PHYSICAL ACTIVITY, BODY FAT, AND ENDOTHELIAL FUNCTION IN MEXICAN AMERICAN MALE ADOLESCENTS

by

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DEDICATION

This dissertation is dedicated to my sons Nathan, Adam, Daniel, and David and to my husband Jay. Thank you for coming with me on this journey.

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ABSTRACT

The goal of this dissertation research was to describe the relationships among psychosocial variables, physical activity and physical fitness, and biological measures indicative of cardiovascular health in Mexican American male adolescents using a biobehavioral model. One aim of the research was to describe the predictive relationship of psychosocial variables, perceived benefits, perceived barriers, self-efficacy, and interpersonal influences, on physical activity and physical fitness. A second aim described the predictive relationship among physical activity and physical fitness and the amount of body fat and levels of biological markers indicative of endothelial function in this population.

Study participants were 28 Mexican American male adolescents ages 15-19. Psychosocial variables were assessed using instruments developed for adolescents by Pender. Physical activity was measured by a 3-day accelerometer recording of activity counts while physical fitness was measured with cycle ergometry withVO2 max. Biologic measures indicative of cardiovascular health included serum leptin, CRP, adiponectin. Fat mass was assessed using BMI and DEXA scans.

Findings demonstrated partial support for the model. Psychosocial variables predictive of physical fitness included perceived benefits of action and interpersonal influences. Perceived benefits of exercise significantly predicted physical fitness, explaining 50% of the variance in physical fitness scores while exercise norms, a measure of interpersonal influence, predicted 17% of the variance. Self-efficacy did not meet criteria as a mediating variable; it directly predicted physical activity. Physical activity predicted 15% of the variance in body fat measured

as BMI percentile. Physical fitness predicted Leptin levels accounting for 23% of the variance. Physical fitness also predicted 51% of the variance related to the DEXA-derived body fat measurement and 18% of the variance related to BMI.

Additional trends were identified including lack of parental support for exercise. Although the study participants reported high acculturated levels, language spoken at home indicated that the family was less acculturated which may have accounted for the lack of parental support. Higher acculturation levels were also significantly associated with increased perceived benefits of action and higher BMI levels.

In conclusion, this study suggests that selected psychosocial variables including interpersonal influences should be considered in designing research with Mexican American adolescent males. In addition results suggest that objectively obtained measures of physical fitness and activity are in part predictive of measures of endothelial function and body fat.

CHAPTER 1: INTRODUCTION

Clinically evident cardiovascular disease (CVD) in adulthood has its inception in childhood and develops insidiously through early life (McGill et al., 2000; Stary, 2000). Longitudinal studies track the same risk factors and cardiovascular (CV) health behaviors from adolescence into adulthood (Freedman, Dietz, Srinivasan & Berenson, 1999; Morrison, Friedman, & Gray-McGuire, 2007; Raitakari et al., 2003; Williams et al., 2002). Knowledge of the early onset of atherogenesis and methods to reduce cardiovascular risk prior to the development of overt disease has resulted in recommendations for the adoption of cardio-protective and risk reduction behaviors during childhood and adolescence (American Heart Association, 2008; Kavey et al., 2003; USDHHS, 1996; Williams et al., 2002). Habitual physical activity and physical fitness have been consistently recommended as health promotion behaviors and strategies to reduce for CVD risk (Healthy People 2010, 2000; Kavey et al.). However, thirty year trends demonstrate decreasing rates of adolescent physical activity and increasing sedentary time (Hayman & Reineke, 2006; Pate, Wang, Dowda, Farrell, & O'Neill, 2006). Mitigation of CVD progression requires knowledge of the psychosocial and physiological correlates of physical activity, as well as the ability to track biological markers of early disease. Chapter one provides an overview of the psychosocial correlates and significance of physical activity as it relates to cardiovascular health in Mexican American male adolescents.

Background and Significance of the Problem

Adolescence

Adolescence is the time between 12 and 20 years of age, during which the young person progresses through physiological, psychosocial, cognitive, and economic changes reaching physical and sexual maturity and independent decision making (Hockenberry, Wilson, Winkelstein & Kline, 2003; Pinz, 2002; Rice & Dolgin, 2005). Three subgroups, early (12-14 years of age), middle (15-17 years of age) and late adolescence (18-20 years of age) are recognized; each stage is associated with specific growth and developmental milestones, decision making processes, and health-related risk (Hockenberry et al.; Turner-Henson, 2005).

Decision-making in the adolescent is a complex process that evolves with cognitive maturation (Hockenberry et al., 2003; Rice & Dolgin, 2005). Adolescents develop the capacity to evaluate potential risks, benefits, and consequences of behaviors (Hockenberry et al.). Primary influences for decisions transition from parental influence in the early adolescent to peer influence and finally to independent decision-making in late adolescence (Pinz, 2002; Rice & Dolgin; Steinberg & Caufman, 1996). Factors that influence the Mexican American adolescents' decision-making process have not been adequately examined.

Many substantial health risks confront the adolescent, including those associated with the development of heart disease. Post-mortem studies indicate atherosclerotic plaques responsible for cardiovascular disease begin early in life and are evident by fifteen years of age (McGill et al., 2000; Stary, 2000). Studies demonstrate that the same risk factors for coronary artery disease (CAD) that begin in childhood continue through adulthood (Morrison et al., 2007; Raitakari et al., 2003; Williams et al., 2002). The most prevalent modifiable cardiovascular risk factors in adolescents include: obesity, lack of physical activity, and exposure to tobacco smoke (Healthy People 2010, 2000; Nicholson, 2000). Early identification of risk and the initiation of appropriate intervention can delay or prevent the development of disease

Moderate to vigorous physical activity levels significantly decrease during the transition from childhood and early adolescence to middle and late adolescence (Taylor, Blair, Cummings, Wun, & Malina, 1999; Trost et al., 2002). Research findings about physical activity levels during the transition to adulthood demonstrate significant variability. While some research reports activity levels present during adolescence are likely to continue into early adulthood (Nelson et al., 2005; Nicholson, 2000; Robbins et al., 2001; Telama et al., 2005) others suggest a continuing decline of physical activity as the adolescent transitions into adulthood (Zick, Smith, Brown, Fan, Kowaleski-Jones, 2007). An understanding of the factors influencing physical activity adoption and adherence provide the opportunity to develop effective interventions to optimize cardiovascular health.

Demographics

Mexican Americans, the largest group of US Hispanics, comprise 9.4% of the total population, or more than twenty million individuals (US Census, 2006). The National Institute of Health (2002) reported that by the year 2050 minority adolescents, the majority of whom are Hispanic, will account for 56% of the US adolescent population. The largest proportion of Mexican Americans resides in the border-states with approximately one-third residing in California (US Census, 2006).

Mexican Americans and Obesity

Disproportionate health risks exist for Hispanic adolescents; including conditions that are known precursors to CVD. Specifically, overweight is the main risk with rates of 22% among Hispanic adolescent males (CDC, 2004). Overweight among youth is attributable to an interaction among biological and environmental influences (Butte, Puyau, Adolph, Vohrra, &

Zakeri, 2007; Perusse & Bouchard, 1999). Wang and colleagues (2006) reported Mexican American youth had the most significant imbalances between these influences, and therefore experienced the greatest weight gain during the childhood to adolescence transition.

Mexican Americans and Physical Activity

Research indicates that Hispanics are the most physically inactive of all United States ethnic/racial groups (Anderson et al., 1998; CDC, 2005; Ham, Yore, Kruger, Heath, & Moeti, 2007; Macera et al., 2005), with only 22. 6% of Hispanic adults participating in regular leisure time physical activity (AHA, 2008).

Research suggests that acculturation of Mexican Americans is associated with adoption of health promoting behaviors (Ham et al., 2007). Mixed results have been obtained from the few studies that have focused on the relationship of acculturation on physical activity adoption. Ham and colleagues (2007) analyzed data from four national surveillance surveys and reported that age, country of origin and birth, acculturation, and education influenced the degree of participation in physical activity. Among Hispanic adults, increased acculturation, assessed through primary English language spoken and years in the US, was associated with increased leisure time activity; those who were less acculturated had increased work based physical activity (Ham et al.). Highest levels of once-per week physical activity occurred among US born Mexican-American young adults with higher degrees of education and acculturation (Ham et al.).

Conversely, a study of Southern California young adolescents demonstrated a positive relationship between acculturation and obesity-related behaviors, specifically more acculturated youth reported decreased physical activity and increased consumption of fast foods (Unger et al., 2004). NHANES data in contrast demonstrated little difference in obesity or moderate to vigorous physical activity among first and second generation Mexican Americans; however, less low-level physical activity and sedentary time were reported among immigrant youth (Gordon-Larsen, Harris, Ward, & Popkin, 2003). All studies used self-report for physical activity, and none examined the association between physical fitness and acculturation.

Accumulating evidence indicates that physical activity plays an important role in the short and long-term cardiovascular health of adolescents. Despite the extensive benefits associated with physical fitness the majority of American adolescents do not meet national guidelines for regular physical activity (AHA, 2008; Sallis, Prochaska, & Taylor, 2000). National surveys estimate that one third of US students in 9-12th do not participate in sufficient moderate or vigorous physical activity during an average week (Hayman et al., 2007). Although Mexican American adolescents are reported to have among the lowest rates of physical activity (AHA, 2008; Butte et al., 2002; CDC, 2004), few studies have measured the physical activity patterns of US Hispanic youth. One large national survey of middle and high school students, which included 18% Hispanics, reports significantly fewer bouts of low intensity physical activity for Hispanics compared with their non-Hispanic white peers (Gordon-Larsen, Adair, & Popkin, 2002). Another survey conducted in California reported lower physical activity levels in "Latino" adolescents than non "Latino" whites (Carvajal, Hanson, Romero, & Coyle, 2002). Among Hispanic adolescents the degree of physical inactivity is greatest among those who are overweight (Butte et al., 2002).

Psychosocial Factors and Physical Activity

Correlates of Physical Activity

Given that research demonstrates a declining rate of moderate to vigorous physical activity during adolescence continuing into the transition to young adulthood (Taylor et al., 1999; Trost et al., 2002), identification of the factors associated with the initiation of and adherence to exercise is an essential step in developing a program of research with this population. Various psychological and cognitive factors have been proposed as determinants of regular physical activity among adolescents (Robbins et al., 2001; Sallis et al., 2000; Van der Horst, Paw, Twisk, & Van Mechelen, 2007). Benefits and barriers of physical activity, interpersonal influences, and self-efficacy hold promise for research with this population of minority adolescents.

Benefits and Barriers of Physical Activity

Positive affective responses and beliefs about exercise are posited to increase motivation for physical activity, while negative beliefs or obstacles hinder participation (Pender, Murdaugh, & Parsons, 2006; Robbins, Pis, Pender & Kazanis, 2004; Sheppard & Parfitt, 2008; Taylor et al. 1999). Perceived benefits and barriers are among the psychosocial factors investigated as determinants of physical activity. Several theoretical frameworks include benefits and barriers as key concepts. Research supports these factors as determinants of physical activity; among youth findings vary by gender, age, and racial divisions. Few studies have included Hispanic youth.

Benefits and barriers are frequently studied as paired concepts. Although an integrative review of adolescent studies reported weak supporting evidence for these concepts (Sallis et al., 2000), research informed by Pender's health promotion model (HPM) demonstrated more conclusive results. Investigators reported significant direct (Garcia et al., 1995; Garcia, Pender, Antonakas, & Ronis, 1998) or indirect (Wu & Pender, 2002; Wu, Pender, & Noureddine, 2003) effects on behavior from perceived benefits and barriers to physical activity.

Perceived barriers have been shown to be the more influential of the two concepts. Consistently higher levels of barriers are reported among older adolescents (Ewing, Dorn, Lan, Huang, & Kalkwarf, 2006; Kimm et al., 2006), females (Allison, Dwyer, & Markin, 1999; Tergerson, & King, 2002) and African American youth (Allison et al., 1999). Inconsistent results were reported in studies investigating specific barriers related to gender. While findings from a study of Canadian youth demonstrated differing barrier levels, specific barriers were consistent (Allison et al., 1999); whereas a US based study reported significantly different barriers between males and females (Tergerson & King, 2002).

Interpersonal Influences and Physical Activity

The relationship between interpersonal influences and physical activity has been examined in a number of studies with mixed results. A positive correlation was demonstrated between adolescents' physical activity and that of their siblings (Sallis et al., 2000). Additionally, physical activity of male adolescents was positively related to parental activity (Van der Horst et al., 2007). Parental support, both emotional and financial, was a significant predictor of physical activity, as was the perceived attitude of significant others (Sallis et al., 2000; Van der Horst et al., 2007). These results are substantiated by several studies using the health promotion model (HPM); in each physical activity was directly (Frenn et al., 2005; Garcia et al., 1998; Garcia et al., 1995) or indirectly (Wu & Pender, 2002, Wu et al., 2003) effected by interpersonal influences. Few studies have included Hispanic adolescents. Freen and colleagues (2005) examined social support for among low-income middle school students for physical activity. In contrast to African American youth, Hispanic students reported lower physical activity support for both genders, lower role modeling for exercise for those with the lowest incomes, and a higher rate of physical activity for females with high social support.

Self Efficacy and Physical Activity

Self-efficacy is a key concept in several theories that inform health promotion research. Self-efficacy is defined as an individual's confidence about his/her ability to achieve a specific goal; it is a basic requisite for motivation and the actualization of behavior change (Bandura, 1977; Janz, Champion, & Strecher, 2002). Self-efficacy may influence a behavior directly or indirectly by mediating perceived barriers to action and/or affecting commitment level or persistence in completing a goal (Pender et al., 2006). This concept has been supported as a significant correlate of physical activity (Dishman et al., 2005; Janz, Champion et al.; Pender et al., 2006).

The majority of self-efficacy and physical activity research has been conducted with both genders or restricted to females; few studies exclusively investigated male participants or included Hispanic participants. Studies report high self-efficacy positively correlates with increased amounts of physical activity (Dishman et al., 2004), more intense physical activity (Straus, Rodzilsky, Burack, & Colin, 2001), and with positive social relationships (Stein, Fisher, Berkey, & Colditz, 2007). These results have been supported by several studies using the HPM. Researchers have reported positive direct (Pender, Bar-Or, Wilk, & Mitchell, 2002; Sallis et al., 2000; Van der Horst et al., 2007; Wu & Pender, 2002; Wu et al., 2003) and indirect (Garcia et al., 1998; Garcia et al., 1995; Robbins et al., 2004; Wu et al., 2003) relationships between perceived self-efficacy or self-confidence and physical activity. Additionally, two integrative reviews have identified positive associations between physical activity and achievement orientation/motivation as well as attitude toward activity and intention to exercise (Sallis et al., 2000; Van der Horst et al., 2007).

Physical Activity and Cardiovascular Health

Physical activity has repeatedly demonstrated positive cardiovascular health effects in the adult population (AHA, 2008; Meyers, 2003; US Department of Health Human Services, 1996). Although less well substantiated in adolescents, significant associations between physical activity and cardiovascular health have been reported. Research demonstrates improvement related to adiposity (weight and body fat), blood pressure, and traditional as well as novel biological markers (Strong et al., 2005).

Tracking risk factors and cardiovascular health behaviors from adolescence into adulthood has been documented in several longitudinal studies (Freedman et al., 1999; Morrison et al., 2007; Raitakari et al., 2003). Physical activity has been consistently recommended as both a health promotion behavior and a strategy for risk reduction (Healthy People 2010, 2000; Kavey et al, 2003). Physical fitness levels have consistently demonstrated strong positive correlations with regular moderate and vigorous aerobic physical activity (Must & Tybor, 2005; Watts et al., 2005; Whaley, 2006).

Physical Activity and Endothelial Function

Identification of factors to optimize cardiovascular health and implementation of measures to decrease or reverse the atherogenic process are essential. One marker of cardiovascular health is endothelial function (Libby, 2002). The vascular endothelium lines the lumen of blood vessels; it has vital secretory, metabolic, secretory, and immunologic functions (DeCaterina, Massaro, & Libby, 2007). Under normal circumstances the endothelium prevents vasospasms, impedes leukocyte and platelet adhesion to the vessel wall, hinders coagulation of blood while promoting fibrinolysis, and inhibits proliferation of smooth muscle cells (DeCaterina et al.).

Research supports biomarkers as an indicator of endothelial functioning. In adult studies, CRP has been associated with vascular inflammation and vasoconstriction (Cleland et al., 2000). Research suggests leptin supports endothelial damage by providing an adequate blood supply for plaque development thus reducing arterial distensibility (Ritchie, Ewart, Perry, Connell, & Salt, 2004). Adiponectin is a protective factor responsible for mediating endothelial inflammation (Ouchi et al., 1999). Early research suggests these markers may be valid in identifying endothelial dysfunction in adolescents.

Empirical evidence supports an inverse relationship between endothelial dysfunction and early atherogenic changes and physical activity (Laufs et al., 2004). Adult studies have reported normalization of endothelial function as a result of exercise training (Hill et al., 2003; Laufs et al., 2004). Positive associations between regular physical activity and increased vasodilation have been reported in adults with coronary artery disease (Hambrecht et al., 2003; Moyna & Thompson, 2004), chronic heart failure (Hambrecht et al., 1998), and hypertension (Taddei, Ghiadoni, Virdis, Versari, & Salvetti, 2003). In healthy adult subjects physical activity has demonstrated a positive association with increased numbers of Endothelial Progenitor Cells (Laufs et al., 2004), an endothelial repair mechanism (Hill et al., 2003). Research reports normalization of CRP and lepin (Barbeau et al., 2003; Meyer, Kundt, Lenschow, Schuff-Werner, & Kienast, 2006) and increased adiponectin (Ischander et al., 2007) associated with exercise interventions in adolescents.

Research on physical activity's effects on endothelial dysfunction in youth is restricted to those with increased cardiovascular risk such as obesity or diabetes. Results are consistent with those reported in the adult population. In populations of overweight and obese youth early atherogenesis was assessed non-invasively to determine functional and structural alterations (Kelly et al., 2004; Watts et al., 2004). Baseline measures indicated varying degrees of abnormal structure and function. Study findings demonstrated significant increases in flow mediated dilation and normalization of CRP after 8 weeks of circuit training (Watts et al., 2004) or aerobic exercise (Kelly et al., 2004) in adolescents. Similar increases in flow mediated dilation as well as decreased carotid intimal thickness were reported following a six month exercise intervention with German young and middle adolescents (Meyer et al.).

Physical Activity and Body Fat

Fat mass and BMI are independent measures of body fat; assessment of each is recommended as a measure of cardiovascular health (Whaley, 2006). Much of the research related to physical activity's effects on fat mass and body weight has been conducted with adolescents who are classified as either overweight or obese (Strong et al., 2005). In longitudinal and cross-sectional descriptive studies, obese youth who participated in moderate to high levels of physical activity demonstrated decreases in adiposity (Gordon-Larsen et al., 2002; Watts, Jones, Davis, & Green, 2005). Experimental studies with overweight youth supported these findings, reporting a decrease in total fat mass and isolated reductions in visceral adiposity

(Gutin et al., 2002; Nemet et al., 2004; Owens et al., 1999; Watts et al., 2004). Evidence in normal weight children is less conclusive, but suggests that the most physically active and fit youth have the lowest levels of fat mass (Butte et al., 2007; Nemet et al., 2004; Watts et al., 2004). Recent research has substantiated these findings in a border population of Mexican American adolescents (Perez, Reininger, Aguirre Flores, Sanderson, & Roberts, 2006).

These results have been supported by studies measuring physical fitness, a correlate of regular aerobic physical activity (Whaley, 2006). Researchers have examined physical fitness as baseline data in descriptive studies, combined with prolonged, monitored exercise interventions, or in moderate to highly trained athletes. Higher physical fitness, also reported as aerobic capacity, demonstrates consistent negative correlations with BMI (Gately, Barth, Radley, & Cooke, 2005; Meyer et al., 2006). Reports indicate that levels of fitness are related to body fat in ways not detectable solely by BMI (Whaley, 2006). Physical fitness continually demonstrates a strong inverse relationship with fat mass (Nemet et al., 2004; Watts et al., 2004); results that have been substantiated in studies with trained youth and BMI matched (Ischander et al., 2007) or lower weight controls (Haluzik et al., 1998).

Study Purpose

The purpose of this study was to test a model to describe the relationship of perceived benefits and barriers of action, interpersonal influence, and perceived self-efficacy with physical activity and cardiovascular health (endothelial function and body fat) in a population of Mexican American middle and late adolescent males.

Aims and Research Questions

Aim 1: Describe the predictive relationship of perceived benefits and barriers, interpersonal influence, and perceived self-efficacy on physical activity and fitness in Mexican American middle and late adolescent males.

Research Question 1) Are perceived benefits and barriers of action, and interpersonal influences significant predictors of physical activity in Mexican American middle and late adolescent males?

Research Question 2) Does self-efficacy mediate the relationship between perceived benefits and barriers of action and interpersonal influences and physical activity in Mexican American middle and late adolescent males?

Research Question 3) Are perceived benefits and barriers of action, and interpersonal influences significant predictor of physical fitness in Mexican American middle and late adolescent males?

Research Question 4) Does self-efficacy mediate the relationship between perceived benefits and barriers of action and interpersonal influences and physical fitness in Mexican American middle and late adolescent males?

Aim 2: Describe the predictive relationship of physical activity and fitness on cardiovascular health (endothelial function and body fat) in Mexican American middle and late adolescent males.

Research Question 5) Is physical activity a significant predictor of endothelial function in Mexican American middle and late adolescent males?

Research Question 6) Is physical activity a significant predictor of body fat in Mexican American middle and late adolescent males?

Research Question 7) Is physical fitness a significant predictor of endothelial function in Mexican American middle and late adolescent males?

Research Question 8) Is physical fitness a significant predictor of body fat in Mexican American middle and late adolescent males?

Significance

The research extends nursing science in several ways. Mexican American adolescents are a large and rapidly growing segment of the US population with disparate cardiovascular health risks and outcomes (AHA, 2008; US Census, 2006); yet insufficient research is being conducted with these youth. Mexican American adolescent males have additional risks not experienced by their female counterparts. These youth are more likely to be uninsured after leaving school, and they are less apt to see a physician or receive preventative healthcare (Callahan & Cooper, 2005; Callahan, Hickson, & Cooper, 2006). In addition, during the transition to adulthood these physically inactive youth become increasingly less active (Dowda, Ainsworth, Addy, Saunders, & Riner, 2003).

Psychosocial correlates of physical activity in this population are not well understood. Benefits and barriers to undertaking physical activity, as well as perceived self-efficacy, have been supported as determinants of physical activity in adolescents however; they have not been substantiated in Mexican American adolescent males. Interpersonal influences, such as acculturation and family modeling and norms, as they influence motivation and participation in physical activity and cardiovascular health have been insufficiently explored.

Limited but promising research exists about novel biological markers as predictors of normal and aberrant endothelial function in youth (National Institute of Health, 2002). However, studies are restricted to a small number of biological measures with insufficient representation across racial/ethnic and age divisions. Few investigations have included Hispanic youth in their samples. Additionally, among Mexican American adolescent males there is limited data demonstrating physical activity's relationship with endothelial function. This study has laid the foundation for expanding the use of endothelial markers and demonstrating the benefit of physical activity on long-term cardiovascular health.

Physical activity's effects on body fat have been demonstrated in subpopulations of adolescents. The majority of research relied on subjective, self-report measures to determine physical activity. Additionally, few studies have included Mexican American male adolescents in their samples. This research provides objective, novel data about the relationship between physical activity, physical fitness and body fat in Mexican American adolescent males.

Summary

The 2000 US Census identified Hispanics as the fastest growing segment of the American population. Hispanics, specifically Mexican Americans are significantly overweight and inactive, however little research to has been conducted to improve health in this population. Identification of the psychosocial predictors of physical activity and cardiovascular health has the potential to significantly influence long-term health in this population. The results of this research provide information to guide the development of interventions that focus on increasing physical activity and associated physical fitness to improve cardiovascular health in Mexican American adolescents.

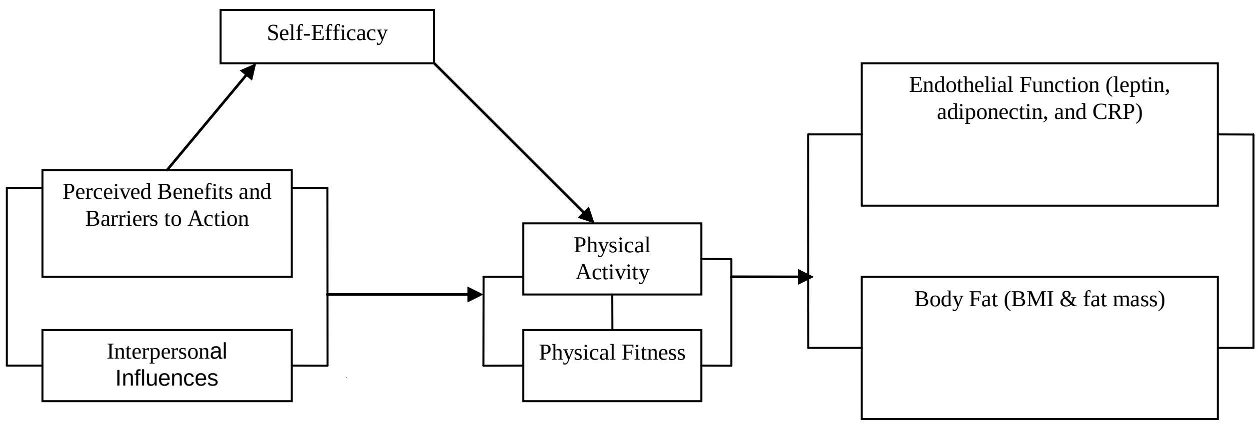
CHAPTER 2: CONCEPTUAL MODEL AND RESEARCH SUPPORT FOR THE MODEL

Cardiovascular health promotion and the prevention or mitigation of cardiovascular disease continues to be a national priority. Development of age- and culturally-specific interventions to meet these goals is a necessity. Physical activity and resulting cardiorespiratory physical fitness have been shown to be as efficacious for cardiovascular health promotion and risk reduction; however, the psychosocial factors responsible for adoption of these activities are not clearly defined for the adolescent, research in Mexican American adolescent males is significantly lacking. This chapter describes a conceptual model designed to identify predictors of physical activity research in Mexican American adolescents. The model incorporates psychosocial concepts theorized to promote adoption and adherence to physical activity as well as biological indicators as outcome measures. Literature support for model concepts is provided.

Conceptual Model

The Winokur Biobehavioral Conceptual Model, a newly developed model based on Pender's Health Promotion Model (HPM), was used to guide the dissertation research (See Figure 1). The model is comprised of psychosocial concepts predicted to influence physical activity adoption and resulting cardiorespiratory physical fitness. Endothelial function and body fat, measures of cardiovascular health, are included as outcomes.

Figure 1. The Winokur Biobehavioral Conceptual Model



Study Concepts

An understanding of specific factors that motivate behavior is integral in the design of intervention studies. Four psychosocial concepts predicted to influence adoption and adherence to regular programs of aerobic physical activity in Mexican American adolescents were adapted from Pender's health promotion model-revised (Pender et al., 2006), a predictive middle-range conceptual model (Fawcett, 2005). Theory concepts and propositional relationships have been supported in numerous studies for activities directed toward health enhancement (Pender et al., 2006). The outcome stage in Pender's model is composed of behavioral outcomes. Winokur's model expands the HPM to include physiologic outcomes.

In the Winokur biobehavioral model, three psychosocial concepts, perceived benefits and barriers to activity, and interpersonal influences, are theorized to have direct effects on the adoption of and adherence to physical activity. Self-efficacy, a fourth psychosocial concept, is a mediator that specifies how the association occurs between perceived benefits and barriers and interpersonal influence and physical activity, the proposed outcome in the model (Bennett, 2000).

Psychosocial factors have been shown to influence health-promoting behaviors. Physical activity, a health promoting behavior, is a proximal outcome in the model. Perceived benefits and barriers, interpersonal influences and self-efficacy are theorized to be predictors of physical activity. Physical fitness, a measurement of aerobic or cardiorespiratory fitness, occurs as a direct result of physical activity.

Biological concepts indicative of cardiovascular health are distal outcomes in the model. Endothelial function, an indication of vascular health, is measured by three biological markers: (a) C-reactive protein, (b) Adiponectin, and (c) Leptin. C-reactive protein is a measure of vascular inflammation, a recognized component of endothelial dysfunction. Both adiponectin and leptin demonstrate measurable associations with early endothelial dysfunction and atherogenesis. Body Mass Index (BMI) and body fat, both are traditional methods to measure cardiovascular health.

Research Support for the Model-Psychosocial Concepts

Perceived Benefits and Barriers

Perceived benefits of action are positive expectations or reinforcing consequences that occur as a result of engaging in a specific behavior (Pender et al., 2006). Perceived benefits of action are posited to directly and indirectly motivate behavior. Personal expectations about specific outcomes directly influence the likelihood that a particular course of action will be undertaken. Direct motivation results from prior positive personal or vicarious experiences. Indirect motivation influences commitment to a plan of action from which anticipated benefits will occur (Pender et al.). Benefits may be intrinsic or extrinsic. Extrinsic benefits are derived from others and may include social inclusion, positive feedback, and/or rewards. Conversely, intrinsic benefits are those occurring from internal cognitive and belief processes. Extrinsic benefits may initially provide a stronger motivating force with adolescents; however intrinsic motivation is associated with stronger commitment to and continuation of change (Pender et al.; Ryan & Deci, 2000).

Perceived barriers are genuine or imagined obstacles to initiating or persevering with an action (Janz, Champion et al., 2002; Pender et al., 2006). Evidence supports barriers as a determinant of health-promoting behavior that can directly or indirectly affect motivation. Perceptions about the tangible or emotional costs of engaging in a behavior can directly impede adoption by blocking actions (Janz, Champion et al. ; Pender et al.). Barriers can directly lead to decreased commitment and indirectly to avoidance of a health-promoting behavior (Pender et al.). Barriers can be affected by other factors. For example, readiness to act can moderate the influence of perceived barriers (Pender et al.) while higher self-efficacy can reduce the impact of perceived barriers through increased perseverance (Bandura, 2007; Pender et al.).

Perceived benefits and barriers are concepts in several health promotion theories. The HPM and the health belief model (HBM) categorize these factors as influences on the adoption of health-health promoting behavior. In social cognitive theory they are labeled facilitators/opportunities and impediments and have an indirect influence on goals through self-efficacy (Luszczynska & Schwarzer, 2005). Self-determination theory further explores these concepts as internal or externally derived, with those internally developed exerting stronger motivation for behavioral change (Ryan & Deci, 2000).

Adolescent studies often investigate perceived benefits and barriers concurrently. The majority of this research has been conducted with both genders or restricted to females; few studies exclusively investigated male participants. Researchers have supported benefits and barriers as a determinant of the degree of and adherence to physical activity during adolescence (Garcia et al., 1995; Garcia et al., 1998; Grubbs & Carter, 2004).

Discrepant results have been reported when examining gender congruence related to benefits and/or barriers of physical activity. In a study guided by the health belief model, 535 predominately Caucasian male and female high school students completed author-developed surveys examining perceived benefits and barriers for exercising (Tergerson & King, 2002). Types of benefits (F [1, 519] =13.51, p =.000) and barriers (F [12, 508] =3.94, p =.000) identified differed significantly between males and females. Competition, development of strength, and acceptance of peers were the most important benefits reported by males, while the strongest barriers were lack of interest and discounting the importance of exercise. However, females identified staying in shape, losing weight, and increasing energy as the most important benefits and lack of time, competing demands, and tiredness as the major barriers to exercise.

Perceived barriers to vigorous physical activity were investigated in Canadian high school students (Allison et al., 1999). Males comprised 51% of the 1,051 participants; the subjects were categorized as ethnically diverse. Barriers were characterized as internal (individual) or external (environmental and social). Findings indicated a higher level of barriers among females; however the hierarchical ranking of barriers were consistent among genders. Internal barriers had an inverse relationship with overall physical activity ($p = 0.003$) and physical activity outside of school ($p < 0.001$). External barriers were found to be a significant predictor of school and external activities however in the opposite direction predicted; in this instance higher barriers were associated with increased physical activity. Congruent with other studies, the level of physical activity was less with females and older adolescents. Perceived barriers, self-efficacy, age and gender explained only a small portion of the adjusted variance in vigorous (6%) physical activity and overall (13%) physical activity.

Similar findings were reported in a physical activity beliefs and behaviors study of younger adolescents (Garcia et al., 1998). Although specific benefits and barriers were not investigated, beliefs about the benefits to barriers ratio comparably worsened for both genders during the elementary to junior high school transition. However, the changes in beliefs did not significantly impact the degree of actual physical activity.

Qualitative studies support the empirical evidence obtained from individual studies and quantitative reviews. Allison and colleagues (2005) investigated the effect of benefits and barriers on physical activity participation in male adolescents. Twenty-six 15 and 16-year old Canadian males participated in focus groups to explore the perceptions, experiences, and factors that promoted and discouraged moderate and vigorous physical activity. Thematic analysis demonstrated the presence of intrinsic and extrinsic factors that supported and hindered participation. Intrinsic benefits centered on enjoyment and skill development. Extrinsic benefits included socialization and relationship building, as well as psychological and health benefits. Internal and external barriers were identified; the former included low priority for exercise, competing preferences, and individual characteristics that hindered participation, such as physical size, while the latter included influences of significant others, lack of time or money, and inaccessibility. Although the authors reported ethno-cultural diversity among participants, specific information about the participants was not provided.

Evidence supports that an adolescent's weight status alters his/her perception of the barriers to physical activity. Normal weight adolescents perceive the fewest barriers (DeForche, DeBourdeaudhuij, & Tanghe, 2006; Taylor et al., 2002). In a European study of normal-weight, overweight and obese adolescents, results demonstrated fewer barriers and greater sports involvement among normal weight youth. Obese adolescents had the lowest benefit scores and highest barrier scores among all groups (De Forche et al.). Similarly, among junior high and high school students, results demonstrated weight status was inversely related to perceived barriers (Taylor et al.).

Interpersonal Influences

Most definitions of interpersonal influence emphasize a person's ability to actively impact the decisions or obtain compliance from another (Dillard, Anderson, & Knoblach, 2002; Schrader & Dillard; 1998). Pender et al. (2006) describes interpersonal influence from the individual's perspective as he/she considers the beliefs, attitudes, and behaviors of significant others in decisions regarding health-promoting behaviors. Expressed as social norms, social support, and modeling behaviors, these interpersonal processes may be the initial impetus as well as the sustaining force for the adoption of health promoting behavior (Pender et al., 2006). In an interaction with other model constructs and in the presence of sufficient motivation, interpersonal influences reinforce behaviors thus increasing the likelihood of action (Pender et al.). Interpersonal influence for health related behaviors are primarily obtained from family, peers, and healthcare providers. The extent of influence varies according to the development level of the individual and across cultures.

Modeling behaviors, defined as vicarious learning occurring as a result of observing others (Pender et al., 2006), has been substantiated as an influence for health promoting activity in adolescents (Davison, Cutting, & Birch, 2003; Neumark-Sztainer, 2005; Trost, Sallis, Pate, Freedson, & Dowda, 2003). In adolescent review papers, results related to significant others' modeling physical activity were mixed. No relationship was demonstrated with teachers', coaches', or peers' behavior (Sallis et al., 2000; Van der Horst et al., 2007); conversely, a positive correlation was demonstrated with sibling physical activity (Sallis et al.) and parental physical activity for male adolescents (Van der Horst et al.). A recent study in high school adolescents reported increased physical activity in those youth who had a friend who exercised (King, Tergerson, & Wilson, 2008).

Although limited, modeling's influence on physical activity has been supported in Hispanic adolescents. In a study of 400 Mexican American 10-15 year old a limited influence was reported for exercise as a result of modeling by "powerful others"; the most substantial results were found among the oldest participants (Guinn et al., 2006). Freen and colleagues (2005) utilized the HPM model in a school-based study with low-income African American and Hispanic youth. They reported a relationship between socio-economic status and modeling; lower role modeling for exercise occurred among Hispanic students with the lowest incomes.

Social norms, expectations of significant others (Pender et al., 2006), have been less frequently studied as a determinant of health related behavior in adolescents. Sallis and colleagues (2000) and Van der Horst et al. (2007) reported that attitudes of significant others supported physical activity intention; these results were obtained from small studies. Peer norms directly and parental norms indirectly predicted intention to engage in physical activity ($p < 0.01$) for males in a study of predominately Caucasian middle adolescents (Baker, Little, & Brownell, 2003). In a British study of late adolescents and young adults (age 19 $\pm$ 3.3 years) social norms significantly ($p < 0.05$) predicted both intention to engage in physical activity and exercise effort (Chatzisarantis, Frederick, Biddle, Hagger, & Smith, 2007). Studies including significant numbers of Hispanic adolescents were not located.

In contrast, social support has been shown to be a predictor of physical activity/exercise in numerous investigations. Compiled adolescent studies demonstrated mixed results related to influence of others (Sallis et al., 2000; Van der Horst et al., 2007). Findings did not substantiate support from teachers, coaches, or peers as a correlate of physical activity adoption (Sallis et al.; Van der Horst et al.); however, parental support, both emotional and financial was a significant predictor of physical activity (Sallis et al.; Van der Horst et al.).

Parental support as a predictor of physical activity has been substantiated among older children and adolescents (Duncan, Duncan, & Stryker, 2005; Duncan, Duncan, & Stryker, & Chaumeton, 2007; King et al., 2008). Several studies have reported increased importance for social support for exercise among female adolescents (Ammouri, Kaur, Neuberger, Gaewski, & Choi, 2007; DiLorenzo, Stucky-Ropp, Van Der Wal, & Gotham., 1998). Peer social support as a determinant of exercise/physical activity demonstrates mixed results. In a population of middle school students, Smith (1999) reported that high peer social support was positively associated with physical activity related affect, and indirectly predicted higher physical self-competence and actual physical activity behavior. Research on social support with Hispanic adolescents is limited. In a school-based study of low income Hispanic and African American adolescents, investigators found lower support for physical activity across genders for Hispanic students (Freen et al., 2005).

Gender differences have also been reported. Analysis revealed that having a friend to exercise with was the most significant cue to exercise for both genders; cues affected females, more than males with the strongest influence from parental exercising (F [12,508] =16.81, p =.000 and friend encouragement (F [12, 519] =13.51, p =.000) (Tegerson & King, 2002).

Social networks and social support have increased significance for Mexican Americans. In general there is an increased role for the family in all aspects of life. Commonly, Mexican American individuals desire family member support in social, as well as healthcare situations. Routine healthcare decisions for minors are primarily made by the mother (Mendelson, 2002); however, significant decisions may made by the family (Burk, Wieser, & Keegan, 1995). In accordance with familism, the needs and achievements of the family as a unit are given priority over those of any one member. Thus an individual may be encouraged to or dissuaded from engaging in a particular behavior or activity for the family's benefit (Burk et al.; Niska, 1999; Pender et al., 2006). The influence of family on adoption of physical activity is not well understood among Mexican American adolescents.

Self-efficacy

Bandura introduced the concept of self-efficacy in 1977 as a component of social cognitive theory. The theorist defined it as the conviction of an individual that he/she can successfully execute a behavior required to produce an outcome (Bandura, 1977). Bandura proposed that self-efficacy determined the initiation, extent, and maintenance of coping behaviors occurring in the presence of challenging demands (Bandura; Janz , Champion et al., 2002; Luszczynska & Schwarzer, 2005). An individual's perceived self-efficacy is influenced by a number of factors. Specifically these include the accomplishments received from engaging in the behavior and self-evaluation and feedback of the act, vicarious observation of others engaging in a behavior and the feedback they receive, encouragement from others regarding the individual's competency in successfully carrying out a course of action, and physiological signals, such as anxiety by which an individual judges his/her abilities and competencies (Bandura; Luszczynska & Schwarzer; Pender et al., 2006). Self-efficacy develops over time; specifically success in an endeavor builds self-efficacy while failures weaken it (Oettingen, 1999).

Although general self-efficacy is referenced in the literature, Bandura specifically conceptualized self-efficacy as behavior-specific (Luszczynska & Schwarzer, 2005). Pender's (2006) definition is congruent with this interpretation; she offers perceived self-efficacy as a "judgment of one's ability to carry out a particular course of action" (p.42). Physical activity self-efficacy is behavior-specific and addresses an individual's confidence in his/her capacity to learn or execute motor skills (Feltz & Magyar, 2006). Perceived self-efficacy is viewed as a motivational influence in adolescent physical activity effecting activity selection, effort, adherence, and resilience (Feltz & Magyar).

Limited studies have examined self-efficacy's influence on physical activity or exercise in adolescents. In a study of Caucasian and African American youth, ages 9 -17 years of age, pre-and post-activity self-efficacy and perceived exertion was evaluated following a treadmill challenge (Robbins et al., 2004). Results demonstrated males had a higher degree of pre-activity self-efficacy and subsequently reported less perceived exertion than females. In both genders, lower perceived exertion was positively correlated with higher post-activity self-efficacy. In a second analysis of the same population, the researchers reported an inverse relationship between post-activity self-efficacy and extent of negative feelings during the exercise challenge (Robbins et al.). This relationship was more pronounced in young adolescents. Perceived self-efficacy was positively correlated with intention to exercise in 13 to 17 year old British adolescents (Umeh, 2003). Perceived physical activity self-efficacy was highest among older adolescent youth of higher social socio-economic status, and in those who more strongly associated exercise with health benefits. Perceived benefits were strengthened by the addition of self-efficacy.

In a study of college undergraduates, Gao and colleagues (2008) examined the influence of exercise self-efficacy and outcome expectancy on behavioral intention and actual performance of behaviors. Findings demonstrated positive relationships among all variables over the 16-week course of the study. Further while outcome expectancy was the most important determinant of intention to exercise at program initiation, self-efficacy was the most important mid-semester determinant of behavioral intention as well as actual behavior. The researchers concluded that subsequent to learning a behavior, self-efficacy explained the majority of variability of future intentions and actual behaviors. In research on predictors of health-related behaviors using a similar population of Southern college students (mean age 19.7 years), perceived self-efficacy was a significant contributor to reported physical activity and nutrition ($R^2 = .43$) (Von Ah, Ebert, Ngamvitroj, Parj, & Kang, 2004).

In a large study of male and female Taiwanese young and middle adolescents, the researchers investigated behavioral indicators (self-efficacy, interpersonal influences, and perceived benefits and barriers) predicting physical activity (Wu & Pender, 2002; Wu et al., 2003). Perceived self-efficacy was reported to be the strongest predictor of physical activity, through direct and indirect effects (Wu et al.). Specifically, interpersonal influences had a weak, nonsignificant direct effect on physical activity, but a significant indirect effect when mediated by self-efficacy and perceived benefits (Wu & Pender). Additionally, perceived barriers when mediated through self-efficacy demonstrated a significant indirect effect on physical activity (Wu et al.).

An individual's culture influences the development and degree of self-efficacy (Oettingen, 1999). Cultural differences have been examined along several dimensions including views about the value of the group versus the individual. Mexican American culture is categorized as collectivist, one with a strong group orientation. The group is the source of protection and is owed loyalty; it is difficult for the individual to separate him/herself from the collective (Oettingen). Self-efficacy development in collectivist cultures relies more heavily on group appraisal and on meeting the goals of the group rather than the individual (Oettingen). Therefore an understanding of the culture's views on physical activity and fitness is essential to developing effective interventions.

In summary, research supports self-efficacy as a major influence in the adoption and maintenance of physical activity among youth and young adults. Although limited research has included self-efficacy as a concept with Mexican American youth, it has been found to be an important influence in physical activity studies in other cultures with strong family orientation (Wu & Pender, 2002; Wu et al., 2003). Self-efficacy, as a mediator in the model, is supported by previous adolescent physical activity research.

Health Promoting Behaviors

Physical activity and the resulting physical fitness are credited with improving short and long-term cardiovascular health (AHA, 2008; Kavey et al., 2003; Meyer, 2003; USDHHS, 1996). Research findings support significant relationships between physical activity and decreased CV health risks related to improvements in blood pressure, lipoprotein profiles, glucose metabolism, insulin sensitivity, and adiposity (Andersen et al., 2006; Eisenmann , Welk, Wickel, & Blair, 2007; Kelley & Kelley, 2003; Kelley & Kelley, 2007; Ribeiro et al., 2005; Strong et al., 2005). Research also demonstrates associations among physical activity and fitness and novel biological markers (Kelly et al., 2004).

Physical Activity

Physical activity is defined as body movement produced by the contraction of skeletal muscle resulting in substantially increased energy expenditure (Amisola & Jacobson, 2005; Sirad & Pate, 2001; Whaley, 2006). Exercise is a form of physical activity characterized by structured, repetitive body movements that enhance or sustain physical fitness (Whaley). Physical activity is categorized along a continuum from light to maximal (Whaley); the majority of physical activity studies examine moderate to vigorous physical activity's influence on cardiovascular health. Physical inactivity or sedentary behavior has been positively associated with increased cardiovascular risk, primarily related to weight gain resulting from a disparity between intake and energy expenditure (Eisenmann, Bartee, & Wang, 2002; Utter et al., 2003).

Longitudinal trends demonstrate continuing declines in adolescent physical activity (AHA, 2008; Kimm et al., 2002). This finding was reaffirmed in a recent study on a large sample of school-aged children and adolescents; findings demonstrated increasing physical activity until the age of 13 followed by a continual decline through adolescence, a trend that was not gender-specific (Kahn et al., 2008). In research assessing health related behaviors among adolescents, parent-adolescent pairs from 100 cities were surveyed (Butcher, Sallis, Mayer, & Woodruff, 2008). Among the approximately 3,000 males participants only 57% were meeting national physical activity guidelines of 60 minutes of moderate physical activity daily; among females only 40% met guidelines.

Research on ethnic and racial differences in physical activity demonstrate mixed results. Although earlier integrative reviews reported non-Hispanic whites consistently participated in more physical activity than all other groups (Gordon-Larsen, 2000; Sallis et al., 2000), some current studies do not conclusively support this finding (Ammouri et al, 2007; Van der Horst, 2007). Research specifically addressing Hispanic participants is limited; however multi-ethnic study results consistently report lower levels of physical activity occurring among Hispanic youth (Butcher et al., 2008; Gordon-Larson et al.; Patrick et al., 2004; Zapata, Bryant, McDermott, & Hefelfinger, 2008).

Conflicting results were obtained by researchers in a Texas-based study of Hispanic (77%) and non-Hispanic white (23%) adolescents (Stovitz, Steffen, & Boostrom, 2008). Contrary to many other studies, findings did not support lower rates of aerobic physical activity among Hispanic male adolescents. Furthermore Hispanic males reported significantly greater participation in strength training sessions than their white counterparts. This finding was unexpected since most previous research has confined survey questions to aerobic exercise. These results support the need for further evaluation, because toning and physical strengthening is posited to indirectly increase aerobic activity through increases in self-confidence (Amisola &

Jacobson, 2005). Congruent with other research, Hispanic males were significantly more overweight than white males, a condition partially attributed to significantly increased sedentary time reflected as daily hours of watching television.

Discrepant results have been reported about the relationship between socio-economic status and physical activity. Some studies indicate a lack of association (Patrick et al., 2004; Sallis et al., 2000; Van der Horst, 2007); others demonstrate a positive correlation between family income and moderate to vigorous physical activity (Butcher et al., 2008; Gordon-Larsen et al., 2000). The influence of parental education is mixed, while some studies reported a valid relationship between increased physical activity and higher education only for males (Sallis et al.), others describe positive correlations for both genders (Butcher et al.; Van der Horst et al.). Gordon-Larsen and colleagues concluded that high levels of maternal education were significantly associated with the likelihood of regular moderate to vigorous adolescent activity. Mexican American parents have the lowest reported high school completion rates of all races and ethnicities and among the lowest income levels (US Census, 2008).

Physical activity interventions demonstrate efficacy in reducing cardiovascular risk in adolescents. In an 8-week exercise intervention with obese adolescents and normal weight controls, researchers used flow-mediated dilation as a measure of early vascular disease (Watts et al., 2004). Results indicated improvements in vascular function in obese-trained subjects with results comparable to the lean control group. Additionally the intervention group had improvements in lipids and adiposity. Findings indicated the majority of fat mass change occurred in visceral fat (Watts et al.).

Physical Fitness

Physical fitness is an attribute describing an individual's ability to perform physical activity; it is composed of physiologic, skill-related, and health-related factors (Whaley, 2006). Health-related components include endurance and muscle-strength, flexibility, body composition, and cardiovascular endurance; these factors influence the individual's ability to energetically perform activities of daily living. Skill related components are strongly associated with motor skills and sports performance; these factors include agility, balance, coordination, speed, power, and reaction time. Physiological fitness describes biological systems that are affected by regular activity. Categories of physiological fitness include (a) metabolic fitness which details risk for diabetes and cardiovascular disease, (b) morphological fitness inclusive of body fat content and distribution, and (c) bone mineral density (Whaley). Physiological and health-related fitness can be altered through physical activity or exercise (Nemet et al., 2005; Whaley).

Physical fitness, typically measured as aerobic capacity, has been associated with improved cardiovascular health. Aerobic fitness has demonstrated positive changes in blood pressure, lipoproteins, BMI, and adiposity, including changes in fat mass distribution (Byrd-Williams et al., 2008; Ekelund et al., 2007; Gately et al., 2005; Janz, Dawson & Mahoney, 2002 Meyer et al., 2006). Recent research reported an inverse relationship between physical fitness and novel biomarkers and/or ultrasonic measures of early cardiovascular disease. For example C-reactive protein, a marker of inflammation, has demonstrated an inverse relationship with physical fitness in adolescents (Isasi et al., 2003). Additionally, effects of physical fitness on leptin, an emerging cardiovascular biomarker, were examined in obese adolescents. Leptin was determined to have an inverse relationship with physical fitness over the 8-month course of the study (Barbeau et al., 2003).

Physical fitness research in Hispanic youth is limited. In a recent Los Angeles-based longitudinal study with overweight and at risk for overweight Hispanic youth, researchers described the effects of physical fitness on body fat over a four-year period of time (Byrd-Williams, 2008). In males increased physical fitness at baseline was significantly associated with decreased weight gain over the course of the study. Results indicated that physical activity occurring during the study timeframe was inversely related to decreases in fat mass.

Biological Outcomes

Endothelial Function

The vascular endothelium is the largest organ in the body; composed of a single layer of cells, it lines the lumina of all blood vessels (De Caterina, Massaro, & Libby, 2007; Libby, 2002). It is responsible for maintaining homeostasis through the synthesis, secretion, and metabolism of an array of substances as well as performing immunological functions (De Catrina et al.; Ross, 1999). Normally functioning endothelium inhibits vasospasm, prevents platelet and leukocyte adhesion to the vessel wall, supports fibrinolysis, resists blood coagulation, and hinders the proliferation of vascular smooth muscle cells (De Catrina et al.).

Endothelial dysfunction is the initial, pre-clinical stage of atherogenesis that results from compensatory mechanisms enacted in response to an insult or injury that alters the normal functioning of the vascular endothelium (Davignon & Ganz, 2004; Ross. 1999). Insults such as pathophysiological levels of C-reactive protein, reactive oxygen species, oxidized low density lipoprotein cholesterol (LDL-C), or oxidants initiate an inflammatory process and immune response (Ouedraogo et al., 2007; Ross) resulting in a disruption in the endothelium's balance between anticoagulant/ procoagulant and antiproliferative/proliferative factors (Endlemann & Schriffin, 2004; Ross). This abnormal cell function is detectable before clinical evidence of plaque occurs (Endlemann & Schriffrin; Libby, 2002).

In the initial phase of endothelial dysfunction a microinflammatory response is generated (Endemann & Schiffrin, 2004; Libby, 2002). The vascular endothelium increases in permeability and in the expression of leukocytes or platelet specific adhesion molecules, specifically vascular adhesion molecules (VCAM), intracellular adhesion molecules (ICAM), and selectins (Carlos & Harlan, 1994; De Caterina et al., 2007; Ross, 1999). As the immune response continues to develop vasoactive molecules, cytokines, chemokines, and growth factors are released (Cohn et al., 2004; Ross). Nitric oxide dependent vasodilation is disrupted (De Caterina et al.). Adhesion molecules attach on circulating monocytes and T-cells; chemokines promote initial adhesion of these cells to the endothelium and subsequent migration of these cells into the vascular intima (Cohn et al., 2004; Endemann & Schiffin; Ross).

Subsequent to transmigration, monocytes mature into macrophages, digest oxidized LDL-C, and are transformed into foam cells. Foam cells and T-cells are the primary components of fatty streaks, the precursor of plaque (Cohn et al., 2004; Stary, 2000). These processes activate chemical mediators, such as Endothelin-1, that stimulates a phenotype change in vascular smooth muscle cells resulting in a loss of contractile properties, increased replication ability, and cytokine secretion. Ultimately these cells migrate into the vessel's intimal layer where they become part of a developing atheroma (Rainger & Nash, 2001).

Biomarkers of Endothelial Function

Biomarkers are proposed as the optimal method to assess endothelial function, thus providing an opportunity for assessment and intervention prior to the development of cardiovascular symptomology (Charakida, Tousoulis, & Stefanadis, 2005; Mansoub, Chan, & Adeli, 2006; Vasan, 2006). Biomarkers indicative of CVD risk in adults have been used for more than 15 years (Vasan). Promising research exists for the use of biomarkers as an indicator of cardiovascular health in youth (NIH, 2001). However, unlike adults with more advanced vascular changes the status of the endothelium cannot be ascertained through the use of traditional markers of risk such as LDL. Instead novel biomarkers indicative of the earliest changes provide a method to determine status of the endothelium.

Early atherogenesis can be assessed non-invasively to determine functional and structural alterations. Flow mediated dilation (FMD), an indirect measure of nitric oxide, assesses the responsiveness of the artery to changes in blood flow pre and post-occlusion; healthy endothelium demonstrates an increase in vessel size and a brisk response (Charakida et al., 2005; Jarvisalo & Raitakari, 2005; Korkmaz & Onalan, 2008). Distensibility, a structural change is a measure of arterial stiffness and calcification (Cooke & Oka, 2002); the smaller the difference between systolic and diastolic diameter, the greater the disease (Charakida et al.). Arterial intima-media thickness (IMT) measures the proliferative changes that represent initial overt atherosclerosis (Charakida et al.). Although useful for research purposes, these techniques have limited clinical utility related to lack of standardized values, reproducibility, and cost (Jarvisalo & Raitakari; Vasan, 2006).

Nitric Oxide

Essential for vascular homeostasis and dilation, nitric oxide (NO) protects the endothelium through its anti-inflammatory, anti-thrombotic, and non-proliferative functions (Ganz & Vita, 2003; Landmesser, Hornig, & Drexler, 2004; Verma, Buchanan, & Anderson, 2003). Many researchers consider disturbances in nitric oxide function as the primary indicator of endothelial dysfunction (Libby, 2002; Endemann & Schiffrin, 2004). Endothelial nitric oxide, however has limited utility for clinical screening due to absence of a direct, easily obtainable measurement method; instead this marker is indirectly measured ultrasonically. The most reliable method requires arterial infusion of NO agonists or sublingual nitrates; the invasive nature and associated risk of this test reduces its applicability in studies with youth (Verma et al.; Vasan, 2006).

Although considered excellent indicators of endothelial dysfunction, nitric oxide, FMD, and IMT have several detractors. Either they are difficult to obtain or are invasive and not routinely used in youth. (Charakida et al., 2005; Libby, 2002). C-reactive protein, adiponectin, and leptin not only provide similar data but provide additional information indicative of endothelial dysfunction. Assays of each are readily available, easily obtained, and cost effective.

C-reactive Protein

C-reactive protein, an acute phase protein predominately synthesized in the liver following stimulation by cytokines interleukin (IL) 1- beta, IL 6 and tumor necrosis factor-alpha (TNF-α), is identified as the best validated inflammatory biomarker (Packard & Libby, 2008). Extrahepatic production in adipocytes and coronary artery smooth arterial muscle cells has been documented under inflammatory conditions (Calabro, Chang, Willerson, & Yeh, 2005).

In vitro studies have identified CRP as a mediator of endothelial function. In cultured endothelial cells and after stimulation by interleukin (IL-6) and endothelin-1, CRP induces the expression of ICAM-1, VCAM-1, selectins, and monocytes chemoattractant proteins (Pasceri, Willerson, & Yeh, 2000; Verma et al., 2004). CRP promotes receptor-mediated deposition of monocytes in the arterial wall, mediates the uptake of biochemically intact LDL-C into macrophages, facilitates low density lipoprotein cholesterol (LDL-C) oxidation in the sub intimal space, and stimulates macrophage induced reactive oxygen species production (Calabro et al., 2005; Torzewski et al., 2000; Zwaka, Hombach, & Torzewski, 2001). Through disruptions in nitric oxide production, it impairs vasodilatation (Verma et al., 2003) and disrupts the endothelial self-repair process by inhibiting production and increasing apoptosis of endothelial progenitor cells (Verma et al., 2004). CRP is considered an amplifier of other proinflammatory cytokines, and increases the endothelial expression and activity of plasminogen activator inhibitor-1 (PAI-1), an acute phase protein associated with prothrombotic states (Devaraj, Xu, & Jialal, 2003).

In human studies at normal physiological concentrations, C-reactive protein’s role as a mediator of endothelial dysfunction is less well established (Packard & Libby, 2008). However, the function of CRP as an established inflammatory biomarker of cardiovascular risk prediction, is widely recognized (Ridker, Rifai, Rose, Buring, & Cook, 2002; Tsimikas, Willerson, & Ridker, 2006). Research with adults supports associations with degrees of atherosclerosis (Devaraj, Torok, Dasu, Samols, & Jialal, 2008; Yeh, 2005), as a predictor of ischemic cardiac events (Blake & Ridker, 2003), and vascular events (Rizzo, Corrado, Coppola, Muratori, & Novo, 2008).

Recent pediatric studies demonstrate relationships between CRP and markers of early atherogenesis. Jarvisalo and colleagues (2002) conducted an exploratory study with 79 healthy children to determine the relationship between ultrasonic measures of endothelial dysfunction and serum measures indicative of cardiovascular disease. Higher levels of CRP were correlated with lower flow-mediated dilation ($p = 0.015$), increased carotid artery intima-media thickness ($p = 0.002$), and intracellular adhesion molecule expression (I-CAM) levels ($p < 0.02$). Findings from a recent study provide additional support for the relationship between CRP and carotid intima media thickness (IMT). CRP and IMT examinations were restricted to obese participants, CRP correlation was observed only in the top quartile of IMT results (Beauloye et al., 2007).

The relationship among CRP, insulin resistance, and cardiovascular risk was explored in a large sample of healthy adolescents from the northern Midwest (Moran et al., 2005). CRP was strongly correlated with BMI ($r = 0.27$, $p <0.001$), percent body fat ($r = 0.29$, $p = 0.0004$), and serum leptin levels ($r = 0.26$, $p = 0.002$). Further support for the association among the components of the metabolic syndrome and CRP was demonstrated by a secondary analysis of NHANES 1999-2000 data. Median CRP was associated with overweight and indicators of the metabolic syndrome; CRP levels increased proportionally in concert with increased numbers of metabolic syndrome factors ($p < 0.0001$) (DeFerranti et al., 2006). Largest increases in CRP were noted in non-Hispanic black and Mexican American adolescents.

Research supports the relationship between physical activity (exercise) and/or physical fitness and measures of C-reactive protein in adolescents. CRP demonstrated significant negative correlations with increased physical activity and fitness (Cook et al., 2000; Kasapis & Thompson, 2005; Meyer et al., 2006; Rosenbaum et al., 2007); however others have reported gender specific (Isasi et al., 2003) or inconclusive results attributed to the influence of BMI and fat mass (Ischander et al., 2007; Verdaet et al., 2004).

Research assessing physical activity's influence on markers indicative of cardiovascular risk and endothelial function was conducted with obese early and middle adolescents (Meyer et al., 2006). Lean control subjects were used for baseline comparison. Subsequent to the 6-month physical activity study, the intervention group demonstrated significant improvements in carotid intimal media thickness, flow mediated dilation, and C-reactive protein; no improvements were found in the control group. Although cardiovascular indicators improved in the intervention group after the 6-month physical activity intervention, the levels did not reach those of the lean control group.

Similar findings were reported in a recent physical intervention and lifestyle modification study (Kelishadi, Hashemi, Mohammadifard, Asgary, & Khavarian, 2008). Obese Irani adolescents, ages 12 to 18, participated in a 6-week intervention comprised of supervised physical activity sessions and diet counseling. At study completion and without significant changes to carotid intimal media thickness, youth demonstrated significant improvements in flow mediated dilation, body mass index, and CRP; additional positive findings were reported in waist circumference and insulin resistance. CRP, waist circumference, and low density lipoproteins were most strongly correlated with the improvements in flow mediated dilation; CRP and body fat showed the strongest association with improved carotid intimal media thickness.

Hispanic adolescents, predominately from the Dominican Republic, were the subjects in a study designed to examine the effects of health and nutrition education and aerobic activity on diabetes risk (Rosenbaum et al., 2007). C-reactive protein, Interleukin 6 (IL-6), adiponectin, tumor necrosis factor (TNF)-alpha, lipids, and insulin sensitivity were used to assess cardiovascular and diabetes risk. Both the intervention and control groups had a BMI of 24 and body fat of 24-25 percent. The intervention group participated in three-time weekly physical activity and weekly education classes. Participation in the intervention was associated with significant reductions in body fat, insulin resistance, and concentrations of CRP and IL-6. The control group experienced an increase in BMI and body fat and either unchanged or worsened biomarker concentrations during the course of the study.

Adiponectin

Adiponectin is a protein synthesized by adipocytes and stimulated by insulin. Plasma adiponectin levels inversely correlate with BMI, visceral adiposity, fasting insulin levels and insulin sensitivity, triglycerides, and parental history of coronary artery disease; conversely adiponectin positively correlates with high density-lipoproteins and insulin-sensitivity (Huang et al., 2004; Nemet et al., 2003; Patel, Srinivasan, Xu, Chen, & Berenson, 2006; Pilz et al., 2005). Adiponectin has a protective effect on the vasculature; its antiatherogenic properties were first demonstrated in animal model and tissue culture studies.

Adiponectin functions at several phases along the continuum from endothelial dysfunction to atherosclerosis (Endemann & Schriffin, 2004). In human tissue cultures it inhibits adhesion molecule expression and monocyte rolling and endothelial bonding (Ouchi et al., 1999), suppresses TNF-α production and smooth muscle proliferation (Ouchi et al., 2000), and hinders macrophage to foam cell transformation (Arita et al., 2001; Ouchi et al., 2001). Under atherogenic conditions, adiponectin promotes vasodilatation through increased bioavailability of nitric oxide (Hattori, Sukuki, Hattori, & Kasai, 2003).

Human studies that have examined the relationship between adiponectin and atherogenesis in adults concur with experimental findings. Adiponectin levels were found to be negatively associated with increased carotid intima media thickness in healthy subjects (Iglseder et al., 2005) as well as with degrees of coronary plaque development in asymptomatic individuals (Rothenbacher, Brenner, Marz, & Koenig, 2005). These investigations support the use of adiponectin as a biological marker of cardiovascular health among adults (Packard & Libby, 2008; Szmitko, Teoh, Stewart, & Verma, 2007).

Limited studies have examined adiponectin as a biomarker for cardiovascular health in youth. In a small study of healthy pre-adolescents, Nemet and colleagues (2003) demonstrated relationships between adiponectin and biomarkers associated with atherogenesis. Adiponectin was positively correlated with HDL ($r = 0.448$, $p = 0.019$), and inversely correlated with TNF-α ($r = -0.384$, $p = 0.048$) and IL-6 ($r = -0.398$, $p = 0.04$). Direct correlations between early atherogenesis and adiponectin were demonstrated in a 2005 study by Pilz and colleagues (2005) of 240 normal weight and obese youth. Carotid intima media thickness (CIMT) was utilized as a measure of early atherogenesis. Results demonstrated a highly significant inverse correlation between adiponectin and CIMT ($r = -0.34$, $p < .001$). These findings were substantiated by a recent European study. Beauloye and colleagues (2007), in an investigation of 104 obese children, reported that adiponectin, not classical CV risk factors such as visceral adiposity, an abnormal lipid risk profile, or a family history of diabetes or cardiovascular disease predicted CIMT; these results remained significant after controlling for BMI, gender and tanner stage.

Recent research supports a relationship between physical activity and adiponectin. Ischander and colleagues (2007), in a small study of sedentary versus physically active adolescent females, demonstrated a significant correlation between higher reported physical activity and higher levels of adiponectin ($p < 0.05$). This relationship remained significant after controlling for body fat percentage.

Kondo, Koyayashi, & Murakami (2006) conducted an exercise intervention with a population of obese and normal weight late adolescent and young adult females. Findings indicated improved physical fitness and increased adiponectin concentrations; among obese participants adiponectin concentration increased by 42.8 % ($p<0.01$), while normal weight participants demonstrated non-statistically significant increases in adiponectin and physical fitness (Kondo et al.).

Similar findings were reported in a recent study of overweight and obese Italian youth (Cambuli et al., 2008). The one-year life style modification study explored the effects of increasing physical activity, decreasing sedentary time, and improving nutrition on physiological markers of cardiovascular health. A control group of normal weight youth completed anthropometric and assay baseline data. At the completion of the study, most physiological indications were improved in the obese youth. The most significant changes were noted in adiponectin concentrations which increased by 245% ($p<0.0001$), reaching the levels of the normal weight control group. Leptin levels did not substantially improve.

A divergent finding reported by Nemet and colleagues (2003) demonstrated higher adiponectin levels in less physically fit, overweight adolescents; a result that was attributed to higher muscle mass in these subjects as compared to their leaner counterparts. This finding substantiates the need to include body composition measures in any cardiovascular risk measurement. No research conducted with adolescent Hispanic males was located.

Leptin

A circulating peptide hormone, leptin is synthesized from adipocytes (Friedman, & Halaas, 1998; Mansoub et al., 2006). Leptin is directly implicated in a hypothalamic feedback-loop that is responsible for regulation of energy balance and food intake, and indirectly related to body weight (Lau, Dhillon, Yan, Szmitko, & Verma, 2005; Mansoub et al.). Blood levels are positively correlated with the amount of triglycerides fat stored in adipose tissues and with weight (Barbeau et al., 2003; Pilz et al., 2005; Sierra Honigmann et al., 1998). Higher leptin levels are associated with worse endothelial function.

Leptin is a novel cardiovascular biomarker that is predominately linked to endothelial dysfunction by its immune and inflammatory affects (Moschen et al, 2007). The majority of the evidence arises from experimental animal model or tissue culture studies. Leptin receptors on the vascular endothelium and in smooth muscle cells stimulate intima media smooth muscle cell proliferation and transmigration (Sierra-Honigmann, et al., 1998; Oda, Taniguschi, & Yokoyama, 2001). Leptin upregulates endothelin-1 and decreases production of endothelial nitric oxide synthase; the former is a potent vasoconstrictor, while the latter diminishes the amount of available nitric oxide (Lau et al., 2005). Yagmashi and colleagues (2001) demonstrated an increase in reactive oxygen species production and subsequent transcription of oxidant-sensitive genes implicated in atherosclerosis (Yamagishi et al., 2001). Leptin induces calcification of vessel walls, an atherogenic condition responsible for decreased vessel responsiveness (Parhami, Tintut, Ballard, Fogelman, & Demer, 2001).

Although human studies are limited, promising research exists for leptin as a measure of impaired vascular function, an early measure of endothelial dysfunction. Adult studies link leptin to CV risk through associations with hypertension and adverse cardiovascular events such as myocardial infarction and stroke (Ciccone et al., 2001; Thogerson et al., 2004; Ren, 2004). Although the causative mechanism is not clearly understood, several hypotheses have been proposed (Beltowski, 2006). Additionally, a link between leptin and CRP has been demonstrated in several studies (Shamsuzzaman et al., 2004; Singh, Hoffmann, Wolk, Shamsuzzaman, & Somers, 2007; Viikari et al., 2007). Leptin has been independently associated with CRP after controlling for gender, age, BMI, body fat, and smoking ($P = 0.007$) (Shamsuzzaman et al.; Viikari et al.).

In research with youth a significant association has been identified between early atherogenesis and leptin. Singhal and colleagues (2002) measured arterial function, biological markers, and anthropometric data in a sample of 294 healthy adolescents. After controlling for fat mass and other biomarkers associated with metabolic and inflammatory disturbances, results indicated a significant inverse correlation between arterial distensibility and leptin concentration with a 1.3% decreased in distensibility noted for every 10 % increase in leptin concentration (95% CI, -1.9% -0.8% $p <0.001$). These results support an in vitro study by Parhami and colleagues (2001) in which leptin induced calcification of human aortic endothelial cells.

Similar findings were noted in a study of Turkish youth with diabetes. Atabek and colleagues (2004) examined the relationship between leptin and insulin-like growth factor 1 and carotid intima media thickness. Among all youth leptin was positively correlated with carotid intima media thickness ($p =0.04$) and vessel reactivity ($p =0.01$). These findings were independent of the influence of insulin-like growth factor.

Recent research on human adults demonstrated a counterintuitive finding. Schindler and colleagues (2006) demonstrated a positive correlation between leptin and improved myocardial blood flow (0.37, $p = 0.036$) among obese adults. Other than indicating the need for additional research, no explanation was offered.

Physical activity and physical fitness' influence on leptin has been studied. In child, adolescent, and young adult physical activity studies conflicting results have been reported. While some research reports no effect between physical activity and leptin concentration (Cambuli et al., 2008), others have demonstrates a significant inverse correlation with physical fitness (Barbeau et al., 2003; Gutin et al., 1999; Haluzik et al., 1998; Tsolakis, Bogdanis, Vagenas, & Dessypris, 2006; Tsolakis, Vagenas, & Dessypris, 2003). Some of these studies have corrected for changes in fat mass. In a four-month physical training study with youth, the relationship between leptin and physical activity remained significant even when corrected for changes in fat mass (Gutin et al.). The converse was found in a study of normal weight active and sedentary females where leptin's association with physical activity did not remain when correcting for fat mass (Ischander et al., 2007).

Obese adolescents participated in an 8-month study to measure the effects of moderate or vigorous physical activity on leptin concentrations (Barbeau et al., 2003). Pre-intervention leptin levels were associated with total body fat. At the completion of the intervention, leptin was associated with the degree of physical fitness achieved during the intervention and baseline leptin levels. Contrary to other studies, leptin was not found to be associated with physical activity level, diet, visceral adiposity, and glucose levels.

A European descriptive study of young adult male rugby players and healthy normal weight controls examined the relationship of physical fitness and leptin levels (Haluzik et al., 1998). Results indicated significantly higher body weight and BMI in the athletes while body fat was slightly but non-significantly higher in the control group. Leptin concentrations were significantly lower in the athletes than in the healthy controls. The authors posited the relationship was related to regular vigorous physical training. No studies with data obtained from Hispanic adolescent males were located.

The rate of inflammation as a primary component of early atherogenesis can be measured by biomarkers of inflammation to assess cardiovascular health and predict risk. Additional studies in select populations are necessary to validate the role of other novel biomarkers, such as adiponectin and leptin in assessing cardiovascular risk and providing efficacious interventions that improve cardiovascular health among youth. However results may be confounded by the sensitivity of these markers to other conditions such as increased fat mass or other inflammatory conditions (Tomiyama et al., 2012; Viikari et al, 2007).

Body Fat

Cardiovascular health and risk assessments require measuring body fat. Fat mass and BMI are independent measures of body fat; assessment of each is recommended for risk stratification (Whaley, 2006). Elevated body fat is strongly associated with or is a precursor to type II diabetes, dyslipidemia, coronary artery disease, hypertension, and adult obesity (AHA, 2008; Eckel & Krauss, 1998; Watts et al., 2005). Recent evidence demonstrates a significant inflammatory component of obesity and an associated link to endothelial dysfunction (Tilg & Moschen, 2006; Lee & Prately, 2005; Lau et al., 2005).

Body Mass Index

Body mass index (BMI) is a body composition measure reflecting a person's weight scaled to height. BMI for children and adolescents is reported as an age and height adjusted percentile. National pediatric age and gender-based BMI parameters identify underweight, normal, "at risk for overweight" and overweight (CDC, 2004). A BMI value greater than or equal to the 85th and less than the 95th percentile is defined as "at risk" while a BMI greater than or equal to the 95th percentile is considered "overweight" (CDC). BMI is a frequently reported variable in the pediatric CV risk and diabetes literature; many physical activity studies utilize pre and post BMI to measure intervention efficacy. Decreases in BMI are associated with normalization of traditional and novel markers of cardiovascular risk (Hara et al., 2005; Oberbach et al., 2006; Reinehr, Stoffel-Wagner, Roth, & Andler, 2005)

Mexican Americans and BMI

A recent analysis of NHANES data demonstrated that Mexican American male adolescents had higher body mass indices than Caucasian, African American, and Asian youth (Ogden et al., 2006). Among adolescent males 12-19 years of age, 47% were categorized as at risk for overweight (85th to the 95th percentile) or overweight (greater than the 95th percentile). Examination of the1999-2002 NHANES data yielded factors associated with overweight in the Mexican American adolescent (Forrest & Leeds, 2007). Males had higher rates of overweight than females. Associated factors included low family income and perceptions of less physical activity and poorer health than normal weight youth. Overweight adolescents had increased prevalence of asthma and systolic hypertension. Overweight adolescents also reported less caloric intake than normal weight adolescents, a finding attributed to underreporting.

A known relationship exists between cultural beliefs, customs, and values and health outcomes (Pender et al., 2002). Mexican American cultural beliefs about weight in children have received some examination. Findings from limited studies demonstrate differing perceptions of overweight. Anderson and colleagues (2005) conducted a study in which the majority of participants were low-income Mexican American, reported that 78% of the parents of an overweight child viewed the child as average or underweight. These results supported earlier results by Myers and Vargas (2000) where 35% of parents of children of children with a BMI greater than the 90^{th} percentile did not categorize the child as overweight.

In a study that included Hispanic youth and their parents, a significant correlation was found in the relationship between parental obesity and overweight (Dowda et al., 2001). This association was strongest with maternal overweight but equally affected male and female adolescents. Conclusions related to modeling behavior versus diet and/or exercise beliefs were not offered.

Fat Mass

Although useful, BMI has limitations because it does not account for the percentage of fat free mass and bone density in total weight (Ischander et al., 2007; Whaley, 2006). Predictive measures such as skin fold thickness and bioelectrical impedance present similar issues (Wells & Fewtrell, 2006). Dual-energy X-ray absorptionmetry (DEXA) and Densitometry, considered two-component techniques account for the percentage of other tissues. Densitometry however is limited to applications where lean mass is normal issues (Wells & Fewtrell). Hydrometry, requires suspension in water rich in various isotopes which are then measured provides accurate information however is difficult to obtain, user intensive, and confounded by participant hydration status (Wells & Fewtrell).

Fat mass is categorized as visceral or subcutaneous. Visceral fat mass is considered more detrimental to health and is related to the metabolic syndrome phenotype in adolescents (Shaibi et al., 2007) while subcutaneous fat is strongly related to overall percentage of body fat (Huang, Johnson, Figueroa-Colon, Dwyer, & Goran, 2001). Inflammatory cytokines, including adiponectin and leptin, are predominately increased from visceral fat but also are produced by subcutaneous fat (Fain, 2006).

Levels of BMI and body fat are negatively correlated with high density lipoprotein-cholesterol (HDL-C) (Martins et al., 2005; Okada et al, 2006) and adiponectin (Ischander et al., 2007; Nemet, 2003); both are cardioprotective factors. Body fat has been positively correlated with leptin and inversely related to arterial distensibility (Singhal et al., 2002). Lo and colleagues (2004) demonstrated a significant relationship between leptin and BMI. CRP was shown to be significant correlated with both BMI and body fat in a large sample of Caucasian and African American adolescents (Moran et al., 2005).

Physical Activity, BMI, and Fat Mass

Obesity research with moderate or prolonged physical activity interventions repeatedly demonstrates a significant inverse relationship between exercise and BMI and/or fat mass (Watts et al., 2006). Consistent results are reported with isolated exercise interventions (Kondo, et al., 2006) and those combined with nutrition and/or lifestyle modification (Gately et al., 2005; Gutin et al, 2002; Meyer et al., 2006; Nemet et al., 2004). In normal and overweight adolescents aerobic and resistance exercise is associated with improved CV risk profiles (Ischander et al., 2007; Flynn et al., 2006; Oberach et al., 2006).

Physical Fitness, BMI, and Fat Mass

Researchers have examined physical fitness as baseline data in descriptive studies, combined with prolonged, monitored exercise interventions, or in moderate to highly trained athletes. Higher physical fitness, also reported as aerobic capacity, demonstrates consistent negative correlations with BMI (Gately et al., 2005; Meyer et al., 2006). Reports indicate that levels of fitness are related to body composition in ways not detectable solely by BMI (Whaley, 2006). Physical fitness continually demonstrates a strong inverse relationship with fat mass (Nemet et al., 2004; Watts, 2004). Results have been substantiated in studies with trained youth and BMI matched (Ischander et al., 2007) or lower weight controls (Haluzik et al., 1998).

Summary

Conceptual models provide a framework to support research (Fawcett, 2005). This chapter presented an author-developed biobehavioral health promotion model that delineates concepts predictive of physical activity adoption by Mexican American male adolescents as well as the relationship of physical activity and fitness to physiological biomarkers. Literature support was provided for all concepts and their proposed relationships.

CHAPTER 3: METHODOLOGY

Assisting adolescents to establish positive patterns of physical activity is critical for their immediate as well as long-range cardiovascular health and general well-being. It is essential for healthcare providers to understand factors that motivate or interfere with adolescents adopting and participating in moderate to vigorous physical activity. However these factors have been insufficiently delineated. This dissertation serves as a step toward providing insight on the development of interventions. This chapter describes the methodology for the dissertation research.

Research Design

A descriptive cross-sectional design was used to investigate conceptual relationships and test the Winokur Biobehavioral Conceptual Model. Descriptive cross-sectional designs collect data at only one point in time. Among Hispanic adolescents limited research has addressed psychosocial predictors of physical activity and fitness, or biological assays that measure cardiovascular health. Thus a descriptive design provides the opportunity to identify significant predictors of physical activity and physical fitness prior to subsequent intervention studies.

Sample

Inclusion and Exclusion Criteria

Inclusion criteria were male adolescents 15-19 years of age who self-identified as Mexican American, were able to read and speak English, and currently live in a family environment with at least one parent or guardian in the home. The parent must have been able to read or speak English or Spanish. Exclusion criteria for the adolescents were physical disability resulting in an inability to perform physical activity and the daily use of anti-inflammatory or anti-cholesterol medications that could influence biological assay results.

Power Analysis

The sample size was determined through a power analysis. Using an effect size of 0.25, an alpha of 0.05, and a power of .80, a sample of 62 participants was calculated to be appropriate to test the model. This sample size provides an R^2 0.20 with 6 independent variables and a Beta of 0.19232. Multiple regression with the six predictor variables was used to determine associations among the psychosocial variables and physical activity and the distal biological outcome variables.

Setting

The Investigation Clinical and Translational Science Center (ICTS) at the University of California, Irvine, funded by the National Institute of Health Clinical and Translational Science Award Program, was the data collection site. The program has two Applied Physiology/Human Performance Core Laboratories; the one at the Medical Center Campus was used for data collection. The CTSC housed equipment to assess height and weight, obtain blood samples, equipment to perform an exercise challenge, and a DEXA scan to measure body composition. The ICTS is staffed by registered nurses, support staff, exercise physiologists, and a DEXA technician. The ICTS also contained a laboratory for analysis of blood samples. Samples were transported to the laboratory by the investigator or a member of the staff.

Mexican American adolescent males were to be recruited predominately from two sites, the Boys and Girls Club in the city of Santa Ana and an established St Joseph Hospital Foundation Program: Healthy for Life. The Boys and Girls Club operated from several sites within the city. The program served 900 children and adolescents on a daily basis; 98% of the participants were Hispanic, predominately Mexican American. Healthy for Life had a data base with the names of students located throughout Orange County who have agreed to participate in prior research projects. The program's data base had the names of more than 100 male Hispanic adolescents between the ages of 15-19. The program director, Mr. Barry Ross, mailed letters to participants following IRB approval of this study.

Measures

Demographic Information

Demographic information was collected to describe the sample. The participant was asked to complete a set of questions to obtain information including age, ethnicity, school grade, living situation, birth order, and acculturation. Use of medication and general health was obtained by self-report to determine eligibility for the study.

A point of care blood sugar and a lipid panel were completed by the primary investigator. Values outside of normal limits for adolescents served to exclude participants from the study.

Acculturation

Acculturation was measured with the Brief Acculturation Rating Scale for Mexican Americans-II ("Brief ARSMA-II") (Cuellar, 2004). This 12-item Likert-type scale comprised of 6-items from the Anglo Oriented Scale (AOS) of the ARSMA-II and 6-items from the Mexican Oriented Scale (MOS), measured acculturation in the cognitive, affective and behavioral domains. Scale responses range from 1 (not at all) to 5 (almost always/ extremely often). The scale form contains both English and Spanish items, permitting all participants to receive the same form. The scale is based on the premise that individuals can have a number of outcomes based on the acculturation process ranging from complete assimilation to separation from the dominant culture maintaining the values, behaviors, and customs of the culture of origin.

Cuellar (as cited in Bauman, 2005) evaluated the Brief ARSMA-II with 2,422 Latino adolescents ages 12 to 19. Alpha coefficients reported were .79 on the AOS and .91 of the MOS. Concurrent validity with the original ARSMA was .89. Acculturation scores were correlated with generation level (r =.61), a recognized proxy measure of acculturation. A recent study investigated the reliability and validity of the ARSMA-II in children and adolescents. Two samples of Mexican American children and adolescents from the southwest participated (Bauman, 2005). Internal consistency reliability was calculated using Cronbach's alpha; among the two samples the MOS had values of .93 and .84 while the AOS had results of .69 and .75. Spearman-Brown split-half coefficient for the MOS was .91 and .81 while the AOS was .81 and .79.

Construct and content validity of the ARSMA II was also examined. Factor analysis using principle component analysis with a Varimax rotation confirmed the presence of two factors; these accounted for 59% of the variance, similar to the original ARSMA. The MOS items loaded at .78 to .84 and AOS .44 to .76. The researchers examined language selected by the participants as a measure of concurrent validity. Results supported the researcher's prediction that a greater percentage of "very Mexican oriented" (Spanish speaking) participants were geographically located closer to the Mexican American border. Finally, older children reported more Anglo orientation than younger one, a finding associated with greater acculturation with increased time in school.

The scale developers described two methods for scoring the ARSMA II, linear acculturation levels and orthogonal acculturation categories. Linear acculturation levels were determined by calculating the means of the MOS items and the AOS items and then subtracting the mean of the MOS from the mean of the AOS. Positive scores indicated a more Anglo orientation and negative scores a more Mexican orientation. Linear acculturation was reported as levels one to five, with five indicating the highest level of Anglo-orientation. Orthogonal categories provide a bidirectional measure of acculturation by considering both the AOS and MOS scores. Subscale scores were considered simultaneously to determine categorizes such as high biculturals (MOS > 3.59; AOS > 3.7) or assimilated (MOS ≤ 2.44; AOS ≥ 4.11). Other categories are low biculturals (MOS < 3.59; AOS < 3.7) and traditionals (MOS ≥ 3.7; AOS ≤ 3.24). Unclassified individuals were those who don’t fit into any of the defined categories. The researchers reported a significant number of unclassified individuals in their study.

Psychosocial Variables

Perceived Benefits and Barriers

Perceived benefits were measured with the Adolescent Physical Activity Perceived Benefits Scale (Robbins, Gretebeck, Kazanis, & Pender, 2006). The 10-item Likert-like scale is based on Pender’s HPM; the instrument consisted of items measuring physical activity outcome expectations and personal satisfaction resulting from physical activity (Robbins, Wu, Sikorskii, & Morley, 2008). Items were preceded by the phrase “A major reason for being physically active or exercising for me is to … (Robbins, Wu et al., 2008, p. 103)” Items included “improve or have more athletic skills”, “have more energy (Robbins, Wu et al., p. 105).” Response options were 1 (not at all true), 2 (not very true), 3 (sort of true), and 4(very true). Scores were obtained by computing the mean of a participant's total score. Higher scores corresponded with a higher level of perceived benefits to physical activity.

Perceived barriers were measured with the Adolescent Physical Activity Perceived Barriers Scale (Robbins, Gretebeck, et al., 2006). This nine-item Likert-like scale was designed to identify personal obstacles to engaging in physical activity. Items were preceded by the phrase "Please show how true each statement is regarding certain barriers or problems that prevent or stop you from exercising, being active, or doing sports (Robbins, Wu et al., 2008, p. 103)." Included among the instruments' items were "I am tired, I had a bad day at school (Robbins, Wu et al., p. 106)." The scale score is calculated by determining the total score; higher scores indicate a higher level of perceived barriers to physical activity.

The Perceived Benefits and Barrier Scales were initially developed and used in a physical activity intervention study of female adolescents (Robbins, Gretebeck et al., 2006). This study reported Cronbach's alpha reliability and content validity through focus groups of adolescent girls. Both instruments were tested in a recent study of 206 sixth, seventh and eighth grade students in the Midwestern United States (Robbins, Wu et al., 2008). Reliability was supported for the Perceived Benefits to Physical Activity and the Perceived Barriers to Physical Activity through test-retest (r = .70 and .69, respectively) and internal consistency (Cronbach's coefficient alpha of .80 and .78, respectively). Questionnaire completion occurred at a 2-week interval. Inter-item correlations for both scales were below .70 and corrected item-total correlations were all above .30.

Construct and content validity was assessed through factor analysis, hypothesis testing, and focus groups. Principle component analysis with a Varimax rotation was used to explore the structure of both scales. Each scale demonstrated a 2-factor solution as predicted by the researchers. The hypothesized relationship between self-reported physical activity and both the Perceived Benefits and Perceived Barriers Scales scores was supported and provided further evidence of construct validity. Content validity was obtained through a review of instrument items by five university faculty members with expertise in adolescent physical activity/fitness, health promotion, health communication, and pediatrics. Initial focus group testing was conducted with adolescent girls; subsequently four focus groups with male adolescents supported the content validity of instruments.

Interpersonal Influences

Interpersonal influences for physical activity were measured with adolescent versions of three instruments indexing interpersonal norms, social support, and role modeling (Pender, n.d.). The Exercise Norm's Scale, a 5-item Likert-like scale for assessing interpersonal norms, or the expectations of significant others related to adolescent exercise (Pender.). Items were preceded by the phrase, "How much do you think the following people (family members, friends, personal physician, and a teacher) expect you to exercise?" Response options were not at all (0), sort of (1), a lot (2), and don't know (0). Responses are summed to obtain a total score.

The Exercise Social Support Scale assessed significant others' involvement with an adolescent's exercise. The phrase "In a usual week, how much do the people in your family do things with you?" introduces seven items which assess mothers, fathers, and brothers/sisters physical, emotional, and psychological support for exercise. Items included "praise me for exercising," "complain about me exercising," and "exercise with me." Five items were assessed for peers; this section is preceded by the phrase "During a normal week, how much do your friends do these things with you?" Response choices are never (0), sometimes (1), often (2), and don't know (0). The instrument's total score is the sum of all items, as negative item are reverse scored.

The Exercise Role Model Scale for adolescents is a 12-item Likert-like scale was used to assess the involvement of parents, siblings, and the youth's best friend in weekly exercise (Pender, n.d.). It was based on the concept that significant others' exercise behaviors influence adoption and maintenance of exercise in the adolescent. Items are preceded by the question, "In a usual week, how much do the following people (mother, father, brother/sister, and best friend) exercise?" Response choices evaluated levels of exercise (light, medium-hard, and hard) in relation to never (0), sometimes (1), often (2), and don't know (0). The instrument's total score was obtained by summing the responses.

Test-retest reliability for the instruments has been reported (Pender, n.d.). The test-retest for the Exercise Norms Scale was .76, the Exercise Role Modeling Scale was .84, and the Exercise Social Support Scale was .82. The interpersonal influence scales were used in a recent study of adolescent girls. The authors (Robbins, Gretebeck, et al., 2006) reported Cronbach's alpha of .81 for the Exercise Role Model Scale and .86 for the Social Support Scale. The Exercise Norms Scale was altered to one item, so calculation of internal consistency was not possible. In a study of Mexican American and Hispanic middle school children, Frenn et al (2005) utilized the Role Modeling (friends and family) and Social Support Scales (friends, families, and classmates), Cronbach alphas were reported 0.73- 0.83 and 0.79-0.87, respectively and test-retest reliability 0 .735- 0.763 and 0.553-0.650.

Perceived Self-efficacy

Self-efficacy for physical activity was measured with Pender's (n.d.) 8-item Perceived Self-efficacy Scale (Self Regulatory Efficacy-Adolescent Version). The instrument, derived from Pender's HPM, measures participants' beliefs about their capability to exercise. The scale stem asked the participant to respond to "how true is each sentence about you" on a five point Likert type scale ranging from "Not true at all" to "Very true." Items included "I could exercise even if I was tired" or "I could exercise even if I was not in the mood."

The instrument was developed for and used in 1995 study of racially diverse middle-school adolescents ages 11-14 (Garcia et al., 1995). Reliability derived from test-retest and internal consistency was reported. At five to seven days test-retest reliability among adolescents was 0.77. Cronbach's alpha was 0.87 (Garcia et al., 1995; Pender, n.d.). No published studies using this scale have included Mexican American adolescents.

Health Promoting Measures

Physical Activity

Physical activity was measured with accelerometers, electronic devices that objectively measure accelerations caused by body movement. These instruments record accelerations that are converted by microprocessors to quantifiable digital signals or "counts". The Actical Physical Activity and Caloric Expenditure Monitoring System (Respironics-Minimitter, Bend. OR) was used for this study. This instrument provided calculated energy expenditure values for active energy expenditure (AEE) in kilocalories and total energy expenditure in metabolic equivalents per time (METS) in kilocalories/min/kg providing a measure of physical activity over time. The sealed, waterproof device was worn around the waist. Acquired physical activity information was downloaded through a computer port interface.

Reliability and validity of the instrument has been reported in studies with preschoolers (Pfeiffer, McIver, Dowda, Almeida, & Pate, 2006) and adolescents (Heil & Kippell, 2003). In a 2005 study, researchers examined the relationship between accelerometer counts and indirect calorimetry VO_2 (ml/kg/min) (Pfeiffer et al.). Eighteen children wore the Mini-mitter accelerometer and a portable metabolic analyzer (Cosmed $K4b^2$; Rome, Italy) during resting and structured activities (slow walk, brisk walk, and jog) for the purpose of calibrating the accelerometer. Additionally, the researchers determined the cut-points for moderate and vigorous physical activity. Results indicated the Moderately Vigorous Physical Activity (MVPA) cutpoint was 715 counts/15 seconds; sensitivity=97.2%, specificity=91.2 %. The Vigorous Physical Activity (VPA) cutpoint was 1410 counts/15 seconds; sensitivity=98.2 %, specificity=61.4 %. The correlations between measured VO_2 and that predicted by accelerometer counts from the prediction equation were moderately high; intraclass correlation (ICC) r = 0.59, Pearson r = 0.75 ($p<.001$), Spearman r = 0.80 ($p<.001$). The modified Kappa for MVPA was 0.46, and was 0.71 for VPA. The ICC assesses rating reliability by comparing the variability of different ratings of the same subject to the total variation across all ratings and all subjects.

Algorithms for predicting activity energy expenditure (AEE) using the output of the Actical accelerometer were validated in children and adolescents during laboratory testing (Heil & Kippel, 2003). Researchers examined the relationship between accelerometers and VO2 max (SensorMedics Corp., Yorba Linda, CA.) in 24 children and adolescents aged 8 to 17 years of age. The participants wore the accelerometers on their wrists, ankles, and hips as they performed sedentary, light, moderate, and vigorous activities. Data from all body sites (ankle $R=0.80$, hip $R = 0.89$, and wrist $R = 0.89$, $p < 0.001$) provided accurate predictions of AEE.

Physical Fitness

Physical fitness was measured by a direct observation technique, cycle ergometry with corresponding VO2 measurement. This progressive exercise test concludes with occurrence of symptoms of exertion or time-limited maximum. Computer assisted measurements were obtained including oxygen intake and CO2 output, ventilation patterns, heart rate, blood pressure, and participant rated perceived exertion. Considered a primary measure or criterion standard, this technique produces a measure of physical fitness, an indirect indicator of physical activity (Sirad & Pate, 2001).

Exercise testing was performed at the UCI Clinical Translational Science Center Applied Physiology/Human Performance Core Laboratory; each subject underwent testing during the visit to the Center. Measurements were made of O2 intake and CO2 output, ventilation and breathing pattern, heart rate and blood pressure, and rating of perceived exertion. The ventilatory anaerobic threshold was identified. Predictive data were derived for measurements at maximal and submaximal exercise.

Subsequent to collection of all other data, each participant had cardiac electrodes placed on his chest. The participants were fitted with a nose clip. An explanation of the procedure was completed by the exercise physiologist who performed the testing. Fitness was assessed using a ramp-type progressive exercise test on an electronically braked cycle ergometer (SensorMedics Ergoline 800S, Yorba Linda, CA). The work rate was increased by 10 W per min (or adjusted according to the subjects' age and fitness level) so that the total exercise time roughly equaled 12-14 minutes. Each participant exercised to the limit of tolerance; measures of heart rate, breath to breath gas exchange, and peak VO2 were collected at pre-determined intervals during testing (Nemet et al., 2003; Sirad & Pate, 2001).

Biological Variables

Cardiovascular Biomarkers

C-reactive protein (CRP), adiponectin, and leptin blood levels were measured with Enzyme-Linked Immunosorbent Assay (ELISA), an in vitro method utilized to determine the quantity of a specific analyte in a liquid biological sample at the UCI Clinical Translational Science Center Laboratory. Primarily utilized for diagnostic purposes, ELISA is based on the addition of a simply assayed-enzyme conjugated to an antibody specific for the antigen or protein to be detected. Following the addition of a final reactant the amount of the molecule of interest in the sample is detected by chemiluminescence (Conley & Portugal, n.d.; Lequin et al., 2005; Wu et al., 2006).

Enzyme Linked Immunosorbent Assay requires that a protein or antigen-specific (capture) antibody is purified and affixed to a matrix on the bottom of a microtiter plate. An antigen or a protein is applied to the plate and allowed to bind with an epitope of the attached antibody (Janeway, Travers, Walport, & Shlomchik, 2001). After a specified time-interval unbound antigens are removed through a washing procedure (Janeway et al.). Subsequent to drying through suctioning, the enzyme-linked detection antibody is applied to the plate and attaches to a different epitope on the surface of the antigen or protein; the antigen/protein is now "sandwiched" between the capture and detection antibodies (Janeway et al.). Alternatively through an additional step, an enzyme labeled secondary antibody can be utilized to attach to the detecting antibody. Since the secondary antibody can bind to the Fc region of multiple other antibodies, this method is more cost effective and expands the types of proteins/antigens which can be tested (Chemicon, 2007). Following incubation, washing, and suctioning, dry a colorimetric reagent is added to the plate (Janeway et al.). In the final step, the color change was measured photometrically and compared by computer analysis against a standard curve to determine the sample's antigen or protein concentration (Janeway et al.; Chemicon).

Color production occurs at the culmination of the testing procedure (Janeway et al, 2001). As a result of the interaction between the enzyme-label and the colorimetric reagent, increased levels of the enzyme produce more color (Conley & Portugal, n.d.). Since the enzyme is coupled to the secondary antibody, increased levels of enzymes were associated with increased levels of secondary antibodies (Conley & Portugal). Secondary antibodies directly reflected the numbers of antigens to which they were bound (Conley & Portugal.). Thus the color change was an indirect indication of the amount of antigen/protein initially present in the sample (Conley & Portugal).

Sensitivity of the Sandwich ELISA is determined by four variables (Chemicon, 2007; Diagnostic Systems Laboratories, 2003). An issue with any of the four can negatively affect results. Incompatibility between either of the antibodies and antigens/proteins will result in less than expected levels of the antigen (Chemicon). An inadequate or surplus amount of capture antibody molecules bound to the matrix provides results demonstrating concentrations that are higher or lower than actual (Chemicon; Diagnostic Systems Laboratories, 2003). Finally, activity levels of the detecting antibody can be altered; this condition is often attributable to the number and type of labeled molecules contained within the conjugate solution (Chemicon). Reported mean sensitivity of the C-reactive protein is 0.010 nanograms/mL (ng/mL) with a range of 0.005ng/mL to 0.022 ng/mL (R & D Systems DCRP-OO, 2008). Mean sensitivity of adiponectin is 0.246 ng/Ml with a range of 0.079 ng/mL to 0.891 ng/mL (R & D Systems DRP 300, 2008). Mean sensitivity of Leptin is 7.8 pg/mL (R & D Systems DRP00, 2008). Specificity was reported for each biological marker. No cross reactivity or interference was noted for any of the analytes.

Body Composition

Body Mass Index

Body mass index was calculated by dividing weight in kilograms (kg) by height in square meters (kg/m^2). A stationary scale was used to measure weight recorded to the nearest 10^{th} of a kg. Participants removed shoes and stepped onto the scale. Weight was obtained while the adolescent stood motionless with feet slightly apart and with weight equally distributed on both feet. To determine height, participants stood tall, held their breath, and looked straight ahead while they were measured with a stadiometer. Height was recorded to the nearest centimeter. Height and weight was recorded on the Anthropometric Measurement Form and reported to the participants and in the case of minors, their parents.

Centers of Disease Control and Prevention (CDC) criteria were used to determine BMI values by percentile for age. BMI categories were used to describe the sample. Participants were identified as underweight with a BMI percentile less than the 5^{th} percentile, normal weight from the 5^{th} to 84^{th} percentile, "overweight" with a BMI greater than or equal to the 85^{th} but less than the 95^{th} percentile, and obese if BMI values were greater than or equal to the 95^{th} percentile

(Centers for Disease Control and Prevention, 2011). The BMI percentiles for age were analyzed as a continuous variable. Calculation of BMI percentiles for age were performed using the SAS program provided by CDC and accessed from the CDC website (Centers for Disease Control and Prevention, 2004).

Body Fat

Dual-energy X-ray absorptionmetry (DEXA) was used to measure body composition. This method, developed in the 1990s, is routinely used to determine indices for bone conditions such as osteoporosis or osteogenesis imperfecta (Heyward & Wagner, 2004). DEXA has expanded use in that it provides data about estimates of total bone mineral density and content, body fat percentages, and lean tissue mass. Determination of body composition for Hispanic males from DEXA scans has been validated by a study of multi-ethnic male youth (Ellis, 1997). Reported results indicated higher body fat among Hispanic adolescents than in their Caucasian and African American counterparts.

DEXA is based on the principle that weakening or attenuation of X-rays with high and low-photon energies is measureable and varies according to the density, thickness, and chemical composition of underlying tissues. The attenuation ratios for the different energies are constant for all individuals (Pietrobelli, Formica, Wang, & Heymsfield, 1996). Several factors influence DEXA interpretation (1) soft-tissue composition is calculated from pixels that do not contain bone, therefore in areas with a large bone mass fewer pixels are used to determine the amount of soft-tissue mass and thus may over estimate the amount of lean tissue, (2) hydration status of the individual may affect DEXA measurements, for example, a 5% change in the fat free mass' water content can affect body fat percentage estimates by 1%-2.5% (Lohman, Harris, Teixeira, &

Weiss, 2000), and (3) techniques to measure body fat in overweight individuals who do not fit the scanning area are not completely developed (Brownbill & Ilich, 2004).

Accuracy of DEXA scans is enhanced by preparation of the operator, instrument, and participant (Heyward & Wagner, 2004). On testing days, calibration of the DEXA scanner must be completed with a manufacturer-provided calibration marker. Participant clothing and positioning can affect results; light weight clothing provides the most accurate results. Appropriate participant positioning on the scanner bed for a supine, anterior-posterior, head to toe exam enhances scan quality. Body thickness measurements must be obtained and appropriate scanning adjustments made for those participants who sagittal abdominal diameter (SAD) is greater than 27 cm. Additionally assessing DEXA scan's validity is difficult because each one of the three manufactures has different models with multiple software versions.

In this study fat mass was determined with a Hologic QDR 4500 densitiometer (Hologic, Inc., Bedford, MA); this fan beam system scanner rapidly produced a high resolution, precision image (Gagnepain, Clary, Grando, & Kotzki, n.d.). The scan was completed by a technician who received training in the operation of the scanner. Participants were scanned while lying supine and in light clothing. DEXA scans were performed and analyzed using pediatric software. On test days, the DEXA instrument was calibrated following manufacturer provided procedures.

Institutional Review BoardS

In order to ensure protection of human subjects, permission to conduct this research was obtained from the University of Arizona Institutional Review Board and the University of California Irvine Institutional Review Board. Approval to recruit subjects was obtained from the Fullerton and Santa Ana Boys and Girls Clubs. Additional youth was recruited from the

“Healthy for Life Program”, a school-based program of youth who have volunteered to participate in various programs directed at improving health. Permission to contact these youth was obtained from the program director.

Data Collection Plan

Recruitment and Informed Consent

The program director of “Healthy for Life” mailed a letter to potential participants’ parents of minor participants of the Healthy for Life program explaining the study and inviting participation. Additionally, teachers working with these students received a letter explaining the study. The investigator then waited for participants to contact her. Flyers explaining the study were prepared for the Boys and Girls Club of Santa Ana and letters were prepared for distribution to interested parents.

If an individual expressed interest in participating and met study criteria, the principle investigator further explained the study to each adolescent and his parents. Prior to data collection, informed consent was obtained from the parents or guardians of minors of participants less than18 years of age. Consents were also obtained from participants 18 years of age or greater. Assent was obtained from minors. A Spanish translator was available to answer questions and obtain consents from parents. The principle investigator scheduled appointments and coordinated data collection.

Data Collection Protocol

Data Collection was limited to one visit at the exercise clinic. Three days following the exercise clinic visit the principle investigator coordinated return of the accelerometer. The adolescent and parent were given a scheduled appointment at the Applied Physiology/Human

Performance Core Laboratories. Informed consent and assent was obtained or verified prior to data collection. Parental or participant questions were answered. The participant was placed in a quiet area within the facility and given the demographic and psychosocial instruments. Written instructions were provided for all paper and pencil instruments. Demographic data were checked for missing data immediately following completion, in the event data were missing, the participant was asked if he intended to leave items unanswered. For all other questionnaires the participant was instructed to read each item and select his response by placing a check in the appropriate box in the response column.

Subsequent to completion of written instruments, the participant was weighed and height was obtained. The scale and stadiometer were self-calibrating; the medical center's biomedical technicians verified calibration quarterly. Information was recorded on the Anthropometric Measurement Form.

Next the participant had blood samples collected. Study samples were collected, processed, and stored according to manufacturers' instructions (R &D Laboratory Systems). Serum samples which possess fewer contaminants than plasma were used (Janeway et al., 2001). Blood was collected by direct phlebotomy by laboratory personnel into two serum separator tubes and immediately transported to the cytokine laboratory. Once in the cytokine laboratory, a small sample of blood was removed to perform a point of care lipid panel. The remainder of the sample was allowed to clot for 30 minutes, and then centrifuged for 10 minutes as 1000 x g. Serum and was removed immediately and aliquoted. Samples were stored at -80°C. Dilution of specimens, as necessary was provided prior to assay (R & D Systems). Assay was completed by the principal investigator and laboratory staff members who routinely performed ELISA testing.

Following blood collection, and subsequent to receiving a snack, the participant accompanied the DEXA technician to the DEXA scan laboratory. Verbal explanation of the procedure was provided by the technician prior to and, as appropriate, during the procedure. DEXA results were placed in the participant's record.

Following the DEXA scan, the adolescent returned to the Applied Physiology/Human Performance Core Laboratory. The physical fitness assessment consisting of cycle ergometry withVO2 max was completed. An exercise physiologist explained the procedure. Cardiac electrodes were placed on the adolescent's chest and a nose clip will be fitted on the youth. The adolescent was instructed to pedal to his maximum ability. The test lasted approximately 10-12 minutes. Following the exercise challenge, the participant was provided with a light snack. Before discharge from the exercise laboratory, an accelerometer was placed on the adolescent. An instruction sheet detailing placement, care, and return of the accelerometer was given to the participant. An appointment to retrieve the accelerometer was arranged with the adolescent and parent or guardian.

Data Analysis Plan

Data Management

The principle investigator assumed full responsibility for data management including data input, data cleaning, and maintenance of records. These records included copies of approvals, permission, informed consents and assents, data and records of any adverse events or problems until all participants reach their 21st birthday. Confidentiality of information was assured by the principle investigator. Identifying data was secured in a locked cabinet inside a locked office. Data access was limited to the principle investigator and during data collection, staff of the

CTSC. Computerized data has been secured on a secure server with firewall and password protection. Identifying information has been replaced by a number code

Data was assessed for completeness and outliers. Missing data was assessed for type of missingness. Based on instrumentation and the sample, the most probable situation was data missing at random (Figueredo, McKnight, McKnight, & Sidani, 2000). This category of missingness is best managed by data imputation with either substitution from the mean of group responses or coding with dummy variables. Data outliers have been assessed by comparing results to the individual's results on other psychosocial and biological testing. Multiple unrelated variables can affect biological results; therefore significant biological variable outliers, such as those which are physiologically improbable, have been examined. None needed to be omitted from the study.

Data were into the data analysis program, SPSS- version 19 as soon after the visit as possible. Data were entered into duplicate files and was regularly reviewed and reconciled. Missing data were identified and managed after all data was collected. Subsequent to all data collection and cleaning, data were analyzed to addressed study aims and research questions.

Demographic data, including acculturation levels, were used to describe characteristics of the sample. Descriptive statistics, inclusive of measures of central tendency, were used to report demographic variables.

Research Questions

The first research question was: Are perceived benefits and barriers of action, and interpersonal influences and perceived self-efficacy significant predictors of physical activity in Mexican American middle and late adolescent males? The third research question was: Are perceived benefits and barriers of action, and interpersonal influences and perceived self-efficacy significant predictors of physical fitness in Mexican American middle and late adolescent males? The first and third research questions addressed the test of the Winokur Biobehavioral Model, as the analysis allowed assessment of the influence of the independent variables (perceived benefits and barriers, interpersonal influences, and self-efficacy) on physical activity and physical fitness (dependent variables) using multiple regression equations (Munro, 2005). Standardized beta was used as the value for the path coefficient; this process allowed comparison of the magnitude of the influence among independent variables. The level of significance was set at 0.10. First a Pearson correlation matrix was generated to assess the relationship among (1) measures of perceived benefits and perceived barriers and (2) the instruments indexing interpersonal influences: exercise norms, social support for exercise, and exercise role modeling. Correlations were generated to examine the strength and direction of the relationships prior to entering the variables into the multiple regression equation.

The second research question was: Does self-efficacy mediate the relationship between perceived benefits and barriers of action and interpersonal influences and physical activity in Mexican American middle and late adolescent males? The fourth research question was: Does self-efficacy mediate the relationship between perceived benefits and barriers of action and interpersonal influences and physical fitness in Mexican American middle and late adolescent males? Multiple regression was used to test for the mediator effects of self-efficacy. Mediator variable testing is restricted to situations where a significant effect exists between the independent and dependent variable (Bennett, 2000). Three regression equations are utilized to test for a mediator effect. In the first equation the independent variable is entered with the mediator variable; the second equation contains the independent variable and the dependent variable, and in the final equation the independent variable and mediator variable are entered simultaneously with the dependent variable (Bennett). A mediator effect is present if 1) the mediator is a significant predictor of the dependent variable and 2) the direct relationship of the independent variable is less significant than it was in the second equation. Standardized beta was used as the value for the path coefficient; this process allowed comparison of the magnitude of the influence among independent variables. The level of significance was set at 0.10.

The fifth research question asked: Is physical activity a significant predictor of endothelial function in Mexican American middle and late adolescent males? The seventh queried: Is physical fitness a significant predictor of endothelial function in Mexican American middle and late adolescent males? In order to test the influence of physical activity and physical fitness on endothelial function, several regression equations were conducted. C-reactive protein (CRP), adiponectin, and leptin were separately regressed on to physical activity and then physical fitness (Munro, 2005). Standardized beta was reported for the path coefficient. Level of significance was set at 0.10. Pearson's correlation was also reported to describe the relationship among leptin, adiponectin, and CRP and served as a measure of construct validity.

Research Question 6 questioned: Is physical activity a significant predictor of body fat in Mexican American middle and late adolescent males? Research question 8 asked: Is physical fitness a significant predictor of body fat in Mexican American middle and late adolescent males? In order to test the effect of physical activity and fitness on body fat separate regression equations were used. Body mass index and fat mass were separately regressed onto physical activity and then physical fitness (Munro, 2005). Standardized beta was used for the path coefficient. Level of significance was set at 0.10. Pearson's correlation was also reported to describe the relationship among BMI and fat mass and served as a measure of construct validity.

Summary

This chapter described the methodology for the study including the study design, variables, and data analysis plan; sample inclusion and exclusion criteria and study setting were also described. A descriptive cross-sectional design was selected to test the model and describe the association between perceived benefits and barriers to physical activity, interpersonal influences, and perceived self-efficacy for physical activity and the proximal outcomes physical activity and fitness, and the distal biological outcomes. Measures for the demographic data and each concept were described. Finally, data collection and analysis plans were described for each of the research questions.

CHAPTER 4: RESULTS

The importance of cardiovascular health promotion among children and adolescents is widely recognized. However, the factors responsible for engaging in physical activity, eating well, and maintaining a healthy weight in early life have not been adequately explored. Research is more limited among culturally diverse groups such as Mexican American adolescents.

The purpose of this study was to describe the relationship among specified psychosocial concepts and objective measures indicative of cardiovascular health in a sample of adolescent Mexican Americans. Chapter four describes the study results, including a description of the sample and the results of testing the study aims.

Sample

Recruitment

Study recruitment began after Human Subjects Approval was obtained. A convenience sample of 62 participants was calculated as being optimal for the study. Thirty seven potential male participants were screened for inclusion and exclusion criteria. Eight participants did not meet the age inclusion criterion as they were either older than 19 years of age or younger than 15 years of age. One participant met criteria and initially agreed to participate. Prior to his enrollment, he withdrew citing new health related issues. A final sample of 28 participated in the study protocol.

The Boys and Girls Club of Santa Ana and the Healthy for Life Program were initially planned as the primary recruitment sites. Between the time of the agreement and receipt of Human Subject’s approval, the Boys and Girls Club of Santa Ana changed leadership and withdrew from the project. Healthy for Life’s program administrator contacted all school and after school sites (Fullerton and Anaheim Boys and Girls' Club); he also distributed letters to students, parents, and program faculty. Only one student was recruited from Healthy for Life.

Additional sources of recruitment were sought. The principal investigator attended and recruited at a conference sponsored by the Hispanic Nurses Association that focused on introducing Hispanic adolescents to health care careers. Four participants were recruited at this conference. The most profitable source of recruitment was a local community college. The principal investigator requested and received permission from the Rancho Santiago Community College District to recruit on campus. Participants were either approached on campus or responded to a flyer that was posted in several campus locations. A total of 16 were recruited from the community college site. Seven participants were referred from health care professionals. One participant was referred from Latino Health Access. Finally, three were referred from other subjects. The final sample size was 28 participants.

Sample Characteristics

Demographic information was collected to describe the sample. Participants were asked to complete a set of questions to obtain information including age, ethnicity, school grade, living situation, birth order, and acculturation. Use of medication and general health was obtained to determine eligibility for the study.

All 28 participants were Mexican American males ranging from 15 to 19 years of age (mean 17.43 $\pm$ 1.28). Thirty-six percent of participants were minors. All were able to speak and read in English. Minor's parents were able to read English and/or Spanish. The participants' education ranged from 10-15 years (mean 12.18 $\pm$ 1.29), and most had already completed high school. All participants except one were currently attending school.

All of the adolescents were residents of Southern California. Two were from Los Angeles County, all others (N = 26) resided in Orange County. All participants except one who was born in Mexico reported place of birth as California. English was the most common language spoken at home in a little over one third of the sample (n = 10, 36%); 32% (n=9) of participants identified Spanish as the primary home language while an additional 32% (n=9) identified a combination of English and Spanish as being spoken at home.

All participants lived in a family environment. Almost half lived with both parents (48 %), 35% lived in single parent homes with their mothers, 7 % lived in single parent homes with their father. One participant lived with his older brother's family, another with his wife and her family. The majority (93%) of the participants had at least one sibling; 43 % had between one and five younger siblings. For birth order, 22 % of the sample reported being the oldest child in the family while 42 % of the participants were the youngest child.

Vital Sign Measures. Health data collected included blood pressure, heart rate and respiratory rate. The average blood pressure was 120/64 (SD=9.68 (SBP) and SD=7.00(DBP). Average heart rate was 63 (SD= 8.79). Blood pressure, pulse, and respiratory rate were within normal ranges for all participants (Kliegman, Stanton, St. Geme, Schor, & Behrman, 2011). Mean participant height was 68.5 ± 3.2 inches (174.8 ± 7.1 cm); mean weight was 164.4 lbs. (74.85kg).

Anthropometric Measures. Height and weight were obtained to calculate body mass index. Mean participant height was 68.5 ± 3.2 inches (174.8 ± 7.1 cm); mean weight was 164.4 lbs. (74.85 kg). Anthropometric measures are discussed in detail in the section on body composition.

Glucose and Lipid Measures. Fasting blood glucose ranged from 81 to 114 with a mean glucose of 93 (SD=8.06). All values were within the normal range for age (Kliegman et al., 2011). All participants had normal total cholesterol with levels below 170 (AHA, 2011). Optimal HDL levels are greater than 60; however the normal range begins at 35. A total of 64% (n=16) of the sample had HDL cholesterol above 35; none had HDL cholesterol levels above 60. The ratio of total cholesterol (TC) to HDL cholesterol is less than 5; optimal measures are considered less than 3.5. The majority of the sample (n=22, 78%) had ratios of 3.5 or less. Two participants had cholesterol ratios greater than 5. Both participants were counseled to follow-up with their health care provider. One participant had an elevated triglyceride level; he also had the highest total cholesterol/HDL cholesterol ratio (TC/HDL). This adolescent was counseled to seek follow-up with his health care professional.

Table 1. Anthropometric, Glucose, and Lipid Measures (n=28)

	Mean ± SD	Range	Normal Values
Anthropometric Measures			
Height	68.5 ± 3.2 inches	60.65 – 76.4	N/A
Weight	164.38	117.3 -240.9	N/A
BMI (raw data)	24.3± 3.99	18.4-33.20	< 25
BMI (percentile)	63.21 ± 31.6	2-98	5 - 85
Fasting Glucose	93 ± 8.06 mg/dl	81 – 114 mg/dl	80-120 mg/dl
Total cholesterol HDL cholesterol Triglycerides	115.61 ± 16.20 mg/dl 37.54 ± 9.04 mg/dl 62.25 ± 48.08 mg/dl	99-157 mg/dl 22-55 mg/dl 49-302 mg/dl	< 170 mg/dl >35 mg/dl; optimal >60 mg <150 mg/dl

Ratio TC/HDL	3.23 ± .86	2.10-5.84	< 5

Perceived Health Status. Perceived Health was measured by a Likert-like scale where participants were asked to rate their health as healthy (4), mostly healthy (3), somewhat healthy (2), not at all healthy (1). Table 2 displays the frequencies and percentages of the sample for perceived health status.

Table 2. Perceived Health Status (n=28)

	Frequency (n)	Percent (%)
Healthy	14	50%
Most Healthy	7	25
Somewhat Healthy	6	21
Not at All Healthy	1	4

Most participants rated themselves as healthy or mostly healthy (75 %). One participant rated himself as not at all healthy. This participant had the highest BMI, triglyceride level, and worst TC/HDL cholesterol ratio.

Acculturation. Acculturation was assessed with The Brief Acculturation Rating Scale for Mexican Americans –II (Cuellar as cited in Bauman, 2005). This 12-item scale was developed for Mexican American adolescents. Each scale item is presented in both English and Spanish. The instrument has 2 six-item subscales; one measures an Anglo orientation (AOS) and the other measures a Mexican orientation (MOS).

Orientation was calculated using both the linear and orthogonal methods. The linear orientation was determined by subtracting the mean of the Mexican orientation items from the mean of the Anglo orientation items. Linear orientation has predetermined ranges from one through five. Level one is correlated with the highest Mexican orientation and five is associated with the highest Anglo orientation. The participants' raw scores ranged from -0.5 to 3.5 with a mean of 1.51 ± 1.00. Linear orientation level ranged from 2 – 5 with a mean of 3.71 ± .85, demonstrating that participants had a greater Anglo orientation. Table 3 reports acculturation scores with the linear level method.

Table 3 :Acculturation: Linear Level Scores (n=28)

	Possible Range	Range	Mean ± SD
Raw Scores	<-1.33 – >2.45	-0.5 – 3.5	1.51 ± 1.00
Linear level cultural orientation	1 – 5	2 – 5	3.71 ± .85

The orthogonal perspective is a bi-dimensional approach which reflects affinity to both the heritage and the mainstream cultures simultaneously (Bauman, 2005). Orthogonal categories classify participants into four defined categories based on their Mexican orientation and Anglo orientation scores. Scores outside these values are assigned an unclassified category. Over one third (36%) of the participants were categorized as unclassified, indicating no clear association with any of the defined categories. Assimilated individuals or those who were highly bicultural accounted for 29% of the sample. No one was classified as 'traditional. Table 4 reports the orthogonal derived orientation.

Table 4. Acculturation: Orthogonal Scores (n=28)

	Frequency	Percent
High biculturals	4	14
Assimilated	8	29
Low biculturals	6	21
Unclassified	10	36

In summary, the adolescents were 17 year old Mexican Americans born in the United States and spoke English; they lived in a family environment and attended school. All had normal fasting blood glucose levels, and almost all had normal body weights and fasting lipid panels. They considered themselves to be healthy and held an Anglo orientation

Psychosocial Concepts

The psychosocial concepts in the Winokur model were measured using instruments developed for an adolescent population by Nola Pender, PhD (Pender, n.d.). Range, mean, and standard deviation of the instruments measuring psychosocial variables were calculated using SPSS – version 19. The normal ranges in Table 5 were provided by Pender.

Table 5. Item and Scale Means and Ranges for Psychosocial Concepts. n = 28

	Mean ± SD	Range	Normal Range
Perceived Benefits of Physical Activity	3.44 ± .34*	2.9 - 4.0	1 -4
Perceived Barriers of Physical Activity	1.85 ± .51*	1.11-3.0	1-4
IPI Exercise Norms Scale	4.89 ± 3.12**	0 - 10	0-10
IPI Social Support for Exercise Scale	1.97+ .42*	1 to 3.0	1-3
IPI Exercise Role Model Scale (total)	9.92 + 4.76**	0 – 19	0 - 24

Self-efficacy: Self-Regulatory for Exercise Scale	4.15 + .67*	1-5	1-5

∗ Item Mean   ∗∗ Total Scale Mean   IPI = Interpersonal Influence Measure

Perceived Benefits of Physical Activity

The Perceived Benefits of Physical Activity – adolescent version scale describes the individual's perception about the positive value of exercise (Pender, n.d.). The 10-item instrument uses a 4 - point Likert-like scale with scores ranging from 1 representing not at all true to 4 indicating very true (Pender, n.d.). The instrument is scored by adding individual item selections and calculating an item mean.

The sample's mean score was 3.44 ± .34 (range 2.9 to 4.0) indicating a high level of perceived benefits of exercise. Item scoring ranged from 1 (not at all true) to 4 (very true). The item reflecting exercise/physical activity as an opportunity to play or be active scored the highest (3.75). Other high scoring items reflected the beneficial effects of exercise for the individual. These included 'take care of myself, be healthier (3.71) and improve or have more athletic skills (3.71).

There was a demonstrated correlation between perceived health and perceived benefit of exercise; participants who perceived themselves to be healthiest reported the greatest perceived benefit from exercise (X2 (df) = -.412, p = 0.03). Perceived benefits of exercise were also correlated with orthogonal acculturation. Those with the highest level of acculturation level reported the greatest perceived benefit of exercise (X2 (df) = -.-.375, p = 0.05).

The item with the lowest overall score (2.96) stated that physical activity or exercise allowed others to see the individual's athletic skills or fitness. A statistically significant relationship between age and this item was found X^2 (df) = 14.993, p = 0.02; those who were youngest (15 and 16 years of age) scored this item higher than those who were 18 and 19.

Perceived Barriers of Physical Activity

The Perceived Barriers of Physical Activity –adolescent version scale was used to describe the participant's perceived barriers to physical activity. The 10-item instrument uses a 4- point Likert-like scale with item scores ranging from (not at all true) to 4 (very true) (Pender, n.d.). This instrument is scored by adding all item responses and calculating an item mean. The higher the mean score the greater the perception of barriers to physical activity.

The item mean score was 1.85 $\pm$ .51 indicating a relatively low perception of barriers among participants. Item mean scores ranged from 1.11 to 3.0. Responses demonstrated some commonalities across the group. The most common barrier for not exercising was being too busy (2.39), followed feeling tired or lazy (2.29). Feeling self-conscious (2. 07) was the third highest reason selected as a barrier to physical activity. The obstacle with the lowest score was that physical activity is hard work (1.43).

Interpersonal Influences

Interpersonal influences (IPI) for exercise were measured with three instruments: The Exercise Norms Scale, Exercise Social Support Scale, and the Exercise Role Modeling Scale (Pender, n.d.). All scales were developed for and tested specifically for adolescents.

Exercise Norms Scale. The Exercise Norms Scale was used to assess the adolescent's perception of significant others' expectation of his exercising; significant others include parents, siblings, friends, teachers, and personal physician (Pender, n.d.). The 5-item instrument utilizes a three point Likert-type scoring of options of 0 (not at all), 1 (sort of), and 2 (a lot). The scale was scored by adding all items and calculating a total scale mean. A maximum score of 10 could be obtained.

The total scale mean was 4.89 ± 3.14, indicating a less than moderate expectation of exercise participation. The participant's personal doctor was rated the highest as expecting exercise (1.29 ± .76) followed by family members (1.14 ± .75); participants' teachers were rated the lowest at (.57 ± .79).

Exercise Social Support Scale. The Exercise Social Support Scale examined support of the participant's mother, father, siblings, and friends for exercise. The 26-item three point Likert-like Scale measures whether there is 1 (never), 2 (sometimes), or 3 (often) support for various aspects of physical activity. Four items are reversed scored. In cases where the participant had a deceased parent or no siblings, the mean was calculated minus these items.

The item mean score for the sample was 1.97 + .42 indicating a moderately high support for exercise. Findings demonstrated that praise for exercise was highest from the mother (2.07 + .86), followed by friends (1.86 + .8) and siblings (1.73 + .78). Fathers gave the least praise (1.69 + .84). Highest participation in exercise activities were with friends (2.54 + .77). Criticism or complaining about exercise was reverse scored (never = 3, sometimes = 2, often = 1). Complaining about or criticizing the participant for exercising occurred least from siblings (2.92 + .27), then friends (2.82 + .48), followed by father (2.77); mothers had the highest rate of complaining about or criticizing the participant for exercising (2.68 + .67).

Exercise Role Model Scale. The Exercise Role Model Scale measured the intensity and frequency of exercise that important others engage in during a week. Participants were asked to indicate the intensity and frequency of their mothers, fathers, siblings, and friends' exercise.

Intensity level choices were little effort, medium hard, and hard; examples of each level were provided. Frequency was rated as 0 (never), 1 (sometimes), 2 (often). The instrument is scored by totaling all12 items with a possible range of 0 to 24. Data was imputed for participants who indicated that they had a deceased parent or did not have siblings.

The participant's total scores ranged from 0 to 19. The mean score was 9.95 $\pm$ .49 indicating important others sometimes exercised. The highest exercise frequency was among friends, 53 % of whom exercised often at a high intensity and 29 % who sometimes exercise at a high intensity. Parents had the lowest reported exercise at all intensity levels. Only 10.7% of mothers and fathers exercised often at a hard level; 28% of participants indicated that their mothers did not exercise at any intensity level.

Self-regulatory for Exercise Scale

Self-efficacy was examined using the Self-Regulatory for Exercise Scale which was developed and tested specifically for exercise (Pender, n.d). The 8-item instrument used a 5-point Likert-type scale with options of 1(not at all true), 2 (not very true), 3 (in-between), 4 (sort of true), and 5 (very true) describing factors that influence exercise participation. Each item begins with the statement, "I could exercise even if…" The instrument was scored by adding all items and then calculating an item mean.

The item mean score was 4.15 $\pm$ .67, indicating the participants reported a high level of exercise self-efficacy. Two items shared the lowest mean sample score (3.89), "other things to do," and "feeling lazy" while the highest individual item score was "I could exercise even if I needed to exercise alone" (4.5). Item means for the participants ranged from 2.38 to 5.0.

In summary, the adolescents perceive a high level of benefits and low level of barriers for physical activity. The three measures of interpersonal influences on physical activity indicated that expectation for exercise and support for exercise was not high. In addition the frequency and intensity of significant other's exercising also was highly role modeled by significant others. Parents provided the least support, the greatest criticism and the least role modeling of exercise for the adolescents. All indicated that they felt confident in undertaking physical activity.

Health Promoting Behaviors

Physical Fitness

Physical fitness was measured with a progressive exercise test, cycle ergometry with corresponding VO2 measurement. Considered a primary measure or criterion standard, this technique produces a measure of physical fitness. Computer assisted measurements were obtained including oxygen intake and CO2 output, ventilation patterns, heart rate, blood pressure, and participant rated perceived exertion.

This fitness measurement required the participant to ride a stationary bicycle with continuous computer measures of VO2 and heart rate. Raw measures indicate maximal performance during the 12-15 minute test. Data was stratified into 6 levels of fitness from very poor (< 35) to superior (> 55.9). The session ended when the participant reported that he was unable to pedal any longer or the pre-established time limit was reached. All participants completed the test; no adverse outcomes occurred.

Reported VO2 max raw scores ranged from 27.10 to 63.0; representing levels of very poor to superior physical fitness. The mean participant score was 39.10 $\pm$ 8.5 (fair 38.4 - 45.1), indicating a moderately low level of physical fitness for this group. Stratified results (table 6) indicate that the physical fitness of greater than 79 % of the participants was in the very poor, poor, and fair range. Only 6 participants performed at levels rated as good, excellent, and superior.

Table 6: Physical Fitness (n=28)

	Number of Participants	Percent
Very poor < 35	8	29
Poor 35-38.3	4	14.5
Fair 38.4-45.1	10	36
Good 45.2-50.9	4	14.5
Excellent 50.1-55.9	1	3
Superior 55.9	1	3

Physical Activity

Physical activity was measured with the Actical Physical Activity and Caloric Expenditure Monitoring System (Respironics-Minimitter, Bend. OR). Active energy expenditure, the energy unit measured by the accelerometer, is the number of kilocalories expended per minute per kilogram of subject's weight above the individual's resting metabolic rate (Actical, 2007).

Each participant was instructed to wear the accelerometer for 3 days. Data was downloaded using the Actical software (2007). Physical activity was reflected as spikes (activity counts) on the energy expenditure graphs. During 'awake time' spikes occurred in groupings or patterns, while during night time or when the participant did not wear the accelerometer, there was an absence of spikes. Custom intervals measuring energy expenditure were set to reflect the time the participant was awake. Custom intervals selected by the researcher were double-checked by comparing to estimates provided by the Actical software.

Participant's average energy expenditure, which was derived from activity counts, ranged from 0.35 kcal/minute to 1.21 kcal/minute. The groups' mean average energy expenditure was .75 ± .24 kcal/minute. Data from one participant was not recorded as the accelerometer was damaged during the time the participant was wearing it. Data was deemed non-recoverable by an Actical technician. Another participant did not wear the accelerometer on day two. Selected custom time intervals excluded day two for that participant and reported only days one and three.

Accelerometer activity counts reflect differences in intensity based on the height of the "spikes" on the energy expenditure graphs. Data was collected for sedentary, light, moderate, and vigorous levels; cut points for each level are automatically determined by the program for each individual. Total time in minutes of all activity levels was determined for each participant as well as minutes at each of the four intensity levels. Mean percentage of time at each activity level were calculated.

The majority of recorded activity was at sedentary (58.62 ± 12.49) and light levels (22.45 + 5.92). Sedentary level indicates a resting state such as watching TV; light level activity indicates low intensity of movement such as using a computer or eating (Actical, 2007). Only 8 of the 28 participants had any vigorous activity recorded by the accelerometer. The participant with the highest VO2 max (63.0) also had the greatest percentage of time (4.71%) at the vigorous level.

Table 7: Accelerometer Physical Activity Level Means and Percent (n=27)

Activity Level	Percentage of time (%)
Sedentary	58.62 ± 12.49
Light Activity	22.45 ± 5.92
Moderate Activity	17.38 ± 7.86
Vigorous Activity	.26 ± .92

Biological Variables

Laboratory Results

Laboratory specimens were drawn while the participant was fasting. A total of 16 ml of blood was collected. After removing a sample for lipid screening and blood glucose the blood was spun. Separated serum was moved into mini tubes labeled with a coded identification number and put into a freezer at – 80C.

Laboratory samples were tested using specific ELISA testing kits by laboratory personnel. All samples were analyzed by laboratory personnel. Controls were performed for each of the biological measure. Each participant's sample was separately tested for C-reactive protein (CRP), Adiponectin, and Leptin. Each participant's serum was placed into two separate wells of each of the ELISA plates. Individual results were reviewed to test concordance. The mean of the specimens was used as the participant's result. Coded specimen results were returned to the primary investigator.

C-Reactive Protein

C –reactive protein was tested using R & D System ELISA kit DCRP00. Immunoassay controls were achieved using purified NS0-expressed recombinant human CRP produced at

R&D Systems. Each participant's mean and individual results were reported. A standard curve was generated by the set of assayed samples. Results were reported in ng/ml. High CRP is associated with increased inflammation and a higher risk of cardiovascular disease.

Participants' CRP results ranged from 60.07ng/ml to 13154.60ng/ml. Mean for the entire sample was 1778.36 ng/ml (SD ± 2867.81). The manufacturer reported prior assay results from a healthy sample were a mean =1769ng/ml (SD ± 1214), range =109ng/dl-4291ng/ml. The mean CRP for the adolescents was considered normal.

The participant with the highest CRP (131154.60 ng/ml) had elevated body fat by BMI (28.90) but not by DEXA. No positive correlations were found between CRP and any other variables.

Adiponectin

Adiponectin was tested using R & D Systems ELISA kit DRP 300. Immunoassay controls were achieved using purified NS0-expressed recombinant human adiponectin produced at R&D Systems. Each participant's mean and individual results were reported. A standard curve was generated by the set of assayed samples. Results were reported in ng/ml. Higher adiponectin levels are associated with cardiovascular health. Participant adiponectin results ranged from 1,049.74 ng/ml to 23,343.08 ng/ml. Sample mean was 8832.34 + 2867.80. Manufacturer reported assay results from a previously tested healthy sample: mean =6641 ng/ml (SD + 3665), range =865ng/dl-21,424ng/ml. The mean adiponectin level for the adolescents was normal.

The participant with the highest adiponectin had a low DEXA-derived body fat, high perceived self-efficacy, and high perceived benefits of action. Unfortunately, due to accelerometer damage correlations with physical activity were not available.

Leptin

Leptin was tested using R & D Systems ELISA kit DLP00. Immunoassay controls were calibrated against a highly purified E. coli-expressed recombinant human leptin produced at R&D Systems. Each participant's mean and individual results were reported. A standard curve was generated by the set of assayed samples. Results were reported in pg/ml. Higher leptin levels are inversely related to cardiovascular health.

Participant leptin values ranged from 664.15pg/ml to 20,12.38 pg/ml with a sample mean of 5118.48. The manufacturer reported a previously tested sample of males with a mean of 4760pg/ml and a range 2205pg/ml to 11,149 pg/ml. Among participants with a BMI percentile of 85 or greater, Leptin levels were 8268.5pg/mL as compared to normal weight participants whose Leptin levels were 4068 pg/ml. The mean and range leptin levels for the adolescents were higher than the manufacturer reported sample.

A correlation between perceived health and leptin (.583, $p = .001$) and VO2 max (-.425, $p= .024$) was found; those with the poorest perceived health had the highest leptin levels and performed the poorest on the physical fitness test. An inverse correlation was found between leptin levels and perceived benefits of exercise (-.338, $p = 0.78$). Those who perceived the greatest benefit from exercise had the lowest leptin levels.

Body Composition

Body composition was examined using two measures, body mass index and DEXA scan. DEXA scan in addition to body fat provided measures of lean body mass and bone density.

Body Mass Index

Body Mass Index (BMI) was calculated by entering the participant's age, height and weight into the Centers for Disease Control and Prevention's website. BMI percentiles in 85-95 range are associated with being overweight, while BMI percentiles of 95 or greater represent obesity (CDC, 2011).

Participant's raw BMIs ranged from 18.4 to 33.20, representing the 2^{nd} to the 98^{th} percentile. Participant's mean raw BMI was 24.31 + 4.0; the percentile mean for the sample was 63.21 ± 31.61. Thirty-two percent (9 of 28) of the participants had BMI percentile's above the 85^{th} percentile, indicating overweight and obese. Only one participant had a BMI less than the 5^{th} percentile representing underweight (CDC, 2011). The percentage of overweight and obese in this sample is higher than the 26.8% reported for Mexican American adolescents in the NHANES data (CDC, 2010).

Table 8: BMI Raw Data and Percentiles

BMI Data	BMI – raw	BMI percentiles
Mean	24.31 ± 4.0	63.21 ± 31.61
25^{th} Percentile	21.0	29.0
50^{th} Percentile	24.35	74.50
75^{th} Percentile	26.38	87.0

Body Fat – DEXA Scan

DEXA scans were used to more accurately determine percentage of body fat. All participants were scanned while lying supine in light clothing in the Hologic QDR 4500 Densitiometer (Hologic, Inc., Bedford, MA). Everyone fit within the scanning field necessary to obtain an accurate scan. A technician trained and experienced in the operation of the scanner completed all scans. Reported results included the percentage of body fat and lean muscle mass, total body mass, and Z and T scores indicative of bone density.

Ideal body fat when measured by DEXA in a male adolescent is less than 25 percent. Participant's body fat ranged from 9.7% to 32.9% with a mean body fat percentage of 19.83 $\pm$ 7.1**.** Twenty-five percent (7 of 28) of participants had body fat percentages greater than 25 indicating they were overweight. Although a difference in reported body fat percentages was found between the DEXA and BMI, a statistically significant correlation was found between these measures $r = .572$, $p < .01$.

Table 9: DEXA Scan Results (n=28)

Mean Body Fat %	19.83%
Range	9.7- 32.9%
Normal DEXA (≤ 25th percentile)	N=21, 75%
Overweight	N=7, 25%

Four participants had both a BMI and a DEXA indicating body fat outside of the optimal range, five had BMI greater than 25 with a DEXA body fat less than 25, and three participants had a BMI less than 25 with a DEXA of greater than 25. Those with a more Anglo orientation demonstrated significantly higher BMIs than those who with a more Mexican orientation.

In summary, the physical fitness measures showed that most of the adolescents were in the moderately low fitness range. The accelerator results show that over half their time was spent in sedentary activity with very little moderately active or vigorous activity. Although all of the measures of endothelial activity (CRP, adiponectin, lepin) were in the normal range, leptin mean values and ranges were higher than the normal range. About one third of the sample was overweight or obese and one fourth had body fat percentages indicating overweight.

Model Testing

Research Aim 1

Research aim 1 focused on the predictive relationship of perceived benefits and barriers, interpersonal influences, and perceived self-efficacy with physical activity and physical fitness in Mexican American middle and late adolescent males. To address the four research questions for this aim a correlation matrix was generated to describe the relationship among the psychosocial variables. Perceived barriers and benefits of exercise, perceived self-efficacy, and the three measures of interpersonal influence (IPI) were correlated to assess the strength and direction of relationships among these six variables.

A significant relationship was observed between the exercise norms scale and the exercise role model scale (.566, $p = .005$) and the exercise role model scale and the exercise social support scale (.562, $p = .001$). Exercise norms was significantly correlated with perceived benefits of exercise (.421, $p = .026$). A high correlation was noted between exercise norms and exercise social support (.722, $p < .0001$) however these were both measures of interpersonal influence and exercise support was not significantly correlated with either physical activity or physical fitness so the interrelatedness was not considered an issue (Munro, 2005). No other variables were significantly correlated.

Table 10: Correlation Matrix: Psychosocial Variables

		Benefits Scale Mean	Barrier Scale Mean	Exercise Norms Scale (3)	Exercise Social Support Scale (4)	Exercise Role Model Scale (5)	Perceived Self-efficacy Mean
Benefits Scale Mean	Pearson Correlation	1					
	Sig.(2 tailed)						
	N	28					
Barrier Scale Mean	Pearson Correlation	-0.18	1				
	Sig.(2 tailed)	.928					
	N	28	28				
IPI Exercise Norms Scale (3)	Pearson Correlation	.421*	-.106	1			
	Sig.(2 tailed)	.026	.592				
	N	28	28	28			
IPI Exercise Social Support (4)	Pearson Correlation	.262	-.251	.722**	1		
	Sig.(2 tailed)	.178	.198	.000			
	N	28	28	28	28		
IPI Exercise Role Model Scale (5)	Pearson Correlation	.036	.210	.515**	.589**	1	
	Sig.(2 tailed)	.856	.282	.005	.001		
	N	.28	28	28	28	28	
Perceived Self-efficacy Mean	Pearson Correlation	.155	-.205	.118	.146	-.009	1
	Sig.(2 tailed)	.432	.296	.551	.459	.965	
	N	28	28	28	28	28	28

*Significant at 0.05 level (2-tailed).
**Significant at 0.01 level (2-tailed).

The psychosocial variables were correlated with physical activity and physical fitness to determine the strength and direction of relationships prior to entering into regression equations. Exercise norms (.407, p =.032) and perceived benefits (.479, .p = .01) demonstrated a significant relationship with physical fitness, measured as raw VO2 max. Perceived self-efficacy demonstrated a significant correlation with average energy expenditure (AEE), the selected measure of physical activity (410, p = .03), but was not significantly correlated with physical fitness (.105, p=.593). See chapter 3 for rationale for physical activity and physical fitness measures.

Results for Research Questions 1 and 3

Research question 1 asked: are perceived benefits and barriers of action, and interpersonal influences significant predictors of physical activity in Mexican American middle and late adolescent males? Examination of the correlation matrix indicated that there were no statistically significant relationships among the psychosocial variables and physical activity so a regression analysis was not conducted.

Research Question 3 queried: are perceived benefits and barriers of action and interpersonal influences significant predictor of physical fitness in Mexican American middle and late adolescent males? To address this question exercise norms and perceived benefits were entered individually into a regression equation with physical fitness.

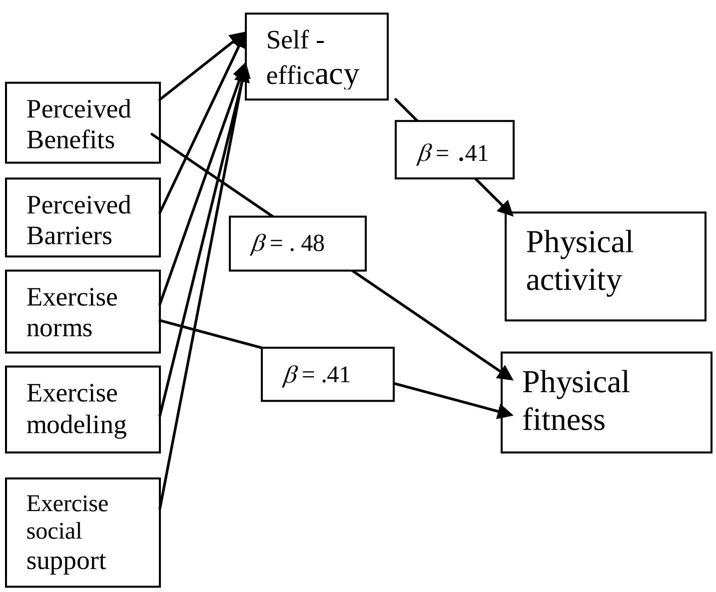
Exercise norms, a measure of interpersonal influence, significantly predicted physical fitness $\beta = .41$, $t(27) = 7.9$, $p = .032$ and explained a significant proportion of variance in physical fitness scores, $R^2 = .17$, $F(1, 27) = 7.9$, $p = .032$. Perceived benefits of exercise significantly predicted physical fitness, $\beta = .48$, t (27) = 7.7, p =.01 and explained a significant portion of the variance in physical fitness scores $R^2 = .23$, $F(1, 27) = 7.6$, p = .0.01. When entered together into a regression equation, perceived benefits of exercise and exercise norms significantly predicted physical fitness explaining 28% of the total variance in physical fitness ($F(2,27)$= 7.49, p =.056). Figure 2 illustrates these relationships.

Table 11: Aim 1, RQ 3: Regression Analysis: Summary of Psychosocial Variables Predicting Physical Fitness

Dependent Variables		Unstandardized beta	Standardized beta	T	Sig.
		Dependent variable: Physical Fitness			
Perceived benefits of action		9.375	.374	2.001	0.56*
IPI Exercise Norms		3.373	,249	1.334	.194

R2=.28 (F(2,27)= 7.49, p =.056) *Significant at .1

Figure 2: Research Aim 1 Results



Research Questions 2 and 4 Mediator Testing

Based on the correlation, self-efficacy was entered into a regression equation with physical activity. Self-efficacy was a significant predictor of physical activity. $\beta = .41$, $t(2.25) =$

.22, p = .033. Self-efficacy also explained a significant proportion of the variance in physical activity scores R2 = .17, *F*(1, 26) = .22, p = .032. No other psychosocial variables demonstrated a significant relationship. Figure 2 illustrates the direct relationship among these variables.

Research Question 2 asked: does self-efficacy mediate the relationship between perceived benefits and barriers of action and interpersonal influences and physical activity in Mexican American middle and late adolescent males? Research question 4 queried: does self-efficacy mediate the relationship between perceived benefits and barriers of action and interpersonal influences and physical fitness in Mexican American middle and late adolescent males?

Self-efficacy in the model was theorized to mediate the relationship between the psychosocial variables and physical activity and physical fitness. Barron and Kenny (1987) described four steps in establishing mediation. The first step requires that the independent variable must affect the mediator. Exercise norms and perceived benefits of exercise, the independent variables, were separately entered into a correlation equation with self-efficacy. No statistically significant relationship was determined in either equation. Therefore self-efficacy did not mediate the relationship between perceived benefit and physical fitness or exercise norms and physical fitness.

Research Aim 2

Aim 2 focused on the predictive relationship of physical activity and fitness on cardiovascular health (endothelial function and body fat) in Mexican American middle and late adolescent males**.** To address the four research questions for this aim initial correlational analysis was completed to describe the relationship of these variables. Physical activity and physical fitness were also correlated with each other to assess the strength and direction of relationships between these variables. No significant correlation was found (.207, $p=.30$).

The measures of endothelial function, CRP, leptin, and adiponectin were correlated to determine the strength and direction of relationships among these biological measures. Adiponectin was inversely correlated with leptin (-.379, $p =.047$). No significant correlation was found between leptin and CRP or adiponectin and CRP. Leptin was significantly correlated with triglycerides (.629, $p= <.001$) and the total cholesterol/HDL ratio (.418, $p=.027$). Adiponectin significantly negatively correlated with total cholesterol (-.434, $p =.021$). CRP approached significance negatively correlating with HDL cholesterol (-.311, $p =.107$)

Raw and percentile body mass index and DEXA were also correlated with each other. Raw BMI was significantly correlated with percentile BMI (.881, $p < .001$) and DEXA body fat (.572, $p=.001$). Additionally, DEXA body fat was significantly correlated with percentile BMI (.430, $p=.022$).

C-reactive protein, leptin, and adiponectin were correlated with BMI and DEXA. Leptin had a significant positive correlation with raw BMI (.500, $p =.007$) and DEXA body fat measures (438, $p = .02$). C-reactive protein approached a significant positive correlation with raw BMI (.310, $p =0.11$). Adiponectin did not correlate with any of the body fat measures. Although CRP did not significantly correlate with sedentary levels of physical activity, results approached significance (.255, $p= .19$).

Table 12: Correlation Matrix – Biological Variables (n=28)

		Adiponectin	CRP	Leptin	DEXA body fat	BMI raw	BMI %
Adiponectin	Pearson Correlation Sig.(2 tailed) N	1 28					
CRP	Pearson Correlation Sig.(2 tailed) N	-.220 .261 28	1 28				
Leptin	Pearson Correlation Sig.(2 tailed) N	-.379* .047 28	.244 .210 28	1 28			
DEXA Body Fat	Pearson Correlation Sig.(2 tailed) N	-.80 .687 28	.108 .586 28	.438* .020 .28	1 28		
BMI-raw	Pearson Correlation Sig.(2 tailed) N	-.219 .263 28	.309 .109 28	.500** .007 28	.572** .001 28	1 28	
BMI -%	Pearson Correlation Sig.(2 tailed) N	-.155 .432 28	.252 .195 28	.253 .194 28	.430* .022 28	.881** .000 28	1 28

* Significant at 0.05 level (2-tailed).
** Significant at 0.01 level (2-tailed).

Physical activity and physical fitness were entered into a correlation matrix with the biological measures to determine the strength and direction of relationships prior to entering into regression equations. Physical activity demonstrated a positive correlation with BMI percentile (.410, p=.033). There was no statistically significant correlation between physical activity and laboratory assays. Physical fitness was significantly correlated with leptin (-.480, p=<.001), raw BMI (.480, p = .010) and DEXA body fat (.712, p < .001).

Research Question 5 and 7

Questions 5 and 7 addressed the relationship between physical activity and physical fitness and measures of endothelial function. Question 5 asked if physical activity was a significant predictor of endothelial function in Mexican American middle and late adolescent males. Physical activity was not significantly correlated with any measure of endothelial function, so regression analysis was not conducted. Therefore, physical activity was not a significant predictor of endothelial function in this sample of adolescent males.

Question 7 queried if physical fitness was a significant predictor of endothelial function in Mexican American middle and late adolescent males. Based on the correlation physical fitness was entered into a regression equation with leptin. Physical fitness significantly predicted leptin $\beta = -.48$, $t(27) = -2.79$, p = .01 and explained a significant portion of the variance in leptin levels R^2=.23, $F(1,27)$=7.77, p=.01. Physical fitness did not predict adiponectin or CRP.

Table 13: Aim 2, RQ7: Regression Analysis Summary of Physical Fitness Predicting Endothelial Function

Independent variables		Unstandardized beta	Standardized beta	t	Sig.
		Dependent Variable: Leptin			
Physical Fitness		-274.024	-.480	-2.787	.01
		(R2=.23, F(1,27)=7.77, p=.01)			

Research Questions 6 and 8

Research questions 6 and 8 addressed the relationship physical fitness and physical activity with body fat. Research question 6 asked if physical activity was a significant predictor of body fat in Mexican American middle and late adolescent males? Research question 8 queried if physical fitness was a significant predictor of body fat in Mexican American middle and late adolescent males? Regression equations were used to address these research questions.

Based on the results of the correlation matrix, physical activity was entered into a regression equation with BMI percentiles. Physical activity predicted BMI percentile β =.410, t(2.25)=5.35, p =.033. Physical activity also explained a significant proportion of the variance in BMI percentile, R^2 =.17, F(1,26) =28.64, p= .033. Physical activity was not a significant predictor of raw BMI or DEXA body fat.

Table 14: Aim 2, RQ 6. Regression Analysis Summary of Physical Activity Predicting Body Fat (BMI Percentile)

Independent variables		Unstandardized beta	Standardized beta	t	Sig.
		Dependent Variable: BMI percentile			
		53.168	.410	2.250	.033
		R2 =.17, F(1,26) =28.64, p= .033			

Physical fitness was entered into a regression equation with DEXA-determined body fat and BMI. Physical fitness was a significant predictor of both body fat measures. Physical fitness more strongly predicted DEXA body fat β = -.71, t(27) =-5.16, p<.001, physical fitness also explained a significant proportion of the variance in DEXA body fat R^2 = .51, F(1,27) =26.67, p<.001. Physical fitness predicted raw BMI β = -.422, t(27) =-2.38, p=.025; physical fitness also explained a significant proportion of the variance in BMI R^2 = . 183, F(1,27)= 5.65, p=.025. Physical fitness was not a significant predictor of BMI percentile.

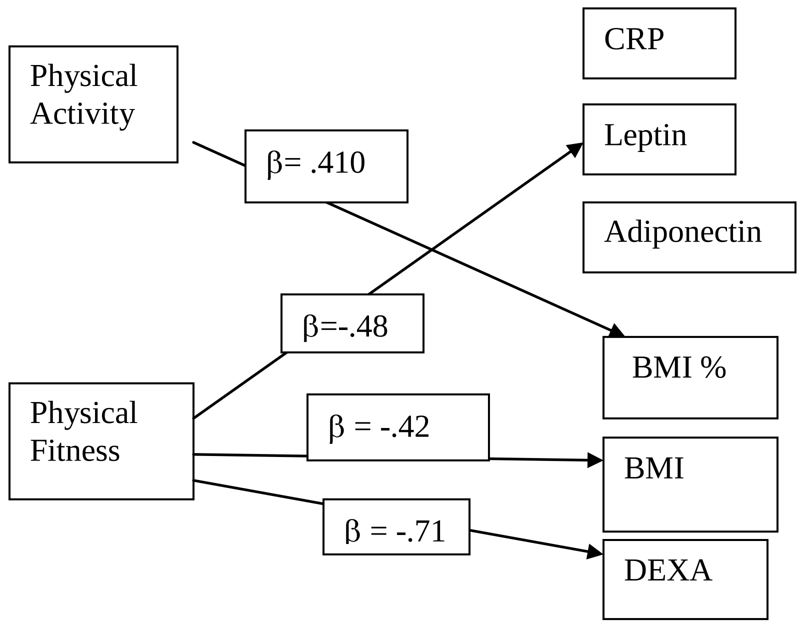
Table 15: Aim 2, RQ 8: Regression Analysis Summary of Physical Fitness Predictors of Body Fat (DEXA, BMI)

Independent Variables		Unstandardized beta	Standarized beta	t	Sig.
		Dependent Variable DEXA			
Physical fitness		-.594	-.712	-5.164	<.001
		($R2$ = .51, F(1,27) =26.67, p<.001)			
		Dependent Variable: BMI			
		-.199	-.422	-2.377	.025
		($R2$ = . 183, F(1,27)= 5.65, p=.025)			

In summary, results of analysis of the research questions for specific aim one resulted in partial support for research question 3, which tested the predictive relationship of benefits, barriers, and physical fitness. Results demonstrated that exercise norms, a measure of interpersonal influence, and perceived benefits of exercise predicted a significant proportion of the variance of physical fitness. Research question one, predicting physical activity, was not supported. In addition research questions 2 and 4, testing the mediating effects of self-efficacy were not supported.

Results of analysis of Research Aim two resulted in significant findings for research questions 6, 7, and 8. Physical activity predicted percentile of BMI (research question 6). Physical fitness significantly predicted leptin, a measure of endothelial function, as well as measures of body fat (research question 7, 8). Figure 3 illustrates the relationship among these variables.

Figure 3. Results for Aim 2



Summary

This chapter presented the results of the analysis of data obtained from a total of 28 adolescent males. First the sample was described in terms of their demographic profiles, the model psychosocial concepts and the results of their biological measures of physical fitness, physical activity, endothelial function and body fat. Next the results of data analysis to answer the research questions for the specific aims were presented. The final significant models were also depicted. The results are discussed in the final chapter.

CHAPTER 5: DISCUSSION

Cardiovascular disease with its inception early in life has been the impetus for research focused on prevention and health promotion activities (American Heart Association, 2008; Kavey et al., 2003; USDHHS, 1996; Williams et al., 2002). Research has examined the current state of adolescent cardiovascular health including risk factors, screening methods, and targeted interventions (Ebbeling et al., 2012; Storey et al., 2012). The two-fold purpose of this study was 1) to investigate six psychosocial variables for their ability to predict physical fitness and activity in Mexican American male adolescents and 2) describe the predictive value of physical fitness and activity on laboratory assays indicative of cardiovascular health and body fat. Chapter five discusses study findings as they compare to other adolescent research as well as novel trends noted in the results. Relevance to practice, study limitations, and implications for further research are described.

Nationally Mexican American male adolescents have the highest reported rates of obesity (American Heart Association, 2012) and the lowest rates of physical activity of all youth (US Department of Health and Human Services, n.d.). In this purportedly healthy sample of 28 male Mexican American adolescents one fourth had DEXA-determined body fat percentages indicating that they were overweight or obese. In addition as a whole this sample had relatively low levels of physical activity and fitness, congruent with the reported literature. Less than one fifth (17%) performed at a moderate physical activity level and less than 1% performed at a level of vigorous activity.

Factors responsible for engaging in physical activity and the degree of physical fitness among Mexican American youth are less well understood. This research demonstrated two specific psychosocial variables, perceived benefits and interpersonal influences explained 28% of the variance in physical fitness.

Lack of support for exercise from families, specifically parents, which was reported as lack of praise and criticism about engaging in physical activity supported findings reported in a multi-ethnic study which included Hispanic middle school students (Freen et al., 2005). Although not specific to parents the research reported lower family support and role modeling for physical activity. Research with adolescents not restricted to Mexican Americans has identified parental support as a primary influencing factor for engaging in physical activity (Sallis et al., 2000). There are a number of possible mechanisms through which lack of parental support may influence an adolescent's physical activity and physical fitness participation. One possible explanation may be related to the concept of Familism in the Mexican American culture (Burk et al. 1995; Niska, 1999). Familism is a cultural norm where the priorities and the needs of the family supersede that of the individual (Burke et al.). Although these adolescents rated high on acculturation, studies have reported higher rates of familism among more acculturated families or in those families where English or English and Spanish is spoken in the home (Andrea et al., 2005; Updegraff, McHale, Whiteman, Thayer, & Delgado, 2005). In this study almost two thirds spoke either Spanish or English and Spanish at home. Thus in a less acculturated family environment where Familism is operating competing family demands such as having to help support the family or take care of younger siblings may have dissuaded adolescent from spending time engaging in physical activity or becoming physically fit.

Participants with higher scores reflecting the dominant American culture reported the greatest perceived benefits from exercise. Divergent findings have been reported related to reported participation in physical activity and acculturation level in Hispanic youth and adults. Some studies have report greater likelihood of physical activity in more acculturated individuals (Ham et al., 2007; Stovit et al, 2008), others report less (Gordon-Larsen et al., 2003; Unger et al., 2004); a recent report indicated no difference when controlling for socio-economic status (Liu, Probst, Haruna, Bennett& Torres, 2009). None of these studies specifically have addressed perceived benefits and barriers associated with activity in this population.

Adolescents who reported greater benefits for physical activity also reported a more positive health status. This statistically significant finding may suggest that those who perceive themselves to be most healthy are the most likely to positively view exercise and by extension may engage in physical activity or be physically fit.

Sample

Most previous studies have included Mexican American male adolescents within a larger sample of racially and culturally diverse youth. Few studies have focused solely on Mexican American children and adolescents (Oria & Sender, 2007). This sample consisted of 28 Mexican American male adolescents from 15-19 years of age.

Although most of the sample self-identified as healthy or mostly healthy approximately 40% of the boys had BMIs indicating they were at risk for overweight or overweight. This finding was slightly higher than that of the reported 27% -39% BMI in national samples of Mexican American adolescent males (National Center for Health Statistics, 2010; Odgen et al., 2006). This higher rate may be accounted for by the smaller sample in the current study.

The boys demonstrated low levels of physical activity and physical fitness. Cycle ergometry performance demonstrated that 80 % in the very poor to fair fitness range.

All but one of the boys was born in the United States, this is higher than the 73%- 75% reported in recent studies (Knight et al., 2010; Liu, Chu, Frongillo & Probst, 2012). As noted earlier, sixty-four percent of the participants indicated that either Spanish or a combination of English and Spanish were spoken at home, slightly less than the national rate of 71% (US Census, 2010). Although the findings are less than the national rate, almost two thirds lived in homes that were not highly acculturated.

Acculturation in the majority of studies of obesity, physical activity, or cardiovascular health has been determined by language spoken at home and/or by generational status; in general studies attribute report less physical activity, poorer eating habits, and less healthy cardiovascular behaviors to first and subsequent generations of immigrants (Liu et al., 2012). However reports indicating less physical activity and poorer eating habits among less acculturated individuals have also been reported (Liu, Probst, Harun, Bennett, & Torres, 2009). Consistent with many studies, this sample's linear acculturation level demonstrated a statistically significant correlation with BMI with those who were least acculturated having the highest BMI (.490, $p = .008$).

All of the boys lived in a family environment. One third lived in a family with their mothers only. Interpersonal influences especially those of important other's expectation for exercise were found to be significantly related to physical fitness, a long-term measure of physical activity. There was a lack of support for physical activity and increased criticism of exercise by the parents. In addition there was almost no expectation reported from their teachers to engage in physical activity. Other interpersonal influences operating included moderate support from siblings and higher support for and participation in physical activity by friends. Participants selected their physicians as most supporting of and expecting exercise from them.

Model and Instruments

Pender's health promotion model (2006) was the basis for the Winokur Biobehavioral Model. According to Pender's model an individual's personal factors and psychosocial factors have a major influence on the individual's decision to engage in a health behavior (Pender et al., 2006). Based on a review of prior research, the Winokur model incorporated perceived barriers and benefits of physical activity, perceived self-efficacy for physical activity, and interpersonal influences as predictors of physical activity and physical fitness.

Pender's instruments which were adapted for adolescents were used to test the model. All instruments demonstrated reliability and validity from previous adolescent studies. However, these instruments have been most frequently used with females; including Taiwanese female youth (Garcia et al., 1995; Garcia, Pender, Antonakos, & Ronis, 1998; Wu & Pender, 2002). Few studies were found using these instruments with male adolescents; no research with Mexican American male adolescents was found that measured perceived benefits and barriers of physical activity. Psychometric analysis of the instruments was not conducted in this study.

Objective measures were chosen to measure physical activity and physical fitness. These included a 3-day accelerometer recording for physical activity and cycle ergometry with VO2 max for physical fitness. Few studies use objective measures, as they are costly, time consuming, and present greater subject burden. However, these measures were considered important to obtain an accurate account of the participant's level of activity and fitness rather than relying on self-report alone.

Model Testing-Research Aims and Questions

Research Aim 1. Research aim 1 focused on the predictive relationship of the psychosocial variables and physical activity and fitness. Four research questions were used to examine these relationships.

Research question 1 described the relationship among perceived benefits and barriers of action, and interpersonal influences with physical activity in Mexican American middle and late adolescent males. Prior studies report significant relationships among psychosocial variables and physical activity (Butt, Winberg, Breckon, & Claytor, 2011, Nelson et al., 2005) however, this research failed to demonstrate a significant relationship among these variables. The difference in part may be related to the use of objective measures of physical activity. Prior studies have measured physical activity through both self-report and objective measures (accelerometer or observation (McGuire, Hannan, Neumark-Sztainer, Cossrow, & Story, 2002; Prochaska, Rodgers, & Sallis, 2002; Sallis, Prochaska, & Taylor, 2000). In prior studies despite significant results with self-reported data, few significant findings were reported for objective measures (Prochaska, Rodgers, & Sallis, 2002).

A review paper on determinants of physical activity for children and adolescents reported inconsistent associations between social support and youth physical activity (Sallis, Prochaska, & Taylor, 2000). Eighteen studies investigating the association of social support with physical activity were reviewed. In addition to differing measures of social support these studies used differing modes of physical activity measurement. Four studies used objective measures of physical activity (e.g., accelerometer, observation); the remainder (n = 14) relied solely on self-report. Within studies, those that relied on self-reported physical activity were more likely to find a significant association (M = 57% of tests), than studies that used objective measures (M = 25% of tests). In all likelihood, the adolescents were overestimating their physical activity on the self-report measures. However, it is unknown if this was the factor producing the significant results.

Multiple studies of perceived benefits and barriers have demonstrated a positive relationship with physical activity (Garcia et al., 1995; Garcia, Pender, Antonakos, & Ronis, 1998; Grubbs & Carter, 2004). These studies which focused predominately on girls and younger youth utilized self-report of physical activity. No objective measures of physical activity were included. Limited research included Mexican American male adolescents.

Perceived barriers were not found to be a predictor of physical activity or physical fitness levels. This is in contrast to some studies that have identified perceived barriers as a major deterrent in populations with middle and late adolescents (Dunton, Schneider, & Cooper, 2007; Tegerson & King, 2007). However, the majority of these studies were conducted with girls. Conversely, a review article examining barriers to physical activity found no positive correlations between barriers and physical activity (Van Der Horst, 2007).

Research question 3 described the relationship among the psychosocial variables and physical fitness. Significant findings were found between perceived benefits and a measure of interpersonal influence, the exercise norms scale, and physical fitness. This sample's mean score indicated a high level (3.44 + .34) a high level of perceived benefits.

One scale item on the perceived benefits scale stated that physical activity or exercise allowed others to see the individual's athletic skills or fitness. There was a statistical significant relationship between age and importance of others viewing the individual's athletic skills. The sample's 15 and 16 year olds scored this item higher than those who were 18 and 19 year olds. This finding is consistent with the literature regarding adolescent decision-making. Specifically, peer approval and acceptance is more important to middle adolescents than older adolescents, the latter group is more likely to perform actions for themselves than for others (Pinz, 2002; Steinberg, 1996; Rice & Dolgin, 2005). Limited literature exists related to decision making in Latino adolescents; however in a study regarding health related risky decision making, middle adolescents were significantly influenced by peers as well as parents (Livaudais, Napoles-Springer, Steward, & Kaplan, 2007).

Little research has been conducted that combined psychosocial variables and objectively measured physical fitness among adolescents. An Australian study of 7-15 year old males and females examined interpersonal influences on physical fitness (Cleland, Venn, Fryer, Dwyer, & Blizzard, 2005). Findings demonstrated a weak but significant relationship between parental role modeling and physical fitness in female but not male youth.

Research questions 2 and 4 addressed self-efficacy as a mediator of perceived benefits and barriers of physical activity and interpersonal influences. Although self-efficacy did directly predict physical activity. It did not satisfy the criteria for mediation with the other psychosocial variables. This is in contrast with some previous adolescent physical activity research which has demonstrated self-efficacy as a mediator of perceived barriers to physical activity and interpersonal influence among adolescents (Kenyon, Kubik, Davey, Sirard, & Fulkerson, 2012; Shields et al., 2008). The majority of adolescent studies demonstrating mediation were conducted on adolescent girls both in and outside of the United States (Lubans, Foster, & Biddle, 2008). Conversely other adolescent studies did not support criteria for mediation.

Self-efficacy's direct influence on physical activity suggests that these adolescents believe they were competent to perform physical activity if they choose to engage in it. Additionally they recognize the benefits associated with physical fitness. However, perhaps related to less than optimal family support for physical activity and fitness, interpersonal influences altered these results. Further exploring the role of interpersonal influence as a mediating variable may support the relationship among benefits, self-efficacy, barriers and physical activity and fitness.

Research Aim 2. Research aim 2 focused on the predictive relationship of physical activity and fitness on measures of endothelial function and body fat. Four research questions were used to examine these relationships.

For research question 5 the relationship of physical activity with the biological measures of endothelial function (leptin, adiponectin, CRP) was examined. Physical activity did not significantly predict any of the measures of endothelial function. This finding is consistent with a recent studies of Spanish (Martinez-Gomez et al., 2012) and Greek (Aggeloussi et al., 2012) male and female adolescents. In the descriptive study of Spanish adolescents, participants were asked to wear an accelerometer for 7 days (Martinez-Gomez et al.). Aggeloussi and colleagues (2012) measured Adiponectin in students who participated in a year-long swimming intervention study. In neither study was adiponectin significantly associated with physical activity.

However other adolescent studies have reported a positive association between physical activity and adiponectin and leptin in adolescent females (Ischander et al., 2007). Discrepant findings have been reported with CRP and physical activity. Some studies demonstrate no association (Rosenbaum et al., 2007; Meyer, Kundt, Lenschow, Schuff-Werner, & Kienast al., 2006; Kasapis & Thompson, 2005; Cook et al., 2000) while others find an inverse relationship between elevated CRP and low activity (Sabiston et al., 2010). The link between elevated adiponectin and CRP has been confirmed as early measures of atherosclerosis among adults (Packard & Libby, 2008; Szmitko, Teoh, Stewart, & Verma, 2006; Yeh & Willerson, 2003). Lack of findings in this study may be related to the small sample size or limited time on the accelerometer.

Research question 7 focused on the relationship among physical fitness and the biological markers indicative of endothelial function. Physical fitness significantly predicted 23% of the variance in leptin levels, with higher fitness predicting lower leptin levels (.β= -.48, t(-2.79) = 4342, p = .01). Although higher leptin levels are associated with increased fat mass, physical fitness predicted 23% of the variance in leptin among normal weight individuals. These findings are congruent with physical activity research demonstrating an inverse correlation between lepton levels and physical fitness (Barbeau et al., 2003; Gutin et al., 1999; Haluzik et al., 1998; Ischander et al., 2007; Tsolakis et al., 2006; Tsolakis et al., 2003). Recent research has further identified leptin as a novel marker for identification of early metabolic syndrome in adolescents (Gonzalez, Del Mar Bibiloni, Pons, Llompart, & Tur, 2012), so physical fitness levels may serve as an indicator as well since these levels are inversely related to leptin. No significant relationship was found between physical fitness and adiponectin or CRP. Prior adolescent studies demonstrating strong associations between adiponectin and/or CRP and physical activity had largely obese samples (Weiss et al., 2004). The small sample in this study with mainly normal weight adolescents may explain the findings.

Research questions 6 and 8 addressed the relationship of physical fitness and physical activity with objective measures of body fat. Physical activity predicted 18% of the variance in BMI percentile. Physical fitness predicted 51 % of the variance in DEXA derived body fat and 18% of the variance in BMI body fat.

Inverse correlations between physical activity and Body Mass Index t have been reported in the literature (Chung, Skinner, Steiner, & Perrin, 2012; Telama, 2005). However, this study found a positive relationship between physical fitness and BMI percentile but not raw BMI. These results may be due to the small sample size and limited ranges of fitness may have resulted in BMI percentile being a poor predictor of BMI percentile.

Studies have reported decreasing amounts of physical activity or diminished physical fitness across the transition from high school to college (Chung et al., 2012; Telama, 2005). These findings were not supported by this study. Physical activity in the younger (15 & 16 year old) and older (18 & 19 year old) adolescents were not significantly different. Physical fitness measured as VO2 max was slightly higher among the 18 and 19 year olds (38.8 ± 9.1) than the 15 and 16 year old (36.9 ± 7.2) adolescents. Again, these findings may be due to the small sample size.

As predicted, physical fitness strongly predicted body fat, obtained from DEXA scan and measured BMI. DEXA derived body fat was the more accurate measure and demonstrated the strongest results, predicting 51% of the variance in physical fitness. Only 5 participants were identified by both BMI and DEXA as being overweight. Studies that have objectively measured physical fitness and used BMI as a measure of body fat support the inverse association between physical fitness and BMI (Martins et al., 2009; Pahkala et al., 2012). Limited studies were found that examined objectively measured physical fitness and DEXA derived body fat. Among 10 year old children, high level physical fitness was associated with lower DEXA body fat and improved vascular function measures (Hopkins et al., 2009).

Limitations

The major limitation of this study is its small sample size which poses threats to statistical conclusion validity and restricts generalizability. The projected sample size was determined through a power analysis. Using an effect size of 0.25, and alpha of 0.05, and a power of .80, a sample of 62 participants was calculated to be appropriate to test the model. However, only 28 adolescents participated in the study. Because of the small sample, conclusions could not be drawn. Instead, the study serves to identify trends among this sample of Mexican male adolescents. Additionally the study used a convenience sample that was predominately recruited from one community college. Therefore there was a degree of homogeneity among many of the subjects. In order to select specific health promotion interventions for this population, factors associated with cardiovascular health must be identified.

The physical activity concept did not perform as predicted in the model. Although it was measured objectively, wearing an accelerometer for three days may not have provided an adequate time to determine the participant's level of physical activity. Additionally, the three day period began on the day of collection; therefore some participants had week-end or non-school days included in their data collection period.

Social desirability bias must be considered with any study where the researcher administers paper and pencil instruments. Efforts to minimize bias were employed in that participants were given a private area to complete the instruments, and instructions stressed that there were no right or wrong answers. Findings of high benefits and low barriers to physical activity suggest that this may have been a factor. However, because participants shared negative views about interpersonal support for physical activity, it appeared that minimal bias was involved.

Nursing Practice Implications

Findings form a beginning target for cardiovascular health promotion interventions among Mexican American male adolescents. This population has been previously identified as at risk for cardiovascular disease and its antecedents, obesity and diabetes. Findings from the study highlight the importance of interpersonal influences which must be considered in all physical activity/fitness interventions with this population. Therefore not only the middle and late adolescent, but the family, particularly the parents must be considered and involved in specific health promotion activities. Results suggest that without parental approval and support adequate levels of physical activity and physical fitness may not occur. In addition the role of the teacher in supporting physical activity needs to be targeted, as teacher support for physical activity may have an influence on the physical activity of adolescents as well.

Findings reinforce the importance of physical fitness as a cardio-protective mechanism. Objectively measured physical fitness predicted body fat measured by BMI but more strongly predicted DEXA-derived body fat. Ideally, DEXA-derived body fat is the best objective measure to determine effectiveness of physical activity interventions, but because of time and cost-constraints, BMI can be used and considered an effective measure.

Methods to measure endothelial dysfunction in adolescents are not readily available. Leptin levels were predicted by physical fitness in both normal and overweight adolescents.

However, Leptin may provide additional benefit as an indirect measure of impaired arterial distensibility, a measure which is difficult to obtain through ultrasonic measures (Singhal et al., 2002).

Recommendations for Future Research

Some of the significant trends point to the need to replicate the study in a larger sample of adolescents. In addition, the sample should focus of adolescents who are at greatest risk; those who are overweight and obese. Although the self-report instruments have been used with adolescents, few studies have included males, so the instruments need to undergo psychometric testing with male adolescents to assess both reliability and validity with this gender.

Future research should focus on further identifying the biobehavioral variables that predict cardiovascular health. Psychosocial variables predicting physical activity and physical fitness in this understudied population should be clarified and confirmed. Trends from this study as well as prior research suggest the importance of retaining perceived benefits and barriers as well as perceived self-efficacy. Interpersonal influences should be included in the model and explored either as a predictor variable or as a mediator using a larger sample. Consideration of acculturation as a predictor variable is suggested. Adolescent-specific measures of Familism may also provide additional clarification about the predictive effects of interpersonal influences.

Wherever possible, objective measures of physical fitness and physical activity need to be used in research. Objective data provides the most accurate level of information from which to form conclusions. The accelerometers provided good quality data, however collection time should be expanded to a minimum of 7 days. A one-week period would account for day of the week variations in activity as well as reduce the likelihood of the Hawthorne effect.

Body fat is a strong predictor of cardiovascular risk and should continue to be included in the model. Initial indications suggest that leptin provides a measure of endothelial function. Other measures of endothelial function such as newly refined measures for ICAMs and VCAMs and IL-6 should be considered as predictors of endothelial functions. Each of these measures is specific to inflammatory processes in the endothelium and may be valuable in identifying early atherogenesis. Although adiponectin and CRP did not result in significant findings, there is some suggestion that they may be appropriate measures in physical activity intervention studies.

Finally, after the model is refined and strengthened, longitudinal studies with larger samples that implement physical interventions with biologic outcomes of endothelial function and body fat should be undertaken. These interventions may not only improve endothelial function but reduce other complications associated with obesity.

Conclusion

In conclusion, in this study of Mexican American adolescents' interpersonal influences and perceived benefits predicted physical fitness while self-efficacy directly predicted physical activity. Lack of parental praise and increased criticism was noted as a finding with this sample. Objective measures of physical activity and physical fitness were an identified strength of the study. Both predicted measures of body fat, whereas physical fitness also predicted Leptin, a measure of endothelial function.

Limitations of the study, including sample size and sampling issues, were identified. Implications for nursing practice as well as recommendations for future research have been included.

APPENDIX A

INFORMED CONSENT - PARTICIPANT

Appendix A. 1 Study Consent – English (participant ≥ 18 years of age)

University of Arizona

Informed Consent

Physical Activity, Body Fat, and Endothelial Function in Mexican American Male Adolescents.

Introduction

You are being invited to take part in a research study. The information in this form is provided to help you decide whether or not to take part. Study personnel will be available to answer your questions and provide additional information. If you decide to take part in the study, you will be asked to sign this consent form. A copy of this form will be given to you.

What is the purpose of this research study?

You have the choice to participate in this research project. The purpose of this project is to gain an understanding of the factors that may help Mexican American male adolescents take part in physical activity and become physically fit. Additionally, the research will describe the relationship of physical fitness and physical activity with body fat and blood tests that indicate early heart disease

Why are you being asked to participate?

To be in this study because you must be between 15 and 19 years of age, male, Mexican American, and living with at least one parent/guardian in your home. You must be able to read and speak English

How many people will be asked to participate in this study?

Sixty-two people will be asked to participate in this study.

What will happen during this study?

You will be given an appointment at the General Clinical Research Center for all tests. Your height and weight will be measured. You will also be asked to answer questions about your health and cultural background and six questionnaires that relate to physical activity.

You will next have your body fat measured with a special machine called a dual-energy X-ray absorptiometry (DEXA). This test will be done in a special place called the Bionutritional/Metabolism Core Laboratory. You will be asked to lie flat on a padded table for 10 to 20 minutes. During this time, the machine will move over your body and take a picture with low level X-rays. The DEXA scan will measure both the strength of your bones (bone density) and the amount of body fat (body composition) The DEXA scan will be done before the exercise test. You will receive a copy of your results at the end of the session.

Next you will have two tubes of blood drawn. The blood will be drawn by a nurse. A tight band (tourniquet) will be placed on your arm. The nurse will use a small needle to withdraw about less than ½ an ounce or about 2 tablespoons of blood. This blood will be used to examine the health of your blood vessels.

An exercise test will then be done to measure your muscle strength. You will be asked to pedal a cycle ergometer (a stationary bicycle that stays in place when you pedal). At first the pedaling will be easy, but it will get harder with time. An exercise specialist and a member of the clinic staff will closely watch your condition and performance. The exercise (bicycle pedaling) will be stopped if they notice any wheezing, unusual change, in heart rhythms, or if you ask to stop. You will be asked to breathe through a mouthpiece and wear nose clip so that the air you are breathing in and out of your mouth can be measured. Four chest stickers (electrodes) will be taped to your chest to continuously measurer your heart rate and rhythm. The amount of oxygen (saturation) in your blood will be measured with a clip (pulse oximeter) attached to your finger. At the end of the test you will be able to rest and given a snack.

Finally, a small heart rate monitor (accelerometer) will be placed around you waist. You will be asked to wear the monitor on your waist for three days and nights. This monitor is light weight and can be worn in the shower (water proof). At the end of three days, the accelerometer will be picked up by the researcher.

How long will I be in the study?
Almost all of the information will be collected in one, 2-hour session. A second brief meeting is needed to remove the accelerometer.

Are there any risks to me?
The tests may create some minimal risk. Possible risks/discomforts include:

- The exercise test may cause muscle soreness, dizziness, fainting, or shortness of breath. In rare instances, exercise tests may cause chest pain, tightness, or changes in your blood pressure, heart rate, respiratory rate, or oxygen saturation.
- DEXA Scan: the DEXA scan uses x-rays (ionizing radiation). The amount of x-rays (radiation) from each scan is very small, and is about one-quarter of one mrem effective dose. If there is any risk from this exposure, it is too small to be measured and is low compared to everyday risks. For comparison, everyday radiation to which everyone is exposed is approximately 1 mrem each day; radiation workers are allowed to accumulate 5000 mrem each year.
- You may feel that some questions or procedures we ask you to do may be stressful or upsetting. If this happens you can stop taking part in the study immediately. We can give you names of individuals who may be able to help you with these problems.

Are there any benefits to me?
You may have some benefits from the procedures described in this study. You will be given the results of the exercise test and body fat assessment. The body fat assessment will describe the optimal lean and fat amounts for males who are your age, and your results. In the event you are

outside the best range you will be given written advice to help you achieve healthier body composition.
The information gained from this project may have long term benefits to others by describing the association of exercise with short and long term heart health.

What are the alternatives for participating in this study?
The alternative is not to participate in this study.

Will there be any costs to me?
Aside from your time, there are no costs for taking part in the study.

Will I be paid to participate in the study?
You will be paid $50.00 for your participation in the study. The money will be paid when the monitor around your waist (accelerometer) is returned.

Will the information that is obtained from me be kept confidential?
The only person who will know that you participated in this study will be the researcher (Principal Investigators) and other research staff. Your records will be confidential. You will not be identified in any reports or publications resulting from the study Representatives of regulatory agencies including the University of Arizona Human Subjects Protection Program may access your records.

What if I am harmed by the study procedures?
Side effects or harm are possible in any research program despite the use of high standards of care and could occur through no fault of yours or the investigator involved. Known side effects have been described in this consent form. However, unforeseeable harm also may occur and require care. You do not give up any of your legal rights by signing this form.

If you believed you have been harmed by this study, please contact the principle investigator, Beth Winokur to notify her.

Any costs for the treatment of research related side effects will be charged to you or your insurance carrier. However, if for any reason these costs are not covered by insurance, they will be your responsibility.

May I change my mind about participating?
Your participation in this study is voluntary. You may decide to not begin or to stop the study at any time. Your refusing to participate will have no effect on your ability to use the UCI Medical Center for health care. Also any new information discovered about the research will be provided to you. This information could affect your willingness to continue your participation.

Whom can I contact for additional information?
You can call the Research (Principal Investigator) to tell her about a concern or complaint about this research study. The Principal Investigator, Elizabeth Winokur, RN can be contacted at 714-

402-4270. If you have questions about your rights as a research subject you may call the University of Arizona Human Subjects Protection Program office at (520)626-6721. If you have questions, complaints, or concerns about the research and cannot reach the Principal Investigator; or want to talk to someone other than the investigator, you may call the University of Arizona Human Subjects Protection Program office at the toll-free number 1-866278-1455. If you would like to contact the Human Subjects Protection Program via the web (this can be anonymous), please visit http://www.irb.arizona.edu/contact.

Your Signature

By signing this form, I affirm that I have read the information contained in the form, that the study has been explained to me, that my questions have been answered and that I agree to take part in the study. I do not give up any of my legal rights by signing this form.

____
Name (printed)

___________________________ ________________________
Participant's Signature Date signed

Statement by person obtaining consent

I certify that I have explained the research study to the person who has agreed to participate, and that he or she has been informed of the purpose, the procedures, the possible risks and potential benefits associated with participation in this study. Any questions raised have been answered to the participant's satisfaction.

________________________.
Name of study personnel

___________________________ ________________________
Study personnel signature Date signed

APPENDIX B

INFORMED CONSENT – PARENT OF MINOR

Appendix A. 2 Study Consent – English (parent of minor participant)

University of Arizona

Informed Consent

Physical Activity, Body Fat, and Endothelial Function in Mexican American Male Adolescents.

Introduction

Your child is being invited to take part in a research study. The information in this form is provided to help you decide whether or not your child should take part. Study personnel will be available to answer your questions and provide additional information. If you decide to have your child take part in the study, you will be asked to sign this consent form. A copy of this form will be given to you.

What is the purpose of this research study?

Your child has the choice to participate in this research project. The purpose of this project is to gain an understanding of the factors that may help Mexican American male adolescents take part in physical activity and become physically fit. Additionally, the research will describe the relationship of physical fitness and physical activity with body fat and blood tests that indicate early heart disease

Why is your child being asked to participate?

To be in this study your child must be between 15 and 18 years of age, male, Mexican American, and living with at least one parent/guardian who is able to read and/or speak English or Spanish.

How many people will be asked to participate in this study?

Sixty-two people will be asked to participate in this study.

What will happen during this study?

Your child will be given an appointment at the General Clinical Research Center for all tests. His height and weight will be measured. He will also be asked to answer questions about his health and cultural background and six questionnaires that relate to physical activity.

Your child will next have your body fat measured with a special machine called a dual-energy X-ray absorptiometry (DEXA). This test will be done in a special place called the Bionutritional/Metabolism Core Laboratory. Your child will be asked to lie flat on a padded table for 10 to 20 minutes. During this time, the machine will move over his body and take a picture with low level X-rays. The DEXA scan will measure both the strength of his bones (bone density) and the amount of body fat (body composition) The DEXA scan will be done before the exercise test. You will receive a copy of your results at the end of the testing session.

Next your child will have two tubes of blood drawn. The blood will be drawn by a nurse. A tight band (tourniquet) will be placed on your arm. The nurse will use a small needle to withdraw about less than ½ an ounce or about 2 tablespoons of blood. This blood will be used to examine the health of his blood vessels.

An exercise test will then be done to measure your child's muscle strength. He will be asked to pedal a cycle ergometer (a stationary bicycle that stays in place when you pedal). At first the pedaling will be easy, but it will get harder with time. An exercise specialist and a member of the clinic staff will closely watch his condition and performance. The exercise (bicycle pedaling) will be stopped if they notice any wheezing, unusual change in heart rhythms, or if your child asks to stop. Your child will be asked to breathe through a mouthpiece and wear nose clip so that the air he is breathing in and out of your mouth can be measured. Four chest stickers (electrodes) will be taped to his chest to continuously measurer his heart rate and rhythm. The amount of oxygen (saturation) of your child's blood will be measured with a clip (pulse oximeter) attached to his finger. At the end of the test your child will be able to rest and given a snack.

Finally, a small heart rate monitor (accelerometer) will be placed around your child's waist. He will be asked to wear the monitor on his waist for three days and nights. This monitor is light weight and can be worn in the shower (water proof). At the end of three days, the accelerometer will be picked up by the researcher.

How long will I be in the study?
Almost all of the information will be collected in one, 2-hour session. A second brief meeting is needed to remove the accelerometer.

Are there any risks to me?
The tests may create some minimal risk. Possible risks/discomforts include:

- The exercise test may cause muscle soreness, dizziness, fainting, or shortness of breath. In rare instances, exercise tests may cause chest pain, tightness, or changes in blood pressure, heart rate, respiratory rate, or oxygen saturation.
- DEXA Scan: the DEXA scan uses x-rays (ionizing radiation). The amount of x-rays (radiation) from the scan is very small, and is about one-quarter of one mrem effective dose. If there is any risk from this exposure, it is too small to be measured and is low compared to everyday risks. For comparison, everyday radiation to which everyone is exposed is approximately 1 mrem each day; radiation workers are allowed to accumulate 5000 mrem each year.
- You may feel that some questions or procedures we ask you to do may be stressful or upsetting. If this happens your child can stop taking part in the study immediately. We can give you names of individuals who may be able to help you with these problems.

Are there any benefits to me?
Your child may have some benefits from the procedures described in this study. You will be given the results of the exercise test and body fat assessment. The body fat assessment will describe the optimal lean and fat amounts for males who are your child's age, and your results. In the event your child is outside the best range you will be given written advice to help your child achieve a healthier body composition.

The information gained from this project may have long term benefits to others by describing the association of exercise with short and long term heart health.

What are the alternatives for participating in this study?
The alternative is not to participate in this study.

Will there be any costs to me?
Aside from your time, there are no costs for taking part in the study.

Will I be paid to participate in the study?
Your child will be paid $50.00 for his participation in the study. The money will be paid when the monitor around your waist (accelerometer) is returned.

Will the information that is obtained from me be kept confidential?
The only persons who will know that your child participated in this study will be the researcher (Principal Investigators) and other research staff. Your child's records will be confidential. Your child will not be identified in any reports or publications resulting from the study. Representatives of regulatory agencies including the University of Arizona Human Subjects Protection Program may access your child's records.

What if I am harmed by the study procedures?

Side effects or harm are possible in any research program despite the use of high standards of care and could occur through no fault of yours or the investigator involved. Known side effects have been described in this consent form. However, unforeseeable harm also may occur and require care. You do not give up any of your legal rights by signing this form.

If you believed your child has been harmed by this study, please contact the principle investigator, Beth Winokur to notify her.

Any costs for the treatment of research related side effects will be charged to you or your insurance carrier. However, if for any reason these costs are not covered by insurance, they will be your responsibility.

May I change my mind about participating?
Your child's participation in this study is voluntary. Your child may decide to not begin or to stop the study at any time. Your child's refusing to participate will have no effect on your or your child's ability to use UCI Medical Center for health care. Also any new information discovered about the research will be provided to you and your child. This information could affect your child's willingness to continue your participation.

Whom can I contact for additional information?
You can call the Research (Principal Investigator) to tell her about a concern or complaint about this research study. The Principal Investigator, Elizabeth Winokur, RN can be contacted at 714-

402-4270. If you have questions about your child's rights as a research subject you may call the University of Arizona Human Subjects Protection Program office at (520)626-6721. If you have questions, complaints, or concerns about the research and cannot reach the Principal Investigator; or want to talk to someone other than the investigator, you may call the University of Arizona Human Subjects Protection Program office at the toll-free number 1-866278-1455. If you would like to contact the Human Subjects Protection Program via the web (this can be anonymous), please visit http://www.irb.arizona.edu/contact.

Your Signature

By signing this form, you affirm that you have read the information contained in the form, that the study has been explained to you, that your questions have been answered and that you agree to have your child take part in the study. You do not give up any of your legal rights by signing this form.

____
Name (printed)

___________________________ ________________________
Participant's Signature Date signed

Statement by person obtaining consent

I certify that I have explained the research study to the person who has agreed to participate, and that he or she has been informed of the purpose, the procedures, the possible risks and potential benefits associated with participation in this study. Any questions raised have been answered to the participant's satisfaction.

____
Name of study personnel

___________________________ ________________________
Study personnel signature Date signed

APPENDIX C

MINOR ASSENT

Appendix A 3 University of Arizona

Minor Assent

Physical Activity, Body Fat, and Endothelial Function in Mexican American Male Adolescents.

Purpose of Study:
You have been asked to participate in a research project to learn what factors help teenagers exercise and what the link is between exercise and physical fitness and changes blood vessels and body fat.

Subjects:
You will be able to participate if you are a Mexican American male, between 15 and 18 years of age. You must live with a parent or guardian who is able to read or speak English or Spanish. You will not be able to participate if you regularly take anti-inflammatory medications (like Advil) or medications for high cholesterol or have a problem or disease that would make it hard for you to pedal on the stationary bike.

This study will include approximately 62 teenagers at the UCI General Clinical Research center.

Procedures:
If you agree to participate, the following will occur: You will be given an appointment; on that day report to the UCI General Clinic Research Center. You will not be able to eat or drink anything on the morning of the visit.

Your height and weight will be measured and some questions about your health your beliefs about exercise will be asked by the staff at the center. The staff will be very careful with any with any information that you give. They will not tell anyone what you say without your okay unless there is something that could be dangerous to you or to someone else.

The researchers will then ask you to perform a special test to measure the strength of you bones and the amount of my body fat. This procedure is called a DEXA scan. The DEXA scan requires that you lie flat on a padded table for 10-20 minutes. During this time the machine will move over your body and form a picture with a very low level of X-rays. The DEXA will be done once.

After the DEXA scan you will go to the exercise laboratory. Four small stickers will be placed on your chest so that the researchers can measure my heart rate. I will also have a clip placed on my finger to measure the oxygen in your blood. You will then be asked to exercise on a stationary bicycle (one that does not move when you pedal). During the exercise, you will breathe through a mouthpiece, a nose clip will be worn, and measurements of the air you are breathing will be taken. The level of the exercise will increase from easy to hard. You will be asked to continue to exercise until you feel that you are no longer conformable about continuing to exercise. You can raise your hand to stop exercising at any time. Total exercise time will last no longer than 20 minutes.

After the exercise, the staff will draw a small amount of blood, no more than 30 mL (2 tablespoons).

After the blood is drawn the staff will put a small monitor (accelerometer) around your waist. It will measure your activity for three days. It is waterproof. You will wear it all the time for three days and nights.

Three days after the procedure one of the researcher will remove the monitor.

Risks:
The possible risks and/or discomforts associated with the procedures described in this study include:
Exercise test- Exercise might cause your muscles to feel sore. Also, you might feel short of breath, sick to your stomach, dizzy or tired, or event feel faint. If you do feel these things at any time, the researchers will stop the procedure. In rare cases, you may develop wheezing, chest pain, or chest tightness.

Blood sampling- drawing blood from the veins in your arms may cause pain, bleeding, or bruising. Some people (about 5-10%) may feel faint or actually faint when the blood is drawn. To reduce these problems, you may be lying down on your back when the blood is drawn. If you do become faint at any time, the researchers will stop the procedure.

DEXA scan – The DEXA scan uses x-rays. The amount of x-rays you will receive from each scan is very small. If there is any risk from the x-rays, it is too small to be measured and is low compared to other everyday risks. There may be unknown risks from x-rays.

There may be other unknown risks from this study.

Benefits
You may have some benefits from the procedures described in this study. You will be given the results of the exercise test and body fat assessment. The body fat assessment will describe the optimal lean and fat amounts for males who are your age, and your results. In the event you are outside the best range you will be encouraged to share this information with your healthcare provider as well as being given written advice to help you achieve healthier body composition. The information gained from this project may have long term benefits to others by describing the association of exercise with short and long term heart health.

Cost/Compensation
You will be paid $ 50.00 when the monitor is picked up. You may receive cash, check or a gift certificate for compensations. There will be no cost to you for your participation in the study.

If you have Questions:
If you have any comments, concerns, or questions about this research, you should contact the researcher listed at the top of this form. This number can be used 24-hours to report any health concern or unexpected problems you experience after normal hours or on weekends.

If you have questions, complaints, or concern about the research and cannot reach the researcher; or want to talk to someone other than the researcher, you may call the University of Arizona Human Subjects Protection Program office at the toll-free number 1-866278-1455. If you would like to contact the Human Subjects Protection Program via the web (this can be anonymous), please visit http://www.irb.arizona.edu/contact.

Voluntary Participation

Participation in this study is voluntary. You may refuse to answer any questions or discontinue your involvement at any time without any penalty or loss to you. Your decision to quit will not affect your future relationship with UCI or quality of care of UCI Medical Center. Your signature below indicates that you have read the information in this consent form and have had a chance to ask any questions that you have about the study.

____
Name (printed)

____________________________ ________________________
Participant's Signature Date signed

Statement by person obtaining consent

I certify that I have explained the research study to the person who has agreed to participate, and that he or she has been informed of the purpose, the procedures, the possible risk and potential benefits associated with participation in this study. Any questions raised have been answered to the participant's satisfaction.

____
Name of study personnel

Study personnel signature

Date signed

APPENDIX D

RAW BIOMARKER LABORATORY RESULTS

Raw Biomarker Laboratory Results

Participant	*CRP (ng/ml)*	*Adiponectin (ng/ml)*	*Leptin (pg/ml)*
1	1303.91	5582.66	11067.44
2	97.63	8370.92	685.07
3	267.99	23343.08	1080.25
4	7575.24	9273.96	1195.55
5	220.71	18597.51	6527.82
6	1512.74	10858.63	2718.46
7	13154.60	4425.14	9384.59
8	991.78	8900.56	8893.93
9	2549.85	11253.00	6272.95
10	1314.85	12526.45	3564.30
11	2476.58	5112.14	2364.32
12	446.61	11626.08	1909.15
13	2025.11	10897.17	3445.07
14	653.70	5123.48	7926.11
15	496.63	11151.54	1182.39
16	60.07	5771.25	664.15
17	458.31	6272.95	11253.00
18	263.62	7968.82	1164.81
19	692.75	5130.16	4839.72
20	122.97	7196.67	2307.17
21	528.84	9843.02	3186.79
22	388.84	8346.82	6657.33
23	427.95	10740.54	1598.29
24	4533.74	7791.49	850.04
25	266.76	9862.54	4205.14
26	232.47	1049.74	14550.01
27	5751.91	5902.46	20912.38
28	1258.07	4386.73	2911.34

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