSC. Their intervention did not result in a reduction in body-fat for either the intervention or control group. Secondly, there was a significant proportion of the participants in the control group that were enrolled in PE classes. Despite the lack of improvements in physical fitness or vigorous physical activity participation for the control group participants, the researchers of this study suggested that the level of rigor used for the physical activity intervention group may not have been necessary to promote favorable changes in PSC for sedentary adolescent females. Cardiovascular fitness affected global PSC levels and not the domain-specific constructs of PSC which, the authors hypothesized, would more closely capture the changes in specific physical fitness attributes such as improved cardiovascular fitness more closely than the global PSC construct.

Velez, Golem and Arent[122] reported on a randomized controlled trial that was conducted on 28 Hispanic adolescent girls and boys (mean age: 16.14 years) with a mean BMI of approximately 23 kg/m^2. The participants were randomized to a 12-week (3 days per week; 35-40 minutes each session with a 1:3/1:4 trainer to participant ratio) upper and lower extremity resistance training program (in lieu of normal PE class) or a control group instructed to continue to participate in the usual PE classes. They examined the effects of this program on PSC (sport/athletic competence, condition/stamina competence, attractive body adequacy, strength competence, physical self-worth, and global self-worth), upper and lower body strength (10 RM for bench press, squats, seated row, and seated press test), and body composition (percent body-fat, lean body mass, fat mass, and BMI). They noted significant pretest – posttest improvements in PSC sub-domains of condition/stamina competence, attractive body adequacy, and global self-worth for the resistance training group only. In addition, the resistance training group had significant improvements in each of the 10 RM tests while the control group had non-significant increases in the bench press and seated row but improved significantly on the squat 10-RM tests. The body composition tests showed significant reductions in body-fat percentages for the resistance trained group as opposed to a significant increase for the control group. The opposite was true for lean body mass, the resistance trained group displayed significant increases in lean body mass as compared to a non-significant decrease for the control group. This is one of the few studies that examined the interrelationships between the alterations in physical activity levels using resistance training and changes in physical fitness, body composition and PSC in adolescents who are Hispanic. The researchers point out that their dropout rate was low but inferences about the effectiveness of this program for overweight or obese Hispanic adolescents are difficult because they used participants with normal BMIs.

The impact of regular participation in physical activities on PSC persists into young adulthood. Van Vorst, Buckworth, and Mattern[119] examined the relationship between the stage of readiness that college-aged individuals were in and the adoption of a structured weight training program as part of an elective course at a university. Measures of PSC and muscular strength were obtained. They found that those who were in the preparation stage of readiness (intent to start an exercise program < 1 month) had lower levels of muscular strength and PSC than those who were in the action or maintenance stages of readiness (regular exercise < 6 months and regular exercise >= 6 months, respectively). They also found that those individuals who were in the preparation stage had higher relative increases in PSC after completing the weight training course than those who were in the maintenance stage, suggesting that PSC may be a construct that stabilizes with sustained adherence to exercise programs. They also found a significant correlation between leg press strength and PSC for those novice exercisers who were in the preparation stage of readiness, which may lead one to consider the relationships between PSC, muscular strength and experience with muscular strengthening exercise programs. Resistance training programs have been shown to foster improvements in PSC because often the adaptive changes in the physique appearance can be directly observed and used to further enhance domains of PSC which also serve to improve compliance.

Monroe, Thomas, Lagally, and Cox, et al[123] published a study in which they determined if a relationship exists between self-perceived and measured levels of physical fitness for male and female college students with a mean age of 20.1 years. They used the Physical Self-Description Questionnaire (PSDQ) for the participants to self-evaluate their competencies in the four sub-domains of PSC (Body-Fat, Endurance/Fitness, Flexibility and General PSC). He devised additional questions to assess the muscular endurance sub-domain of fitness. He then assessed the participants' body composition (impedance plethysmography), submaximal aerobic fitness (Bruce protocol), muscular endurance (maximum number of curl ups done in 1 minute) and flexibility (sit and reach test). He found significant, moderately strong, inverse correlations between the Body-Fat subscale and measured body composition, which was the strongest of all the correlations found between the subjective and objective measures. Significant, moderately strong, positive correlations were found between self-perceived and objective measures of cardiorespiratory endurance, muscular endurance and flexibility. A significant negative correlation was found for self-perceived overall fitness and measured body fat which was the strongest correlation found. Significant and positive correlations were found for self-perceived overall fitness and objectively measured muscular and cardiorespiratory endurance. The correlations between the subjective and the objective measures of overall fitness were low to moderate. The researchers of this study noted moderate correlations between the subjective and objective fitness measures which they hypothesized may have been due to individuals of this age group (young adults in their early twenties) possibly having a better sense of their physical capabilities due to prior experiences with physical activity and exercise. It is important to note that in their study, both the men and women in this study had average to above average age and sex-specific normative values in VO_2 max, curl ups and sit and reach scores. The correlations were moderate between the subjective and objective measures of cardiorespiratory endurance, muscular endurance and flexibility and these are the same physical fitness components that the participants of this study did well on relative to their peers. The researchers also noted that subjective and objective measures of body composition displayed the strongest correlations of any of the physical fitness measures; the objective measures of body composition had the strongest relationship with subjectively measured overall physical fitness. These findings may lead one to conclude that for these relatively fit participants, heightened awareness of body-fat is an important contributor to their appearance, which is a sub-factor of overall PSC. This population group may highly value reduced levels of body-fat and leanness as indicators of being fit, which may be valued more than the other physical fitness components. The fact that the strongest correlations were found between subjective and objective measures of body composition was noted to contradict prior studies that found the strongest associations for subjective and objective measurements of cardiorespiratory fitness.

The Relationships among Physical Activity Interventions, Physical Self Concept and Other Psycho-social Variables/Models that Affect Physical Activity Levels

Moore, Mitchell, Bibeau and Bartholomew[116] studied the effects of resistance training on PSC using the exercise and self-esteem model that was proposed by Sonstroem.[70] They recruited 120 college aged men and women (mean age: 20.2 years) to a 12-week total body resistance training program (twice a week). The outcomes used were: PSC, physical self attributes, and self-esteem. PSC was measured using the Physical Self Perception Profile. Physical Self Attributes were measured using a four-section scale. General self-esteem was assessed using the Rosenberg Self Esteem Scale. The study was a pretest – posttest design that analyzed the data according to demographic and lifestyle information such as gender and self-reported frequency and intensity of exercise. The resistance training program was able to significantly improve self-perceived competencies in all aspects of the Physical Self-Perception Profile (Strength, Condition, Body and Sport). Significant increases in 1-RM strength were found for the bench press for both men and women in this study. The researchers noted that partaking in a resistance training program can improve competence in domains other than strength. They noted that this was an important finding because the Physical Self Perception Profile measures competencies in the aforementioned sub-domains but it does not reflect an individual’s acceptance of one’s level of competency.

In previous work cited by the aforementioned researchers, they noted that acceptance of one’s competency in performing a particular physical task is based on the premise that the individual must assign a relative level of importance of being able to perform that task.[116] An understanding of the discrepancies must be made between how individuals judge their own performance against what they perceive as "ideal." The authors concluded that a level of certainty must be present to ensure that the judgments made are indeed accurate. Using a path analysis, they found that strength changes had a positive influence on self-esteem through the subdomains of strength, attractiveness and sport. The aforementioned subdomains affected physical self-worth which is the construct that directly relates to overall self-esteem based on the model proposed by Sonstroem.[70] Thus the changes in strength affect sub-domains of physical self-perceptions that affected the more global construct of physical self-worth which subsequently mediated the effects on self-esteem. These findings confirmed the hierarchical relationships between exercise, physical self-concept/perceptions and the apex of the hierarchy, self-esteem/self-concept. In this study, improvements in self-esteem occurred due to improved sense of physical self-worth which was modified by the subjective changes in the strength sub-domain. The researchers noted that change scores from the actual strength measures (1-RM bench press) were not predictive of changes in the strength domain. They hypothesized that although the participants increased their objectively measured 1-RM strength, the weight training program may have also improved other domains of physical perception such as body composition or muscular endurance. Increases in 1-RM strength may have also resulted in increased perceptions of strength if the participants had changed their acceptance levels of their performance. The researchers pointed to several limitations of this study: no control group, no accounting for other exercise that may have been performed during the intervention such as cardiovascular exercises, previous exercise history, non-standardized exercise prescription for all the participants and the fact they recruited participants from a local university, assigning them a positive grade if they participated in the study. From a psycho-social standpoint, the study did not assess motivation. The premise of this study was based on the Exercise Self-Esteem model which proposes that increases in self-esteem from exercise may affect exercise participation levels, but not examining specific motivation to change behavior was a limitation of this study. They noted that motivation to change behavior occurs when an individual is in a state of high discrepancy about his or her perceived physical abilities that are based on normative assumptions and low levels of acceptance for being in the state they are in, thus leading to strategies and behaviors to rectify these perceptions. They noted that future studies that examine behavioral changes in the context of health promotion should assess levels of motivation to change.

Lindwall and Hassmen[69] recruited 164 college freshman students who attended a university in Sweden to examine the effects of gender and exercise levels on physical self-perceptions and the importance of individual sub-domains across gender. Multiple regression analyses were used to determine that significant and strongest relationships exist for gender, exercise frequency and duration that explained 35% and 31% of the perceptions of Condition and Sport, respectively, using the Physical Self-Perception Profile. They noted that the strong relationships between these predictor variables and

Condition could be explained by the operational definition for Condition that resembles many of the attributes required to partake in exercise. They found that the aforementioned variables had significant but weak relationships with the sub-domains of Body (15%), Strength (11%) and Physical Self-Worth (15%). They also found that exercise frequency, duration, and gender explained 22% and 18% of the variance assigned to the importance that the participants had for being competent in the Sports and Physical Condition sub-domains, respectively. They noted that when the predictors of physical self-perceptions were analyzed individually, they found that exercise frequency was a stronger predictor of PSC than exercise duration, with frequency explaining 16% and 6% of the variance in Condition and Strength sub-domains, respectively. They noted that gender was the strongest predictor of Sport and Body sub-domains. Using zero order correlations, they found that as individuals exercised more frequently and for longer durations there were positive correlations with each sub-domain of physical self-perceptions and the perceived importance of each of those sub-domains. They hypothesized that as the level of physical activity engagement increases, the individual may perceive him/herself as being stronger and fitter. They also noted from Harter's[172] studies that individuals will often adhere to activities in which they perceive to have attained a level of mastery and competence. Adherence to performance of the specific physical activity will persist as long as individuals remain motivated. The researchers noted that the direction of the relationships between exercise adherence and physical self-concept cannot be made because of the cross-sectional design of their study. In this study, gender had a negative association with each sub-domain of physical self-perception and the perceived importance assigned to it. Most notably, they found that women had negative self-perceptions for the Body-Image and Sport competence domains as well as the perceived importance of the Sport and Strength domains. The researchers noted these results are not surprising given the societal views of the roles that are often assigned to women as being more concerned about body image, less concerned about proficiency in sports and less caring about whether they perceive themselves as being physically strong and athletic. From a practical perspective, this study suggests that health promotion programs should tailor messages to increase physical activity by focusing more on consistent and frequent bouts of physical activity to promote adherence.

Parker, Martin, Martinez, Marsh and Jackson[110] performed a study in which they sought to validate the stages of change from the Transtheoretical Model of Change with self-reported levels of physical activity, physical activity motivation, PSC and flow. The Transtheoretical Model of Change is an important concept to consider when designing health promotion programs that aim to produce higher incidences of healthy behaviors. Prochaska and Velicer[124] proposed that individuals move through the change process in a predictable, stepwise process beginning with pre-contemplation (no thoughts about becoming more physically active), contemplation (considerations of becoming more physically active within the next 6 months), preparation action (planning to become more physically active in the near future), action (have begun to make regular changes to be more physically active but have not engaged in the increased physical activity for a prolonged period), and maintenance (have undertaken the physical activity regimen on a regular basis and have done so for at least 6 months). The hypothesis of this study was that as an individual progresses through the stages of change, there should be an increase in the measures of PSC (Physical Self-Description Questionnaire), motivation to exercise (Physical Activity Motivation Scale-Revised and Flow (a construct that reflects the state of balance between the perceived physical challenge of the task itself and the perceived level of physical skills that the person believes that he or she possesses). They performed the study on 705 late stage adolescents (mean age: 17 years) in Australia. They found an increase in the values of positive psychological constructs of flow, PSC, and motivation (adaptive behaviors and cognitions) present for those students that were in the higher stages of the transtheoretical change spectrum. Higher levels of the aforementioned constructs were present along with higher levels of self-reported physical activity. Conversely, they found for individuals in the earlier stages of change that these stages were associated with lower or more negative values of PSC and motivation (maladaptive behaviors only). This research validates the Transtheoretical Model of Change in that for individuals who are in the pre-contemplation, contemplation and preparation stages of change, the levels of physical activity were low until they reached the action and maintenance stages. The physical activity trends followed the psychological construct trends such that as physical activity levels increased, so did levels of PSC and physical activity motivation across each successive stage of change. They noted that the maladaptive behavioral components of motivation were decreased for those participants who were in the higher stages of the change process.

From a practical perspective, health promotion programs that attempt to increase physical activity levels using the stage of change model may need to consider other psychosocial factors that influence physical activity adoption and adherence. Motivation, PSC and flow are important constructs to consider when attempting to successfully transition individuals to higher stages of change. The researchers noted that increasing levels of PSC and motivation may influence the types of physical activities that one chooses (ones that a person feels most competent in performing) and the persistence in doing them (ones that individuals feel that they can reasonably adhere to while promoting a sense of accomplishment). The available research that examines potential mediators among PSC, physical activity and physical fitness is more abundant in the adult population for those who have and have not participated in structured exercise programs.

A study by Short, DiCarlo, Steffee and Pavlou[80] was done on 48 obese men randomized to a supervised aerobic exercise plus instruction group or an instruction group only to examine aerobic fitness and PSC using the Tennessee Self Concept Scale. The researchers found that the men who participated in the supervised aerobic training group had an approximate threefold increase in their aerobic capacity as compared to the instruction only group. Both groups had an increase in four components of PSC, but the physical self and self-satisfaction subscales had a more dramatic increase in the supervised aerobic exercise group.

Amesberger, Finkenzeller, Wurth and Muller[115] performed a study to examine the relationships between PSC, physical fitness and the effects of gender on elderly individuals who received a 12-week guided skiing intervention. They found relationships among aerobic capacity, lower extremity power and strength with components of PSC such as: sports proficiency, endurance, strength and global physical self. They also found gender differences in the psychological effects of the intervention. Males tended to relate improvements in lower extremity strength and power to improved perceptions of sports proficiency and global physical self, whereas females tended to relate improvements in aerobic capacity to improved sports proficiency and global physical self.

Studies that involve obese adults utilizing exercise with and without nutritional and/or behavioral support highlight some interesting relationships with PSC. One study compared the effects of a 20-week weight loss program for African-American and Caucasian women who were obese.[125] The program consisted of monthly instruction on use of cardiovascular machines and six nutritional educational sessions over the 20-week period. The subjects were instructed to increase their exercise program components to three times per week for 30 minutes with a perceived exertion rating level of 12-14. Measures of self-concept, body area satisfaction and exercise self-efficacy were measured in addition to bodyweight changes. He found that the weight loss was significant for both groups, but the Caucasian women lost significantly more weight than their African-American counterparts. He found that body area satisfaction, exercise self-efficacy and PSC combined to predict body weight for both groups, but the contributions of each psychological predictor differed by group. For the Caucasian group, body area satisfaction was the greatest predictor of weight loss, whereas for the African-American group, it was the exercise self-efficacy levels. PSC was not an independent predictor of weight loss in either group.

Another research report gave rise to a theoretical, but un-tested, relationship comparing body image with weight loss and maintenance.[109] This study sought to determine if there is a difference in body image between obese women randomized to one of two different intervention groups. One group received an exercise and nutritional program only and the other group received the same program but with the addition of a cognitive-behavioral component. The purpose of the cognitive-behavioral component was to improve aspects of self-efficacy, stimulus control and self-regulation. He found that the group that received the additional cognitive-behavioral component had significant improvements in weight loss, body composition and exercise self-efficacy as compared to the comparison group. PSC improved in both groups, but to a greater amount in the group that received the cognitive-behavioral component. For the prediction of body image, PSC and exercise self-efficacy were the two factors that were significant. It is important to note that in this study, body weight changes were not a significant predictor of body image. If the theory of body image holds true with regards to the potential effect it may have on weight loss or maintenance, then PSC along with exercise self-efficacy may mediate these effects independent of changes in body weight.

As noted previously, the theoretical relationship between body image and weight loss still requires more rigorous scientific testing. Annesi and Whitaker[111] examined the direct and indirect contributions that psychological variables made on exercise session attendance and weight loss, respectively. The subjects were women who ranged from Class I/II obesity (BMI: 30-34.9 kg/m^2 and 34-39.9 kg/m^2 respectively) and Class III obesity (BMI: $\geq$ 40) obesity undergoing a weight loss program that included nutrition and exercise instruction along with the aforementioned cognitive-behavioral component. They noted that the direct effects on exercise session attendance that were accounted for by changes in the psychological variables (PSC, mood, exercise self-efficacy and body area satisfaction) was 14% and 22% of the variance for women with Class I/II and Class III obesity respectively. They noted that BMI changes accounted for by the psychological variables were 12% and 21% of the variance for women with Class I/II and Class III obesity, respectively.

Theoretical Bases of General Self Concept, General Self Esteem, Physical Self Concept, and Other Psycho-social Constructs that Affect Physical Activity Levels

The concept of self "is a system of constructs that has been organized by theorists into a directing/organizing self and a composite of attributes and characteristics that make up the self in action".[173] Self-concept is a multidimensional construct that uses perceptions of competency in the key domains that comprise self. The key domains act to direct or organize the self into action based on the level of perceived competency in each of the distinct key domains.[28] These domains are academic, social, emotional and physical. Each domain requires conscious perception of one's competencies which serve to influence present and future behaviors. The theory of self-concept has been derived by Shavelson, Hubner and Stanton[35] as a hierarchical, multi-dimensional construct that places general self-concept at the apex of the hierarchy, domain specific facets below the apex and specific events/tasks at the base of the hierarchy.[35] PSC is the domain of interest regarding the adoption and maintenance of a physical activity program.[66,68,69,80,112,115,120] It involves the conscious *perceptions* of sub-domains that comprise “physicality” such as Strength, Endurance, Athletic/Sport Competence, and Appearance.

Self-esteem relates to self-concept in that self-esteem uses the conscious perceptions that are derived from self-concept to generate an evaluation of self or in essence “how am I doing” with regards to each domain that comprises self. [35,112] Self-esteem allows for the evaluation of each domain to be determined as positive or negative based on the level of importance and value assigned to the particular task and perceived competency in performing the task[35,112] Self-esteem is a measure of how much individuals like or value themselves. It consists of a series of judgments based on the conscious perceptions that are derived from self-concept to form an evaluation. Self-concept or “knowledge of thyself” allows for the genesis of these evaluations of self-esteem to occur.[35]

Like self-concept, self-esteem is domain specific and thus provides a positive or negative evaluation of each domain that comprises self. As present in general self-concept, the domains of self-esteem include academic, social, emotional and physical self-esteem.[113] Physical self-esteem involves the same sub-domains as PSC but involves the *feelings* of how one likes or dislikes their performance on the sub-domains of Strength, Endurance, Appearance and Athletic/Sport Competence.[35] PSC has been shown to influence the adoption and maintenance of physical activity programs. Previous literature by Fox and Corbin[126] has shown that PSC exerts its effects on general self-esteem via a mediated relationship with physical self-worth.

The relationship between physical self-concept and overall self-esteem was described by Sonstroem and Morgan in 1989[70] as the “Exercise and Self-Esteem model” They noted that physical self-worth was needed to improve overall self-esteem. Physical self-worth in this model is the value one places on domain specific physical competencies which is enhanced when the perceived levels of competency (how well can I perform a specific task) and self-acceptance (how you feel about what you are able to do or not do) are high.[116] This model is hierarchical as well, with general self-esteem at the apex, and the domain and physical self-worth directly influencing self-esteem. The sub-domains of sport, physical condition, body and strength each have a distinct influence on physical self-worth which in turn are each influenced by specific physical tasks such as lifting a weight for the Strength sub-domain, being able to dribble a basketball for the Sport sub-domain and possessing good grooming techniques for the Appearance sub-domain.[126] Self-perceptions feed into this model by allowing the transfer of perceptions of competency in each of the specific physical tasks to the sub-domains that feed into physical self-worth, which mediates the relationships between those specific tasks and self-esteem.

The Effects of Weight Loss Interventions for Minority Women

Weight loss programs typically involve one or a combination of the following: physical activity, reduced calorie diet, written/didactic education and a behavioral component. The National Heart Lung and Blood Institute has documented that weight loss programs typically yield a 10% loss in body weight over a 6-month period.[50] A 5% percent weight loss has been deemed clinically significant for reducing the metabolic derangements such as hyperglycemia, hyperlipidemia, insulin resistance and hypertension due to excess body-fat.[50,127] Minorities are represented in disproportionate amounts for individuals who are in the lower socioeconomic stratum with increased prevalence of obesity.[1,2] Weight loss is a difficult task for many, but minority women, especially those from lower socioeconomic backgrounds in general, have less success than Caucasian women and women from higher socioeconomic backgrounds.[73,128-130] Research points to a multitude of reasons as to why the effects of various types of weight loss programs have smaller effects for women of minority backgrounds as compared to Caucasian women. The possible reasons include educational, economic, hormonal, psychological and physiological.[73,74,128,130-133]

There is a paucity of published findings on interventions that exclusively include African-American women and even less for women from Hispanic ethnic backgrounds. Fitzgibbon, Tussing-Humphreys, Porter, Martin, Odoms-Young and Sharp[69] performed a systematic review and noted that in two prominent multicenter trials the mean weight loss for African-American women was 4.7 kg and 4.1 kg for the Diabetes Prevention Program

(DPP) and Weight Loss Maintenance (WLM) trials, respectively. The DPP trial included 2921 participants, of which 341 were African-American women. The DPP was a 6-month intervention that consisted of meal replacement program, dietary and physical activity education, a supervised physical activity program and 16 individually tailored behavioral self-management sessions that had cultural adaptations for the African American participants. The WLM intervention recruited 1685 participants which included 540 African-American females and consisted of a combination of physical activity (supervised and unsupervised), dietary education and 20 weekly group behavioral sessions with the option for individual sessions to be conducted by phone if needed. The behavioral sessions were based on social cognitive theories (SCT) and transtheoretical models of change (TTC). The SCT basis allows for the participants to attain a level of self-efficacy, self-management and self-monitoring that is conducive for gradual weight loss and long term weight maintenance. The TTC models of change are based on the concept that lifestyle changes evolve in a continuous and predictable manner from pre-contemplation to maintenance of healthy change behaviors. This intervention was culturally adapted to African-Americans who participated in the program.

The PREMIER trial is another multi-center trial that included dietary, self-directed physical activity and behavioral components.[73] The intervention was also culturally adapted for the African-American participants and included behavioral interventions that were based on the SCT and TTC which were more intensive than the WLM. The PREMIER trial recruited 810 participants, including 211 African–American women. They recruited medically at risk participants. The mean weight loss of 3.2 kg for the PREMIER trial was less than the DPP and WLM trials. The authors of this review speculated that the WLM trial was conducted by many of the same researchers and that worked on the PREMIER trial and thus the PREMIER trial may have served to help develop and refine the intervention for the WLM trial. In addition, both the DPP and the PREMIER trials recruited male and female participants from diverse ethnic backgrounds and both trials were able to culturally adapt the components of the program to the African-American participants. Cultural adaptation to lifestyle management programs have been shown in other studies as an important reinforcing aspect of more successful weight management programs.[73,130]

Bronner and Boyington[130] performed a systematic review in which they noted from a synthesis of previous studies that interventions using culturally sensitive food guides, recommendations to adapt the preparation of foods that are commonly eaten in the African-American community and culturally acceptable networks such as churches, have each been shown to improve outcomes. Trials that recruited medically at risk subjects, such as those who were overweight or obese and had impaired glucose tolerance, hypertension and/or hyperlipidemia, tended to have better results than interventions that recruited overweight/obese subjects who were healthy. Often obese individuals cite the reason(s) for participating in a weight management program was to become healthier. Weight loss interventions are often difficult to compare because of several design issues of the intervention itself. The different anthropometric measures that are used to denote changes in “fatness” (e.g., BMI, percent body-fat and waist circumference), the diverse characteristics of populations studied and the various types of interventions used complicate the notion of “best” practices to reduce obesity. This systematic review pointed to diverse issues in the research design such as an adequate sample size, randomization and intensities of the program that may affect the outcomes of the weight loss interventions. The studies included in their analyses tended to use younger subjects with a mean age of 39.5 ± 0.4 years who were moderately obese (mean BMI of 33.2 ± 0.4 kg/m^2). The mean duration of all the programs reviewed was relatively short (15.6 ± 0.6 weeks). The exercise only programs had the longest mean duration (20.9 ± 1.8 weeks), followed by the diet only (15.1 ± 0.8 weeks) and lastly the diet plus exercise interventions (13.4± 0.7 weeks).

A Cochrane review done by Shaw, Gennat, O'Rourke and Del Mar[45] examined the varying effects of exercise with and without other types of treatments on measures of adiposity and metabolic function and revealed similar results. Forty-three published interventions that included a total of 4376 subjects were included in their review.[40] The effect size in kilograms for two published interventions (N= 270) that compared isolated exercise programs to no treatment control was -2.03 kg [95% CI: -2.82, -1.23]. Seven studies (N = 467) were included in their review that compared the weight loss effect between isolated exercise vs. diet based programs with an effect size of 3.61 kg [95% CI: 2.95, 4.26]. Programs that combine diet and exercise have been recommended as the most optimal interventions for promoting weight loss. This review included 15 studies that combined diet and exercise programs (N = 1079). The effect size of the combined diet plus exercise programs as compared to diet only programs was -0.65 kg [95% CI: -0.97, -0.33]. The aforementioned effect size was based on studies that included both male and female participants. To further analyze the effects of these combined modality programs on weight loss, the researchers reported the effect sizes by gender. The effect sizes for males and females that compared the combined diet plus exercise with diet only programs were -0.23 kg [95% CI: -0.68, 0.23] and -0.55 kg [95% CI: -1.26, 0.16], respectively. These effect size results appear to contradict previous studies that report smaller weight loss effects for women as compared to men. Comparison of these effects must be interpreted carefully as the number of studies used to generate the effect size for men were significantly lower than the number used for women. Three studies that yielded a sample of 100 males as compared to six studies that included a total of 367 women were used in this review.

The wide ranges in effect sizes are due to the varying components of published interventions and the lengths and durations of the programs. Even the effect sizes for weight loss programs that have used only one type of intervention are difficult to compare because many use different types of diets (reduced carbohydrate, high protein to low calories to very low calorie diets), exercise programs (aerobic and/or resistance training vs. combined aerobic and resistance training protocols), behavioral interventions (SCT, TTC models, motivational interviewing, to no set behavioral theme) and settings (community, wellness, or primary care centers to individualized, self-managed programs to group interventions).[73]

The 1998 NHLBI Clinical Guidelines on the Identification, Evaluation and Treatment of Overweight and Obesity in Adults Evidence Report[50] suggested that effective weight loss programs must include dietary and physical activity components. This is evident in a published study by Foster-Schubert, Alfano, Duggan, et al[96] in which they randomized 439 overweight and obese postmenopausal women into groups for a 1-year intervention.[96] The groups included a supervised and unsupervised aerobic exercise program only (starting at ≥ 3 days per week, intensity 60-70% and progressing to 70-85%, durations starting at 15 minutes and progressing to 45 minutes 5 days per week); a low-fat reduced calorie diet supported individually and in small groups; a combination of both diet and exercise and a control group. An important note made by the researchers was that their goals for attaining physical activity were reflective of the American College of Sports Medicine (ACSM) guidelines for to reduce bodyweight or maintain weight loss, of 150-250 minutes per week of moderate to vigorous physical activity. The weight loss results were significantly higher for the diet plus aerobic exercise group as compared to the other three groups. They noted that the diet + exercise group had a 5% increased adherence rate to the prescribed exercise volume of 225 minutes/week as compared to the exercise only group (85% vs. 80% adherence rates). Maximal aerobic capacity (VO_2 max) revealed equal levels of improvements between the diet and exercise group and the exercise only group. The researchers of this study noted the adherence rates for the individuals in the separate diet, exercise or diet and exercise groups were high.

Villareal, Chode, Parimi, et al[134] compared the effects of a diet-only, exercise only or combined diet and exercise program on physical function and frailty in older adults. The intervention was a 1-year randomized controlled trial that compared the outcomes of a diet program (weekly group dietician meetings to promote 500- 750 kcal/day reduction; 1g of protein per kg of bodyweight, use of food diaries to monitor intake, with goal of achieving 10% weight reduction in 6 months); exercise program (90 minute exercise program 3 days-per-week: aerobic, resistance training, flexibility exercises); and control group (prohibited from changing current dietary or exercise patterns, given general health advice). The outcome measures were the modified Physical Performance Test (PPT) (walking 50 feet, donning/doffing a coat, picking up a penny, standing up from a chair, lifting a book, climbing one flight of stairs, progressive Romberg test) plus climbing up and down four flights of stairs, and performing a 360 degree turn. They also measured VO_2 peak, and used the Functional Status Questionnaire (FSQ) to self-assess each participant's ability to complete ADLs. They found a significant reduction in bodyweight for the diet only group (mean weight loss: 9.0 kg) and the diet and exercise group (mean weight loss: 7.7 kg) with no significant changes in body weight for the exercise only group. Significant within and between group improvements were found at the one year follow up for the PPT (change scores at 1 year follow up: 5.4, 4.0, 3.1 for diet and exercise, exercise, diet groups, respectively). FSQ scores had significantly increased within each intervention group with the largest differences found for the diet and exercise group (change scores at 1 year follow up: 2.7, 1.8, 1.3 for diet and exercise, exercise, diet groups, respectively). In addition, one year change scores in VO_2 max were the highest for the diet and exercise group, followed by the diet only and exercise groups (3.1, 1.7, and 1.4 ml * kg^{-1} * min^{-1}, respectively). There were significant within group improvements at one year for the diet and exercise and exercise only groups for gait speed (16.9 m/min vs. 8.2 m/min, respectively), single leg stance (7.9 vs. 3.4 seconds, respectively), and obstacle course completion (-1.7 seconds vs. -1.5 seconds, respectively). The only physical performance measure that resulted in significant within group changes for which the diet and exercise group did not exceed the other groups was improvement in 1-RM strength changes at one year (174 lbs. for exercise group vs. 164 lbs. for diet and exercise group).

Group exercise programs are utilized as a cost effective way to provide an intervention to multiple people at a given time. A study was done recently that compared the weight loss effects between a 10-week program of meal replacements and encouragement to exercise with a program of supervised group physical activity with meal replacements for sedentary obese women.[135] The results were a significant decrease in weight for the supervised physical activity program as compared to the program that encouraged physical activity. Another study compared weight loss effects using a supervised exercise program comprised of brisk walking and moderate intensity lower extremity strength training to a group that received general health education only.[136]

The results were a significant difference in weight loss for the supervised exercise group.

Another study used a reduced calorie and fat diet group, a 5-day-per-week aerobic exercise group and a combined diet-and-exercise group to examine weight loss over a 12-month period for 439 overweight-to-obese postmenopausal sedentary women.[96] The results revealed a percent weight loss of 8.5%, 2.4% and 10.8% for the diet, exercise and combined groups, respectively, as compared to the controls. Regardless of the characteristics of the intervention, it appears that minority women lose less weight than their non-minority counterparts.

A meta-analysis performed by Fitzgibbon, Tussing-Humphreys, Porter, Martin, Odoms-Young and Sharp[73] that examined weight loss interventions for women, noted that the weight lost by African-American women was significantly less than that for Caucasian women. They found mean differences that were -4.7 kg and -2.6 kg for Caucasian and African-American female participants respectively in one weight loss trial.[73] Two other published reports in her analysis noted similar respective mean weight loss differences between Caucasian and African-American women that were -4.9 kg and -1.9 kg for one report and -3.4kg and -0.4 kg for the other.

Svetkey, Erlinger, Vollmer, et al[137] performed a randomized controlled trial to examine the effects of a lifestyle intervention designed to control blood pressure, increase physical fitness levels and increase food and vegetable intake with a concomitant decrease in saturated fat as part of the multi-center PREMIER trial. The participants were African-American and non-African-American men and women with stage 1 hypertension that were randomized to either a lifestyle advice group (control), supervised physical activity and diet education program (established program (Est.) and the established program plus the DASH diet for 18 months (Est.+DASH). The 6-month results of the program revealed that fewer African-American women met the 15-lb. weight loss goal set at the beginning of the intervention as compared to their non-African-American counterparts. For the control, Est. and Est. + DASH groups the percentages of African-American women meeting this 15-lb. weight loss goal were 5%, 13%, and 15% as compared to non-African-American women with 11%, 33%, and 45%, respectively. The percentage of African-American women in both intervention groups who attended at least 15 sessions was 56% for the Est. group and 71% for the Est. group + DASH as compared to non-African-American women with attendance rates of 77% and 82% for the Est. and Est. + DASH groups, respectively. When examining the socioeconomic levels of the African-American women as compared to the non-African-American women, they had similar education levels but a higher percentage of African-American women in this study resided in households whose incomes were < $29,999 as compared to non-African-American women (23% vs. 6%).

West, Elaine, Bursac and Felix[129] conducted the multi-centered DPP that involved an intensive lifestyle intervention aimed at the prevention of type 2 diabetes in high risk individuals. To compare the effects of weight loss across gender and ethnicity, the subjects were randomized to one of three groups that received a 30-month lifestyle program only, lifestyle program plus Metformin or lifestyle program plus placebo intervention. Compared to White and Hispanic women, African-American women lost the least amount of weight during this trial. At 12 months, the average percent weight loss for White women was 8.1%, Hispanic women, 7.1% and African-American women, (4.5%). These differences in weight loss between the three groups were ameliorated when the participants took the medication Metformin. This suggests that Metformin which is a commonly used medication to control hyperglycemia in persons who are pre-diabetic and to lower body weight may have compensated for possible physiological differences that may have existed between the groups of women in this study to equalize the weight loss effects of the intervention.

Outcome Measures: Physical Self Concept (Physical Self-Description Questionnaire and Physical Self-Perception Profile)

As previously discussed, PSC is a multidimensional construct that is a part of the hierarchical model of general self-concept. PSC is comprised of several distinct sub-domains that can be individually examined and analyzed to determine the magnitude of their relationships with overall PSC, physical self-worth and general self-concept. The two most commonly used instruments to evaluate levels of PSC are the Physical Self-Description Questionnaire (PSDQ) by Marsh[113] and the Physical Self Perception Profile (PSPP) developed by Fox and Corbin.[126] Both of these are questionnaires that are used to assess each sub-domain of PSC as well as general physical self-concept or physical self-worth. The PSDQ contains 11 sub-domains that assess an individual's self-perceptions of competence on the following: Body-Fat, Endurance/Fitness, Sports Competence, Strength, Coordination, Health, Appearance, Flexibility, Activity, Global Physical Self

Concept and Global Self Esteem.[114,138] The PSDQ has a short version of the questionnaire that is 47 questions long with each question that assesses a particular sub-domain being scored from 1 (false) – 6 (true) with gradations from each polar level of agreement for each question.[113] Some of the questions utilize a reverse scoring method for negatively phrased questions to prevent the respondents from answering the questions in socially desirable manner. The PSPP contains 30 questions with each question containing two polar opposite statements that individuals must choose from that reflect their perception of their physical self with regards to the particular sub-domain of interest. The PSPP contains 4 sub-domains and 1 global domain that assess an individual's self-perceived competence in the following areas that comprise PSC: Physical Strength, Physical Condition, Body Attractiveness, Sport Competence, and Global Physical Self Worth.[126]

The psychometric properties of the PSDQ and the PSPP have been reported in the literature. As discussed by Dishman, Physical Activity and Obesity[23], instruments used to measure constructs such as PSC need to undergo rigorous psychometric evaluations using such tools as confirmatory factor analyses (to assess the validity of the sub-domains that comprise a construct across different populations to determine measurement equivalence or invariance), or item response modeling (how precisely does a scale indirectly measure a latent construct such as PSC using probability-based models to determine the association between the responses given on a survey or questionnaire and the underlying latent trait that is measured by the items.[23,139] He states that an instrument used to measure a construct must possess factorial validity, which is the validity associated with each factor (sub-domain) that comprises a multi-dimensional construct. The instrument must also be able to similarly measure the theoretical sub-domains of the construct across a range of different populations (multi-group factor invariance). The instrument must display longitudinal factor invariance, which means a psychometrically sound instrument has the capability of displaying similar measurement properties across time. These concepts are important considerations when reviewing psychometric properties of instruments that measure latent constructs such as PSC. Differences in the construct of interest between two or more diverse populations and/or two more different test administration times may be due to issues regarding the interpretation of the items on the questionnaire. Attributes of a population such as maturation, age, gender, or ethnicity can influence the interpretation of the items of an instrument that measures a latent construct.[23,35,110,113,114,138,140] The time period at which that the instrument was administered can also influence the interpretation or the response to items that comprise the sub-domain of a latent construct. Thus the measured differences in the construct may be partially due to the inherent differences in the attributes of the population or when the instrument was administered and not actual differences in the construct itself, thus confounding the interpretation of the research findings of the instrument.

The most common methods used to establish the validity of the sub-domains that comprise a multidimensional construct are confirmatory factor analysis (CFA) and the Multitrait Multi Method Matrix (MTMM).[113,114,126] The CFA uses statistics such as Root Mean Square Error (RMSEA), Non-Normed Fit Index (NNFI) and Relative Noncentrality Index (RNI) and X^2 to assess how well the data fit the discreet domains that comprise the construct of PSC. The Multi-trait Multi-Method Matrix (MTMM) is primarily used to establish convergent and discriminant validity of an instrument. Reliability indices for instruments that measure multi-dimensional constructs such as PSC are test-retest and Cronbach α internal consistency estimates.

The PSDQ has well established reliability and validity with populations from several different cultures and age groups. Marsh et al[113] conducted a study that examined the stability and discriminant validity of the PSDQ on 141 high school students in Australia. The subjects completed the PSDQ on four separate occasions over a 14-month period. They noted good internal consistency at each test period (median alpha = 0.92) and stability over time (r = .83 and r = .69 over a 3- and 14-month period, respectively).

Dishman, Hales, Almeida, Pfeiffer, Dowda and Pate[140] examined the factorial validity and invariance of the PSDQ among 658 African-American and 479 Caucasian adolescent girls. They found that the Cronbach α estimates ranged from .77 to .92 and from .82 to .95 for the 11 sub-domains of the PSDQ for African-American and Caucasian girls, respectively. The performed a multi-group factorial invariance analysis which revealed that the Black girls had a comparative fit index (CFI) = .92, NNFI = .91 and RMSEA = .06; the White girls had a CFI = .93, NNFI = .92, RMSEA = .07. The researchers of this study concluded that the data for both groups of girls fit the factors that comprise PSC based on the acceptable levels for each statistic as follows: CFI ≥ .93, NNFI ≥ .91 and RMSEA ≤ .062.

Marsh, Marco and Abcy[138] performed a cross-cultural validation of the PSDQ on high school students from three different countries using CFA.[138] They obtained a sample of high school students from Spain (N= 986), Turkey (N = 1137) and Australia (N=986) (mean age of the entire sample = 13.5 years) that completed the PSDQ. Students from one of the high schools in Sydney, Australia were between the ages of 12-16 years and was considered non-elite athletes. The sample of students from Spain was chosen to match the age, gender and grade levels of the Australian students. The students from Turkey were older (mean age = 21.5 years) as they were university students enrolled in elective courses in PE. The researchers reported RMSEA of 0.42, 0.44 and 0.47 for the sample of students from Australia, Spain and Turkey, indicating that the data from these samples were a good fit for the factors that comprise the PSDQ. The use of a multi-group analysis revealed that the factor loadings were most similar for the Australian and Spanish students as compared to the Turkish students, which may be reflective of the age and educational similarities and differences among them.

Peart, Marsh and Richard[141] performed a psychometric analysis of the short form of the PSDQ (PSDQ-s). They compared the psychometric properties of the PSDQ-s with the long version by obtaining 158 individuals (age range 18-79 years) from Australia that served as a cross validation sample. The cross validation sample completed the 47-item short form only and their responses were used to validate the responses from a previous sample of 986 high school students from Australia that completed the 70-item long version of the PSDQ. They noted that Cronbach α estimates were greater than .80 for every scale on the PSDQ-s except for Global self-esteem ($\alpha = .77$). The mean $\alpha = .88$ for all 11 factors of the PSDQ-s and PSDQ long version. When the PSDQ-S was compared to the items on the PSDQ long version that were discarded, the mean $\alpha = .86$. Goodness of fit was performed using CFA. The results were RMSEA = .0723 for the cross validation group that completed the PSDQ, which reflects a reasonable fit of the data to the factors with the cutoff point being below .08. The NNFI and RNI, which are both statistics that reflect the fit of the data, were high (.981 and .982, respectively). The results of this validation study revealed that the PSDQ-S is a sound alternative to the already psychometrically robust long version of the PSDQ.

The PSPP is another instrument to measure PSC that was devised and validated by Fox and Corbin[126] in 1989. The PSPP consists of one primary domain; physical self-worth, and four sub-domains: sports competence, physical condition, body attractiveness and physical strength. Sports competence relates to perceptions of sports and athletic ability. Physical condition refers to confidence in one’s fitness level (e.g., stamina) and the ability to maintain it through exercise, sport and fitness pursuits. Body attractiveness refers to perceived level of physical attractiveness of figure or physique and confidence in appearance and the ability to maintain it over time. Physical strength refers to perceived muscle development, strength and confidence in situations requiring strength.[142]

Physical self-worth refers to feelings of pride, satisfaction, happiness, confidence and respect about one’s physical capabilities and physical self. The PSPP uses the hierarchical PSC model with four sub-domains having an equal relative placement to each other. Each of the sub-domains leads upward to the physical self-worth domain which serves to mediate the relationships between them and general self-esteem. The PSPP contains 30 questions with each sub-domain represented by 6 structured alternative formatted questions that are designed to minimize socially desirable responses.

Fox and Corbin[121] assessed the psychometric properties of the PSPP using 1191 college aged (mean age: 19.7 years) men and women from a mid-western United States university. They used confirmatory factor analyses to derive the four sub-domains and one sub-domain structure of the PSPP. They reported that the sub-domains of the PSPP were able to discriminate between active and inactive students, including those students at the extremes of both spectrums of activity levels, with an accuracy range of 66-72% for men and 67-76% for women. They reported the internal consistency coefficients of the five subscales ranged from .81 to .92; the test-re-test reliability coefficients ranged from .74 to .92 for a 16-day period and from .81 to .88 for a 23-day period.[126,143] Factorial analyses of the PSPP have been performed on colleges students from a multitude of different cultures in the United States, United Kingdom, Belgium, France, Spain and Turkey .

Karteroliotis[143] noted in a published report, as he reviewed the literature on the PSPP, that some cultures did not support the four subfactor composition of the PSPP. The PSPP has been validated on men and women of varying physical activity levels. Gender variances in PSC are most notably found in men with higher perceptions of physical self-worth, sport competence, and strength than women; women had higher perceptions of physical attractiveness than men. Other studies of the PSPP and in particular, the Youth PSPP, have found factorial invariances, but Fox and Corbin[121] recommend that the PSPP be analyzed separately by gender.

Karteroliotis[143] also examined the four factor structure of the PSPP to determine if there were any differences in the factorial structures of the instrument between genders. He used a sample of 131 male and 184 female students from two different mid-western universities that were enrolled in an elective health and wellness course.[143] Exploratory factor analysis was used to determine the common factors of the PSPP model and the contributions of each factor to the total explained variance. Confirmatory factor analysis was used to test the four factor structure separately on male and female students. Multi-group analysis was used to determine factorial invariance across both groups of male and female students. The exploratory factor analysis found that the four sub-domains that comprise the PSPP accounted for 67.9% and 70% of the total variance for the male and female students, respectively. The confirmatory factor analyses found that the goodness of fit measures (Goodness of Fit index, Normed fit index, Nonnormed fit index) did not support the four factor structure of the PSPP for both the male and female students. The explanations for this finding were due to the varied levels of physical activity participation.

Karteroliotis[143] noted that Fox and Corbin's[126] validation study used participants that were physically active whereas his study used less physically active participants.

Karteroliotis[143] suggested there may have been differences in the interpretation and instructions given to the student participants by the PE instructors who administered the PSPP. The multi-group analysis revealed the PSPP is not invariant to gender which was contradictory to Fox and Corbin's[126] published report. Karteroliotis[143] criticized the use of the exploratory factor analyses by Fox and Corbin because it may not have been adequate enough to compare the factors that comprise the PSPP across different genders as well as other diverse populations such as athletes and non-athletes.

Another published report by Hayes, Crocker and Kowalski[144] examined the differences between genders for physical self-perceptions, global self-esteem and physical activity. They used a sample of 94 female (mean age 19.46 years) and 89 male (mean age 20.03 years) college students enrolled in an introductory first year PE class in social-behavioral issues at a university in Canada. The participants were given the PSPP to measure physical self-perceptions, the "What Am I Like" global self-esteem scale and, the Leisure Time Exercise Questionnaire to assess physical activity levels over the previous 7 days. They found positive correlations between global self-esteem and physical self-worth for both male and female participants. They found positive relationships between physical self-worth and each sub-domain of the PSPP. They noted that the relationship between each sub-domain of the PSPP affected physical self-worth. Physical self-worth in turn was the higher order construct that affected global self-esteem. Using multiple regression analysis, only three of the sub-domains were significant predictors of physical self-worth for both men and women. Physical strength was the sub-domain that did not contribute to the explained variance of physical self-worth for both men and women. Body attractiveness was the strongest predictor of physical self-worth for both men and women. Because body attractiveness is a strong predictor of physical self-worth, this negates the use of physical self-worth in a multiple regression equation to predict global self-esteem when body attractiveness is entered. The authors noted that in previous work, body attractiveness had high levels of inter-correlations with physical self-worth with zero order correlations that range from .71 to .85, reflecting a large interdependence between these two variables.[144] Karteroliotis[143] noted that in previous studies, the level of interdependence between a superordinate variable such as physical self-worth with a subordinate variable such as body attractiveness essentially neutralizes the contribution of the superordinate variable physical self-worth. The result was a more parsimonious model when physical self-worth was deleted from the model.

Hayes, Crocker and Kowalski[144] examined the relationship between the sub-domains of the PSPP and self-reported physical activity. They found each of the components of the PSPP had a significant relationship with self-reported physical activity for men. For women, only the physical conditioning was related to self-reported physical activity. They noted these findings were consistent with other studies. They speculated that these findings may be due to the use of physical activity questionnaires that either have not been previously validated or the tendency for the questionnaires to capture aerobic based activities which may be reflective of the physical conditioning sub-domain of the PSPP. For women, body attractiveness was related to self-reported physical activity; this finding further questions the utility of the physical self-worth domain for the prediction of physical activity for this gender group. Global self-esteem had a weak relationship with self-reported physical activity for both men and women, but the relationship was significant only for men.

Based on their findings, Karteroliotis[143] suggests that the PSPP should be tested on several different populations to improve external validity. He noted the levels of independence among the sub-domains need to be established to determine the weaknesses and strengths of the PSPP on different populations. In addition, he suggests the PSPP needs to be tested on larger samples for each gender group to determine which models best predict physical self-esteem amongst men and women.[144]

Outcome Measures: The International Physical Activity Questionnaire- Short Form (IPAQ-s)

The International Physical Activity Questionnaire (IPAQ) is widely used tool in large scale research studies to assess physical activity levels.[145-149] The IPAQ is a self-reported questionnaire that can be administered in written or verbal format for use over the phone. The IPAQ asks the recipient about various types of physical activities associated with household, transportation, occupational and recreational pursuits. The IPAQ has two formats, a long and a short version. The long version contains more detailed questions that partitions the physical activities into different types based on the intended goal (occupational, recreational, transportation, etc.).

The IPAQ has been validated for use in several countries. Like many other self-reported measures that attempt to quantify health related behaviors, it is subjected to many flaws that make the interpretation of the data it produces difficult. Complex processes are required for a respondent to accurately report physical activity levels;[24] one such process is the Flexible Processing Model.[24] The model involves the tasks of: memory retrieval, comprehension of the question, decisions about how to answer the question, recall methods using estimation or enumeration and finally a response. He describes contextual cues used by a respondent to help assist with memories that are less frequent or episodic in nature using enumeration or estimation for more frequent or generic memories that are more difficult to store in long term memory. Many forms of physical activities are done in conjunction with daily tasks required for transport, household chores and occupational tasks. It may be easy to recall these types of physical activities because they are associated with structured, contextual activities that make recall of estimates for duration, intensity and frequency easier. Spontaneous activities such as light walking and other less structured ADLs may lack the contextual cues to more accurately recall them and that is an important consideration for physical activity questionnaires that attempt to quantify activities that are light to moderate in intensity.

Several research studies have examined the validity of the IPAQ using more sophisticated measures such as accelerometry, doubly labeled water and other self-reported questionnaires. Hagstromer, Oja and Sjostrom[145] performed a construct and concurrent validity study of the long-version of the IPAQ using 46 healthy male and female subjects (mean age: 40.7 years) from Sweden. They found strong relationships between the IPAQ and the activity monitor counts for total physical activity ($r = 0.55$, $p < .001$) and vigorous physical activity ($r = 0.71$, $p < .001$) with a weak, non-significant relationship between moderate physical activity and total physical activity ($r = 0.21$, $p = 0.051$). They found a significant correlation between the calculated METS from a 21-day physical activity log book and the METS calculated from the IPAQ ($r = 0.67$, $p < .001$). They found weak correlations between aerobic fitness assessed via a 15-minute submaximal treadmill test and the IPAQ ($r = 0.21$, $p = 0.051$) and the IPAQ and BMI ($r = 0.25$, $p = 0.009$).

MacFarlane and Wu[150] performed a validation study of six commonly used instruments to assess physical activity levels in 49 Chinese adults with an age range of 15 to 55 years. The six instruments used were: Polar heart rate monitor, Chinese version of IPAQ, daily physical activity log book, Yamax pedometer, Tritrac triaxial accelerometer, and MTI uniaxial accelerometer. They found low correlations between the Chinese version of the IPAQ and the other five physical activity measures (r-values ranged from .059 to .555). The strongest correlations was found between the Chinese version of the IPAQ and the Polar heart rate monitor for the quantification of vigorous physical activity. The weakest correlation was found for the assessment of moderate activity between the Chinese version of the IPAQ and the MTI uniaxial accelerometer.

Kurtze, Rangul and Hustvedt[146] performed a reliability and validation study on the IPAQ short form (IPAQ-S) using 108 male subjects from Norway with an age range of

20-39 years. The subjects were administered the IPAQ-S twice in one week to assess test-retest reliability. Validity of the IPAQ-s was assessed using the ActReg accelerometer and a ramped maximal aerobic fitness test using a treadmill. Test-retest reliability coefficients ranged from 0.3 for the number of hours spent on moderate activities to 0.8 for the number of hours spent sitting per day. They found significant ($p < .01$) but moderate correlations between the IPAQ-S measures of frequency and duration of vigorous physical activity and VO_2 max ($r = .36$ and $.40$, respectively). Weak but significant correlations ($p < .01$) were found between the IPAQ-S for physical activity related to walking and the physical activity log ($r = .23$), and the duration spent performing light, moderate and vigorous physical activity measured by the Actreg accelerometer (r = -.0.27, 0.26, 0.24, respectively). The IPAQ-S demonstrated significant but weak to moderate negative correlations between hours spent sitting and the calculated energy expenditure from the Actreg accelerometer ($r = -0.25$), physical activity log ($r = -0.35$), and hours spent performing moderately intense physical activity ($r = -0.42$). A moderateand positive relationship was found between the IPAQ-S and hours spent performing light physical activity ($r = 0.44$).

Fogelholm, Malmberg, Suni, et al[147] performed a criterion validity study between the IPAQ-S and actual measures of physical fitness. They used 951 subjects with an age range of 21 to 43 years to validate the moderate and vigorous calculations of METS from the IPAQ-S with VO_2 max, muscular fitness (number of pushups, sit ups performed in 60 seconds). Positive relationships were found between minutes of reported moderate and vigorous physical activity levels from the IPAQ-S with muscular fitness and VO2 max levels that were divided into quintiles. Paradoxically, the 5th quintile, the highest level of self-reported physical activity had lower, VO_2 max levels than the 4th quintile. The researchers used frequency distributions between the IPAQ physical activity levels and the frequency of reported vigorous physical activities performed over the past 3 months with a single question. They found a discrepancy between levels of vigorous physical activity for the subjects in the highest quintile of the IPAQ and the amounts of reported vigorous physical activity gleaned from the single question. The subjects in the highest quintile of reported vigorous physical activity based on the IPAQ had poorer levels of cardiovascular and muscular fitness when compared with subjects from the lower quintiles. When they reviewed the data, the researchers found the subjects in the highest quintile of self-reported physical activity had fitness levels that were comparable to those in the lowest quintiles. In addition, those subjects in the highest quintile were more obese, smoked more and were less educated. The researchers hypothesized that the subjects in the highest quintile of the IPAQ physical activity levels may have over-reported their physical activity due to a combination of low levels of education and very infrequent bouts of physical activity that may have influence how they interpreted and reported their actual physical activity amounts.

Tehard, Saris, Astrup, et al[148] performed a multi-center study that compared the IPAQ-S to the Baecke Questionnaire and two self-reported physical activity measures. They recruited 757 obese adults (75% female) (mean age 37.1 years). The IPAQ classified only one third of the subjects as being insufficiently active based on previous activity recommendations. Moderate and significant ($p \leq 0.0001$) correlations were found between the Baecke[174] and the IPAQ-S ($\rho = 0.51$) for total physical activity after adjustments for age, gender and center location. The adjusted correlations between the Baecke and the IPAQ-S were moderate and significant for walking and sitting activities for both men and women. Weak but significant correlations ($\rho = -0.16$) were found between the IPAQ-S and a composite measure of abdominal obesity. The researchers explained their findings due to the possibility of over reporting of physical activity amounts. The subjects in this study were obese but a high proportion of them reported that their activity levels were in the sufficiently active to highly active range. Only one third of the subjects reported themselves as being insufficiently active; this was a much lower proportion than the general non-obese adult population that typically reports levels of insufficient physical activity between 40 to 50%.

Rangul, Holmen, Bauman, Bratberg, Kurtze and Midthjell[117] conducted a reliability and validity study on two self-reported physical activity questionnaires, the IPAQ-S and the Health Behavior of Schoolchildren. They used 71 adolescents between the ages of 13-18 years. They were administered both questionnaires twice over an 8 to 12-day interval for test-retest reliability using intraclass correlation coefficients (ICC). The questionnaires were validated by a ramped maximal cardiovascular fitness test on a treadmill to determine VO_2 max and a physical activity monitor that was worn for 7 consecutive days. The ICCs for the IPAQ-S ranged from 0.10 for minutes spent walking each day to .62 for number of days spent walking for 10 minutes or more. The ICCs were .54 and .55 for the number of days spent performing vigorous and moderate physical activities per-week. The correlations between the IPAQ-S and the VO_2 max ranged from -0.32 for minutes spent-per-day performing physical activity ($p < 0.05$) to 0.32 for the classification of physical activities in all three levels (low, moderate and high). When the correlations were examined between the IPAQ-S and total energy expenditure, the correlations were all non-significant and ranged from -0.14 for minutes of vigorous physical activity spent-per-day to 0.19 number days-per-week spent doing vigorous physical activity. The relationships between the IPAQ-S and the average physical activity level (PAL) over a 7-day period (PAL defined as total energy expenditure divided by basal metabolic ratio) ranged from a non-significant correlation of -0.29 for minutes-per-day spent sitting to a significant correlation of 0.43 for minutes-per-day spent walking. When PAL was partitioned by gender, the correlation between the IPAQ-S and PAL was stronger for boys. The correlations for boys were both significant at $p < 0.01$ for the number of minutes spent walking per day at 0.61 and the minutes-per-day spent sitting at -0.68.

In a systematic review of 23 studies that attempted to validate the IPAQ-S, Lee, Macfarlane, Lam, Stewart, et al[149] found the tendency of the IPAQ-S to overestimate physical activity levels when compared to other more reliable instrument measures. They noted the correlations between the IPAQ-S and other physical activity instruments such as accelerometry, pedometry, or doubly labeled water failed to achieve correlations that were equal or above the minimal accepted levels of 0.5 for objective activity measures. In many of the studies reviewed, the IPAQ-S failed to achieve correlations of 0.4 with other fitness measures such as VO_2 max. The authors of this review discussed potential methodological issues that affect the interpretation of these studies such as: population heterogeneity, variations in sample sizes and the ratio of male to female subjects. They noted that the studies that were used to validate the IPAQ used different criterion measures such as accelerometry, pedometry or doubly labeled water to validate the IPAQ. They also noted that the units of measurement gleaned from these instruments varied (number of counts/day, total energy expenditure, MET scores, time spent in vigorous, moderate or sedentary activity). The IPAQ quantifies total physical activity levels, but this can be partitioned into sedentary, moderate, vigorous and this can be another source of variation when interpreting validation studies of the IPAQ.

Outcome Measures: Static Strength Tests (Hand-held Dynamometry, Isometric Strength Tests)

Static strength tests are easy to administer and often use equipment that is relatively low in cost. Dynamometry involves the use of a device that can measure torque based on a pre-set lever arm that can be fixated to derive an isometric strength test. Static grip strength is commonly used to assess handgrip function after a hand injury.[151] As noted previously, several studies have shown that handgrip strength correlates well with total body strength as well as morbidity and mortality from all causes. Jamar® hand-grip dynamometer is commonly used in the rehabilitation setting to assess handgrip strength and its reliability and validity have been published in numerous reports.

Hamilton, McDonald and Chenier[152] found a test re-test reliability value of .82 for the Jamar® hand-grip dynamometer when tested on 29 college aged females that were right handed. They tested the validity of the Jamar® with use of a sphygmomanometer and calculated a correlation coefficient of .75. Mathiowetz[153] performed a study that examined the concurrent validity between the Jamar® and Roylan hand-grip dynamometers on a total of 60 college aged male and female subjects (50% males). They found excellent inter-instrument reliability for both units (ICC > .90) and both had high levels on concurrent validity using known weights ($r \geq .9994$). Bohannon and Schaubert[154] examined the test retest reliability of the Jamar hand-held dynamometer over 12 weeks for community dwelling elders. They reported ICCs of .954 and .912 for the left and right hand, respectively.

Stationery dynamometry has been used to assess limb and trunk strength. These devices can been used isometrically, isotonically and isokinetically to accurately measure muscular strength, power, and endurance. The reliability of these devices has been tested in previous studies. Blazevich, Gill and Newton[155] used 14 male subjects to establish the reliability and validity of the lower extremity squat test performed isometrically and isotonically. The isometric maximal squat test yielded excellent test-retest reliability (ICC = .97) with a strong and significant correlation with the 1-RM isotonic free-weight squat ($r = .77$; $p < .01$).

Leggin , Neuman, Iannotti, Williams and Thompson[156] examined the inter-rater and intra-rater reliability among three different shoulder isometric dynamometers. Two investigators tested every subject on the same day for shoulder internal rotation, external rotation and abduction using the Nicholas Manual Muscle Tester (MMT), Biodex Isokinetic Dynamometer, and Isobex 2.01. The same test procedure was repeated within a one week period. They found excellent inter-rater reliability for all three devices (Nicholas MMT = .79 to. 94, Biodex =. 93 to. 96, and Isobex 2.0 = .90 to .97.). Similarly excellent intra-tester reliability was found for all three devices (Nicholas MMT= .84 to .97, Biodex = .97 to .99, and Isobex 2.0 = .95 to .98.).

Ford-Smith, Wyman, Elswick and Fernandez[157] evaluated the one week test re-test reliability of lower extremity stationary dynamometry for community dwelling senior adults. One examiner performed both right and left sided isometric strength tests using the dynamometer and calculated a composite score from each side based on the muscle group tested. The same procedure was repeated by the same examiner one week later. The muscle groups tested were the hip and knee flexors/extensors and the ankle plantar/dorsiflexors. The reliability coefficients ($ICC_{3,1}$) were good to excellent (range .76 to .90) for individual muscle groups tested on each side. The composite measure reliability coefficients ($ICC_{3,1}$) ranged from .84 to .91 for the composite score (mean value of the left and right side of a muscle group). These studies highlight the reliability of stationary dynamometry and the utility of them to assess muscular strength.

Outcome Measures: Reliability and Validity of Select Aerobic Fitness Tests (Six Minute Walk Test, Bruce Protocol with Indirect Calorimetry)

Measuring aerobic fitness capacity is an important measure of physical fitness. There are many modes to evaluate aerobic fitness capacity. These evaluation modes range from field tests such as one mile walk/run and bench step tests to the six and twelve minute walk. The six minute walk test (6MWT) is one of the most commonly used field tests to assess aerobic fitness in the clinical setting. It is easy to administer and does not require use of expensive equipment such as electrocardiography (ECG) or indirect calorimetry.

Cahalin, Mathier, Semigran, Dec and DiSalvo[158] performed a predictive validity study on the 6MWT using 45 patients with advanced heart failure. The subjects' VO_2 max was tested using a maximal ramped bicycle protocol while monitored with indirect calorimetry and radionuclide angiography. On a different day, the same subjects performed the 6MWT while being monitored via ECG, indirect calorimetry with blood pressure, heart rate and ratings of perceived exertion. Nineteen subjects repeated the 6MWT twice on the same day (two different times of the day) to assess reliability. The subjects' respiratory capacity was tested using spirometry to assess their Functional Vital Capacity (FVC) and Forced Expiratory Vital Capacity in one second ($FEVC_1$). The researchers found test-retest reliability coefficients for the 6MWT to be excellent (ICC = .96). A moderate to strong correlation was found for the distance walked during the 6MWT and peak VO_2 ($r = 0.64$, $p=.0001$). The researchers were able to develop a regression equation that used the distanced walked during the 6MWT, the individual's age, weight, rate pressure product and FEV_1 and FVC to predict peak VO_2 with a standard error of estimate (SEE) of 2.59. The authors of this study noted that a 6MWT distance of 300 meters or less was the cutoff value for the prediction of short term survival (< 6 months) due to cardiac death due to heart failure.

Hulens, Vansant, Claessens, Lysens and Muls[159] performed a study that compared walking ability of women classified as overweight/obese (N= 85) and morbidly obese (N= 133) with 82 age-matched, lean women who served as the control group. Their study had three purposes: to examine the medical conditions that affect walking ability; assess the differences in walking capacity, perceived levels of exertion and physical complaints between the groups of women and lastly, the anthropometric, physical fitness and physical activity factors that contribute to walking ability amongst the three different groups of women. They found a significantly higher prevalence of conditions that may affect walking ability (friction of the skin, foot problems, urinary incontinence, knee and low back pain and hip arthritis) in the obese and morbidly obese women as compared to their lean counterparts. The physical complaints of dyspnea, musculoskeletal pain and minor pain complaints were significantly higher for the obese and morbidly obese participants as compared to the lean group of women. Correlation coefficients were used to evaluate the relationships between the various factors believed to affect walking ability and the distance walked during the 6MWT. The researchers found significant ($p \leq .0001$) and strong relationships between anthropometric measures such as BMI, fat mass, and weight with negative correlations that ranged from -.68 to -.77. Strong and positive relationships were found between the distance walked on the 6MWT and fat free mass percentage ($r = .80$) and peak VO_2. The relationships between the 6MWT distance and self-reported physical activity levels (Baecke questionnaire) and isokinetic knee strength of the weakest knee were all significant ($p \leq .0001$) but moderate in strength (r values ranged from -.44 for time spent watching television to .40 for knee flexion torque of the weakest knee). Using stepwise multiple regression analysis, the researchers found that 75% of the variance of the distance walked during the 6MWT could be explained by BMI, age, peak VO_2 max, knee extension torque of the worse performing knee, and hours spent watching television or sports participation.

Larsson and Reynisdottir[160] performed a study that examined the reproducibility and validity of the 6MWT on 43 obese outpatients with a mean age and BMI of 47 years and 40 kg/m^2, respectively. Forty-one lean, age matched controls were used to establish validity by using the known group validity method. The subjects were tested on the 6MWT twice within one week. The reproducibility of the 6 MWT was strong ($ICC_{1,1}$ = .96, the coefficient of variation = 4.7%; measurement error = 25 meters). Using the known group validation method to establish validity of the 6MWT for obese individuals by comparing distance walked, levels of perceived exertion and pain felt during the walk with the lean group. The researchers found that the obese group walked 33% less than the lean group. Using multiple regression analyses, they found that BMI contributed to 38% of the variance in the distance achieved during the 6MWT. They determined that BMI, heart rate at the end of the 6MWT, height and age explained 71% of the variance of the distance achieved during the 6MWT. They found that the morbidly obese subjects (BMI > 41 kg/m^2) walked significantly less ($p < .001$) than the less obese subjects by 84 meters. The obese subjects also performed higher levels of work during the 6MWT which was calculated by multiplying the distance covered during the 6MWT by the individual's body weight. The work performed for the obese group was 60.5 kg*km as compared to the lean group at 47.5 kg*km ($p < .001$). Pain was assessed using the Borg CR-10 scale and revealed a significant difference between the obese and lean groups (mean pain levels of 2 and 0 respectively) with pain mostly felt at the knee and tibial periosteal region for the obese subjects.

Beriault, Carpentier, Gagnon, et al[161] examined the reproducibility of the 6MWT in 21 obese (mean BMI = 37.2 kg/m^2) adults. The participants performed the 6MWT twice on the same day. They found high levels of reproducibility between the morning 6MWT distance (mean = 452 meters) with the afternoon distance (mean = 458 meters) ($r = 0.948$). Significant correlations were found between the distance walked during the 6MWT and BMI ($r = -0.47$, $p=.03$), waist circumference ($r = -.43$, $p=.05$) and pre-test heart rate ($r = -.54$, $p=.01$).

The Bruce Protocol is a widely used staged treadmill aerobic fitness test first described by Dr. Bruce in 1973. The Bruce Protocol is used to assess VO_2 max either directly as a maximal test or indirectly as a submaximal test that extrapolates VO_2 max via a regression equation or nomogram.[162] The Bruce protocol involves a gradual progression in the treadmill speed and inclination until one or more indicators to stop the test has been met. The Bruce protocol has been tested and used on many different clinical populations including active and sedentary men and women, male and female cardiac and elderly patients. The Modified Bruce protocol is essentially the same staged treadmill test as the Bruce but is used for more deconditioned or elderly individuals or for patients who may have suffered a recent cardiopulmonary event or surgery. The Modified Bruce protocol involves two preliminary stages at a slower speed and incline that progresses to a third stage that is the same as the first stage of the actual Bruce protocol. Regression equations have been developed to predict VO_2 max for various clinical populations.[163] The equations all have in common the time in minutes that an individual is able to complete the protocol as the variable inputted into the equation along with the use of regression constants to predict VO_2 max. The standard errors of the estimate of these equations range from 2.7 to 4.9 ml * kg^{-1} * min^{-1}. Noonan and Dean[163] published a report that reviewed the most widely used submaximal aerobic exercise tests in the clinical rehabilitation setting. They reported correlation coefficients in previous published reports by Dr. Bruce that ranged from 0.87 to 0.94 for the relationships between predicted and actual VO_2 max for patient populations that ranged from cardiac patients and men and women without cardiac conditions.

Indirect calorimetry is a method of measuring oxygen consumption that uses expired respiratory gases to estimate maximal aerobic capacity. Indirect calorimetry can be used to determine metabolic substrate use by an individual both at rest and steady state exercise. The typical indirect calorimeter used in a laboratory or clinical setting uses an “open circuit” mode of calorimetry. This type of calorimetry uses expired gases to determine oxygen consumption and metabolic substrate preference by inhaling room air comprised of 20% oxygen and .04% carbon dioxide with exhaled air, which is typically comprised of 16% oxygen and 4% of carbon dioxide. The difference in oxygen and carbon dioxide concentrations between inhaled air and expired air represents the oxygen that is consumed for the metabolic processes needed to provide energy. There are several indirect calorimeters otherwise known as “metabolic carts” used in the laboratory or research setting.

ParvoMedics TrueOne® 2400 is a metabolic cart that is currently being used in several university and research centers such as NASA, Texas Woman’s University Denton/Houston campuses, National Institutes of Health and Universities of Florida, Stanford, Duke, Washington and Tennessee to name a few.[165] It uses infrared and paramagnetic sensors to measure carbon dioxide and oxygen levels with high degrees of measurement accuracy (within .03% and .02%, respectively).[164] The reliability and validity of the ParvoMedics TrueOne® 2400 has been tested in previous published studies.[165,166]

Crouter, Antczak, Hudak, DellaValle and Haas[165] evaluated the accuracy and reliability of the TrueOne® 2400 and another metabolic cart MedGraphics VO2000. They tested 10 healthy male subjects (mean age 20.0 years) at rest and on a bicycle ergometer at 50, 100, 150, 200, 250 watt stages with each stage being 10-12 minutes long. The Douglas Bag method of gas collection and analysis was the criterion measure used to compare the validity for both metabolic carts. The subjects were tested on two separate days with the order of testing for the two types of metabolic carts randomized. The

ParvoMedics TrueOne® 2400 metabolic cart did not vary significantly from the Douglas Bag method for minute ventilation, volume of oxygen consumed and carbon dioxide produced per minute. Significant differences ($p < .05$) were found between the ParvoMedics TrueOne® 2400 and the Douglas Bag method for the fraction of expired air that is oxygen and carbon dioxide at rest, 50, and 100 watt workloads. The test re-test reliability was excellent between the two days the subjects performed the aerobic tests on the bicycle ergometer using the ParvoMedics TrueOne® 2400. The Pearson correlation coefficients were significant ($p < .01$) at .975, .994 and .991 for minute ventilation, volume of oxygen consumed and carbon dioxide produced per minute, respectively. The coefficient of variation between the two days for the ParvoMedics TrueOne® 2400 were 7.3, 4.7 and 5.7% for minute ventilation, volume of oxygen consumed and carbon dioxide produced per-minute, respectively.

MacFarlane and Wu[166] performed a study that examined the inter-unit variability of two ParvoMedics TrueOne® 2400 machines in a study of 15 healthy adult males (mean age 21.7 years). The subjects rode a bicycle ergometer to perform a graded exercise test at 30, 60, 90 and 120W with each stage lasting for 7 minutes at a pedal frequency of 60 revolutions per-minute. Each subject was tested on two separate days with two different set up modes used to examine the levels of agreement between the two TrueOne® 2400 units. The subjects performed the aerobic test using a collateral set up, meaning that both TrueOne® 2400 units were being used during the test to alternately analyze the concentrations of expired oxygen and carbon dioxide to calculate rates of oxygen consumption and carbon dioxide production. The second setup involved a simultaneous setup in which both TrueOne® 2400 units were measuring the concentrations and rate of oxygen consumption and carbon dioxide production from the expired air of each subject at the same time. The researchers found no significant differences for any of the physiological respiratory responses to the bicycle ergometer test at each workload using paired t-tests for the collateral setup. The effect sizes for the collateral setup ranged from .01 to .32 and the coefficient of variation ranged from .4% to 8.6% for the physiological parameters measured at each of the aforementioned workloads. For the simultaneous setup, a similar trend of non-significance was found for each physiological parameter at each workload except for respiratory exchange ratio at 120 watts ($p < .002$), but this measure had a coefficient of variation of .6% and an effect size of .16, thus questioning the utility of t-tests as a measure of reliability.

Outcome Measure: Isokinetic and Isotonic Strength Assessment

Assessment of muscular strength can be performed using a variety of different methods from field tests such as calisthenics (e.g. pushups and sit-ups), free-weight/machine based equipment to more sophisticated computerized equipment that employs the use of computerized dynamometry. The term strength is often used disparately throughout the strength and conditioning literature. The definition of strength was defined by Knuttgen and Kraemer[57] as the maximal force that a muscle or muscle group can generate at specific velocity.

There are several different modes to assess strength. One mode is isokinetic strength testing. Isokinetics requires a maximal contraction of a muscle group at a constant velocity throughout the entire range of joint motion.[162] Isokinetic strength testing is usually performed on a dynamometer. Isokinetic testing is one of the few ways that the force generating properties of a muscle can be maximally assessed throughout the entire range of joint motion due to the accommodating nature of the resistance applied to match the fluctuations in length-tension relationships of the muscle and the moment arm changes in the applied force. Isokinetic testing is the only type of strength test that perfectly matches the proposed definition of strength devised by Knuttgen and Kraemer.[57] The properties of the dynamometer allows for loads (torque) applied to a lever arm to produce a voltage that is amplified, filtered and converted from an analog to a digital signal to be read in binary language by a computer to allow for the acquisition, computation and interpretation of the force produced by the tested muscle groups.

The reliability of isokinetic muscle testing has been published in numerous research studies with good results. Keskula, Dowling, Davis, Finley and Dell'omo[167] performed a study that examined the inter-rater reliability of isokinetic testing of the knee extensors and flexors. Four different investigators on four different occasions tested 8 male and 8 female subjects (mean age 25.4 years) on the Cybex 6000. Knee extension and flexion peak torque and total work at 60 and 180 degrees per second were measured. The calculated ICCs ranged from .90 to .96 for peak torque and .90 to .95 for total work.

The standard error of measurement estimates ranged from 8.9 to 13.3 Nm for peak torque and 11.3 to 16.8 N*m for total work.

Feiring, Ellenbecker and Derscheid[168] performed a study that examined the test re-test reliability of the Biodex Isokinetic dynamometer. They tested 19 healthy subjects (10 females) with an age range of 20-35 years on two separate occasions over a 7-day period. Knee flexion and extension peak torque and total work were tested. The calculated peak torque ICCs ranged from .95 to .97 and .82 to .98 for the knee extensors and flexors, respectively. The ICCs for total work ranged from .95 to .97 and .93 to .96 for knee extensors and flexors, respectively.

Sole, Hamren, Milosavljevic, Nicholson and Sullivan[169] examined the test-retest reliability of the Kin Com Isokinetic dynamometer using 18 recreational to elite athletic subjects (11 men) with a mean age of 21 years. The subjects' knee extension and flexion were tested at 60 degrees per second for 3 trials on 2 occasions separated by one week to examine peak torque and total work. The researchers found ICCs that were > .90 for peak torque and total work with standard error of measurement that ranged from 5-10% of the initial tested values for both peak torque and total work.

Another mode of strength testing is through the use of isotonics. Isotonics requires a maximal contraction of a muscle group at a constant load throughout the entire range of joint motion. The isotonic contraction involves a concentric and eccentric component. The external force delivered to the muscles fluctuated based on the dynamic properties of the joint lever arm and length/tension relationships of the muscle itself.[57] Isotonic strength assessments have been performed using multiple methods ranging from free weights to various machines that simulate the same type of movements as free weights. The 1-RM is typically used to assess the maximal contractile ability of a muscle group. Often this is easier to perform as it takes less expensive equipment than isokinetic tests and there is little error involved due to equipment and/or calibration malfunctions. Proper technique, motor learning, previous weight training experience and individual motivation can all serve as sources of error that may affect the ability to obtain a "true" measurement of one's maximal lifting capacity. The ability to assess an individual's maximal strength can involve the performance of multiple repetitions of an exercise to estimate the one repetition maximum has been used extensively in research studies that involve a measurement of strength.[57]

The benefits of assessing strength using multiple repetitions is that it may be a safer method of assessing strength rather than using maximal or near maximal loads to individuals who are unaccustomed to lifting weights of that intensity.[57] Using formulas to extrapolate an individual's one repetition maximum is impacted negatively by error. Errors in the equations themselves to estimate one repetition maximum as well as motivational factors can influence an individual's true measurement of strength. Although the ability to measure strength can be performed using numerous methods, the one repetition maximum method is considered the "gold standard" of isotonic strength testing.[23,52] The literature points to a gradual progression of loads applied to the individual when the assessment of muscle groups are needed. Usually by starting with a weight that is between 50-70% of one's perceived capacity and gradually increasing the loads by approximately 5-20% of the previous amount (depending on the muscle group(s) being tested) for each set with a 3-5 minute rest period in between has been recommended. The goal is to bring the individual to his or her one repetition maximum within 4-5 test sets.[29,57]

There are very few published studies that elucidate the reliability of the one repetition maximum test. Tagesson and Kvist[170] examined the intra- and inter-rater reliability of the 1-RM test for the squat and knee extension exercise for 16 and 27 healthy subjects, respectively. The subjects had a mean age of 25 years and were recreationally active (exercised 2-3 days per week). Each subject's 1-RM for single leg squat and single leg knee extension were assessed by two different examiners on two different occasions. The researchers calculated ICCs of .94 and .96 for the inter tester reliability of the single leg squat and single leg knee extension, respectively. The intra tester reliability coefficients were .64 and .90 for the single leg squat and single leg knee extension, respectively.

Levinger, Goodman, Hare, Jerums, Toia and Selig[171] assessed the reliability of the 1-RM test on 53 untrained middle aged adults. The subjects performed a 1-RM test for seven different exercises after they had a familiarization session with each exercise done on a previous day. Each subject's 1-RM for all seven machines were re-tested 4-8 days after the initial session and again 10 weeks after the second session. The researchers calculated ICCs > .99 and test retest correlation coefficients > .90 for all seven exercises tested across all three occasions. The coefficients of variation for each of the seven exercises tested between the first and second and the second and third occasions ranged from 2.2% to 10.1% demonstrating acceptable levels of error for each 1-RM test.

CHAPTER III

ARE THERE RELATIONSHIPS BETWEEN PHYSICAL FITNESS AND SELF ESTEEM IN YOUNG ADULTS?

ABSTRACT

The purpose of this study was to assess the bi-variate relationships between objective measures of physical fitness and the corresponding subdomains that comprise physical self-concept in young adults. Thirty participants were recruited from a local university. The International Physical Activity Questionnaire and the Physical Self Perception Questionnaire – Short Form (PSDQ-S) were used to assess levels of physical activity and physical self-concept, respectively. Objective fitness measures included isotonic 3 repetition maximum (3-RM) loads lifted using upper and lower body muscle groups, isokinetic thigh strength and a maximal aerobic fitness test. The Sport and Activity subdomains of the PSDQ-S and the 3-RM seated row appear to be the best measures for estimating overall levels of physical fitness.

INTRODUCTION

Physical activity (PA) is defined as “bodily movement produced by the skeletal muscles that results in caloric expenditure. ”[1] The lack of PA in the United States has become a concern as the number of individuals diagnosed with diabetes have tripled from the years 1980 to 2011 and the rates of adult obesity have climbed to 35.7% of the U.S. population. Diabetes, obesity and poor physical fitness are factors that have led to the development of cardiovascular, metabolic and certain neoplastic disorders.[2-7] Young adulthood represents a time period that is transitional for many individuals. The transition period from high school to college or from college to the work force is associated with a reduction in the necessary PA needed to attain or even maintain muscular and cardiorespiratory fitness. The Centers of Disease Control and Prevention (CDC) 2011 Behavioral Risk Surveillance Survey[2,3] revealed that only 21% of adults participated in the necessary amount of PA to comply with Federal aerobic and strength guidelines. The precipitous decline in PA between the adolescent and young adulthood periods is speculated to be the result of a myriad of factors. Many PA researchers attribute the lack of recommended PA amounts for this cohort to several psychological factors seen in young adulthood, such as altered perceptions of body image and low self-esteem.[14-21] Physical self-concept (PSC) is one of the psychological factors that has been shown to be an important contributor to the initiation and maintenance of programs designed to increase PA levels.[15,18,22,29-31] PSC relates to an individual's perception of competence in the areas of physical appearance, condition, sports and strength. Harter[32] theorized that individuals tend to adhere to activities in which they perceive to have attained a level of mastery and competence. Based on this theory, as the level of PSC increases, there should be a concomitant increase in PA that will lead to improved components of Physical Fitness (PF) with adherence to a physical exercise regimen over time, but the strength and direction of these relationships has not been established. The question arises as to whether PSC is related to PF and PA in young healthy adults and to what magnitude.

The primary purposes of this study are to assess the bi-variate relationships between objective measures of muscular strength and cardiovascular endurance and the corresponding subdomains of PSC; and between self-reported weekly volume of moderate or vigorous PA and overall PSC and self-esteem (SE). The first and second hypotheses are: there are significant positive linear correlations between: 1) muscular strength and cardiovascular endurance and the Strength and Endurance subdomains of PSC; 2) muscular strength and cardiovascular endurance and the Global PSC and SE; the third hypothesis is that the Body-Fat and Health subdomains of the PSC will have significant negative correlations with objective measures of muscular strength and cardiovascular endurance. The fourth hypothesis is the Activity subdomain, overall PSC and SE will have moderate and significant positive correlations with self-reported weekly volumes of moderate or vigorously intense PA.

METHODS

Participants

Thirty participants (10 men, 20 women) were recruited from a local university. The inclusion criteria were: between 18-30 years old, with no report of current participation in organized recreational activities or sports teams. The exclusion criterion was any self-reported current medical condition using the Physical Activity Readiness

Questionnaire.[70] This study was approved by the Texas Woman's University Institutional Review Board.

Instrumentation. measures were used to assess levels of self-reported physical activity, physical self-concept and physical fitness. All assessments were conducted in the exercise laboratory in the order as listed below.

Self-reported physical activity. The International Physical Activity Questionnaire (IPAQ) was completed by the participants to document the self-reported volume of PA performed over the previous 7 days. The IPAQ is widely used in large scale research studies to assess PA levels.[39-41] Previous studies have documented the IPAQ's test-rest reliability (r = 0.3 - 0.8) and concurrent/criterion validity (r = 0.55 - 0.71) to be moderate.[39,41-47] The IPAQ inquires about the various types of physical activities associated with household, transportation, occupational and recreational pursuits. The intensity, frequency and durations of each type of PA can be quantified, summed and expressed as the number of minutes spent performing activities at a particular intensity (i.e., with energy level expressed as METs) per week. The physical activities documented are those that are used to enhance overall health, through formal exercise programs, occupational tasks, household chores, and modes of transportation that are moderate to vigorously intense. Moderate PA is defined as PA with an energy expenditure of 4 METs while vigorous PA is defined as PA with an energy expenditure of 8 METs. Activity volume is expressed as the number minutes spent at each intensity level per week.[48]

Physical self-concept. The Physical Self Perception Questionnaire – Short Form (PSDQ-S) was used to assess levels of PSC. The PSDQ-S was developed by Marsh[23,28,35] to measure the multidimensional construct of PSC. The PSDQ-S is comprised of 9 distinct subdomains and two global measures that include: Body-Fat (BF), Endurance (END), Sports Competence (SP), Strength (ST), Coordination (COOR), Health (HLH), Appearance (APP), Flexibility (FLEX) and Activity (ACT); and Global PSC (Global PSC) and Self-Esteem (Global SE). Each respective subdomain and global measure can be individually examined and evaluated by averaging the responses for questions that pertain to the corresponding subdomain.[23,28,35] The PSDQ-S contains 47 questions with each question scored on a Likert scale from 1 (false) to 6 (true).[26] Some of the questions utilize a reverse scoring method for negatively phrased questions to prevent the respondents from answering the questions in a socially desirable manner, and the responses to these singular questions are re-coded appropriately for data analysis. Therefore, the maximum average score for each sub-domain would be 6. The psychometric properties of the PSDQ-S have been reported in the literature and it has well established internal consistency (median α = .92) and test stability (r = .69 - .83) with populations from several different cultures and age groups.[26]

Physical fitness measures were performed to assess levels of muscular strength and aerobic endurance. These measures commenced in the order as described below.

Anthropometrics and vital signs. Height and weight were measured with a stadiometer and the Tanita® BF-350 body composition scale (Arlington, IL), respectively. Each participant's body mass index was read directly from the body composition scale. Each participant's resting blood pressure and heart rate were assessed via an electronic sphygmomanometer.

Muscular strength. The maximal muscle strength measures were assessed both isotonically and isokinetically. The 3 repetition maximum (3-RM) loads lifted isotonically, using the seated chest press, seated row and supine leg press (QuantumFitness®; Stafford, TX), were divided by the participant's body weight and multiplied by 100 to provide a relative measure of strength (3-RM/BW%). The three different sets of muscles assessed were: 1. pectorals, deltoids and triceps; 2. latissimus dorsi, deltoids, 3. biceps brachii; 4. quadriceps, gluteal muscles and hamstrings. For participants able to perform repetition maximums that exceeded three repetitions at the highest allowable weight that can be selected for the machine, their 3-RM was estimated using the Brzycki equation, which has excellent reliability (ICC: .95- .98) and validity (error rate: 3 – 6.3%) with 1-Repetition Maximum (1-RM) tests.[49-51]

The isokinetic tests were used to measure the peak torque divided by the participant's body weight (PK TQ/BW %) to derive a percentage for the quadriceps muscle groups. The Biodex System 3 Isokinetic Dynamometer™ (Shirley, NY) was used at the set angular velocities of 60 (QUAD60) and 180 (QUAD180) degrees/second. The test-retest (ICC: .95-.97) and inter-rater (ICC: .90-.96) reliability values of isokinetic quadriceps muscle strength measurements have been excellent in numerous research studies.[52-54]

Aerobic fitness. Maximal aerobic fitness (VO_2 max) was assessed using a metabolic cart (ParvoMedics TrueOne® 2400; Sandy, UT)) and the Bruce protocol multi-staged maximal treadmill test.[10,55] Respectively, the blood pressure and heart rate were monitored during the treadmill test via a manual sphygmomanometer and Polar® (Lake Success, NY) chest strap sensor that relays the heart rate to the computer. Participants performed the protocol until they requested to discontinue the test or if one of the relative contraindications to exercise testing was noted as set forth by the American College of Sports Medicine.[10] The test re-test reliability (r = .98-.99) of the ParvoMedics TrueOne® 2400 metabolic cart and the Bruce protocol for the assessment of VO_2 max have been well established in previous research reports.[56,57]

Statistical Analysis

Means and standard deviations (SD) were calculated for the following variables: weekly volumes of both moderate and vigorous PA collected from the IPAQ, each objective PF measure, and the nine sub-domains and two global measures from the PSDQ-S. The Pearson product moment correlation coefficient (r) was utilized to determine the bi-variate strength and direction of the relationships between the ST and END subdomains of the PSDQ-S and the objectively measured muscular strength and cardiovascular endurance fitness tests. The data were screened for the assumptions of normality and linearity between each bi-variate correlation via scatterplots, and the assumption of normality was tested. If any variable's distribution was skewed, its values were logarithmically transformed to the base 10 to meet this assumption.[58] If the variable remained skewed after the logarithmic transformation, then the non-parametric Spearman's rho correlation coefficient was utilized using the original, untransformed data value(s) for the skewed variable(s). All bi-variate correlation coefficients were tested for significance using a one-tailed test with alpha set at .05. Data were analyzed using the IBM-Statistical Program for the Social Sciences (IBM-SPSS), Version 21.0 for Windows (IBM Inc., Chicago, IL)

RESULTS

The means (SD) of the participants' age, height and weight were: 25.03 years (1.94); 167.43 cm (7.74); and 70.85 kg (13.51), respectively. The means and SD and minimum/maximum values for each physical fitness measure and self-reported moderate and vigorous PA weekly volume from the IPAQ for all participants are presented in Table 3.1. Two participants did not complete the entire IPAQ instrument and their data were not included in the analyses. All thirty participants completed each component of the physical fitness test battery. Nine of the 30 participants (7 males and 2 females) were able to perform repetitions on the isotonic strength tests that exceeded three repetitions at the highest settings on one or more of the machines used, or they were able to perform repetitions that exceeded the machine's capacity, therefore the Brzycki equation was used for those participants to estimate the 3-RM load.

Table 3.1.*Mean Physical Fitness and Self-Reported Physical Activity Measures: BMI, Aerobic Fitness, 3-RM Upper and Lower Body Strength and Quadriceps PK TQ/BW %*

	Mean (SD)	Minimum	Maximum
BMI (kg/m^2)	25.23 (4.01)	18	38
VO_2max: ml*kg^{-1}*min^{-1}	39.06 (8.96)	16.80	54.90
3 RM Chest Press(kg/BW(kg) x 100	68.54 (29.90)	21.29	140.09
3 RM Seated Row(kg)/BW(kg) x 100	94.58 (33.47)	28.15	162.96
3 RM Leg Press(kg)/BW(kg) x 100	236.45 (123.18)	73.30	619.91
QUAD180	153.14 (35.22)	87.00	240.10
QUAD60	209.34 (53.14)	96.70	303.40
IPAQ moderate (minutes/week)	247.86 (266.77)	0.00	1200.00
IPAQ vigorous (minutes/week)	154.25 (289.87)	0.00	1440.00

The means (SD) for the nine sub-domains and two global measures of the PSDQ-S are presented in Table 3.2

Table 3.2. *Mean Scores* of the Nine Subdomains and Two Global Measures of Physical Self- Concept from PSDQ-S*

Measure	Mean (SD)
Activity (ACT)	3.37 (1.52)
Appearance (APP)	4.54 (.069)
Body-fat (BF)	2.99 (1.50)
Flexibility (FLEX)	3.74 (0.64)
Sport (SP)	4.32 (1.31)
Health (HLH)	5.30 (1.10)
Coordination (COOR)	4.70 (0.65)
Endurance (END)	3.38 (1.35)
Strength (ST)	4.12 (1.00)
Global PSC	4.63 (0.93)
Global SE	3.83 (0.39)

Note:*Maximum score of 6 for each subdomain and global score

The assumption of normality was met by all measures except BMI, leg press, moderate/vigorous physical activity levels (reported via the IPAQ), and the Coordination subdomain of the PSDQ. The BMI, leg press, and both IPAQ PA levels were positively skewed. The data values for these measures were logarithmically transformed to attempt to meet the assumption of normality. The total amounts of moderate physical activity remained skewed despite logarithmic transformation, so non-parametric analysis was conducted when including that variable.

All bi-variate correlations had linear relationships. The correlations between the maximal aerobic physical performance measure and the Endurance and Activity subdomains of the PSDQ-S were moderately strong at r = 0.60 and r = 0.54, respectively. Low but significant relationships were found between VO_2 max and the Sport subdomain (r = .35).

One significant and moderately strong correlation was found between the seated row and the Activity subdomain for the 3-RM/BW% (r = 0.64). The Strength subdomain measure significantly correlated with the 3-RM/BW% for the seated row (r = 0.35) and chest press (r = 0.43). The ACT and SP subdomains both demonstrated the greatest number of significant correlations with the strength physical performance measures. ACT demonstrated weak to moderate correlations with chest press (r = 0.40), seated row (r = 0.61), and QUAD180 (r = 0.34) SP was correlated with chest press (r = 0.40), seated row (r = 0.39), leg press (r = 0.33), and QUAD180 (r = 0.35.) For Global PSC and SE, only the quadriceps isokinetic measures yielded moderate but significant relationships (r = 0.33 and r = 0.37 for 60 and 180 degrees per second speeds, respectively). The Body-Fat subdomain was significantly correlated with BMI (r = -0.51). The Health subdomain significantly correlated with QUAD60 (r = 0.38). Vigorous physical activity participation had no significant correlation with either global measure, but it did correlate significantly with the ACT subdomain (r = 0.54). Moderate physical activity participation had no significant correlation with either global measure or the ACT subdomain.

DISCUSSION

Our participants' self-reported moderate and vigorous PA volumes of 250 and 150 minutes-per-week, respectively are higher than the recommended amounts from the U.S. Federal government.[9] However, with the exception of lower body strength, their PF measures for upper body strength and maximal aerobic fitness were near or below the 50th percentile relative to their age and gender-matched peers. This may reflect a discrepancy between the self reported PA volume and actual PA conducted on a habitual basis.[10]

In general, weak to moderately strong correlations were found between the subdomains of PSDQ-S and actual the PF measures. This finding is in agreement with previous studies conducted using young[61] and middle aged[60] adults. Depending on the physical activity or sport performed, the requirements for muscular strength, cardiovascular endurance, coordination and flexibility will vary. The fact that the ACT and the SP subdomains had the greatest number of significant correlations with the PF measures may represent their multi-dimensional nature. The SP and ACT subdomains appear to be the best self-reported measures for estimating actual levels of physical fitness.

The seated row had the greatest number of significant correlations with the subdomains of PSDQ-S and the strongest correlations of all the PF measures with the ACT, ST and Global SE measures of the PSDQ-S; it also had the second highest correlations with the FLEX, SP, and END subdomains. This result would suggest that the seated row measure might represent an individual’s perceived physical competency across several dimensions that comprise PSC. Published studies that examine the relationships between objective muscular fitness measures and self-perceived measures have used the chest press, grip strength, upper body calisthenics or isometrics as the primary modes for assessing upper body strength.[17,19] This is the first known study that used upper body pulling strength as a correlate to self-perceived physical competency in specific domains of physical health. The strongest correlation between the strength subdomain and the seated row is surprising considering that the leg press tests larger muscle groups used to perform everyday activities that require lower body strength such as lifting heavy objects from the floor, squatting, rising from a chair, jumping and climbing stairs. In a study using a similar population of college students[19] only the leg press and not the bench press strength test demonstrated a significant correlation with subdomains of the PSDQ.

The strongest correlation in the current study was found between the END subdomain and VO_2 max. Similar relationships have been found in published reports that examined self-perception of aerobic endurance capacity correlation with actual aerobic fitness measures in populations of adolescents and adults, using cycle ergometry[61] and 20-meter shuttle run test.[62] Our correlations were stronger than most reported studies and may be reflective of the fact that we tested our participants' aerobic capacity maximally, while others used submaximal tests that are terminated based on a percentage of the predicted maximal heart rate that is derived from a formula.

It was expected that the Body-Fat subdomain would have a significant positive correlation with BMI. All of the statements in the Body-Fat domain use negatively worded statements such as "my stomach is too big," which when using reversed scoring produces that positive correlation. The fact that the correlation was not stronger ($r > 0.7$) may be reflective of the BMI measurement itself. The use of the BMI as a measure of "fatness" has been scrutinized in several research reports.[72-75] The lack of accuracy of the BMI stems from over-estimation of fatness for individuals that are either extremely well-muscled such as athletes and fitness enthusiasts or under-estimation for elderly individuals who may be thin but have higher body-fat composition due to inactivity that leads to sarcopenia.[67] Since the participants in this study were young, active and moderately fit adults that exhibited normal weight to height ratios, the lack of variability of this sample may have also reduced the apparent relationship between BMI and the Body-Fat subdomain. Also, since the Body-Fat subdomain exclusively contained statements regarding adiposity, it becomes clearer as to why the correlation between it and BMI was only moderate.

The Health subdomain did not correlate with any of the physical fitness measures, supporting the work of Schneider, Dunton, and Cooper[36] who found that improvements in objectively measured cardiovascular fitness did not manifest in changes in any subdomain of the PSDQ-S for sedentary adolescent girls. Other published reports refute these findings. Warr et al[65] noted that deployed soldiers who were able to perform strength and aerobic training more frequently had higher levels of upper body strength, fat mass reduction and self-perceptions of optimal health as compared to the soldiers that trained less frequently. Similar results were found in other published studies that examined the relationships between self-perceived health status and objective measures of cardiovascular fitness.[66,71] The negatively phrased statements in the Health subdomain, such as “I am sick so often that I cannot do the things I want to do”, may not truly reflect health for a population of young adults. The statements appear to be more reflective of being ill versus being in optimal health. A divergence may exist between objective measures of physical fitness and the Health subdomain in young, healthy, and fit adults.

A meta-analysis on the effect of exercise on self-esteem [59] noted that participation in physical activities that improved fitness may have the greatest impact at a domain-specific level. This finding was not supported in our study due to the absence of strong correlations that either SE or PSC had with the PF measures or self-reported PA. This finding is contradictory to many other previous reports that found relationships among physical self-concept, self-esteem and exercise participation.[15,22,28-30,37,62,64] Only the Activity subdomain of the PSDQ-S had a moderate relationship with the self-reported vigorous physical activity measure. This finding may be reflective of the nature of the questions in the Activity domain that appear to be more representative of vigorous and not moderate physical activity, with questions phrased as: “I often exercise or do activities that make me breathe hard” or “I get exercise or activity three or four times a week that makes me huff and puff and lasts at least 30 minutes”.

CONCLUSION

In conclusion, this study provided insight to the use of a self-reported physical competency measure to determine if such a measure can function as a surrogate for objective measures of physical fitness. Based on our findings, the Activity and Sport subdomains of PSDQ-S are the best self-report measures but they should be accompanied by a seated row value to represent overall physical fitness for young adults with high levels of self-reported physical activity. Future studies should utilize multi-variate analyses to determine if these measures can predict actual physical performance in different population groups with varying levels of both self-reported and objectively measured PA levels.

CHAPTER IV

CAN AN UNSUPERVISED HOME EXERCISE PROGRAM MAINTAIN THE AEROBIC AND STRENGTH GAINS ACHIEVED DURING A 12-WEEK SUPERVISED PROGRAM FOR OBESE HISPANIC ADOLESCENTS? A CASE SERIES

ABSTRACT

The U.S. Federal government has recommended at least 60 minutes of moderate-to-vigorous-intensity physical activity each day for all children and adolescents. Hispanic girls had a prevalence rate of 33% of meeting this guideline as compared to their White counterparts with a rate of 42.6%; for Hispanic boys, the rate was 57.1% as compared to White boys with a rate of 62.1%. Low levels of physical activity in Hispanic adolescents have been cited as a serious problem that threatens the health and well-being of this population. Physical self-concept (PSC), which is defined as individual judgments made about one's physical abilities and appearance, has been implicated as a psychosocial factor that may influence exercise initiation and adherence. **Purpose:** This case series will describe the interventions and outcomes for obese Hispanic adolescents that initially completed a 12-week, supervised aerobic and strength training program as part of a previous study that examined the physical fitness, anthropometric and metabolic effects of the program. **Methods:** One male and two female adolescents, between the ages of 14-16 years of age, participated in this study. Pre and post muscular strength and cardiovascular endurance measures were compared to assess effectiveness and compliance with the unsupervised home exercise program along with a self-report of physical activity engagement. **Results:** Mean values of all the factors of the PSC were lower for all three subjects in this case report as compared to a reference population of 986 Australian high school students. Only one of the three subjects met the physical activity guidelines. Isotonic upper and lower body muscle strength and aerobic endurance were in general maintained and in some cases improved. **Conclusion:** Psychological factors such as PSC may play a role in the magnitude of self-reported physical activity and physical fitness changes from an unsupervised home exercise program.

INTRODUCTION

Physical activity has been cited as one of the most important behaviors from which all individuals can benefit to improve health and reduce the onset of many diseases such as obesity, heart disease, stroke, diabetes and certain cancers.[1] For youth from the ages of 6-17 years old, the U.S. Federal government has recommended at least 60 minutes of moderate-to-vigorous-intensity physical activity each day.[3] The overall prevalence rate for meeting these guidelines in adolescents who were in grades 9 through 12 and participated in physical activities was 28.7% in the year 2011.[4] When examined by ethnicity and gender, Hispanic girls had a prevalence rate of 33% as compared to their

White counterparts with a rate of 42.6%; for Hispanic boys, the rate was 57.1% as compared to White boys with a rate of 62.1%.[4] The low levels of physical activity in Hispanic adolescents have been cited as a serious problem that threatens the health and well-being of this population.

Because the prevalence rates of overweight and obesity are high for Hispanic adolescents, examination of the factors that may contribute to physical inactivity in this group warrants serious consideration. The reasons for the rates of non-compliance with physical activity guidelines are multi-factorial. Psychological factors such as self-esteem have been implicated as possible reasons for physical activity reduction in adolescents.[5-12] Psycho-social factors have also been shown to affect the initiation of and adherence to physical activity programs. Physical self-concept (PSC), which is defined as individual judgments made about one's physical abilities and appearance, has been implicated as one of those psychosocial factors that may influence exercise participation.[8,10,12-19]

In the realm of health promotion, PSC is an important area of study due to change as individuals age and its variance across genders, ethnicities and levels of previous physical training.[6,7,12,13,16,19-26] The proposed pathway between PSC and physical activity is not a clear one and the literature implies that the relationships between PSC and other psycho-social variables, such as exercise self-efficacy, appear to be bi-directional; as one engages in more physical activities, physical self-concept increases and as physical self-concept increases one tends to engage in more physical activities.[27]

Previous studies that examined the effects of physical activity programs on overweight and obese Hispanic adolescents have shown promising improvements in cardiovascular endurance and muscular strength, lean body mass development, and in metabolic profile changes such as reductions in systolic blood pressure, systemic inflammatory markers, low density lipoproteins, insulin resistance, and visceral and hepatic fat accumulation, even without weight loss.[28-31] Most published studies that document the effects of interventions designed to increase physical activity and reduce obesity in this population were randomized, controlled trials that utilized rigorous laboratory-based measures, standardized intervention protocols and selective recruitment of subjects to ensure high levels of internal validity. While these controls are important for establishing efficacy of exercise-based interventions to promote weight loss and improve metabolic fitness, there is a dearth of reports that determine effectiveness of health promotion programs targeting obese Hispanic adolescents under more "real world" conditions.[28-30,32]

This case series will describe the interventions and outcomes for obese adolescents of Hispanic descent that initially completed a 12-week, supervised, bi-weekly aerobic and strength training program without dieting, conducted by this investigator as part of a research study that examined the physical fitness, anthropometric and metabolic effects of the program. The primary purpose of this case series was to determine if an unsupervised home exercise program can maintain the cardiovascular and muscular strength improvements that were obtained during the previous supervised program.

METHODS

Subjects

One male (subject 1) and two female teenagers (subjects 2 and 3), between the ages of 14-16 years of age, participated in this study. The inclusion criteria were the completion of twice weekly supervised resistance and aerobic exercise sessions (conducted on separate days) for a duration of 12 weeks without any significant change in body-weight as well as being obese (Body Mass Index [BMI] $\geq$ 30 kg/m^2 or 95th percentile or greater for gender and age) and post-pubertal (Tanner IV-V). Three of the four individuals from the previous study agreed to participate in the present study. This study was approved by the Texas Woman's University Institutional Review Board.

Study Design

The design of this study was a case series. The baseline measures of physical self-concept, muscular strength and cardiovascular endurance were collected and the home exercise intervention commenced at 3, 6 and 10 weeks from the conclusion of the previous 12-week supervised exercise intervention for subjects 1, 2 and 3, respectively. The baseline muscular strength and cardiovascular endurance outcome measures were compared to those at the conclusion of this current intervention to assess effectiveness and compliance with the unsupervised home exercise program along with a self-report of sustained physical activity engagement.

Instrumentation. Measures were used to assess levels of self-reported physical activity, physical self-esteem and physical fitness. All assessments were conducted in the exercise laboratory in the order as listed below.

Self-reported physical activity. The long version of the International Physical Activity Questionnaire (IPAQ) was used to quantify the frequency, intensity and duration of physical activity engagement. The IPAQ is widely used in large scale research studies to assess physical activity levels.[43-47] It is a self-report questionnaire that can be administered in a written format and asks the participant about various types of physical activities associated with household, transportation, occupational and recreational pursuits.

Physical self-concept. The Physical Self-Description Questionnaire - Short form (PSDQ-S) was used to quantify the levels of physical self-concept. The PSDQ-S contains 11 subfactors that assess an individual's self-perceptions of competence on the following: Body-fat, Endurance/Fitness, Sports Competence, Strength, Coordination, Health, Appearance, Flexibility, Activity, Global Physical Self-Concept and Global Self-Esteem.[41,42] It has 47 questions with each question assessing a particular factor and scored from 1 (false) – 6 (true). A reverse scoring method for negatively phrased questions is used to prevent the respondents from answering the questions in a socially desirable manner. The averages were computed from the responses that pertain to each of the nine subfactors and the two global measures from the PSDQ-S. The mean values of all the factors of the PSDQ-S for these three subjects were compared to a reference population of 986 high school students from Australia that were used in another study to validate this tool. The PSDQ-S has well established reliability and validity with populations from several different cultures and age groups.[8,10,17,22,418-12]

Muscular strength. The Biodex System 3 Isokinetic Dynamometer was used to measure quadriceps and hamstring strength at an angular velocity set at 60 degrees per second. Previous studies have documented excellent test-retest and intertester reliability of the Biodex when used to evaluate peak torque and total work performed at the 60 degrees-per-second speed.[33-35] The three-repetition maximum (3-RM) strength tests were conducted using plate loaded weight machines (Quantum Fitness®). The movements tested were upper body pushing strength (chest press) and general lower extremity strength (leg press) according to a standard protocol.[36]

Aerobic fitness. The Parvomedics TrueOne® metabolic cart and a graded aerobic exercise test were used to assess maximal aerobic capacity (Modified Bruce protocol). The reliability and validity of the Parvomedics TrueOne® metabolic cart has been published in previous reports.[37-39] The Modified Bruce protocol is a widely accepted method for testing aerobic fitness that uses the same treadmill speeds and incline levels as the Bruce protocol with the addition of two initial stages at a 0% and 5% incline with the same initial speed. The test was terminated based on the criteria from the 2010 guidelines from the American College of Sports Medicine.[40]

Procedures

After the initial 12-week supervised intervention, the subjects for this study had their height, weight, and BMI data collected using the Tanita® BF-350 body composition scale (Arlington, IL). The subjects then completed the PSDQ-S questionnaire prior to the commencement of the physical fitness tests. The study began with the 3-RM strength tests followed by the Biodex isokinetic tests. The graded maximal aerobic exercise test that used the Modified Bruce Protocol followed the strength tests. At least three months later, the same test procedures were repeated. At that time the subjects completed the IPAQ questionnaire.

All three subjects were instructed in a twice-weekly resistance exercise program using adjustable sports cords that were provided to them. The exercises performed with the adjustable sports cords targeted every major muscle group. The subjects were instructed to do the resistance training program twice-per-week starting at a resistance that allowed for three sets of 10 repetitions to be completed for the following multi-joint exercises: standing chest press, back rows, military press, squats, seated latissimus pulldown. Three sets of 15 repetitions were then conducted for the following single joint exercises: seated knee extension, prone leg curls, standing calf raise, bicep curls. For exercise progression, two repetitions were added to each exercise until the subject reached three sets of 16 repetitions for the multi-joint exercises and three sets of 21 repetitions for the single joint exercises.

Once those targets were met, the resistance was increased by adding another cord and the volume was reduced to the initial levels and progressed in the same way. Abdominal crunch and back extension exercises were included in the program. They started at one set of 20 repetitions and progressed by adding sports cords and increasing the hold times for each repetition. Their resistance training program counted towards their prescribed PA. The subjects were advised to maintain the same independent aerobic home exercise program they performed in the previous intervention at intensities equal to 50-70% and 70-85% of their predicted maximum heart rate (220-age) for at least 40 minutes and 20 minutes, respectively, five days-per-week on the days they did not execute the resistance training program. The subjects also viewed an eight-minute physical activity education video produced by the Centers of Disease Control and Prevention that outlines the frequency and intensity recommendations for aerobic exercise.[50] The subjects received an exercise log to document the type and duration of the exercise performed on a daily basis over the 12-week period that began after the baseline measures and home exercise program training session was conducted. Each subject received email contact at least once-per-month to answer any questions about the exercise program.

Data Analysis

Descriptive analyses were utilized for each subject to compare pre and post-intervention levels of muscular strength and cardiovascular endurance. Data from the previous supervised exercise study were included to assess absolute change over the two different exercise periods. Relative muscular strength was evaluated by dividing each subject’s 3-RM load by his or her body weight and multiplied by 100 to obtain a normalized measure. Subjects who reached the highest obtainable load on the machine or were unable to achieve a 3-RM at the next incrementally higher load had their 3-RM load amounts estimated using the Brzycki Formula.[51,52] The isokinetic data were normalized by averaging the peak torque-per-bodyweight percentages for the left and right sides for both the quadriceps and hamstrings at the 60-degree-per-second speed.

Physical self-concept was assessed at baseline of the unsupervised program by calculating the mean and standard deviation of each of the nine subfactors and the two global factors of the PSDQ-S for all three subjects. Levels of compliance with the PA recommendations were assessed by calculating the total number of minutes of moderate and vigorous physical activities completed per week as reported on the IPAQ.

RESULTS

The mean values of all the factors of the PSDQ-S were lower for all three subjects in this case report as compared to the reference population. The two global factors of self-esteem and overall physical self-concept for subjects 2 and 3 were lower than the reference group. Subjects 1 and 3 displayed levels of the strength factor of PSC that were lower than the reference group, but subject 2 had a 20% higher perception of strength than the reference group. All three subjects had lower levels of the endurance factor of the PSC than the reference group. The Body-Fat factor of the PSC revealed a lower level than the reference group for our male subject and higher levels as compared to the reference group for female subjects 2 and 3. Subjects 1, 2 and 3 had respective mean values of 4.75, 2.00 and 2.25 on the Activity factor of the PSDQ as compared to the reference group's mean value of 4.26. The average volume of moderate and vigorous physical activity reported by subjects 1, 2 and 3 were 180/150 min, 0/40 min, and 15/0 min, respectively. Only one of the three subjects met the physical activity guidelines discussed with them before the home-based program.

The pre and post measures of bodyweight, BMI, maximal aerobic capacity, relative isotonic and isokinetic strength normalized by bodyweight are presented in Figures 4.1 to 4.7

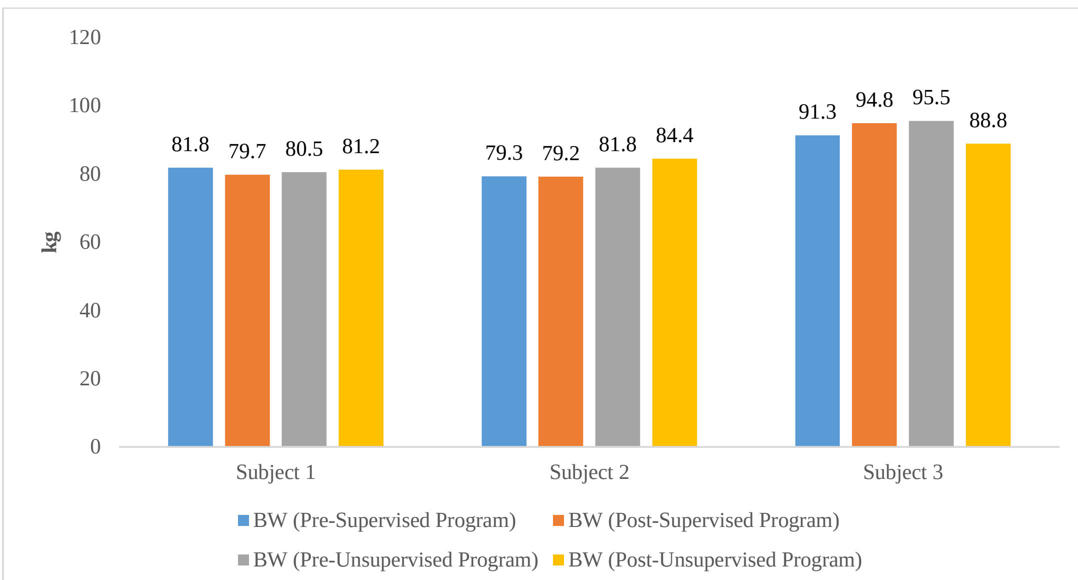

Figure 4.1: Pre-Post Intervention Changes in Body Weight for Supervised and Unsupervised Program

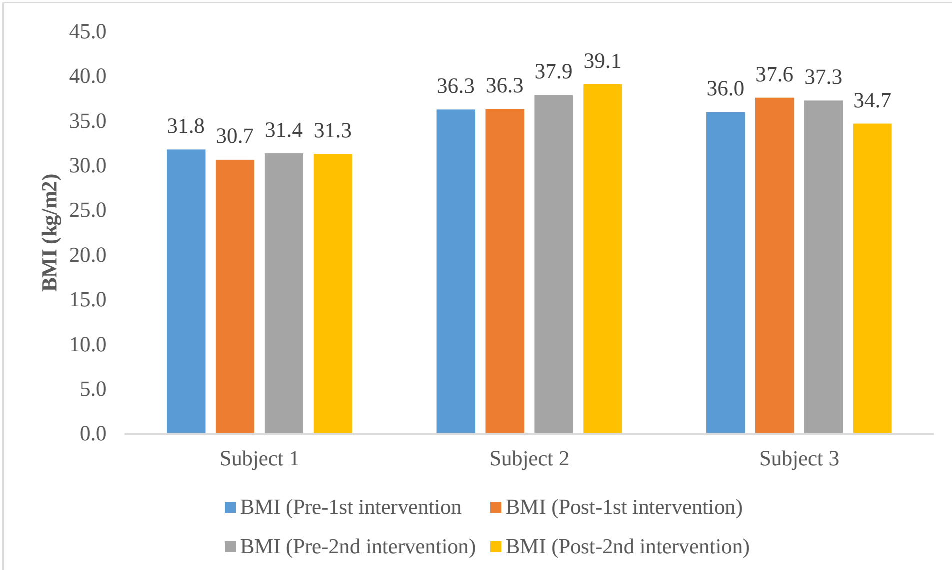

Figure 4.2: Pre-Post Intervention Changes in BMI for Supervised and Unsupervised Program

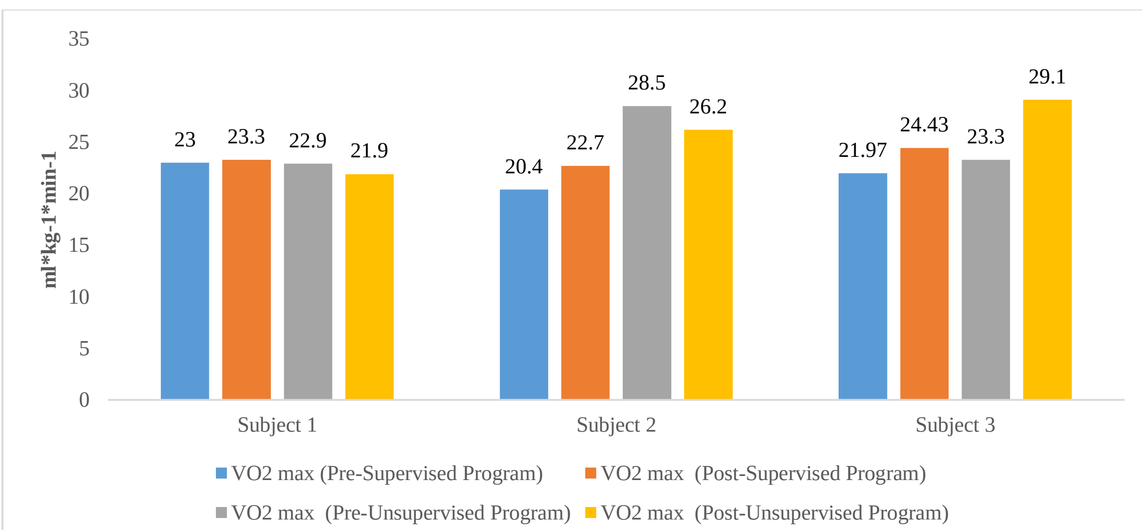

Figure 4.3: Pre-Post Intervention Changes in VO^2 max for Supervised and Unsupervised Program

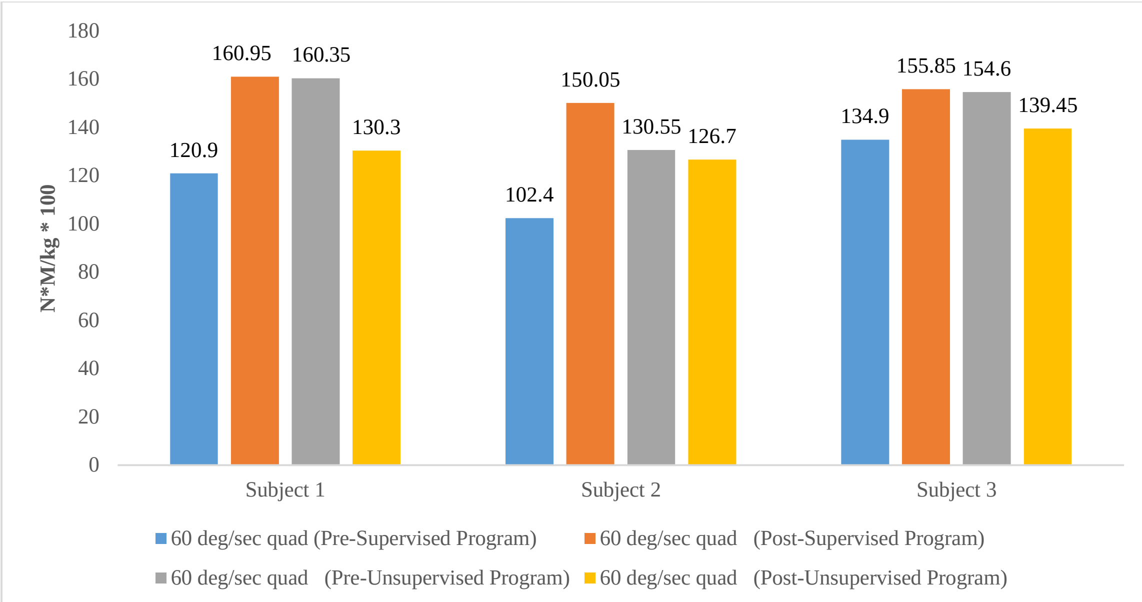

Figure 4.4: Pre-Post Intervention Changes in Normalized Quadriceps Peak Torque at 60 deg/sec for Supervised and Unsupervised Program

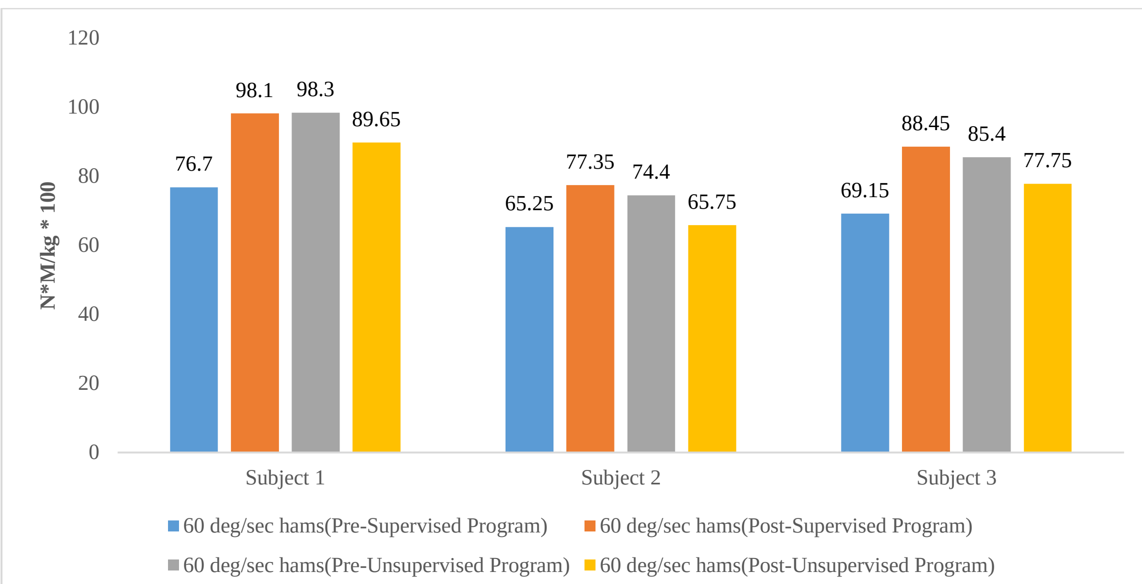

Figure 4.5: Pre-Post Intervention Changes in Normalized Hamstrings Peak Torque at 60 deg/sec for Supervised and Unsupervised Program

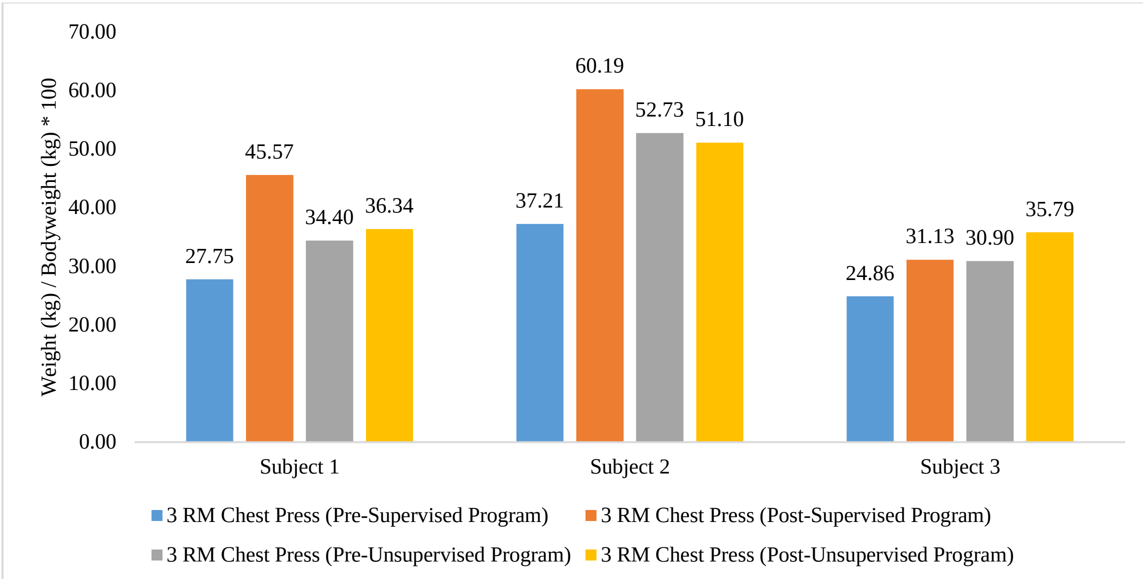

Figure 4.6: Pre-Post Intervention Changes in Normalized 3-RM Chest Press Load for Supervised and Unsupervised Program

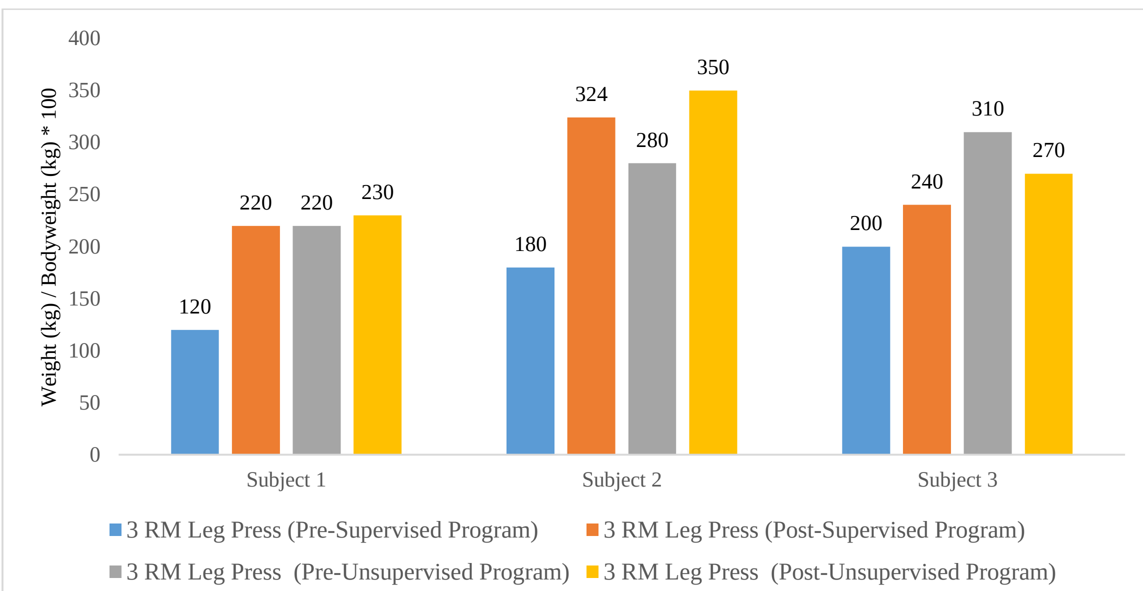

Figure 4.7: Pre-Post Intervention Changes in Normalized 3-RM Leg Press for Supervised and Unsupervised Program

DISCUSSION

In general, our subjects reported lower values of the subfactors of the PDSQ-S than the reference population of high school students from Australia used to validate the instrument, which may reflect cultural differences. PSC has been shown in numerous studies to be perceived differently across different cultures and levels of physical activity engagement.[8,17,22,41,59-61] Self-perceptions of physical attributes such as strength, endurance, body-fat, and appearance, and their influence on physical activity participation have not been studied extensively in Hispanic populations.

A study published by Monroe et al[21] sought to determine the relationships between self-perceived measures of fitness using the PSDQ and objective fitness measures. They found that the endurance and strength factors of the PSDQ had only modest correlations with VO_2 max and abdominal muscle endurance tests (curl ups). Our sample of subjects was too small to compute correlations, but it appears that our subjects' physical self-concept levels do not correspond to their performance changes at the conclusion of unsupervised program. Subject 2 had the highest level of PSC for the Body-Fat factor and gained more weight during the unsupervised program than the other two subjects. Subject 3 displayed weight loss along with a higher perception of body-fat than subject 2. These responses support the findings of previous studies that revealed that adolescent girls that believe that they are "too fat" tend to engage in behaviors to promote weight loss.[62,63]

The wash-out period between the assessments made at baseline of the unsupervised program and at the conclusion of the supervised program ranged from three to ten weeks due to variations in school schedules and other participant commitments. The six-week washout period for our male subject revealed a larger baseline reduction in upper body pushing strength as compared to our female subject 2 who had a longer washout period (10 weeks) with a smaller strength decrement. The literature shows that muscular and cardiovascular fitness improvements can be maintained for several weeks for previously sedentary individuals that undergo an exercise regimen followed by a significant reduction in training frequency.[40] This was evident among our three subjects who showed relatively small decrements in muscular strength and cardiovascular endurance. In some instances, these subjects demonstrated improvements for some of the baseline measures of the unsupervised program as compared to the measures at the conclusion of the supervised program.

There have been many published interventions designed to increase physical activity and physical fitness for adolescents, with most of them conducted in school-based settings. Maximal aerobic capacity expressed in relative terms (VO_2 max) is often used as one of the outcome measures. A systematic review that examined the physiological effects of school-based interventions revealed a range of VO_2 max improvements that were from 1.6 to 3.7 ml/kg*minute.[53] In general, the outcomes for our subjects did not uniformly support these results. Subjects 1 and 2 essentially maintained their VO_2 max while subject 3 had a large improvement (25%) at the conclusion of the unsupervised program from baseline. Previous published reports on interventions aimed at increasing physical activity levels in children and adolescents have mixed results that are dependent on the setting in which were conducted. In a systematic review by Dobbins et al,[53] school based physical activity programs did not result in any significant increase in participation in moderate and vigorous physical activities. Clemmens and Hayman[54] noted in their systematic review of school-based physical activity programs that these programs can be beneficial for improving physical activity levels in children and adolescents if they have multiple components to them. Some of the published home-based physical activity interventions have reported improvements in time spent performing moderate and vigorous physical activities, via number of steps per day and reduction in sedentary behaviors.[55] At the conclusion of the unsupervised program, only subject 1 came close to meeting the Federal Physical Activity recommendations. The other two subjects lacked almost 400 minutes per week of recommended moderate to vigorous physical activity.

The low self-reported physical activity levels of subjects 2 and 3 would suggest a much smaller expected change in aerobic capacity and muscle force generation than what actually occurred. The discrepancy between self-reported physical activity and physical fitness measures may be due to the difficult task of physical activity recall. Complex processes are required for a respondent to accurately report physical activity levels; one such process is the Flexible Processing Model.[1] This model involves the tasks of: memory retrieval, comprehension of the question, decisions about how to answer the question, recall methods using estimation or enumeration and finally a response. Deficits in any one of these aspects of the Flexible Processing Model can lead to highly erroneous estimates of physical activity behavior.[57]

All three subjects at baseline of the unsupervised program had lower hamstring and quadricep isokinetic values as compared to the conclusion of the supervised program. None of the subjects improved in relative strength at the conclusion of unsupervised program despite the large improvements that were made when supervised. These subjects were previously sedentary and thus had a higher potential to improve in muscular strength with the supervised exercise program. The subjects in the unsupervised program started in a more “trained” state with a lower potential for improvement. The training program with adjustable resistance bands was designed to be progressive in nature by adding resistance to the band set once a set amount of volume was achieved for each exercise, so the lack of overall improvement is surprising. There was no monitoring of the actual usage of the band set to determine adherence to the instructions, however.

Despite the subjects’ inability to maintain their lower extremity strength when it was assessed isokinetically, the normalized isotonic strength assessments revealed improvements in the leg press from baseline to conclusion of the unsupervised program for subjects 1 and 2. The 3-RM chest press measure revealed improvements for subjects 1 and 3. Subject 2 exhibited a slight decrease. Compared to a randomized controlled trial (RCT) that examined the effects of a resistance exercise and nutritional program on adiposity, inflammation and insulin resistance for obese Latino and African-American adolescents, with mean increases in relative leg press (24.1%) and chest press (29.7%) loads lifted as compared to baseline,[58] our percentage changes after the supervised program were similar to this study.

Very few published studies exist that document the effects of home-based versus supervised fitness programs for Hispanic individuals, especially when used to promote favorable lifestyle and fitness changes, but our findings demonstrate that large strength improvements may be more difficult to achieve with an independent home exercise program if the program is not supervised to ensure that it is progressed at regular intervals.[67-71] All three subjects were given a calendar to log their physical activities performed each day to promote self-regulation, which is one of the key tenets of the social cognitive theories of change, but only one of the three subjects completed the log. This leads to the possibility that more frequent follow-up sessions via in-person, phone or email contact may have improved compliance in this area.

The PSDQ-S Activity subfactor scores for subjects 2 and 3 (2.00 and 2.25, respectively), both females, were lower than the reference group mean (4.26). Physical activity volumes for girls tend to decline beginning in late childhood through adolescence regardless of race or ethnicity, but girls of Hispanic descent had the highest 2011 prevalence rates of not meeting the Federal Physical Activity Guidelines amongst all adolescent girls.[4] These two subjects also followed this trend. Global PSC tends to be lower for girls than boys, as was demonstrated in this case series, and it has been implicated as one of the factors that explains the lower levels of physical activities for adolescent girls as compared to boys.[7,12,19,65]

Future studies should consider the validation of instruments that measure PSC for adolescent Hispanic individuals with varied physical activity levels. Studies that utilize larger sample sizes and measure PSC before and after an intervention designed to promote unsupervised physical activity would also determine if relationships exist between factors of PSC and levels of PA, especially if objective measures such as accelerometry are used.

In conclusion, isotonic upper and lower body muscle strength and aerobic endurance can be maintained and in some cases, improved with an unsupervised home resistance training and aerobic exercise program. Psychological factors such as PSC may play a role in the magnitude of self-reported PA and the energy expended from them.

CHAPTER V

THE EFFECTS OF A GROUP EXERCISE PROGRAM ON THE WEIGHT MANAGEMENT OF OBESE WOMEN IN A PUBLICLY FUNDED HEALTHCARE SYSTEM

ABSTRACT

African-American and Hispanic women have the highest prevalence rates of obesity and physical inactivity by gender and ethnicity. Supervised group exercise programs have been utilized as effective and efficient interventions to promote physical activity. **Objectives:** to determine if there is a difference in the weight loss between a 12-week supervised group exercise program with educational reinforcement (Ex + Ed) and a 16-week liquid diet and education program (Diet); can the Ex + Ed program alter self-reported physical activity (PA), physical fitness and physical self-worth (PSW). **Design:** quasi-experimental study utilizing samples of convenience. **Setting:** hospital based rehabilitation center. **Participants:** Forty-eight minority women (n = 23 for Ex + Ed group) from low socioeconomic backgrounds that are obese. **Main Outcomes:** bodyweight measured at 12- weeks for both groups; muscular strength, cardiovascular endurance, PA and PSW at baseline and conclusion of the Ex + Ed group only. **Results:** significant between-subject reductions in weight was found for the Diet group only ($p < .001$). Significant within-subject improvements for the Ex + Ed group for cardiovascular endurance ($p < .005$), lower and upper body strength ($p < .006$ and $.042$, respectively),

PSW ($p < .0005$) and moderate PA ($p < .009$). **Conclusion:** as a sole intervention, exercise was inferior to diet for weight loss, however, this study demonstrated that improvements in levels of physical fitness, PSW and PA can be made despite the absence of weight loss

INTRODUCTION

Obesity is a national epidemic that threatens the health and well-being of approximately one third of American adults in this country. It is the second leading cause of preventable death in America with it contributing to the development of Type II diabetes, osteoarthritis, cardiovascular diseases and cancers of the breast and digestive system.[1-4] The obesity prevalence rate is elevated in certain gender, ethnic and socioeconomic groups.[5] Among these groups, African-American and Hispanic women have the highest prevalence rates of obesity by gender and ethnicity, at 58.6% and 40.7%, respectively.[2,5,6] Overall, there have been significant increases in the rates of obesity across all socioeconomic levels from the years 1998-2004 and 2005-2008.[3,6,7] When prevalence rates of obesity are compared across socioeconomic levels, significant contrasts can be made for both gender and ethnic characteristics . For women across all ethnic backgrounds, the rates of obesity increased as poverty-to-income ratios decreased, with rates at 29.0% and 42.0% for women who were at greater than 350% and below 130% of the poverty-to-income ratio, respectively.[5]

While it is important to consider the trends of rising obesity rates in the U.S. as a public health problem, it is just as important to consider the relatively low rates of physical activity (PA) to promote health and fitness as another factor involved in the development of the same maladies that are suggested as being due to obesity.[8] Low levels of physical fitness have been shown to confound the effects that obesity has on the development of many of these health disorders. Previous studies have shown that the ill-effects of obesity are attenuated when physical fitness levels are improved.[77-79] In 2010, only 20.7% of the adults who responded to the National Centers for Health Statistics survey met both the aerobic and strengthening guidelines, and 49.5% of adults didn't meet either the aerobic or strengthening guidelines.[9] The rates of non-compliance with both PA guidelines were higher for women (54.0%) than men (43.8%). When examined by race, non-Hispanic Whites had the lowest levels of non-compliance at 45% followed by non-Hispanic Blacks (58.4%) and Hispanics (60.2%). The rates of non-compliance by poverty level revealed that individuals who were at 400% or greater than their respective poverty levels had the lowest rates of non-compliance (36.9%). These rates of non-compliance progressively increased at each descending poverty level. When the factors of race and poverty levels were examined together, the differences in non-compliance by race were attenuated.[7] Lack of understanding of the importance of regular PA in the prevention of disease, and community role models that can promote the beneficial effects of physical exercise as well as access to health care professionals who can guide individuals in the process of changing lifestyle behaviors are cited as reasons why individuals from underserved communities are often inactive compared to others.[10,11] Lack of safe neighborhood walking areas, decreased leisure time due to extended paid work hours, and a cultural avoidance of voluntary PA due to historical and economic situations were also reasons for a lack of PA participation by the underserved.[10]

In 2005 there were 54.4 million (18.7%) persons living in the United States with a disability.[12] Women had a higher prevalence of any type of disability than men (20.1% vs. 17.3%).[12] When examined by gender and race, African-American women had the highest prevalence rates of severe disability (15.4%), followed by white (13.8%) and Hispanic (10.0%) women.[12] When socioeconomic factors were examined, there was a trend of increased disability severity with increasing levels of poverty. Individuals from a minority and low socioeconomic background that have a physical impairment or disability have even lower rates of PA participation, which makes this population group particularly vulnerable to the maladaptive effects of physical inactivity. Rimmer et al[13] studied 50 African-American women that had a disability to assess their habitual PA patterns. They found that only 50% of them (via self-report) were on an exercise regimen, with only 14% exercising at least three days a week and 54% exercising at a moderate-to-vigorous intensity. Only 8% were involved in any leisure time PA. Taylor WC et al[24] noted that more research is needed to understand the PA patterns of individuals from low-income, ethnic minority backgrounds and populations that are disabled.

The literature cites psycho-social factors, such as self-efficacy and stage of change, as determinants of PA.[14-16] Physical self-concept is a psycho-social construct that utilizes an individual's judgment about how he/she perceives physical self. Harter[17] noted that individuals will often adhere to activities in which they perceive to have attained a level of mastery and competence. Physical self-concept (PSC) has been proposed to influence the adoption and adherence of regular PA programs based on these perceptions of competency and mastery. The proposed pathway between PSC and PA is not a clear one and the literature implies that the relationships between PSC and other psycho-social variables are bi-directional; as one engages in more physical activities, PSC increases, and as PSC increases, one's PA levels increase.[18-20]

Physical self-esteem (PSE) involves the same sub-domains as PSC but involves the *feelings* of how individuals like or dislike their performance on the sub-domains of Strength, Endurance, Appearance and Athletic/Sport Competence.[21] Physical self-esteem and physical self-worth (PSW) are terms that are used interchangeably. Previous literature by Fox and Corbin[22] has shown that PSC exerts its effects on general self-esteem via a mediated relationship with PSW. The relationship between PSC and overall self-esteem was described by Sonstroem and Morgan[23] in 1989 as the "Exercise and Self-Esteem model." In their hierarchical model, which posited general self-esteem at the apex, they noted that PSW directly influences general self-esteem. Many of the theories that employ psycho-social constructs such as PSW must be tested to determine if they have predictive or mediating effects on PA in order for health promotion programs to be successful for particular population groups.

The National Heart Lung and Blood Institute (NHLBI)[25] strongly recommends that successful weight loss programs have a combination of PA, reduced calorie diet and lifestyle management components with moderate evidence for adjunctive support of behaviorally based therapy components. The NHLBI has documented that weight loss programs typically yield a 10% loss in body weight over a 6-month period. A 5% weight loss has been deemed clinically significant for reducing the metabolic derangements such as hyperglycemia, hyperlipidemia, insulin resistance and hypertension due to excess body fat.[25,76] Weight loss is a difficult task for many, but minority women, especially those from lower socioeconomic backgrounds, have, in general, less success than Caucasian women and women from higher socioeconomic backgrounds.[10,26-28] Supervised group exercise programs have been utilized in studies as an effective way to provide an intervention to multiple people at a given time. These studies have reported significant improvements in weight reduction and participation in PA levels that promote positive changes in overall health.[80-82] None of these studies focused on the effects of group exercise programs exclusively for women from minority ethnic backgrounds and low socioeconomic levels with a neuromuscular impairment and/or disability.

The primary purpose of this study was to determine if there is a difference in the weight loss between two groups of minority, obese women: those that participated in a 12-week supervised group exercise program with educational reinforcement (Ex + Ed) and had neuromuscular impairment, chronic medical condition or disability and those who received an education and diet program of replacement meals only (Diet). Participants came from a publicly funded healthcare system. The primary hypothesis was that obese women who received the Ex + Ed program would achieve greater weight loss than women who received the Diet program alone. The secondary purpose was to investigate the effectiveness of the Ex + Ed intervention for changing muscular strength, functional endurance, and PSW. The secondary hypothesis is that muscular strength, functional endurance, and PSW would increase at the completion of the 12-week group Ex + Ed program.

METHODS

Participants

A convenience sample of English speaking women that met the following inclusion criteria: BMI $\geq$ 30 kg/m^2; between the ages of 18 and 70 years; and diagnosis of a chronic but stable medical condition, neuromuscular impairment or functional disability were selected. The exclusion criteria were: any reported orthopedic or neurological problems that would preclude safe participation in a structured resistance training/aerobic exercise program; reported unstable cardiovascular or metabolic disease (with or without medications), or pregnancy. Participants were referred to the Ex + Ed intervention from physical therapists and physicians from the healthcare system where the participant received rehabilitative and medical services.

The comparison (Diet) group was comprised of women who underwent a diet program that followed six educational sessions on weight management. The Diet group received meal replacement shakes that replaced two meals per day, with monthly instruction by the physician and health educator on the consumption of healthy, balanced, reduced calorie meals once per day and snacks. The participants in the Diet group were selected as a sample of convenience via review of electronic medical records (EMR) if they remained in this intervention for at least 3 months and had a baseline and 3-month bodyweight and BMI measure recorded as part of their clinical exam.

Instrumentation. Self-report measures were used to assess levels of PA, physical self-worth and physical fitness. All assessments for the exercise group were conducted in the exercise laboratory in the order as listed below.

Self-reported physical activity. The International PA Questionnaire short from (IPAQ-S) was completed by the participants to document the self-reported volume of PA conducted over the previous 7-days. The IPAQ is widely used in large scale research studies to assess PA levels. Previous studies have documented the IPAQ's test-rest reliability and concurrent/criterion validity to be moderate.[29-33] The intensity, frequency and duration of each type of PA can be quantified, summed and expressed as the number of minutes spent performing activities at a particular intensity. Moderate PA is defined as PA with an energy expenditure of 4 METs.[29] Vigorous PA is defined as PA with an energy expenditure of 8 METs.[29]

Physical self-worth. Physical self-worth (PSW) was measured by the PSW global domain of the Physical Self Perception Profile (PSPP). The PSPP measures the multi-dimensionality of physical self-concept into four distinct subdomains and one global domain of PSW. The PSPP has been used to measure physical self-concept for adults and children of varying body weights and levels of physical ability and activity.[22,34-36]

Physical fitness measures were performed to assess levels of muscular strength and functional cardiovascular endurance. These measures commenced in the order as described below.

Anthropometrics and vital signs. Height, weight and BMI for the Ex + Ed participants were read from the Health O Meter (model 600KL) digital bodyweight scale and stadiometer (Alsip, IL). For the Diet participants, their weight and height were measured using a standard medical scale with an attached stadiometer. These values were used to calculate the BMI of the Diet participants. Each Ex + Ed participant's resting blood pressure and heart rate were assessed via an electronic sphygmomanometer.

Muscular strength. Muscular strength was assessed using the average of three trials for three different maximal isometric tests: standing upper extremity (UE) push and pull and squat-lift measured in foot-pounds (ft-lbs). The BTE Simulator II™ (Hanover, MD) dynamometer was used to test maximal ability to push and pull with the upper extremities and the squat and pull with the lower extremities isometrically. Isometric strength tests using a stationary dynamometer have been used in previous studies as reliable and valid measures of static muscle strength.[37-40]

The Jamar® grip dynamometer (Sammons Preston Roylan, Chicago, IL) was used to measure isometric grip strength in kilograms (kg). The average of six trials (three for each hand) was used for data analysis. Isometric grip strength has been used as a valid and reliable correlate of total body strength in previous research.[41-48]

Functional cardiovascular endurance. To evaluate functional endurance, the six-minute walk test (6 MWT) was used.[49] The distance walked in meters was used to measure this fitness parameter. This test has been used in the obese population in other studies and is a reliable measure of cardiovascular endurance.[50,51,52]

Intervention

The Ex + Ed intervention was 12 weeks in duration and consisted of bi-weekly group exercise sessions. Each exercise session lasted 30-45 minutes and was preceded by a 45-minute educational session on a diet or PA topic conducted by a licensed dietician or physical therapist. Participants had their resting blood pressure and heart rate taken before each group exercise session. Ratings of perceived exertion on the Borg CR-10 Scale were used as a target intensity measure during the exercise intervention to promote an exercise intensity of moderate or greater.[53,54] Subjects were instructed to exercise intensely enough to achieve a level of a “3” or greater on the CR-10 scale, which is an exertion level of moderate or greater. Every participant performed the same exercise type regardless of level, but the exercise intensity was varied or modified to reflect the needs of the individual. The participants were encouraged to accumulate at least 150 minutes per week of physical activities that were at least of moderate intensity in addition to the bi-weekly group exercise sessions.[55]

All participants were asked to fill out a PA log that tracked the frequency, duration and intensity of the physical activities they performed each day. The participants were asked to use the Borg CR-10 RPE scale to rate their level of exertion during each moderately hard or vigorous PA they performed during the day.

Research Procedures

Each participant in the Ex + Ed intervention received a comprehensive evaluation by a physical therapist who served as the evaluator for all outcome measurements and screened eligible individuals to determine if they were suitable for the exercise intervention. If the individual agreed to participate in the study, then the data produced in the initial and subsequent evaluations were collected and analyzed by this evaluator who was not involved in the delivery of the intervention. This evaluator conducted all study-related assessments on the participants immediately before, after and 3 months from the completion of the 12-week Ex + Ed intervention.

Data Analysis. Means and standard deviations were collected and compiled. In addition, the co-morbidities that each subject possessed were accounted for by placing each individual disease into seven distinct categories: musculoskeletal diseases of the spine / extremities (ie: degenerative disc disease, arthritis of the knee, etc.), neurological diseases (cerebrovascular accident, Parkinson's, etc.), cardiorespiratory (asthma, myocardial infarction, congestive heart failure), metabolic (hypothyroidism, Type II diabetes, hypertension, etc.), impaired function (general weakness, deconditioning, gait impairments, etc.), mental disorders (bi-polar, depression, schizophrenia). The median number of co-morbidities was calculated and compared for both groups at baseline. All statistical procedures were conducted using SPSS® version 21 for Windows (IBM®, Inc., Chicago, IL). The level of significance was set at .05 for the analyses.

A mixed model 2 x 2 ANOVA, using groups (Ex + Ed and Diet) as the “between” factor and time (pre and post intervention) as the “repeated” factor, was used to assess differences in the primary outcome variable bodyweight (kg), with effect sizes also calculated. Post hoc tests were conducted as needed using paired t-tests to analyze within-subjects differences and independent t-tests were used to examine between-group differences. Bonferroni adjustments were utilized as needed for post-hoc analyses. Paired t-tests were used to determine if there were significant pre to post-intervention improvements in the secondary outcome variables: PSW, self-reported PA, muscular strength components and functional endurance for the participants in the Ex + Ed group.

RESULTS

Seventy-seven women enrolled in the Ex + Ed intervention and completed the baseline assessments. Twenty-three women completed the assessments at the conclusion of the 12-week intervention, resulting in a 71.1% attrition rate. The various reasons stated by the participants not completing the intervention are depicted in Figure 5.1.

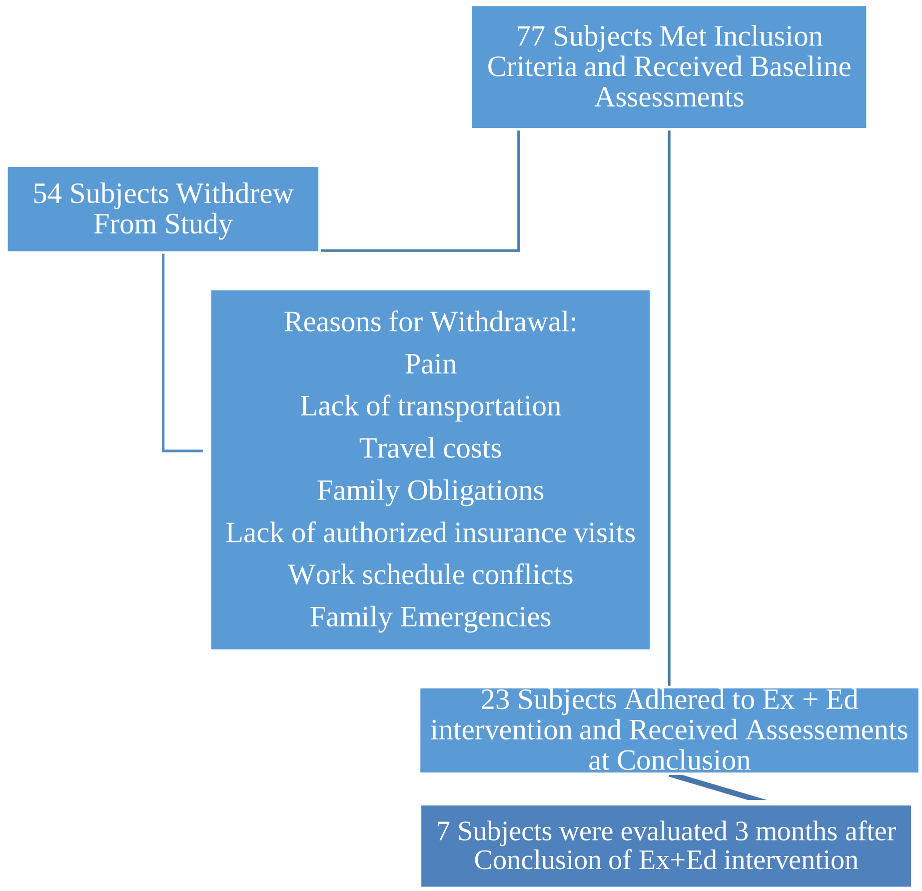

Figure 5.1. Subject Entry and Withdrawal from Intervention

Twenty-five women from the Diet group had baseline and 3-month recordings of their body weight and BMI. Baseline comparisons of both groups are presented in Table 5.1. At baseline, there were no differences in body weight between the women in Ex + Ed and Diet interventions. The women in the Diet group were significantly younger, had fewer co-morbidities and tended to be of Hispanic ethnicity. The ethnic make-up of the women in the Ex + Ed group was predominately African-American.

Table 5.1. Baseline Characteristics of Participants in Ex + Ed and Diet Groups

	Ex + Ed	**Diet Only**	***p-value***
n	23	25	
Height (cm)	164.7 (7.21)	161.8 (7.27)	0.179*
Baseline weight (kg)	112.8 (21.00)	101.2 (20.56)	0.058*
Baseline BMI (kg/m²)	41.7 (7.35)	38.6 (6.98)	0.147*
Mean no. of sessions completed by Ex + Ed subjects (with completion data)	19.91 (4.51)		
Mean no. of sessions completed by all Ex + Ed subjects (with and without completion data)	10.79 (7.79)		
Age (years)	55.1 (12.27)	47.08 (11.46)	0.024*
Median number of co-morbid disease categories present	3.00	1	< .001¥
Race:			
African-American	22	8	< .001†
Hispanic	1	14	< .001†
Caucasian	0	3	< .001†

*Denotes analysis by independent t-test; † Denotes analysis by Chi-square; ¥ Denotes analysis by Mann Whitney U test

The results of the 2 x 2 mixed model ANOVA revealed a significant group x time interaction (p = .02) (Figure 5.2). The Diet group lost more weight at 12 weeks from the start of their intervention compared to the Ex + Ed group, with an effect size (Cohen's d) of .11 as compared to .02. The Diet group had a mean decrease in body weight of approximately 2.31 kg as compared to the Ex + Ed group with a mean decrease of 0.43 kg. Post hoc analysis with alpha set at .025 revealed a significant within-participants' effect for weight loss at the conclusion of the Diet intervention (p < .001).

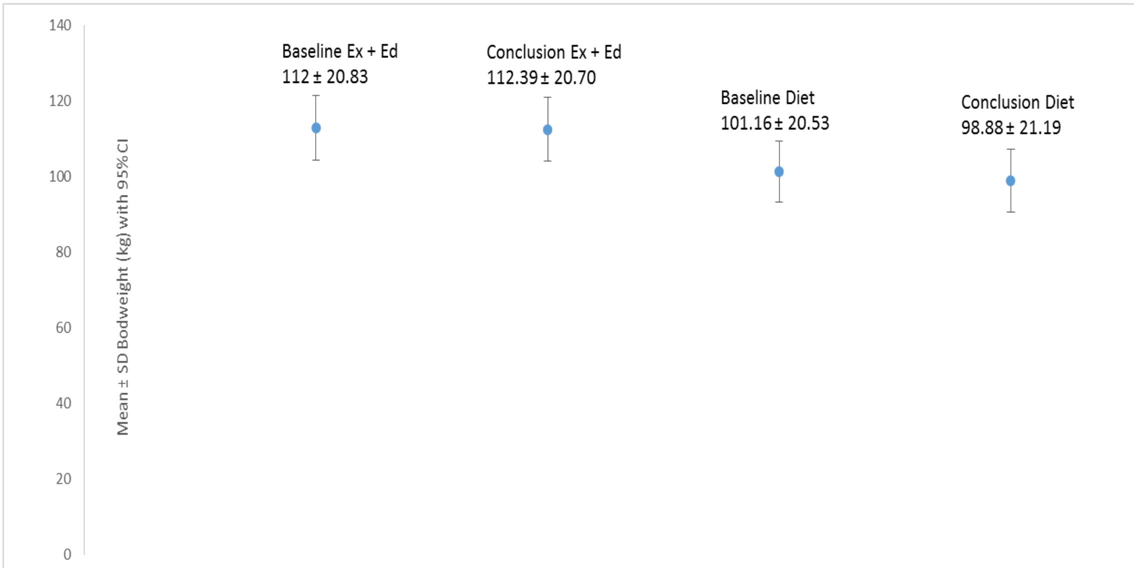

Figure 5.2. Comparison of Weight Loss (kg) for Ex + Ed and Diet Interventions at Baseline and Conclusion

The Ex + Ed intervention group results are presented in Table 5.3. The square root transformation of the self-reported moderate and vigorous PA measure was performed to meet normality assumptions. Only the self-reported vigorous PA measure met this assumption after transformation. Significant improvements were made in the distance walked in six minutes and isometric load lifted for the squat and grip strength averages of both sides (Table 5.2). The self-reported measures of PSW and moderate PA improved significantly from baseline (Table 5.2).

Table 5.2 Levels of Muscular Strength, Functional Endurance, Physical Self-Worth and Self-Reported PA at Baseline and Conclusion of the 12-week Ex + Ed Intervention

	Baseline	**Conclusion**	***p-value* (one-tail)**
	Mean (SD)	Mean (SD)	
Bodyweight (kg)	112.81 (21.03)	112.38 (20.68)	0.27
BMI (kg/m2)	41.7 (7.35)	41.94 (8.04)	0.33
6 MWT (meters)	337.51 (104.11)	379.28 (95.80)	0.005*
Squat (ft-lbs)	75.58 (27.92)	92.22 (23.06)	0.006*
UE push (ft-lbs)	81.78 (27.18)	91.53 (18.06)	0.042*
UE pull (ft-lbs)	78.33 (20.28)	82.41 (16.00)	0.21
Grip strength (kg)	24.59 (5.94)	27.22 (6.09)	0.05
Physical Self Worth	13.18 (5.00)	15.82 (5.03)	0.0005*
Vigorous PA (minutes/week)	101.09 (101.09)	121.74 (132.86)	0.27
Moderate PA (minutes/week)	148.86 (169.19)	317 (521.16)	0.009*

* denotes significance at $p < .05$

DISCUSSION

The results of this study are similar to previous ones that compare weight loss effects between groups that engage in an intervention of diet only vs. exercise only. Miller et al[57] noted in meta-analysis of 493 published weight loss interventions from the previous 25 years that the mean weight loss was 10.7 ± 0.5 kg for diet only and 2.9 ± 0.4 kg for exercise only programs. Another systematic review conducted by Fitzgibbon et al[10] found that in two prominent multicenter trials the mean weight loss for African-American women was 4.7 kg and 4.1 kg for the Diabetes Prevention Program (DPP) and Weight Loss Maintenance (WLM) trials, respectively. It is important to note that the DPP and WLM trials were over five months in duration, as compared to 12 weeks for both interventions in our study. They combined diet, PA and behavioral management sessions. Our study population had a combination of extensive co-morbidities and neuromuscular impairments, and they had been managed by physicians or physical therapists for these disorders. Participants with this history might have lower exercise tolerance in general, as well as lower capacity to expend calories through exercise.

Weight loss can be achieved easier by controlling caloric intake versus increasing caloric expenditure with exercise. PA accounts for approximately 20-30% of total caloric expenditure and resting metabolism accounts for a much larger percentage of total caloric expenditure.[58,59] Relative to resting metabolic activities, energy expenditures via exercise represent a very small proportion of total energy expenditure. As individuals engage in weight loss activities, physiological changes occur that can lower basal metabolic rate.[58,59] It is important to recognize the behavioral compensations that often occur as individuals attempt to lose weight. These compensations diminish the effects of interventions that promote weight loss and in some cases they can promote weight gain. As individuals volitionally increase PA to expend calories, there may be a deliberate reduction of incidental PA required to do everyday tasks that results in a reduction in total caloric expenditures or an increased caloric intake.[60,61]

Neither group in this study achieved the clinically significant weight loss of 5% of their initial body weight at 12 weeks. Both groups received dietary and exercise education, but we did not control or measure caloric intake of the participants in the Ex + Ed group and the PA levels in the Diet group.

Despite the lack of a significant weight loss effect for the participants of the Ex + Ed intervention, favorable improvements in physical fitness, self-reported PA and physical self-worth were found. Distance walked during the 6 MWT has been shown to be reflective of functional cardiovascular endurance for individuals across several clinical populations.[50-52] Improvements in cardiovascular endurance may be more important for reductions in morbidity and mortality than weight loss alone.[77-79, 83] The mean increase in muscular fitness is an important finding because improvements in muscular strength and fitness have been shown to prevent frailty, improve insulin sensitivity and are associated with a reduction in total mortality for older individuals.[46, 67-72] These favorable changes in fitness despite the absence of weight loss supports previous studies that suggest an obese individual can become healthier with a reduced risk of morbidity and mortality due to improved levels of fitness.[77,79,83] This may be an important finding for healthcare professionals that work with obese individuals, so that they can tailor the health promotion messages to enhance physical fitness, which may be more attainable than significant reductions in weight.

Physical self-worth, an important psychosocial factor for the adoption and maintenance of an exercise program, significantly improved for the Ex + Ed intervention group. The mean increase was only 2.64 points and, despite statistical significance, it is unclear if this improvement represents an important change for individuals that embark on an exercise program to promote weight loss. We found that self-reported moderate PA improved significantly. These findings parallel the increase in physical self-worth but it is difficult to establish causality. It is important to recognize limitations when interpreting these results. The fact that just one dimension of physical self-concept, physical self-worth, was measured limits generalizability of these findings to physical self-worth. Fox and Corbin[22] noted that other subfactors of physical self-esteem affect general self-esteem. It is possible that other subfactors of physical self-esteem may have improved to a greater amount than physical self-worth and these subfactors may have influenced PA levels. We assessed PA via self-report, which is another limitation of this study. Numerous studies have pointed to discrepancies between actual and self-reported physical activity levels, with self-reported PA often being overestimated.[30,33,73,74] Many of the discrepancies are due to recall bias and poor conceptual understanding of the physiological definitions of moderate and vigorous PA, which can both serve to overestimate actual PA performed.[75]

One major limitation of this study was the low retention rate. Seventy-seven subjects were enrolled in the study, 23 completed the Ex + Ed intervention and only 7 were assessed 3 months from the conclusion of the intervention. This retention rate was much lower than other weight management interventions reported in the literature. A systematic review conducted by Fitzgibbons et al[10] reported retention rates of five multi-center weight loss trials that ranged from 92% for the Weight Loss Management to 97% for the Trial of Hypertension Prevention program. This review also reported retention rates that ranged from 45% to 100% for African-American women in nine single-site, randomized controlled trials.

Adherence to an exercise program is difficult for most individuals over an extended period of time. Non-adherence can range from non-compliance with scheduled appointments with a healthcare provider to incompletion of prescribed exercise regimes. This study had an extremely high non-adherence rate. To elucidate the reasons for this, we performed several additional regression and receiver operation analyses to determine if there were factors that may contribute to this. The factors examined were baseline levels of PSC, muscular strength, cardiovascular endurance and BMI. The rationale for the use of these variables relates to the theoretical concepts that PSC and other psychosocial constructs tend to improve as fitness levels improve. As PSC and these other constructs improve, adherence to exercise should improve concomitantly. We did not measure these other psychosocial constructs at baseline for our participants but we did not find any of the aforementioned variables predictive of non-adherence. It is possible that other psycho-social factors or issues related to socioeconomic level may have been factors in non-adherence but were not measured. Future studies that attempt to promote healthy lifestyles for individuals from low socioeconomic levels may need to collect this type of data to understand predictors of non-compliance.

One such factor that may minimize non-adherence is cultural adaptation for a health promotion program. Fitzgibbons et al[10] noted that the successful weight loss interventions for African-American women tended to have cultural adaptations to them that fostered adherence and weight loss. The two multi-centered trials reported in their review utilized extensive training modalities for the program staff to ensure that the intervention was delivered within a specific cultural context.[10] Our intervention was not delivered in this manner and it is possible that this could have fostered improved retention rates and weight loss outcomes.

For the 23 participants that did complete the Ex + Ed intervention, only 7 completed the 3-month follow-up assessments. The loss to follow-up at the 3-month assessment point leaves the question of whether the Ex + Ed intervention fostered a more permanent lifestyle change unanswered.

We did not control or measure caloric intake for participants in the Ex + Ed intervention, but we found relatively high levels of self-reported weekly minutes spent performing moderate and vigorous PA. Based on a published position paper for appropriate and effective PA interventions to promote weight loss, moderate levels of PA that exceed 150 minutes per week are needed to reduce body weight, with larger reductions seen for PA amounts in the 225 – 420 minutes-per-week range.[76] Our participants exceeded the recommended amounts of PA that would promote weight loss but they did not achieve statistically significant change for this measure.

Greater than ninety-five percent of the participants that completed the Ex + Ed intervention were African-American women. Hispanic-American women comprised 56% of the Diet Group with African-American women only 32% of this group.[84] This ethnic composition limits the generalizability of the outcomes for the participants in the Ex + Ed group and Diet group to African-American and Hispanic-American women, respectively. The rationale for this ethnic composition for the completers of the Ex + Ed intervention is not clear. Fifty-seven percent of the individuals that reside in the zip code where the Ex +

Ed intervention took place are African-American as compared to approximately 12% for Hispanics. It is possible that many of the participants in the Ex + Ed group resided in an area close to the location of the intervention. In addition, the Ex + Ed intervention frequency was twice a week as compared to monthly follow-up visits with the physician that supervised the liquid diet program for the Diet participants. The more frequent face-to-face intervention with the healthcare provider may have reduced the feasibility of remaining adherent to the Ex + Ed intervention for certain individuals that did not reside in the immediate area.

CONCLUSION

The findings of the present study support previous trials that utilized exercise as the sole intervention to lose weight, which appears inferior to diet only interventions. Both treatment modalities should be combined for optimal weight loss effects. Despite the medical and neuromuscular impairments and diseases that were present in our participants, they were still able to improve in measures of cardiovascular and muscular fitness. Physical self-worth and self-reported moderate PA both improved, but it is difficult to verify the accuracy of the PA level due to the nature of self-report. This study demonstrated that minority women from lower socioeconomic levels with medical disorders and neuromuscular impairments can make improvements in their physical fitness, physical self-worth and self-reported PA levels.

CHAPTER VI

CONCLUSION

The three studies just described have demonstrated that there are relationships among physical activity, physical self-concept and physical fitness regardless of the populations examined. However, the magnitude of these relationships and the correlations that each subcomponent had with the others varied among those disparate populations. The common theme across the three studies is the discrepancy between self-reported physical activity (PA) and the actual physical fitness measures. The young adults reported high levels of PA (250/150 minutes per week of moderate/vigorous physical activity) that far exceeded the U.S. Federal Government recommendations but with upper body strength and aerobic fitness levels that were near or below the 50th percentile for their gender- and age-matched peers.[1-3]

Two of the three obese Hispanic adolescents involved in the unsupervised exercise program intervention described in Chapter 4 reported low volumes of moderate/vigorous-levels of physical activity (at 0/40 minutes per week for subject 2 and 15/0 minutes per week for subject 3.) Despite these values being well below the U.S. Federal Government recommendations for children, they demonstrated, over time, minimal decrements in muscular strength and aerobic endurance and, for some fitness measures, an improvement.

The obese women that were predominantly from minority backgrounds reported significant improvements in self-reported moderate physical activity that doubled the U.S.

Federal Guidelines (317 minutes/week), with a significant improvement in functional aerobic endurance but with no reduction in bodyweight. This study produced a result similar to the study that involved the obese Hispanic adolescents and other previously published reports that have demonstrated fitness improvements without significant weight loss.[4-6] It can be surmised from these three studies that reliance on physical activity levels by self-report, in general, does not support individuals' actual anthropometric or fitness profiles.

The literature on physical self-concept describes it as a multi-dimensional construct that can serve both as an outcome and as a mediator of physical activity levels.[7-12] We found that for young adults, subdomains of physical self-concept had weak to moderate relationships with objective measures of physical fitness. For the obese Hispanic adolescents that we studied, the changes in physical self-concept did not correspond to the changes in physical performance from baseline to conclusion of the unsupervised home exercise program. The obese women did show significant improvements in physical self-worth, which serves as an intermediary between the subdomains of physical self-concept and general self-esteem. These women also improved significantly in functional aerobic endurance and upper/lower body strength.

The bi-directional relationship that has been discussed between physical activity and physical self-concept makes the establishment of causality difficultt.[13,14] These studies did reveal that physical self-concept is a construct that relates to physical fitness and in some cases may be a better indicator of individuals' physical activity patterns than self-report. Understanding the multiple dimensions that comprise physical self-concept may be needed to direct individuals towards physical activities in which they can derive a sense of mastery, fostering compliance with the regimen.

Adherence to an exercise program is a complex process and must be operationally defined when interpreting research studies that discuss it.[15] For the purpose of study two, adherence was defined as the completion of the home exercise program at the recommended volumes, frequencies and intensities prescribed at baseline of the unsupervised section of the treatment intervention. For study three, adherence was defined as the number of subjects that had completed at least 50% of the prescribed number sessions of the Ex + Ed intervention with post-intervention outcome data. The obese adolescent Hispanic subjects in study 2 had low levels of home exercise program compliance while the obese female subjects that sought to lose weight in a group exercise program offered in a public healthcare system had extremely low levels of program completion and post intervention outcome reporting.

A systematic review conducted by Jack and McLean et al[16] elucidated strong evidence for factors of non-adherence such as: baseline physical activity levels, low in-treatment adherence with exercise, low self-efficacy, depression, anxiety, helplessness, poor social support, greater perceived number of barriers to exercise and pain invoked by the exercise program. For the subjects in studies two and three, assessments of these psycho-social factors that are predictive of adherence were not performed. The literature has shown that in many obese individuals, depression, social isolation and low self-efficacy are present. The obese women that sought weight loss in the public healthcare system were predominantly minorities from low socioeconomic backgrounds with physical disabilities and impairments. These subjects in particular were vulnerable to the aforementioned implicating factors of non-adherence, particularly due to their anthropometric, socioeconomic and medical profiles. For the subjects in study three, because of the high non-adherence rate, we analyzed baseline levels of: physical self-concept, self-reported physical activity and physical fitness/anthropometric measures as potential predictors for non-adherence; none of these factors was predictive. Future interventions that seek to change exercise behaviors to promote weight loss or improved health should include objective measures of physical activity at baseline, within and post-intervention time periods. Assessments of psycho-social, socioeconomic and physical impairments are paramount to screen for susceptibility to non-adherence for certain individuals. Health promotion interventions must then utilize a more individualized approach, based on these potential factors of non-adherence and the cultural attributes of the individual, to structure exercise programs that are effective and sustainable over an extended period of time.

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APPENDIX A

THE PHYSICAL SELF-DESCRIPTION QUESTIONNAIRE-SHORT FORM

		False					True
1.	I feel confident when doing coordinated movements.	1	2	3	4	5	6
2.	Other people think I'm good at sports.	1	2	3	4	5	6
3.	I am attractive for my age.	1	2	3	4	5	6
4.	I am a physically strong person.	1	2	3	4	5	6
5.	I am quite good at bending, twisting and turning my body.	1	2	3	4	5	6
6.	I can run a long way without stopping.	1	2	3	4	5	6
7.	Overall, most things I do turn out well.	1	2	3	4	5	6
8.	I usually catch whatever illness (flu, virus, cold etc.) is going around.	1	2	3	4	5	6
9.	Controlling movements of my body comes easily to me.	1	2	3	4	5	6
10.	I often do exercise or activities that make me breathe hard.	1	2	3	4	5	6
11.	My waist is too large.	1	2	3	4	5	6
12.	I am good at most sports.	1	2	3	4	5	6
13.	Physically, I am happy with myself.	1	2	3	4	5	6
14.	I have a nice looking face	1	2	3	4	5	6
15.	I have a lot of power in my body.	1	2	3	4	5	6
16.	My body is flexible.	1	2	3	4	5	6
17.	I am sick so often that I cannot do all the things I want to do.	1	2	3	4	5	6
18.	I am good at coordinated movements.	1	2	3	4	5	6
19.	I have too much fat on my body.	1	2	3	4	5	6
20.	I am better looking than most of my friends.	1	2	3	4	5	6
21.	I am stronger than most people my age.	1	2	3	4	5	6
22.	My body is stiff and inflexible.	1	2	3	4	5	6
23.	I can perform movements smoothly in most physical activities.	1	2	3	4	5	6
24.	I do physically active things (e.g. *jog*, dance, bicycle, aerobics, gym, swim) a. at least three times a week).	1	2	3	4	5	6
25.	I am overweight.	1	2	3	4	5	6

		False					True
26.	I have good sports skills.	1	2	3	4	5	6
27.	Physically, I feel good about myself.	1	2	3	4	5	6
28.	I think I could run a long way without getting tired.	1	2	3	4	5	6
29.	Overall, I am no good	1	2	3	4	5	6
30.	I get sick a lot.	1	2	3	4	5	6
31.	I find my body handles coordinated movements with ease.	1	2	3	4	5	6
32.	I do lots of sports, dance, gym, or other physical activities.	1	2	3	4	5	6
33.	My stomach is too big.	1	2	3	4	5	6
34.	I feel good about who I am and what I can do physically.	1	2	3	4	5	6
35.	I am good looking.	1	2	3	4	5	6
36.	I would do well in a test of strength.	1	2	3	4	5	6
37.	I can be physically active for a long period of time without getting tired.	1	2	3	4	5	6
38.	Most things I do, I do well.	1	2	3	4	5	6
39.	When I get sick, it takes me a long time to get better.	1	2	3	4	5	6
40.	I do sports, exercise, dance or other physical activities almost every day.	1	2	3	4	5	6
41.	I play sports well.	1	2	3	4	5	6
42.	I feel good about who I am physically.	1	2	3	4	5	6
43.	I think I would perform well on a test measuring flexibility.	1	2	3	4	5	6
44.	I am good at endurance activities e.g. distance run, aerobics, swim, cross-country, ski.	1	2	3	4	5	6
45.	Overall, I have a lot to be proud of.	1	2	3	4	5	6
46.	I have to go to the doctor because of illness more than most people my age.	1	2	3	4	5	6
47.	Nothing I do ever seems to turn out right.	1	2	3	4	5	6

APPENDIX B

THE INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives. The questions will ask you about the time you spent being physically active in the **last 7 days**. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.
Think about all the **vigorous** and **moderate** activities that you did in the **last 7 days**. **Vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. **Moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal.

PART 1: JOB-RELATED PHYSICAL ACTIVITY

The first section is about your work. This includes paid jobs, farming, volunteer work, course work, and any other unpaid work that you did outside your home. Do not include unpaid work you might do around your home, like housework, yard work, general maintenance, and caring for your family. These are asked in Part 3.

1. Do you currently have a job or do any unpaid work outside your home?
Yes

No ***Skip to PART 2: TRANSPORTATION***

The next questions are about all the physical activity you did in the **last 7 days** as part of your paid or unpaid work. This does not include traveling to and from work.

2. During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, digging, heavy construction, or climbing up stairs **as part of your work**? Think about only those physical activities that you did for at least 10 minutes at a time.
_____ days per week

No vigorous job-related physical activity ***Skip to question 4***

3. How much time did you usually spend on one of those days doing **vigorous** physical activities as part of your work?
_____ hours per day
_____ minutes per day

4. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like carrying light loads **as part of your work**? Please do not include walking.
_____ days per week

No moderate job-related physical activity ***Skip to question 6***

5. How much time did you usually spend on one of those days doing **moderate** physical activities as part of your work?
_____ hours per day
_____ minutes per day

6. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **as part of your work**? Please do not count any walking you did to travel to or from work.
_____ days per week

No job-related walking ***Skip to PART 2: TRANSPORTATION***

7. How much time did you usually spend on one of those days **walking** as part of your work?
_____ hours per day
_____ minutes per day

PART 2: TRANSPORTATION PHYSICAL ACTIVITY

These questions are about how you traveled from place to place, including to places like work, stores, movies, and so on.

8. During the **last 7 days**, on how many days did you **travel in a motor vehicle** like a train, bus, car, or tram?
_____ days per week

No traveling in a motor vehicle ***Skip to question 10***

9. How much time did you usually spend on one of those days **traveling** in a train, bus, car, tram, or other kind of motor vehicle?
_____ hours per day
_____ minutes per day

Now think only about the **bicycling** and **walking** you might have done to travel to and from work, to do errands, or to go from place to place.

10. During the **last 7 days**, on how many days did you **bicycle** for at least 10 minutes at a time to go **from place to place**?
_____ **days per week**

No bicycling from place to place ***Skip to question 12***

11. How much time did you usually spend on one of those days to **bicycle** from place to place?
_____ **hours per day**
_____ **minutes per day**

12. During the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time to go **from place to place**?
_____ **days per week**

No walking from place to place ***Skip to PART 3: HOUSEWORK,***

HOUSE MAINTENANCE, AND CARING FOR FAMILY

13. How much time did you usually spend on one of those days **walking** from place to place?
_____ **hours per day**
_____ **minutes per day**

PART 3: HOUSEWORK, HOUSE MAINTENANCE, AND CARING FOR FAMILY

This section is about some of the physical activities you might have done in the **last 7 days** in and around your home, like housework, gardening, yard work, general maintenance work, and caring for your family.

14. Think about only those physical activities that you did for at least 10 minutes at a time.
During the **last 7 days**, on how many days did you do **vigorous** physical activities like heavy lifting, chopping wood, shoveling snow, or digging **in the garden or yard**?
_____ **days per week**

No vigorous activity in garden or yard ***Skip to question 16***

15. How much time did you usually spend on one of those days doing **vigorous** physical activities in the garden or yard?
_____ **hours per day**
_____ **minutes per day**

16. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, sweeping, washing windows, and raking **in the garden or yard**?
_____ **days per week**

No moderate activity in garden or yard ***Skip to question 18***

17. How much time did you usually spend on one of those days doing **moderate** physical activities in the garden or yard?
_____ **hours per day**
_____ **minutes per day**

18. Once again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** activities like carrying light loads, washing windows, scrubbing floors and sweeping **inside your home**?
_____ **days per week**

No moderate activity inside home ***Skip to PART 4: RECREATION,SPORT AND LEISURE-TIME PHYSICAL ACTIVITY***

19. How much time did you usually spend on one of those days doing **moderate** physical activities inside your home?
_____ **hours per day**
_____ **minutes per day**

PART 4: RECREATION, SPORT, AND LEISURE-TIME PHYSICAL ACTIVITY

This section is about all the physical activities that you did in the **last 7 days** solely for recreation, sport, exercise or leisure. Please do not include any activities you have already mentioned.

20. Not counting any walking you have already mentioned, during the **last 7 days**, on how many days did you **walk** for at least 10 minutes at a time **in your leisure time**?
_____ days per week

No walking in leisure time ***Skip to question 22***

21. How much time did you usually spend on one of those days **walking** in your leisure time?
_____ hours per day
_____ minutes per day

22. Think about only those physical activities that you did for at least 10 minutes at a time.
During the **last 7 days**, on how many days did you do **vigorous** physical activities like aerobics, running, fast bicycling, or fast swimming **in your leisure time**?
_____ days per week

No vigorous activity in leisure time ***Skip to question 24***

23. How much time did you usually spend on one of those days doing **vigorous** physical activities in your leisure time?
_____ hours per day
_____ minutes per day

24. Again, think about only those physical activities that you did for at least 10 minutes at a time. During the **last 7 days**, on how many days did you do **moderate** physical activities like bicycling at a regular pace, swimming at a regular pace, and doubles tennis **in your leisure time**?
_____ days per week

No moderate activity in leisure time ***Skip to PART 5: TIME SPENT SITTING***

25. How much time did you usually spend on one of those days doing **moderate** physical activities in your leisure time?
_____ hours per day
_____ minutes per day

PART 5: TIME SPENT SITTING

The last questions are about the time you spend sitting while at work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading or sitting or lying down to watch television. Do not include any time spent sitting in a motor vehicle that you have already told me about.

26. During the **last 7 days**, how much time did you usually spend **sitting** on a **weekday**?
_____ **hours per day**
_____ **minutes per day**

27. During the **last 7 days**, how much time did you usually spend **sitting** on a **weekend day**?
_____ **hours per day**
_____ **minutes per day**

This is the end of the questionnaire, thank you for participating.

APPENDIX C

THE PHYSICAL SELF-PERCEPTION PROFILE: PHYSICAL SELF-WORTH DOMAIN

THE PHYSICAL SELF PERCEPTION PROFILE (PSPP)

WHAT AM I LIKE?

These are statements which allow people to describe themselves.
There are no right or wrong answers since people differ a lot.

First, decide which one of the two statements best describes you.

Then, go to that side of the statement and check if it is just "sort of true" or "really true" FOR YOU.

	Really True for Me	Sort of True for Me	EXAMPLE			Sort of True for Me	Really True for Me
	☐	☐	Some people are very competitive	BUT	Others are not quite so competitive	☒	☐

REMEMBER to check only ONE of the four circles

1	☐	☐	Some people feel extremely proud of who they are and what they can do physically	BUT	Others are sometimes not quite so proud of who they are physically	☐	☐
2	☐	☐	Some people are sometimes not so happy with the way they are or what they can do physically	BUT	Others always feel happy about the kind of person they are physically	☐	☐

	Really True for Me	Sort of True for Me				Sort of True for Me	Really True for Me
3	□	□	When it comes to the physical side of themselves some people do not feel very confident	BUT	Others seem to have a real sense of confidence in the physical side of themselves	□	□
4	□	□	Some people always have a real positive feeling about the physical side of themselves	BUT	Others sometimes do not feel positive about the physical side of themselves	□	□
5	□	□	Some people wish that they could have more respect for their physical selves	BUT	Others always have great respect for their physical selves	□	□
6	□	□	Some people feel extremely satisfied with the kind of person they are physically	BUT	Others sometimes feel a little dissatisfied with their physical selves	□	□

APPENDIX D

THE INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE-SHORT FORM

INTERNATIONAL PHYSICAL ACTIVITY QUESTIONNAIRE

We are interested in finding out about the kinds of physical activities that people do as part of their everyday lives.
The questions are about the time you spent being physically active in the last 7 days. They include questions about activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Your answers are important.

Please answer each question even if you do not consider yourself to be an active person.

THANK YOU FOR PARTICIPATING.

In answering the following questions,

♦ **vigorous** physical activities refer to activities that take hard physical effort and make you breathe much harder than normal.

♦ **moderate** activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal..

1a. During the last 7 days, on how many days did you do **vigorous** physical activities like heavy lifting, digging, aerobics, or fast bicycling,?

Think about *only* those physical activities that you did for at least 10 minutes at a time.
________ **days per week** ⇨

or

none

1b. How much time in total did you usually spend on one of those days doing vigorous physical activities?

_____ hours ______ minutes

2a. Again, think *only* about those physical activities that you did for at least 10 minutes at a time. During the last 7 days, on how many days did you do **moderate** physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.
________ days per week ⇨

or

none

2b. How much time in total did you usually spend on one of those days doing moderate physical activities?

_____ hours ______ minutes

3a. During the last 7 days, on how many days did you **walk** for at least 10 minutes at atime? This includes walking at work and at home, walking to travel from place to place,and any other walking that you did solely for recreation, sport, exercise or leisure.
________ days per week ⇨

or

none

3b. How much time in total did you usually spend walking on one of those days?

_____ hours ______ minutes

The last question is about the time you spent sitting on weekdays while at work, at home, while doing course work and during leisure time. This

includes time spent sitting at a desk, visiting friends, reading traveling on a bus or sitting or lying down to watch television.

4. During the last 7 days, how much time in total did you usually spend *sitting* on a **week day?**

____ hours ______ minutes

This is the end of questionnaire, thank you for participating.

APPENDIX E

BI-VARIATE CORRELATIONS BETWEEN PHYSICAL FITNESS MEASURES AND THE SUBDOMAINS AND GLOBAL MEASURES OF PHYSICAL SELF-CONCEPT

*. Correlation is significant at the .05 level (1-tailed).

	ACT	APP	FLEX	SP	ST	END	COOR	Global PSC	Global SE
VO_2max	.543**	-.296	-.351*	.373*	.418*	.621**	-.023	.051	.428*
3 RM Chest Press/ BW x 100	.397*	.037	-.252	.397*	.428*	.288	.005	-.071	.148
3 RM Seated Row/ BW x 100	.613**	-.211	-.414*	.391*	.468**	.475**	-.069	-.067	.513**
180 deg/sec: Quads Peak Torque/BW x 100	.335*	-.085	-.485**	.345*	.078	.195	-.322*	.000	.426*
60 deg/sec: Quads Peak Torque/BW x 100	.098	.023	-.235	.256	.067	.197	-.498**	.148	.213
BMI	-.077	.305	-.195	.234	.001	-.105	-.078	-.044	-.282
3 RM Leg Press/BW x 100	.295	-.132	-.382*	.331*	.316	.341*	.001	-.158	.445**

**. Correlation is significant at the .01 level (1-tailed).

APPENDIX F

BI-VARIATE CORRELATIONS AMONG SELF-REPORTED PHYSICAL ACTIVITY, GLOBAL PHYSICAL SELF CONCEPT, GLOBAL SELF-ESTEEM AND ACTIVITY SUBDOMAIN OF PSDQ-S

	Global PSC	Global SE	Activity
IPAQ Mod¥	-.08	.04	.21
IPAQ Vig	.22	.22	.54**

¥ Denotes Spearman's Rho correlational coefficient

*. Correlation is significant at the .05 level (1-tailed).

**. Correlation is significant at the .01 level (1-tailed).

APPENDIX G

INTERNAL CONSISTENCY OF THE NINE SUBFACTORS AND THE TWO GLOBAL MEASURES OF THE PSDQ-S

	Cronbach α
Activity	.94
Appearance	.78
Health	.66
Endurance	.94
Sport	.97
Body-fat	.95
Strength	.94
Flexibility	.92
Coordination	.76
Global Self-Esteem	.68
Global PSC	.92

APPENDIX H

INSTITUTIONAL REVIEW BOARD APPROVAL LETTERS

TWU
TEXAS WOMAN'S UNIVERSITY
DENTON DALLAS HOUSTON

Office of Research
6700 Fannin Street
Houston, TX 77030-2343
713-794-2480 Fax 713-794-2488

May 9, 2011

Mr. Wayne A. Brewer
School of Physical Therapy - S. Olson Faculty Advisor
6700 Fannin Street
Houston, TX 77030

Dear Mr. Brewer:

Re: "Can an Unsupervised Home Exercise Program Maintain the Aerobic and Strength Gains Achieved During a 12-week Supervised Program for Hispanic Adolescents?" (Protocol #: 16661)

Your application to the IRB has been reviewed and approved.

This approval lasts for one (1) year. The study may not continue after the approval period without additional IRB review and approval for continuation. It is your responsibility to assure that this study is not conducted beyond the expiration date.

Any modifications to this study must be submitted for review to the IRB using the Modification Request Form. Additionally, the IRB must be notified immediately of any unanticipated incidents. If you have any questions, please contact the TWU IRB.

The signed consent forms, as applicable, and final report must be filed with the Institutional Review Board in the Office of Research, IHS 10110, at the completion of the study.

Sincerely,

Carolyn Kelley, PT

Carolyn Kelley, PT, DSc, NCS
Institutional Review Board - Houston

TWU
TEXAS WOMAN'S UNIVERSITY
DENTON DALLAS HOUSTON

Office of Research
6700 Fannin Street
Houston, TX 77030-2343
713-794-2480 Fax 713-794-2488

February 27, 2012

Mr. Wayne A. Brewer
School of Physical Therapy
6700 Fannin Street
Houston, TX 77030

Dear Mr. Brewer:

Re: "Are There Relationships Between Physical Fitness and Self Esteem in Young Adults?" (Protocol #: 16876)

Your application to the IRB has been reviewed and approved.

This approval lasts for one (1) year. The study may not continue after the approval period without additional IRB review and approval for continuation. It is your responsibility to assure that this study is not conducted beyond the expiration date.

Any modifications to this study must be submitted for review to the IRB using the Modification Request Form. Additionally, the IRB must be notified immediately of any unanticipated incidents. If you have any questions, please contact the TWU IRB.

The signed consent forms, as applicable, and final report must be filed with the Institutional Review Board in the Office of Research, IHS 10110, at the completion of the study.

Sincerely,

Carolyn J Kelley

Carolyn Kelley, PT, DSc, NCS
Institutional Review Board - Houston

TEXAS WOMAN'S UNIVERSITY
DENTON DALLAS HOUSTON

Office of Research
6700 Fannin Street
Houston, TX 77030-2343
713-794-2480 Fax 713-794-2488

December 13, 2011

Mr. Wayne A. Brewer
School of Physical Therapy
6700 Fannin Street
Houston, TX 77030

Dear Mr. Brewer:

Re: *"The Effects of a Group Exercise Program in the Weight Management of the Obese Patient in a Publicly Funded Healthcare System" (Protocol #: 16858)*

Your application to the IRB has been reviewed and approved.

This approval lasts for one (1) year. The study may not continue after the approval period without additional IRB review and approval for continuation. It is your responsibility to assure that this study is not conducted beyond the expiration date.

Any modifications to this study must be submitted for review to the IRB using the Modification Request Form. Additionally, the IRB must be notified immediately of any unanticipated incidents. If you have any questions, please contact the TWU IRB.

The signed consent forms, as applicable, and final report must be filed with the Institutional Review Board in the Office of Research, IHS 10110, at the completion of the study.

Sincerely,

Carolyn Kelley, PT

Carolyn Kelley, PT, DSc, NCS
Institutional Review Board - Houston