2006

Physical activity behavior of university students: an ecological approach

Lisa Gaye Johnson
Louisiana State University and Agricultural and Mechanical College, ljohns@lsu.edu

Follow this and additional works at: https://digitalcommons.lsu.edu/gradschool_dissertations

Part of the Kinesiology Commons

Recommended Citation
https://digitalcommons.lsu.edu/gradschool_dissertations/1556

This Dissertation is brought to you for free and open access by the Graduate School at LSU Digital Commons. It has been accepted for inclusion in LSU Doctoral Dissertations by an authorized graduate school editor of LSU Digital Commons. For more information, please contact gradetd@lsu.edu.
PHYSICAL ACTIVITY BEHAVIOR OF UNIVERSITY STUDENTS: 
AN ECOLOGICAL APPROACH

A Dissertation

Submitted to the Graduate Faculty of the 
Louisiana State University and 
Agricultural and Mechanical College 
in partial fulfillment of the 
requirements for the degree of 
Doctor of Philosophy 

in

The Department of Kinesiology

by
Lisa Gaye Johnson
B.S., Mississippi University for Women, Columbus, MS, 1982
M.A., Southeastern Louisiana University, Hammond, LA, 1997
May 2006
DEDICATION

As my coach he inspired me to take on new challenges. As my Father he taught me to persevere. As my Daddy he made me laugh. All of which were necessary to complete this process.

Although he is not physically on this earth to see the finished product, I know he is and has been by my side watching over me every step of the way. For these things, I dedicate this dissertation to my Daddy.
ACKNOWLEDGEMENTS

Most of all I acknowledge Debi for all of her love, patience, and dedication through the good days and bad weeks. Without her, this goal would never have been fulfilled. I especially thank Melinda Solmon for her guidance, support and patience throughout the doctoral process. Because of her leadership, I have grown as a researcher and a professional. I wish to acknowledge Amelia Lee for inspiring me to pursue this degree and keeping me on track professionally, and Georgianna Tuuri for introducing me to new research skills and making the research process fun! I want to thank Rebecca Gardner, Robert Wood, and James Geaghan for giving of their time to serve as committee members. Special thanks to my mentors and dear friends, Jeanne George and Robert Kraemer for all of the years of encouragement and support through the masters and doctorate. I extend my appreciation to all of the students who participated in this project and the computer-technicians, Venkat, Ciby and David for helping me construct and administer the on-line survey. And last, but certainly not least, I thank my sister, Kathy, for keeping me grounded and focused through the drama.
TABLE OF CONTENTS

DEDICATION......................................................................................................................... ii

ACKNOWLEDGEMENTS.................................................................................................. iii

ABSTRACT..............................................................................................................................v

CHAPTER
1 INTRODUCTION.............................................................................................................. 1

2 INDIVIDUAL AND ENVIRONMENTAL INFLUENCES ON PHYSICAL ACTIVITY IN UNIVERSITY STUDENTS................................................................. 5

3 EXAMINING VALIDITY OF OBESITY INDICATORS AND RELATIONSHIPS WITH THE BUILT ENVIRONMENT IN UNIVERSITY STUDENTS................................................................. 51

4 SUMMARY....................................................................................................................... 77

REFERENCES.................................................................................................................... 86

APPENDIX
A A REVIEW OF THE LITERATURE................................................................................. 98

B PILOT STUDY.................................................................................................................. 151

C INSTRUMENT................................................................................................................. 164

D CONSENT FORMS........................................................................................................ 173

VITA................................................................................................................................. 178
ABSTRACT

Despite the health benefits associated with active lifestyles, a majority of adults do not engage in sufficient levels of physical activity (PA). Few individual-focused interventions have produced sustained changes in PA behavior. Therefore, public health officials are promoting the use of ecological approaches to examine the multidimensional factors that influence choices about PA and other health behaviors. National statistics are mirrored in college populations, with one-half of students in the US failing to meet current PA recommendations and one-third classified as either overweight or obese. In light of this, increasing PA and obesity prevention have been identified as the top two priorities in the national Healthy Campus 2010 initiative. Research suggests that reductions in PA and increases in weight that occur during the freshman year of college and are likely to continue into adulthood are related to social and physical environmental factors. The assessment of physical environmental influences, however, on PA in college populations has been narrow in scope and inherent limitations associated with self-reported height and weight, and BMI as a predictor of obesity in youth exist. The purpose of this study was to implement an ecological model to explore factors that influence PA behaviors of college students, and to examine how those factors related to risk for overweight and obesity. Using a cross-sectional design, 308 university freshmen were surveyed regarding cognitive beliefs about PA, perceptions of neighborhood features, and participation in specific types of PA. Body composition assessments were conducted on 61 volunteers from that sample to examine the reliability and validity of self-reported BMI as an indicator of weight risk. Results suggest that safe community neighborhoods and better land use mix on campus encouraged participation in PA, but were not as predictive of PA behavior as demographic and cognitive factors. Gender and race specific biases in reported height and weight were evident. Only moderate correlations existed between measured BMI and percent body fat, compromising the ability to establish
associations between the physical environment, physical activity and risk for obesity. Percentage of body fat may be more useful to establish relationships with environmental influences in this population.
CHAPTER 1: INTRODUCTION

Epidemiological, clinical, and laboratory research have provided convincing evidence that increasing physical activity (PA) levels has numerous beneficial effects on physical health, psychological well-being, and overall quality of life (Sparling, Owen, Lambert, & Haskell, 2000; United States Department of Health and Human Services [USDHHS], 1996). Many of the protective effects of PA against cardiovascular disease (CVD) and premature mortality are related to its positive impact on hypertension, diabetes mellitus, and obesity (USDHHS, 1996). Although the relationship between life-threatening health consequences and physical inactivity has been clearly established, a majority of adults continue to lead sedentary lifestyles and obesity rates are at epidemic proportions across populations (Flegal, Carrol, Kuczmarski, & Johnson, 1998; USDHHS, 1996). These trends are mirrored on college campuses with approximately one-half of university students not meeting current PA recommendations (Irwin, 2004), and one-third classified as either overweight or obese (American College Health Association National College Health Assessment [ACHA-NCHA], 2005).

While PA interventions are generally effective during implementation of a program, few result in long-term maintenance of PA levels (Eastabrooks, Courneya, & Nigg, 1996). In fact, half of the individuals beginning an exercise program drop out within six months (Dishman, 1994). Many suggest that poor maintenance of behavioral changes because most PA studies and interventions focus primarily on individually-oriented social and psychological influences (Sallis & Owen, 2002).

According to the Surgeon General's Report (USDHHS, 1996), individual-focused PA interventions are unlikely to make significant or sustained changes in PA behavior, or health outcomes, unless efforts are made to modify barriers to PA within the environment. Furthermore, individual and small group interventions are not likely to impact changes on a large scale,
whereas environmental and policy interventions are designed to target communities and populations (Sallis & Owen, 1997; USDHHS, 1996). On the other hand, environmental factors are not as related to behavior as individual characteristics, thus environmental changes alone are unlikely to have a substantial effect on behavior (Baranowski, Cullen, Nicklas, Thompson, & Baranowski, 2003).

Given that previous approaches have largely been ineffective in the effort to produce positive changes in population health, public health officials and PA researchers have begun to implement ecological approaches to examine the many factors that influence PA and lifestyle health behaviors (Baranowski, et al., 2003). The basic assumption of this model is that outcome behaviors are the result of interactions between individuals and the social and physical environmental factors within a specific behavior-setting (Stokols, 1992, 1996). However, the degree to which a person's decision to be physically active depends on physical surroundings as opposed to personal influences is not well understood.

Discovering ways that communities can encourage healthy lifestyles has become an important component in the national research agenda (Dannenburg, et al., 2003). Efforts to identify mechanisms, and the relative influence of physical environmental factors, that facilitate or hinder PA have evolved as a major focus of public health initiatives and PA research over the past five years (Owen, Leslie, Salmon, & Fotheringham, 2000; Saelens, Sallis, & Frank, 2003). Clear evidence exists that indicates there are specific aspects of the physical environment that encourage sedentary lifestyles that could result in health consequences that are life-threatening (Sparling, et al., 2000).

Physical activity behaviors and habits established by college students are likely to be carried over into adulthood (Sparling & Snow, 2002). Some evidence indicates that reductions in PA and increases in weight that occur during their college tenure may be related to the social and
physical environment (Wallace, Buckworth, Kerby, & Sherman, 2000). However, the assessment of physical environmental influences on PA in college populations has been limited in scope, primarily focusing on access to PA facilities and home equipment (Leslie, et al., 1999; Reed & Phillips, 2005). Furthermore, the limitations associated with self-reported height and weight, and BMI as a predictor of obesity in youth (Arroyo, et al., 2004; Himes & Bouchard, 1989) need to be examined further when investigating relationships between the environment and obesity.

To our knowledge, only one group of researchers have incorporated an ecological approach employing concurrent measures of individual, social, and physical environmental influences on PA behavior (Giles-Corti & Donovan, 2002, 2003). Likewise, only a small number of studies have investigated the relationships between the physical environment, PA, and obesity. Those studies relied on body mass index (BMI) measures with only limited information regarding subgroup differences in this area of research (Frank, Andresen, & Schmid, 2004).

Addressing lifestyle changes that will decrease health risks and improve physical and psychological well-being of individuals aged 18-25 years has become an important aspect of national PA and health promotion initiatives. Healthy Campus 2010 (ACHA, 2000) is a sub-component of the Healthy People initiative designed to encourage colleges and universities to make health objectives a priority and to track PA patterns and obesity markers of college students.

If public health initiatives directed at the college-aged population are to be successful in increasing PA levels and fostering the adoptions of healthy, active lifestyles that will carry over into adulthood, it is important that the strategies employed in those initiatives are evidence based. This research project is an exploratory study that was designed to examine the utility of the ecological model on college campuses. The overall purpose of the dissertation was to investigate factors that influence PA behaviors of college students, and to examine how those factors related
to risk for overweight and obesity. The study consists of two projects. The purpose of the first project was to investigate relationships between individual influences, psychosocial factors, the physical environment, and PA behaviors in a sample of university freshmen. An on-line survey was administered to university freshmen who responded to a mass email soliciting volunteers to complete a questionnaire about their perceptions of neighborhood characteristics, beliefs about PA, and participation in PA. In the second project, a sub-sample of that cohort volunteered to participate in laboratory assessments of height, weight, BMI and percentage of body fat using criterion measures. The purpose of the second project was to examine the reliability of BMI calculated from self-reported data as a valid indicator of weight risk in this population, and associations between percentage of body fat and the physical environment. The findings from these two studies have the potential to provide important insights concerning the development of strategies that can be used to promote college students’ physical activity.
CHAPTER 2: INDIVIDUAL AND ENVIRONMENTAL INFLUENCES ON PHYSICAL ACTIVITY IN UNIVERSITY STUDENTS

Despite well-documented evidence regarding the negative health consequences of physical inactivity, the majority of adults do not meet recommended physical activity (PA) guidelines (United States Department Health and Human Services [USDHHS], 1996). Moreover, a rapid decrease in PA occurs between the ages of 18 and 24 (Stephens, Jacobs, & White, 1985). Furthermore, there is evidence that "diseases of inactivity" may begin in the second and third decades of life (Strong, et al., 1999).

While most campus settings appear to provide a physical environment conducive to PA, reports from national surveys and reviews indicate that more than 50% of college students are insufficiently active (American College Health Association [ACHA], 2005; Douglas, et al., 1997; Irwin, 2004). In light of this disturbing trend, these individuals have gained the attention of public health officials and are identified as a neglected but important population for PA research and public health promotion initiatives (ACHA, 2000).

It has been suggested that the transition from the home environment to a new social and physical environment in college may impact students’ PA patterns (Butler, Black, Blue, & Gretebeck, 2004; Dinger, 1999). The increased use of computers and other technological devices used in college helps to create an environment that does not foster recreational PA (Buckworth & Nigg, 2004). Previous studies have shown that accessibility and proximity to PA facilities are associated with being physically active in undergraduate populations (Leslie, et al., 1999; Reed & Phillips, 2005). Some researchers suggest that supports such as recreational facilities and exercise programs found on most campuses may only be relevant for those individuals who are already active (Leslie, Sparling, & Owen, 2001). Little is known about aspects of the university physical environment that might influence the proportion of the student body that is
insufficiently active. Furthermore, there is some evidence that the PA behaviors of students differ depending on their living arrangements (Brevard & Rickets, 1996; Dinger, 1999; Jones, Harel, & Levinson, 1992; Reed & Phillips, 2005). Students in residents halls are less likely to be insufficiently active (Dinger, 1999) and tend to engage in group physical activities more than students living off-campus (Jones, et al., 1992).

Studies have consistently reported previous PA patterns as an indicator of current and future behavior (Malina, 1996; Wallace, Buckworth, Kerby, & Sherman, 2000). Given the decline in vigorous activity during the first year of college associated with the transition from high school to college (Bray & Born, 2004), and the overall number of insufficiently active and sedentary college students, a better understanding of personal, social, and physical aspects of the environment that might act as supports or barriers to PA is needed (Bray & Born, 2004).

There is evidence that the physical characteristics of the neighborhood environment may be influential in decisions about being physically active. Recent PA studies have reported that aesthetic features, supportive community infrastructure, and accessibility to destinations have a positive relationship with higher levels of PA (McCormick, et al., 2004; Owen, Humpel, Leslie, Bauman, & Sallis, 2004). Most of the PA-physical environment research, however, has focused on middle-aged and older adults with only limited investigation of subgroup differences. The university campus setting provides a physical environment with the potential to make PA convenient and enjoyable (Leslie, et al., 2001). Yet few studies have examined how students’ PA levels might be related to their perceptions of the campus infrastructure.

It has been suggested that the simultaneous examination of psychosocial correlates of PA and environmental factors may offer a clearer understanding of individual variation in PA behavior within specific behavior-settings (Saelens, Sallis, & Frank, 2003). The lack of specificity within the multilevels of ecological models allows for the inclusion of other models
(Sallis & Owen, 2002). One group of researchers adopted this approach and found that environmental factors may serve as secondary influences on PA behavior compared to individual and cognitive factors (Giles-Corti & Donovan, 2002). These authors concluded that accessibility was a determining factor in the use of PA facilities, but that alone may not be adequate to ensure that sufficient PA occurs. However, the same researchers did find that the relative influence of individual, social, and physical environmental determinants on walking at recommended levels was similar (Giles-Corti & Donovan, 2003).

**Social Ecological Approach**

Psychological, social, cultural, and demographic correlates of PA have been studied extensively in adults and youth (Sallis & Owen, 1999; Sallis, Prochaska, & Taylor, 2000). Despite strong associations reported for many of these variables, individual-focused behavioral interventions have not produced sustained changes in PA behavior or health outcomes (Sallis & Owen, 1999). The limited impact of behavioral change models on individual and population PA and health has led public health professionals to embrace and promote the use of ecological models in research and practice to better address the multidimensional influences on lifestyle health behaviors (Baranowski, Cullen, Nicklas, Thompson, & Baranowski, 2003).

The ecological approach was first introduced in the health domain as a means of better understanding the role of human behavior in lifestyle chronic diseases (McLeroy, Bibeau, Steckler, & Glanz, 1988). The model summarized the multilevels of influence on health-related behaviors as intrapersonal characteristics, interpersonal processes and significant groups, institutional factors, community factors, and public policy (McLeroy, et al., 1988). Stokols (1992, 1996) proposed the use of ecological models in health promotion to encourage or discourage healthy behaviors by altering aspects of the physical environment. Based on the work of McLeroy and Stokols, Sallis and Owen (1997) provided a functional application of the
ecological model to PA promotion suggesting that variables in all domains influence PA in adults and children.

In light of the success of national initiatives and multi-discipline partnerships to reduce smoking at the population level, collaborative efforts have been made among public health researchers, educators, government, and industry to develop a framework for determinants of PA habits (Booth, et al., 2001). The framework is conceptualized in a hierarchical manner. Beyond the individual psychobiologic, cultural, and social factors are three levels of environmental and policy influences. The first level is the “behavior setting,” or situational context in which behavior occurs (Barker, 1968; Wicker, 1979). Because specific PA behavior takes place in very specific settings, each with potential enablers of choice (enhancers or barriers), the behavior settings (e.g. neighborhoods, schools, parks, workplace, and exercise facilities) are thought to have the most significant influence on lifestyle choices regarding PA (Sallis & Owen, 2002). Second are proximal leverage points (e.g. schools, community, family, local government, employer, developers) which are perceived to have direct control on the behavior settings. The outermost level of the model consists of distal leverage points (e.g. healthcare industry, transportation system, education system, and entertainment industry) that have indirect, yet significant influence, on one or more of the behavior settings. Although the principles of the social ecological approach are considered to have promise for a better understanding PA and other health behaviors, researchers agree that much work is needed to establish the efficacy and operationalization of such a complex conceptual model (Green, Richard, & Potvin, 1996).

Theory of Planned Behavior

The Theory of Planned Behavior (TPB; Ajzen, 1985, 1991) is considered a particularly efficacious theoretical model in the PA domain producing some of the most promising research on social cognitive determinants of PA behavior (Hagger, Chatzisarantis, & Biddle, 2002;
The TPB constructs are attitude (ATT), subjective norm (SN), intention, and perceived behavioral control (PBC). Within the model, intention is considered to be the primary determinant of behavior representing an individual's level of motivation to participate in the behavior (Ajzen, 1991; Ajzen & Fishbein, 1980). Attitude and SN are the determinants of intention, and thus have an indirect influence on behavior (Ajzen & Fishbein, 1980). Perceived behavioral control can directly influence behavior through intentions (Ajzen, 1991) or serve as a direct determinant of nonvolitional behaviors independent of the intention-mediated effect (Ajzen & Madden, 1986).

Attitude represents an individual's disposition toward participating in a behavior (Ajzen, 1991). It is a function of the strength of behavioral beliefs about the outcome of performing the behavior and the extent to which an individual values those outcomes (Ajzen & Fishbein, 1980). Subjective norm, is a function of an individual’s normative beliefs about expectations of significant others and the desire to please or comply with people of importance (Ajzen & Fishbein, 1980). Perceived behavioral control is determined by control beliefs regarding the presence or absence, and perceived power, of resources, opportunities, and barriers to perform the behavior (Ajzen & Madden, 1986). In general, the more favorable an individual’s ATT and SN, and the greater their PBC, the stronger the intention to participate in a given behavior (Ajzen, 1991).

Numerous narrative (Ajzen, 1991; Blue, 1995; Culos-Reed, Gyurcsik, & Brawley, 2001; Godin, 1993; Godin & Kok, 1996; McAuley & Courneya, 1993) and statistical reviews (Armitage & Conner, 2001; Hagger, et al., 2002; Hausenblas, Carron, & Mack, 1997, Downs & Hausenblas, 2005) have reported the substantial ability of the TPB to predict intentions and behavior within the PA domain. On average, ATT, PBC, and SN account for approximately 40 to 60% of the variance in PA intention and intention and PBC explain 20 to 40% of the variance.
in PA behavior across studies and populations (Culos-Reed, et al., 2001). Supporting these findings, Hagger et al. (2002) found in a meta-analysis of 72 studies that the TPB model accounted for 44.50% of the variance in PA intentions, with ATT and PBC emerging as the strongest predictors, and that 27.41% of the variance in PA behavior was attributed to intention and PBC.

A substantial number of individual research articles have used the TPB to explain PA behavior in undergraduate students. Similar to the findings in other populations, the TPB has served as an efficacious model in the prediction of exercise and PA intentions and behavior in this population (Ajzen & Driver, 1992; Bagozzi & Kimmel, 1995; Dzewaltowski, Noble, & Shaw, 1990; Gatch & Kendzierski, 1990; Madden, Ellen, & Ajzen, 1992; Okun, Karoly, & Lutz, 2002). Recent investigations have reported gender and ethnicity-specific differences in ATT, PBC, SN and intentions to be physically active in children and college populations (Blanchard, et al., 2003; Mummery, Spence, & Hudec, 2000). In addition, the relative contribution of the predictor variables appear to be influenced by gender and ethnicity (Blanchard, et al., 2002; Mummery, et al., 2000; Trost, et al., 2002).

Ecological Approaches and Physical Activity

For years urban planning and transportation researchers have known that PA for transport (walking and cycling) is augmented in "traditional" or high-walkability neighborhoods characterized by closeness and connectivity to destinations, good land use-mix (residential and commercial mixed), high population density, pedestrian-friendly facilities (e.g. sidewalks, street lighting, bike paths), and more aesthetic features (e.g. trees, clean; Cervero & Kockelman, 1997; Frank & Pivo, 1994; Handy, 1996; Saelens, Sallis, & Frank, 2003). It has only been within the last decade that an emphasis has been placed on understanding the impact of physical environmental factors on recreational or leisure-time PA (McCormack, et al., 2004).
Sallis and colleagues (Sallis & Owen, 2002) have built on the strengths of the transportation literature and emphasized the behavior setting concept within the ecological model to demonstrate how environmental contexts and their functions can impact choices to be physically active or sedentary. For example, in a study using a newly developed survey to assess characteristics of neighborhood environments and accelerometers to quantify PA, Saelens, Sallis, Black, and Chen (2003) found that residents living in high-walkability neighborhoods engaged in approximately 70 more minutes of PA, primarily of moderate-intensity, than those living in the low-walkability neighborhoods. Residents in the high-walkability neighborhoods reported better aesthetics, pedestrian and traffic safety, connectivity of streets, higher residential density, and land use mix-diversity. Using a modified version of that instrument, DeBourdeaudhuij, Sallis, and Saelens (2003) found that minutes of walking and moderate intensity activity were related to shopping and public transport accessibility and quality of sidewalks. Vigorous PA was related to presence of home equipment and availability of convenient facilities. More recently, Atkinson, Sallis, Saelens, Cain and Black (2005) reported significant positive correlations between self-reported and accelerometry-measured vigorous PA, residential density, and an overall environmental index. Street connectivity was also correlated with the objectively measured vigorous and total PA. These studies demonstrate how each behavior setting may have environmental characteristics that are relevant to specific types or purposes of PA (Sallis & Owen, 2002).

Others have documented significant associations between achieving recommended PA levels and perceived access to neighborhood or community supports such as public parks, sidewalks (Brownson, et al., 2001; Sharpe, Granner, Hutto, & Ainsworth, 2004), worksite supports (Sharpe, et al., 2004), private recreational facilities (Addy, et al., 2004), and designated routes or trails for activity (Huston, Evenson, Bors, & Gizlice, 2003; Sharpe, et al., 2004). In
addition, sidewalk conditions (Sharpe, et al., 2004), good lighting, neighbor trust (Addy, et al., 2004), enjoyable scenery, and traffic safety (Brownson, et al., 2001) have been reported as significant environmental influences on PA behavior. A recent study of adult residents living in southeast Texas reported that when compared to other neighborhood characteristics, perceived crime and traffic safety had the strongest association with leisure-time PA (Mortality and Morbidity Weekly Report, 2005).

The primary focus in this area of research over the past 10 years has been the identification and measurement of physical environmental correlates of PA behavior (Sallis, Bauman, & Pratt, 1998). DeBourdeaudhuij et al. (2003) found that beyond demographics, the amount of variance accounted for by physical environmental variables ranged from three to nine percent depending on the type of PA (walking, moderate, and vigorous). Few studies have adopted an ecological approach to identify the relative influence of individual, cultural, social, physical, and policy environmental factors on PA (Giles-Corti, Timperio, Bull, & Pikora, 2005).

More research is needed to examine how constructs from different theoretical models might relate to one another and serve complementary roles in changing PA behavior (Baranowski, et al., 2003). Given the success of the TPB to predict PA behavior, it has been suggested that the determinants of PA behavior be examined from an ecological perspective using the TPB model to address psychosocial influences (Baranowski, et al., 2003). The approach used in this study was based on the comprehensive framework proposed by Booth et al. (2002) and the TPB (Ajzen, 1985, 1988, 1991). Figure 2.1 illustrates the target variables in the study.

Research indicates that the transition into the university environment results in a decline in PA participation, particularly during the freshmen year (Bray & Born, 2004). Recent reviews indicate that attributes of the physical environment are important influences on PA behavior
The few physical environment-PA studies involving university students have primarily focused on proximity to exercise facilities and access to home equipment (Leslie, et al., 1999; Reed & Phillips, 2005). Only Sallis, Johnson, Calfas, Caparosa, and Nichols (1997) used a broader examination of behavior settings that included neighborhood features. The unique contribution of this study is the implementation of a multilevel ecological model to simultaneously examine the relative influence of individual, psychosocial, and physical environmental correlates on specific types of PA. It is especially significant because of the focus on an understudied population at risk for developing sedentary lifestyles that are likely to persist into adulthood.

Figure 2.1. Schematic representation of the multilevel ecological framework integrating the ecological model presented by Booth et al. (2003) and the TPB model (Ajzen, 1985, 1991).
In accordance with the national research agenda to promote the utilization of a dual-level framework to investigate the influence of the built environment and behavioral determinants on PA and health outcomes, the purpose of this study was to employ an ecological approach to examine overall and specific PA behavior in first year university students.

Five broad research hypotheses were investigated. Specific sub-hypotheses that were tested are presented below, with the basis for those predictions.

1. It was hypothesized that cognitive determinants of PA, perceptions of the physical environment, and levels of PA would differ by gender, ethnicity and residence. Specifically, it was predicted that:

   A) Cognitive determinants

      1) Males would have higher intentions to be physically active than females (Blanchard, et. al. 2003).

      2) Caucasians would have higher SN and PA intentions than non-Caucasians (Blanchard, et. al. 2003).

      3) On-campus residents would have more positive cognitions about PA than off-campus residents (Giles-Corti & Donovan, 2003)

   B) Perceptions of the physical environment

      1) Perceptions of the neighborhood environment would not differ between males and females (Suminski, Poston, Petosa, Stevens, & Katzenmoyer, 2005).

      2) Caucasians would report more positive perceptions of the neighborhood environment than non-Caucasians (Sallis, et al., 1997).

      3) On-campus participants would report more positive perceptions of the neighborhood environment than off-campus participants (Saelens, Sallis, Black, et al., 2003).
C) PA levels

1) Males and Caucasians would have higher levels of regular PA and participate in vigorous types of PA more often than females and non-Caucasians (Buckworth & Nigg, 2004; Dinger, 1999; Irwin, 2004; Leslie, et al., 1999).

2) Non-Caucasians would engage in physical activities of moderate intensity more often than Caucasians (Douglas, et al., 1997).

3) Participants living on-campus would report higher levels of regular and moderate intensity PA than off-campus participants (Dinger, 1999; Reed & Phillips, 2005).

2. Based on the principles of the TPB (Ajzen, 1985, 1991), it was predicted that:

A) Attitude, PBC, and to a lesser degree SN, would be significant predictors of intention to participate in PA (Ajzen, 1985, 1991).

B) Intentions and PBC would be significant predictors of regular PA behavior (Blue, 1995; Culos-Reed, et al., 2001; Godin, 1993; Godin & Kok, 1996; Hagger, et al., 2002; Hausenblas, et al., 1997).

3. Based on the ecological model, it was hypothesized that participants’ perceptions of the physical environment would be associated with levels of PA. Specifically, it was predicted that:

A) Participants’ perceptions of residential density, connectivity, walking/cycling paths, land use mix-access and -diversity in their neighborhoods would be positively associated with engagement in regular and moderate forms of PA (De Bourdeaudhuij, et al., 2003, Humpel, Owen, & Leslie, 2002; McCormack, et al., 2004; Owen, et al., 2004; Saelens, Sallis, Black, et al., 2003).
B) Perceptions of poor aesthetics, traffic as a problem, and high crime would be associated with lower levels of regular and moderate intensity PA (Humpel, Owen, & Leslie, 2002; McCormack, et al., 2004; Owen, et al., 2004).

C) Residential density and connectivity would be predictive of vigorous PA (Atkinson, et al., 2005).

4. Based on the ecological framework, it was hypothesized that participants’ perceptions of the neighborhood features would account for a significant portion of the variance in PA behavior beyond that of the individual and cognitive influences.

5. Based on pilot data for this study, as well as the integrated models proposed by Baranowski et al. (2003), Booth et al. (2002), and Pikora, Giles-Corti, Bull, Jamrozik, and Owen (2003), it was predicted that participants’ perceptions of the neighborhood environment would be positively correlated with their cognitive determinants of PA.

Method

Participants

The participants in this study were 308 university students classified as first-year freshmen. Email addresses were obtained for all freshmen entering a large southeastern university during the fall of 2004 and used to recruit participants to complete an on-line survey during the 2005 spring semester. A web-site link was emailed to all freshmen students (N = 5382) calling for volunteers to participate in the study. To enhance the response rate, prizes were offered, reminder emails were sent bi-weekly, and confidentiality of information was assured. The survey was emailed three times over a three week period, although, no student could take the survey more than once. The research protocol was approved by the university institutional review board and all participants indicated comprehension of and agreement with the informed consent prior to completing the survey.
The demographics of the study sample and the entire freshmen class are found in Table 2.1. In comparison with the enrollment of all first-year freshmen at the time the survey was conducted, females were slightly overrepresented and non-Caucasians were underrepresented. Mean age for this sample was 18.59 ± 0.57 years.

Table 2.1

Demographics of Sample Participants and Freshmen Population

<table>
<thead>
<tr>
<th>Variable</th>
<th>Study Sample</th>
<th>Campus Population*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
</tr>
<tr>
<td>Male</td>
<td>113</td>
<td>36.7</td>
</tr>
<tr>
<td>Female</td>
<td>195</td>
<td>63.3</td>
</tr>
<tr>
<td>Caucasian</td>
<td>267</td>
<td>86.7</td>
</tr>
<tr>
<td>Non-Caucasian</td>
<td>41</td>
<td>13.3</td>
</tr>
<tr>
<td>On-campus</td>
<td>162</td>
<td>52.6</td>
</tr>
<tr>
<td>Off-campus</td>
<td>146</td>
<td>47.4</td>
</tr>
<tr>
<td>Total</td>
<td>308</td>
<td></td>
</tr>
</tbody>
</table>

*Based on spring 2005 enrollment as of the 14th day of classes

Instrumentation

The survey used in this study was developed to investigate relationships between individual factors, physical aspects of the neighborhood environment and PA behavior of young university students. A pilot of the instrument was administered to 76 students. Based on feedback from those individuals, revisions were made to make the on-line survey more user-friendly.

The survey in its entirety can be found in the appendix. Only the sections and items of the survey that were relevant to this study are presented in this paper. The survey included previously validated questionnaires and additional questions developed by the investigators based on variables deemed theoretically significant in the literature. Items from five sections of
the original survey were used for this study addressing demographics (Section A), perceptions of the neighborhood physical environment (Sections B and D), individual cognitive determinants of PA (Section C), and self-reported engagement in PA (Section F).

Cognitive Determinants of PA. Measures of individual cognitive influences on PA behavior were based on the TPB (Ajzen, 1991). Using Ajzen's guidelines for constructing a TPB questionnaire (Ajzen, 2002), 16 questions were designed to examine the participant’s attitude (ATT), subjective norm (SN), and perceived behavioral control (PBC) toward participation in regular PA. To obtain an estimation of the participants’ overall PA behavior, all questions were relative to an operational definition of “regular PA” specified as “the accumulation of 30 minutes or more of moderate intensity activity on at least five or more days per week (increased heart and breathing rate above resting levels) or at least 20 minutes of vigorous intensity activity on three or more days per week (sweating and large increases in heart and breathing rate).

Verbal continuous-closed 7-point Likert scales were used to evaluate the ATT, SN, and PBC measures. All ATT items began with the following statement, “participating in regular physical activity is.” Four items were used to assess affective ATT (anchor rating 1 = extremely useless; 7 = extremely useful) and four items to assess instrumental ATT (1 = extremely boring; 7 = extremely interesting). Using anchor ratings strongly disagree (1) to strongly agree (7), three items were used to assess injunctive SN (e.g. most people who are important to me support me participating in regular PA) and two items to assess descriptive SN (e.g. most people who are important to me participate in regular PA). Three items were used to assess PBC about participation in regular PA in relation to the participant’s self-efficacy (1 = strongly disagree; 7 = strongly agree), how much control they have (1 = very little control; 7 = complete control), and difficulty to engage in (1 = extremely difficult; 7 = extremely easy). The number of days per
week the participant intended to participate in regular PA and the number of days they participated in regular PA was assessed with one item each using a continuous-open response.

Physical Environment Measures. The students’ perceptions of their current physical environments were assessed using the Neighborhood Environment Walkability Scale (NEWS; Saelens, Sallis, Black, et al., 2003). Students living on-campus were instructed to use the university campus as their neighborhood environment. The neighborhood environment for the students living off-campus was defined as a half-mile radius or a 10-minute walk from their present residence.

The NEWS consists of eight subscales designed to assess the following characteristics of the neighborhood: (a) residential density (frequency of different types of residences), (b) land use mix-diversity (proximity of residence to businesses and public and private facilities), (c) land use mix-access (perceived access to destinations), (d) connectivity (structural characteristics of streets) (e) walking/cycling (availability and condition of sidewalks, paths, and trails), (f) aesthetics (pleasantness), (g) traffic safety (pedestrian specific), and (h) crime safety. Table 2.2 indicates the number of items per subscale and an example of the type of questions.

The residential subscale in the NEWS was modified to better represent types of residences found on and around campus. The six question format was reduced to three questions. The four categories of apartments or condos (1-3 stories, 4-6 stories, 7-12, more than 13 stories) were combined to form one apartment/condo category. The three remaining types of households were then weighted as follows: single-family homes = 1, town/row houses = 10, and apartments or condominiums = 20. Therefore, residential density was assessed using a three-question format and a response range from 1 (none) to 5 (all) to determine the frequency of the three types of residences. The response was multiplied by the weight of the category.
The land use mix-diversity items were assessed using responses ranging from 1 (≥ 30-minute walk or don’t know) to 5 (1-5 minute walking distance). The remaining six subscales used a 4-point Likert response scale ranging from 1 (strongly disagree) to 4 (strongly agree). Except for the residential density subscale, a composite score was calculated as the mean of the items for each of the subscales with higher subscale values indicating a more positive assessment of the environmental characteristic.

Table 2.2
Subscales and Examples of the Items in the Neighborhood Environment Walking Scale

<table>
<thead>
<tr>
<th>Subscale</th>
<th>Items</th>
<th>Sample items</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Residential density</td>
<td>3</td>
<td>How common are the following types of residences in your neighborhood: (a) detached single-family homes, (b) town houses or row houses, (c) apartments or condos…?</td>
</tr>
<tr>
<td>b. Land use mix-diversity</td>
<td>23</td>
<td>About how long would it take to get from your residence to the nearest businesses or facilities listed below if you were to walk? (a) supermarket, (b) library, (c) bank, (d) park, etc.</td>
</tr>
<tr>
<td>c. Land use mix-access</td>
<td>7</td>
<td>Stores are within easy walking distance of my home.</td>
</tr>
<tr>
<td>d. Street connectivity</td>
<td>5</td>
<td>The streets in my neighborhood do not have many, or any cul-de-sacs (dead-end streets).</td>
</tr>
<tr>
<td>e. Walking/cycling</td>
<td>5</td>
<td>There are sidewalks on most of the streets in my neighborhood.</td>
</tr>
<tr>
<td>f. Aesthetics</td>
<td>6</td>
<td>There are trees along the streets in my neighborhood.</td>
</tr>
<tr>
<td>g. Traffic safety</td>
<td>8</td>
<td>The speed of traffic on the street I live on is usually slow.</td>
</tr>
<tr>
<td>h. Crime safety</td>
<td>6</td>
<td>My neighborhood streets are well lit at night.</td>
</tr>
</tbody>
</table>

The psychometric properties of the NEWS subscales have been previously documented and it has demonstrated acceptable reliability and validity (DeBourdeaudhuij, et al., 2003;
Saelens, Sallis, Black, et al., 2003). These studies reported test-retest intra-class correlation values $\geq .75$ for the majority of subscales.

**Physical Activity Measures**

Separate items were used to assess participation in specific types of PA because different PA behaviors typically occur in specific types of behavior settings, and the influence of environmental variables are often behavior-specific (Owen, Leslie, Salmon, & Fotheringham, 2000; Sallis & Owen, 2002). Little is known about how specific neighborhood features impact different types and intensities of PA during the transition to the university environment. Therefore, participation in vigorous and moderate PA was also assessed based on two measures from the 1995 National College Health Risk Behavior Survey (NCHRBS). The term exercise used in the behavioral surveillance measure was replaced with physical activities in the operational definition of vigorous PA. The question was: “on how many of the past seven days did you participate in vigorous physical activities for at least 20 minutes that made you sweat and breathe hard (e.g. running/jogging, swimming laps, fast bicycling, tennis, basketball or similar aerobic activities)?”

Consistent with the NCHRBS, the operational definition of moderate PA was: “on how many of the past seven days did you walk or bicycle for at least 30 minutes at a time (including to or from class or work)?” An additional question was used to address lifestyle PA of moderate intensity. Based on an item from the survey instrument used in the Study on Environmental and Individual Determinants of Physical Activity (Giles-Corti & Donovan, 2002), the operational definition of lifestyle PA was: “apart from what you have already reported, on how many of the past seven days did you accumulate at least 30 minutes of any moderate intensity that raised your heart and breathing rate above resting level (include occupational work, yard-work, and other recreational activities).”
Statistical Analyses

Because of technical difficulties encountered with the server used to administer the on-line survey, the number of students that actually received the email link could not be verified. Subsequently, an accurate response rate could not be determined. Of the 337 students who submitted responses to the on-line survey, two cases were considered non-traditional university students (ages 26 and 31 years) and were omitted. Another 27 cases were eliminated because 15% or more of the data were missing. The mean of the distribution was used to replace any other cases with less than 15% of the data missing (George & Mallery, 2003). Thus, the analysis was based on a total of 308 students who responded to the on-line survey. Cronbach's alpha coefficients were used to assess the inter-reliability of the TPB constructs.

To test the first hypothesis, preliminary analyses were conducted to examine demographic differences in the independent and dependent variables. Two multivariate analyses of variance (MANOVA) were performed to determine if the participants’ cognitive determinants of PA and perceptions of the neighborhood differed by gender, ethnicity, and residence (on- or off-campus). To assess group differences in the PA variables, a 2 (gender) X 2 (ethnicity) X 2 (residence) analysis of variance (ANOVA) was conducted for each outcome measure (regular, vigorous, walk/cycle-moderate, and lifestyle-moderate PA).

Two hierarchical regression analyses were used to test the second hypothesis addressing the efficacy of the TPB model for this sample. Based on the theoretical principles of the TPB, PA intentions were examined first by entering ATT and SN into the first block and PBC into the second block of the regression model. A second regression model was used to determine the contribution of intentions and PBC in the prediction of regular PA behavior by entering PA intentions and PBC into the first and second block, respectively.
To test the third hypothesis, stepwise regression analyses were used to determine which aspects of the neighborhood environment were significant influences on each of the four PA variables. Only the environmental variables that emerged as significant predictors in the stepwise regression were included in subsequent hierarchical models.

Three hierarchical regression models were used to determine the variance explained by demographic, cognitive, and physical environmental factors in the prediction of regular, vigorous, and lifestyle-moderate PA behavior. Because psychobiologic, cultural, and societal influences are believed to be at the core of the ecological framework for determinants of PA and eating habits (Booth, et al., 2001), the demographic and cognitive variables were entered into the first block of the models. The environmental variables deemed significant in the prediction of PA in stepwise regressions were entered into the second block of the models. By doing so, an estimation of the independent contribution of environmental variables could be determined beyond the individual determinants.

The fifth hypothesis was based on findings from the pilot data for this study suggesting that students’ perceptions of the neighborhood environment may be related to their cognitive beliefs about being physically active. Therefore, a canonical correlation was used to assess the multivariate relationships between the cognitive determinants of PA and environmental variables. Responses to the eight neighborhood subscales targeted in the NEWS made up the set of variables representing environmental influences on PA. Self-reported ATT, SN, PBC and intention to be physically active comprised the set of variables representing individual determinants of PA. The level of significance was set at $p < .05$ for all analyses.

Results

Approximately 70% of the participants reported that they had participated in recommended levels of PA on at least three of the seven days prior to completing the survey (i.e.
vigorous activity for at least 20 minutes on three or more days, or moderate activity for at least 30 minutes on 3 or more days). Forty-eight percent indicated they had performed vigorous activity on at least 3 of the 7 days preceding the survey. Compared to other surveys of PA in this population, these data suggest this is a biased sample and probably not representative of most university students’ PA behavior (ACHA, 2005; Irwin, 2004). Therefore, generalizations of the results to other university populations should be made with caution.

Cronbach's alpha coefficients for the ATT, SN and PBC measures were 0.85, 0.71, and 0.63, respectively. Similar alpha levels have been reported for the ATT, SN and PBC constructs in other studies (Ajzen & Driver, 1992; Dzewaltowski, Noble, & Shaw, 1990; Gardner & Hausenblas, 2004; Okun, Karoly, Lutz, & 2002).

**Gender, Ethnicity, and Residence**

The first set of hypotheses investigated the effects of gender, ethnicity, and residence with regard to cognitive determinants, perceptions of the physical environment, and physical activity levels. The means and standard deviations for all variables by these subgroups are reported in Table 2.3. Partial support was evident for the specific hypotheses.

**Cognitive Determinants.** The 2 (gender) by 2 (ethnicity) by 2 (residence) MANOVA for the TPB constructs revealed significant gender, Wilks’ Lambda = 0.96 ($F[4, 297] = 3.45, p < .01$) and residence, Wilks’ Lambda = 0.96 ($F[4, 297] = 3.04, p = .02$) effects. There were no significant effects for ethnicity, and the interactions were not significant. Univariate follow-ups indicated that PBC ($F[1, 7] = 11.89, p = .01$) and intention ($F[1, 7] = 5.01, p = .02$) were significantly higher for males as compared to females. In addition, participants living on-campus had higher SN ($F[1, 7] = 8.69, p < .01$) and PBC ($F[1, 7] = 4.89, p = .03$) than those living off-campus. These data provide partial support for hypothesized gender and residential differences, but do not support the hypotheses with regard to ethnicity.
Perceptions of the Physical Environment. The 2 (gender) by 2 (ethnicity) by 2 (residence) MANOVA for the subscales of the NEWS also yielded significant residence effects Wilks’ Lambda = 0.75 ($F[8, 293] = 12.18, p < .01$). Individuals living on-campus reported more land use mix-diversity ($F[1, 300] = 38.03, p < .01$), better land use mix-access ($F[1, 300] = 10.92, p < .01$), better street connectivity ($F[1, 300] = 6.52, p = .01$), easier access to walking and cycling facilities ($F[1, 300] = 26.85, p < .01$), better aesthetics ($F[1, 300] = 43.38, p < .01$), safer traffic ($F[1, 300] = 25.31, p < .01$), and less crime ($F[1, 300] = 9.85, p < .01$). Generally, the hypothesis that residential status is an important factor in the perception of the physical environment was supported, but again, the hypothesis relevant to ethnicity was not supported. No gender or ethnicity differences were found for these variables.

Physical Activity Levels. Three-way ANOVA models were used to compare each of the four PA measures. Regular PA behavior differed significantly by ethnicity ($F[1, 300] = 5.76, p = .02$) and residence ($F[1, 300] = 6.58, p = .01$). The hypotheses for group difference in PA levels were partially supported. As predicted, Caucasians and students living on campus reported higher levels of regular PA than their counterparts (Table 2.3). Furthermore, there was an ethnicity by residence interaction ($F = [1, 300] 4.89, p = .03$). Figure 2.2 shows that participation in regular PA was not different between Caucasians and non-Caucasians who lived on-campus. However, Caucasians who lived off-campus reported significantly higher levels of regular PA than non-Caucasians living off-campus. With regard to vigorous PA, males reported higher participation levels than females ($F[1, 300] = 5.85, p = .02$) supporting the first hypothesis, but there were no significant ethnicity or residence effects.
### Table 2.3
Mean and Standard Deviation for Neighborhood Variables, Cognitive Variables and PA Behavior by Residence and Gender

<table>
<thead>
<tr>
<th>Variable</th>
<th>On-campus (n = 162)</th>
<th>Off-campus (n = 146)</th>
<th>Male (n = 113)</th>
<th>Female (n = 195)</th>
<th>Caucasian (n = 267)</th>
<th>Non-Caucasian (n = 41)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M ± SD</td>
<td>M ± SD</td>
<td>M ± SD</td>
<td>M ± SD</td>
<td>M ± SD</td>
<td>M ± SD</td>
</tr>
<tr>
<td>Attitude</td>
<td>6.12 ± 0.66</td>
<td>6.12 ± 0.67</td>
<td>6.22 ± 0.63</td>
<td>6.06 ± 0.68</td>
<td>6.12 ± 0.65</td>
<td>6.11 ± 0.73</td>
</tr>
<tr>
<td>Subjective Norm</td>
<td>**5.47 ± 0.86</td>
<td>5.11 ± 0.98</td>
<td>5.29 ± 0.89</td>
<td>5.31 ± 0.96</td>
<td>5.34 ± 0.88</td>
<td>5.06 ± 1.22</td>
</tr>
<tr>
<td>Perceived Behavioral Control</td>
<td>*5.69 ± 0.98</td>
<td>5.48 ± 1.15</td>
<td>**5.88 ± 0.91</td>
<td>5.42 ± 1.11</td>
<td>5.62 ± 1.02</td>
<td>5.39 ± 1.32</td>
</tr>
<tr>
<td>Regular PA Intention</td>
<td>4.59 ± 1.38</td>
<td>4.58 ± 1.53</td>
<td>4.80 ± 1.46</td>
<td>4.47 ± 1.44</td>
<td>4.65 ± 1.42</td>
<td>4.17 ± 1.61</td>
</tr>
<tr>
<td>Residential Density</td>
<td>86.49 ± 23.41</td>
<td>77.18 ± 32.63</td>
<td>83.25 ± 28.16</td>
<td>81.39 ± 28.74</td>
<td>81.70 ± 28.96</td>
<td>84.46 ± 25.46</td>
</tr>
<tr>
<td>Land use mix-Diversity</td>
<td>**3.14 ± 0.67</td>
<td>2.13 ± 0.81</td>
<td>2.62 ± 0.93</td>
<td>2.68 ± 0.88</td>
<td>2.64 ± 0.90</td>
<td>2.81 ± 0.82</td>
</tr>
<tr>
<td>Land use mix-Access</td>
<td>**2.93 ± 0.41</td>
<td>2.60 ± 0.46</td>
<td>2.80 ± 0.46</td>
<td>2.76 ± 0.47</td>
<td>2.76 ± 0.47</td>
<td>2.84 ± 0.40</td>
</tr>
<tr>
<td>Connectivity (streets)</td>
<td>2.79 ± 0.62</td>
<td>2.40 ± 0.64</td>
<td>2.60 ± 0.68</td>
<td>2.61 ± 0.65</td>
<td>2.58 ± 0.67</td>
<td>2.77 ± 0.56</td>
</tr>
<tr>
<td>Walking/cycling facilities</td>
<td>**3.07 ± 0.67</td>
<td>2.18 ± 0.84</td>
<td>2.62 ± 0.86</td>
<td>2.67 ± 0.89</td>
<td>2.60 ± 0.89</td>
<td>2.94 ± 0.71</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>**3.31 ± 0.54</td>
<td>2.56 ± 0.73</td>
<td>2.92 ± 0.72</td>
<td>2.97 ± 0.75</td>
<td>2.96 ± 0.75</td>
<td>2.91 ± 0.68</td>
</tr>
<tr>
<td>Traffic Safety</td>
<td>**2.85 ± 0.42</td>
<td>2.41 ± 0.50</td>
<td>2.67 ± 0.50</td>
<td>2.63 ± 0.51</td>
<td>2.62 ± 0.51</td>
<td>2.76 ± 0.51</td>
</tr>
<tr>
<td>Crime Safety</td>
<td>**3.04 ± 0.46</td>
<td>2.95 ± 0.56</td>
<td>3.07 ± 0.50</td>
<td>2.95 ± 0.52</td>
<td>3.00 ± 0.50</td>
<td>2.96 ± 0.58</td>
</tr>
<tr>
<td>Regular PA Behavior</td>
<td>3.58 ± 1.76</td>
<td>3.34 ± 1.92</td>
<td>3.88 ± 1.93</td>
<td>3.23 ± 1.74</td>
<td>°3.55 ± 1.81</td>
<td>2.95 ± 1.96</td>
</tr>
<tr>
<td>Vigorous PA</td>
<td>2.59 ± 2.05</td>
<td>2.56 ± 2.03</td>
<td>°3.06 ± 2.05</td>
<td>2.30 ± 1.99</td>
<td>2.61 ± 2.04</td>
<td>2.24 ± 2.02</td>
</tr>
<tr>
<td>Walk/cycle-moderate PA</td>
<td>2.76 ± 2.39</td>
<td>2.62 ± 2.28</td>
<td>2.62 ± 2.45</td>
<td>2.74 ± 2.27</td>
<td>2.67 ± 2.26</td>
<td>2.73 ± 2.60</td>
</tr>
<tr>
<td>Lifestyle-moderate PA</td>
<td>2.99 ± 2.28</td>
<td>2.90 ± 2.28</td>
<td>°3.33 ± 2.02</td>
<td>2.73 ± 2.30</td>
<td>°3.06 ± 2.27</td>
<td>2.22 ± 2.20</td>
</tr>
</tbody>
</table>

* p < .05; ** p < .01
In contrast to the first hypothesis, no significant differences were found between groups for the walk/cycle-moderate PA variable, and Caucasians ($F [1, 300] = 4.58, p = .03$) and males ($F [1, 300] = 5.31, p = .02$) engaged in lifestyle-moderate activity more often than non-Caucasians and females, respectively.

Based on these findings and previous research reporting higher PA levels for residents living in high-walkability neighborhoods (Saelens, Sallis, & Frank, 2003; Saelens, Sallis, Black, et al., 2003), separate analyses were executed by residence with gender and ethnicity treated as a potential confounders. Gender and ethnicity were entered into the first block of the regression analyses so that the contribution of the cognitive and environmental variables in the prediction of PA participation could be determined above the variance accounted for by demographics (DeBourdeaudhuij, et al., 2003).

Figure 2.2. Residence by ethnicity interaction for regular physical activity.
Cognitive Influences on PA Intention and Behavior

The findings in this study provided partial support for the second hypothesis. Based on previous research supporting the TPB as a significant predictor of intention with in the PA domain (Blue, 1995; Culos-Reed, et al., 2001; Hagger, et al., 2002; Hausenblas, et al., 1997), it was hypothesized that ATT, PBC, and to a lesser degree, SN would be significant predictors of PA intention. It was also predicted that intention and PBC would be significant predictors of regular PA behavior.

Intention. Overall the models to predict PA intention accounted for 17% and 30% of the total variance in PA intentions for the on- and off-campus groups, respectively. The model presented in Table 2.4 demonstrates that ATT and SN were the best predictors of PA intentions for this sample of university students. Ethnicity accounted for a small but significant amount of the variance for the off-campus group only, but was no longer significant when SN was entered into the model. The finding that PBC did not contribute significantly to the prediction of intention for either group is in contrast to the second hypothesis, numerous empirical studies (Ajzen & Driver, 1992; Blanchard, et al., 2003; Gatch & Kendzierski, 1990; Madden, et al., 1992; Okun, Karoly, & Lutz, 2002) and narrative and meta-analytic reviews (Blue, 1995; Hagger, et al., 2002; Hausenblas, et al., 1997), but supports others (Terry & O’Leary, 1995; Yordy & Lent, 1993).

Reviews suggest that the amount of variance accounted for by SN is typically smaller than PBC (Blue, 1995; Godin, 1993; Hausenblas, et al., 1997). Interestingly, SN was a significant predictor of intention for the on-campus group explaining more variance than PBC (Table 2.4). Although compared to the on-campus participants, the contribution of SN to the prediction of intention to participate in regular PA was smaller for the off-campus group and did not explain a significant amount of the variance in the final model.
Table 2.4.

Prediction of Physical Activity Intention by Residence Using the Theory of Planned Behavior

<table>
<thead>
<tr>
<th>Model</th>
<th>Variable</th>
<th>On-campus (n = 162)</th>
<th>Off-campus (n = 146)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>β</td>
<td>$R^2$</td>
</tr>
<tr>
<td>1</td>
<td>Gender</td>
<td>-0.07</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethnicity</td>
<td>-0.09</td>
<td>0.01</td>
</tr>
<tr>
<td>2</td>
<td>Gender</td>
<td>-0.02</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethnicity</td>
<td>-0.08</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ATT</td>
<td>**0.33</td>
<td>a0.12</td>
</tr>
<tr>
<td>3</td>
<td>Gender</td>
<td>-0.03</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethnicity</td>
<td>-0.07</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ATT</td>
<td>**0.25</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SN</td>
<td>**0.20</td>
<td>a0.16</td>
</tr>
<tr>
<td>4</td>
<td>Gender</td>
<td>-0.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethnicity</td>
<td>-0.07</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ATT</td>
<td>*0.20</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SN</td>
<td>*0.18</td>
<td></td>
</tr>
<tr>
<td></td>
<td>PBC</td>
<td>0.14</td>
<td>0.17</td>
</tr>
</tbody>
</table>

Standardized beta coefficients significant at * $p < .05$; ** $p < .01$; $R^2$ significant at *$p < .05$; **$p < .01$; Change in $R^2$ significantly greater than previous step *$p < .05$; **$p < .01$; Model significant at **$p < .01$

Behavior. The results in this study support the use of TPB in the prediction of PA behavior (Table 2.5). Intention to be physically active explained 45% and 41% of the total variance in PA behavior for the on- and off-campus groups, respectively. Ethnicity explained a significant amount of the variance for the off-campus group, whereas gender was a significant contributor for both. Perceived behavioral control accounted for an additional 4% and 6% of the variance for the participants living on- and off-campus, respectively. The large amount of
variance accounted for in the models ($R^2 = 0.52$ and $0.56$) suggests that in this group of young university students, the TPB is an efficacious model for the prediction of regular PA behavior.

Table 2.5

**Prediction of Regular Physical Activity by Residence Using the Theory of Planned Behavior**

<table>
<thead>
<tr>
<th>Level</th>
<th>Variable</th>
<th>On-campus (n = 162)</th>
<th>Off-campus (n = 146)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$\beta$</td>
<td>$R^2$</td>
</tr>
<tr>
<td>1</td>
<td>Gender</td>
<td>*-0.17</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethnicity</td>
<td>-0.02</td>
<td>0.03</td>
</tr>
<tr>
<td>2</td>
<td>Gender</td>
<td>*-0.13</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethnicity</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intention</td>
<td>**0.67</td>
<td>aa0.48</td>
</tr>
<tr>
<td>3</td>
<td>Gender</td>
<td>-0.09</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethnicity</td>
<td>0.04</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intention</td>
<td>**0.61</td>
<td>aa0.52</td>
</tr>
</tbody>
</table>

Standardized beta coefficients significant at *$p < .05$; **$p < .01$; $R^2$ significant at *$p < .05$; **$p < .01$; Change in $R^2$ significantly greater than previous step *$p < .01$; Model significant at **$p < .01$

**Neighborhood Environment Influences on Behavior**

The third hypothesis proposing that neighborhood characteristics would be predictive of PA behavior was partially supported by these data. All eight NEWS subscales (residential density land use mix-diversity, land use mix-access, street connectivity, walking/cycling facilities, aesthetics, traffic safety, and crime safety) were entered into a stepwise regression model for each type of PA behavior (regular, vigorous, walk/cycle- and lifestyle-moderate). Land use mix-diversity and traffic safety emerged as the only significant predictors of PA. For the on-campus group (Table 2.6), land use mix-diversity accounted for 3.9% of the variance in lifestyle-moderate PA ($F[1, 160] = 6.41, p = .01$).
### Table 2.6

**Stepwise Regression Model for the Neighborhood Environment Variables and Lifestyle-Moderate Physical Activity Behavior**

<table>
<thead>
<tr>
<th>Entered Variable</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-campus (n = 162)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Land use mix-Diversity</td>
<td>0.20</td>
<td>2.53</td>
<td>0.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Excluded Variables</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential Density</td>
<td>-0.03</td>
<td>-0.38</td>
<td>0.70</td>
</tr>
<tr>
<td>Land use mix-Access</td>
<td>-0.03</td>
<td>-0.37</td>
<td>0.72</td>
</tr>
<tr>
<td>Connectivity</td>
<td>-0.09</td>
<td>-1.14</td>
<td>0.26</td>
</tr>
<tr>
<td>Walking/cycling</td>
<td>-0.03</td>
<td>-0.37</td>
<td>0.72</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>0.01</td>
<td>0.17</td>
<td>0.88</td>
</tr>
<tr>
<td>Traffic Safety</td>
<td>0.03</td>
<td>0.37</td>
<td>0.71</td>
</tr>
<tr>
<td>Crime Safety</td>
<td>0.01</td>
<td>0.09</td>
<td>0.93</td>
</tr>
</tbody>
</table>

### Table 2.7

**Stepwise Regression Model for the Neighborhood Environment Variables and Regular Physical Activity Behavior**

<table>
<thead>
<tr>
<th>Entered Variable</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off-campus (n = 146)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic Safety</td>
<td>0.23</td>
<td>2.87</td>
<td>0.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Excluded Variables</th>
<th>β</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential Density</td>
<td>0.02</td>
<td>0.18</td>
<td>0.86</td>
</tr>
<tr>
<td>Land use mix-Diversity</td>
<td>0.04</td>
<td>0.44</td>
<td>0.66</td>
</tr>
<tr>
<td>Land use mix-Access</td>
<td>0.10</td>
<td>1.22</td>
<td>0.22</td>
</tr>
<tr>
<td>Connectivity</td>
<td>0.04</td>
<td>0.49</td>
<td>0.63</td>
</tr>
<tr>
<td>Walking/cycling</td>
<td>0.12</td>
<td>1.42</td>
<td>0.16</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>0.12</td>
<td>1.29</td>
<td>0.20</td>
</tr>
<tr>
<td>Crime Safety</td>
<td>0.13</td>
<td>1.41</td>
<td>0.16</td>
</tr>
</tbody>
</table>
None of the environmental variables emerged as significant predictors of regular, vigorous, or walk/cycle-moderate PA for these participants. For the participants living off-campus (Tables 2.7 and 2.8), traffic safety accounted for 5.4% of the variance in regular PA \( (F[1, 144] = 8.22, p < .01) \) and explained 4.5% of the variance in vigorous PA \( (F[1, 144] = 6.81, p < .01) \). None of the environmental variables emerged as significant predictors for walk/cycle- or lifestyle-moderate PA for this group.

Table 2.8.

**Stepwise Regression Models for the Neighborhood Environment Variables and Vigorous Physical Activity Behavior**

<table>
<thead>
<tr>
<th>Entered Variable</th>
<th>( \beta )</th>
<th>( t )</th>
<th>( p )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic Safety</td>
<td>0.21</td>
<td>2.61</td>
<td>0.01</td>
</tr>
<tr>
<td>Residential Density</td>
<td>0.03</td>
<td>0.40</td>
<td>0.69</td>
</tr>
<tr>
<td>Land use mix-Diversity</td>
<td>0.04</td>
<td>0.44</td>
<td>0.66</td>
</tr>
<tr>
<td>Land use mix-Access</td>
<td>0.06</td>
<td>0.77</td>
<td>0.44</td>
</tr>
<tr>
<td>Connectivity</td>
<td>0.01</td>
<td>0.10</td>
<td>0.92</td>
</tr>
<tr>
<td>Walking/cycling</td>
<td>0.10</td>
<td>1.20</td>
<td>0.23</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>0.04</td>
<td>0.49</td>
<td>0.63</td>
</tr>
<tr>
<td>Crime Safety</td>
<td>0.05</td>
<td>0.56</td>
<td>0.58</td>
</tr>
</tbody>
</table>

The fourth research hypothesis was assessed using three ecological models to determine how much of the variance in PA behavior was accounted for by the individual (demographic and cognitive) and neighborhood environmental variables. A hierarchical regression model was conducted for regular PA, vigorous PA and lifestyle-moderate PA. Because none of the environmental variables contributed significantly to the prediction of walk/cycle PA in the stepwise regressions, no further analysis was conducted. Gender, ethnicity, intention, and PBC
were entered into the first block of each of the three models. Only the environmental variables deemed significant in the stepwise regressions (traffic safety and land use mix-diversity) were entered into the models. For the prediction of regular PA and vigorous PA, traffic safety was entered into the second block of the model. Land use mix-diversity was entered into the second block to predict lifestyle-moderate PA. Traffic safety did not account for a significant amount of variance in regular PA behavior (Table 2.9) or vigorous PA (Table 2.10) beyond the influence of gender, ethnicity, intention, and PBC regardless of where the participant lived. However, for the on-campus group, a small but significant amount of variance in lifestyle-moderate PA was accounted for by diversity (3%) in addition to the 21% explained by gender, ethnicity, intention, and PBC (Table 2.11).

Table 2.9
Prediction of Regular Physical Activity by Residence Using An Ecological Model

<table>
<thead>
<tr>
<th>Level</th>
<th>Variable</th>
<th>On-campus (n = 162)</th>
<th>Off-campus (n = 146)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>( \beta )</td>
<td>( R^2 )</td>
</tr>
<tr>
<td>1</td>
<td>Gender</td>
<td>-0.09</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>Ethnicity</td>
<td>0.04</td>
<td>-0.10</td>
</tr>
<tr>
<td></td>
<td>Intention</td>
<td><strong>0.61</strong></td>
<td><strong>0.58</strong></td>
</tr>
<tr>
<td></td>
<td>PBC</td>
<td><strong>0.21</strong></td>
<td>( a ) 0.52</td>
</tr>
<tr>
<td>2</td>
<td>Gender</td>
<td>-0.09</td>
<td>-0.03</td>
</tr>
<tr>
<td></td>
<td>Ethnicity</td>
<td>0.04</td>
<td>-0.10</td>
</tr>
<tr>
<td></td>
<td>Intention</td>
<td><strong>0.61</strong></td>
<td><strong>0.57</strong></td>
</tr>
<tr>
<td></td>
<td>PBC</td>
<td><strong>0.22</strong></td>
<td><strong>0.26</strong></td>
</tr>
<tr>
<td></td>
<td>Traffic Safety</td>
<td>0.01</td>
<td>0.52</td>
</tr>
</tbody>
</table>

Standardized beta coefficient significant at \( **p < .01 \); \( R^2 \) significant at \( a a p < .01 \); Change in \( R^2 \) significantly greater than previous step \( b b p < .01 \); Model significant at \( c c p < .01 \)
### Table 2.10

**Prediction of Vigorous Physical Activity by Residence Using An Ecological Model**

<table>
<thead>
<tr>
<th>Level</th>
<th>Variable</th>
<th>On-campus (n = 162)</th>
<th>Off-campus (n = 146)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$\beta$</td>
<td>$R^2$</td>
<td>$R^2\Delta$</td>
</tr>
<tr>
<td>1</td>
<td>Gender</td>
<td>-0.11</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethnicity</td>
<td>0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intention</td>
<td><strong>0.46</strong></td>
<td></td>
<td><strong>0.41</strong></td>
</tr>
<tr>
<td></td>
<td>PBC</td>
<td><strong>0.20</strong></td>
<td>$aa0.33$</td>
<td>$bb0.33$</td>
</tr>
<tr>
<td>2</td>
<td>Gender</td>
<td>-0.12</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethnicity</td>
<td>0.05</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intention</td>
<td><strong>0.46</strong></td>
<td></td>
<td><strong>0.39</strong></td>
</tr>
<tr>
<td></td>
<td>PBC</td>
<td><strong>0.20</strong></td>
<td></td>
<td><strong>0.24</strong></td>
</tr>
<tr>
<td></td>
<td>Traffic Safety</td>
<td>0.04</td>
<td>0.33</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Standardized beta coefficient significant at ** $p < .01$; $R^2$ significant at $aa p < .01$; Change in $R^2$ significantly greater than previous step $bb p < .01$; Model significant at $cc p < .01$

### Table 2.11

**Prediction of Lifestyle-Moderate Physical Activity by Residence Using An Ecological Model**

<table>
<thead>
<tr>
<th>Level</th>
<th>Variable</th>
<th>On-campus (n = 162)</th>
<th>Off-campus (n = 146)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>$\beta$</td>
<td>$R^2$</td>
<td>$R^2\Delta$</td>
</tr>
<tr>
<td>1</td>
<td>Gender</td>
<td>-0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethnicity</td>
<td>-0.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intention</td>
<td><strong>0.45</strong></td>
<td></td>
<td><strong>0.37</strong></td>
</tr>
<tr>
<td></td>
<td>PBC</td>
<td>0.00</td>
<td>$aa0.21$</td>
<td>$bb0.21$</td>
</tr>
<tr>
<td>2</td>
<td>Gender</td>
<td>-0.04</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ethnicity</td>
<td>-0.02</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intention</td>
<td><strong>0.44</strong></td>
<td></td>
<td><strong>0.37</strong></td>
</tr>
<tr>
<td></td>
<td>PBC</td>
<td>0.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Diversity</td>
<td>*0.16</td>
<td>$b0.24$</td>
<td>$b0.03$</td>
</tr>
</tbody>
</table>

Standardized beta coefficients significant at * $p < .05$; ** $p < .01$; $R^2$ significant at $a p < .05$; $aa p < .01$; Change in $R^2$ significantly greater than previous step $bb p < .01$; Model significant at $cc p < .01$
Associations Between Cognitive and Environmental Variables

The multivariate relationships between individual and environmental variables were assessed using canonical correlations. The fifth hypothesis, that these variables would be associated, was not supported. No significant functions were revealed between the TPB and NEWS constructs in the canonical correlational analyses for either group (Table 2.9). The canonical correlation for the on-campus group was 0.30, Wilks’ lambda = 0.80, $F(32, 555) = 1.10, p = .32$. For the off-campus group the canonical correlation was .37, Wilks’ lambda = 0.74, $F(32, 555) = 1.32, p = .12$.

Table 2.9.

Canonical Correlations Between Cognitive and Neighborhood Environment Variables.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Standardized Canonical Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive determinants of PA</td>
<td></td>
</tr>
<tr>
<td>On-Campus (n = 162)</td>
<td>Off-Campus (n = 146)</td>
</tr>
<tr>
<td>Attitude</td>
<td>0.73</td>
</tr>
<tr>
<td>Subjective Norm</td>
<td>-0.89</td>
</tr>
<tr>
<td>Perceived Behavioral Control</td>
<td>0.31</td>
</tr>
<tr>
<td>Intention</td>
<td>-0.18</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Aspects of the Neighborhood Environment</td>
<td></td>
</tr>
<tr>
<td>Density</td>
<td>0.46</td>
</tr>
<tr>
<td>Diversity</td>
<td>-0.23</td>
</tr>
<tr>
<td>Access</td>
<td>0.63</td>
</tr>
<tr>
<td>Connectivity</td>
<td>0.16</td>
</tr>
<tr>
<td>Walk/cycle</td>
<td>-0.32</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>-0.40</td>
</tr>
<tr>
<td>Traffic Safety</td>
<td>0.38</td>
</tr>
<tr>
<td>Crime Safety</td>
<td>0.49</td>
</tr>
</tbody>
</table>
Discussion

The transition to a university setting from high school brings about changes during the first year students that can be academic, social, physical, emotional, and even cultural in nature (Bray & Born, 2004). Most studies have examined these factors independent of one another and little effort has been made to investigate the influence of the physical environment in college populations other than access to PA facilities and home equipment. In this study, specific neighborhood features believed to be influential in PA behavior were assessed. Personal, cognitive, and physical environmental factors were examined simultaneously to provide a more comprehensive analysis of the influences on PA in a small sample of university freshman.

A larger proportion of this sample appears to be more active on a regular basis and they participate in vigorous forms of activity more often than most US undergraduate students. Only 44.2% of the 8,485 undergraduate students surveyed in the 2000 NCHA (ACHA, 2005) reported meeting vigorous or moderate recommendations on at least 3 days of week, compared to almost two-thirds of the sample in this study. In addition, 48% of participants in this study met or exceeded vigorous intensity recommendations as compared to 37.6% in the 1995 NCHRBS (Douglas, et al., 1997). It should be noted, however, that this sample consisted of first-year freshman only. Previous data included activity levels of undergraduate students in general. It could be that the successive decline in PA levels that occurs between the ages of 18 and 24 is represented in the national data set (Stephens, et al., 1985).

Demographics, Cognitive Determinants, Environmental Perceptions, and Physical Activity

Gender and ethnicity-specific differences in cognitive determinants of PA have been previously documented in children and college populations (Blanchard, et al., 2003; Mummery, et al., 2000; Trost, et al., 2002). Supporting previous studies (Blanchard, et al., 2003), these data suggest that compared to females, males had higher PBC and intentions to be regularly active.
No ethnicity differences were revealed, although, the disproportionate number of participants in the ethnic groups may have reduced the ability to detect any differences.

Previous research suggests that living arrangements of college students may influence physical activity patterns (Dinger, 1999). Gyrucsik, Bray, and Brittain (2004) found that in first year freshmen the lack of training partners and inactive friends were barriers to being vigorously active. Jones et al. (1992) also reported that students living on-campus engaged in group PA more than other students. In this study, students living on-campus had higher normative beliefs (SN), perceived they had more control over barriers to PA (PBC), and were regularly active more often than those living off-campus. Furthermore, students living off-campus reported having less perceived control about being regularly active. Reed and Phillips (2005) suggested that perceived inconveniences, travel problems, and distance to PA facilities associated with living off-campus could be reasons these students participate in PA less frequently.

The majority of college campuses provide what the transportation literature describes as a high-walkability neighborhood environment (i.e. high population density, adequate pedestrian and bike facilities, and good connectivity and land-use mix). The more favorable perceptions of the physical environment reported by the students living on-campus for all but one of the neighborhood features is consistent with findings in other populations (Saelens, Sallis, Black, et al., 2003). In this study, 26.5 % of the participants living on-campus reported insufficient levels of PA as compared to 32.2 % living off-campus. While this does not represent a statistically significant difference between the two groups, further investigation as to what aspects on-campus and features of off-campus environments influence inactive students warrants further investigation.

As predicted, males in this study reported participating in vigorous PA more often than females and Caucasians were more regularly active than non-Caucasians. These findings are
consistent with most of the PA literature (USDDHS, 1996). In contrast to the hypothesis of this study and data from recent national surveys of college populations (Douglas, et al., 1997), Caucasians reported more lifestyle-moderate PA. In addition, Caucasians living off-campus reported higher levels of regular PA than non-Caucasians living off-campus. However, because the results are based on only 41 non-Caucasian participants, interpretations of these data should be made with caution.

**Cognitive Determinants of Regular Physical Activity**

On a relatively consistent basis, TPB accounts for a significantly large amount of variance in the prediction of PA intention and behavior, indicating the significant effect of PBC in the PA domain (Ajzen & Fishbein, 1980). Subjective norm has not been as consistent in predicting PA intention compared to ATT or PBC (Blue, 1995, Godin & Kok, 1996; Hagger, et al., 2002; Hausenblas, et al., 1997). Consistent with previous investigations of undergraduates, the amount of variance attributed to SN in this study in the prediction of intention was significant, but smaller than ATT (Ajzen & Driver, 1992; Gatch & Kendzierski, 1990; Madden, et al., 1992; Yordy & Lent, 1993). Corroborating the findings of Hausenblas et al. (1997), ATT accounted for approximately two times the variance explained by SN in the prediction of intentions for the on-campus group. Moreover, ATT accounted for almost six times more variance than SN for the off-campus group. Regardless of the students’ place of residence, attitude about PA was the most influential predictor of intention to be active.

An interesting finding was that the amount of variance attributed to SN in the prediction of PA intentions was greater than that explained by PBC for both groups. This could imply that for this sample of young university students, the influence of friends and significant others may supersede perceived constraints to being physically active. Moreover, SN accounted for a significant portion of the variance for the on-campus group, but not for the off-campus
participants, suggesting that significant others have a bigger influence on intentions in that environment.

The insignificant contribution by PBC in the prediction of intention was surprising and in contrast to much of the literature. Meta-analytic and narrative reviews have reported that in the prediction of exercise intention, PBC may be comparable to ATT (Blue, 1995; Hagger, et al., 2002; Hausenblas, et al., 1997). The TPB is based on the assumption that PBC enhances predictions when behavior is thought to be problematic (Ajzen, 1991). Therefore, the failure of PBC to predict PA intentions could suggest that this relatively active sample of students perceived being physically active as within their control (Ajzen & Driver, 1992).

These findings do, however, support earlier studies assessing the utility of the TPB to explain PA intentions of undergraduate students (Terry & O’Leary, 1995; Yordy & Lent, 1993). Terry and O’Leary (1995) proposed that the PBC-intention pathway may be attenuated when a measure of self-efficacy is incorporated into the PBC construct. Because self-efficacy tends to be more representative of one’s perception of internal constraints, the participants may have responded to the questions regarding their willingness to perform PA assuming the external environment was supportive (Terry & O’Leary, 1995).

On the other hand, PBC was a significant contributor in the prediction of regular PA behavior, although to a much smaller degree than in previous investigations. Because behavior reflects the actual carrying out of one’s intentions, external constraints may have been considered (Terry & O’Leary, 1995), thus PBC added to the intention-behavior relationship. In contrast to much of the literature (Blue, 1995; Downs & Hausenblas, 2005; Hagger, et al., 2002; Hausenblas, et al., 1997), PBC had only a peripheral influence on regular PA behavior beyond intentions in this study. Because PBC encompasses internal and external factors, the contribution
of PBC to the model may have been attenuated because intentions and volitional control were high in this active group of students (Ajzen & Driver, 1992; Dzewaltowski, et al., 1990).

**Environmental Predictors of Physical Activity**

Although most university settings offer a physical environment with the potential to make exercise and PA more convenient by offering modern recreational facilities, PA classes, and pedestrian-friendly campuses (Leslie, et al., 2001), PA levels decrease significantly during the first year of college and continue to decline into adulthood (Bray & Born, 2004). Most investigations of PA behavior in this age group have been limited to vigorous PA, structured exercise programs, and accessibility and convenience to exercise equipment and facilities specifically (Bray & Born, 2004; Gyurcsik, Bray, & Brittain, 2004; Leslie, et al., 1999; Reed & Phillips, 2005). While these studies may help explain PA behavior in students that are already prone to be active, more research is needed to investigate how environmental factors might influence the university population that is not active. The relationships examined in this university sample between neighborhood features and different types of PA have not been reported previously.

In this study, perceptions about the convenience to different types of facilities and businesses (land use mix-diversity) by the on-campus group explained 4% of the variance in the accumulation of 30 minutes of lifestyle activities of moderate intensity. This finding is consistent with previous research in adults reporting relationships between higher levels of recreational and transport-related PA of moderate intensity and proximity to stores, bus stops, parks, and other facilities (DeBourdeaudhuij, et al., 2003; Saelens, Sallis, & Frank, 2003).

This relationship was not found for the off-campus group and PA levels were slightly lower than those living on-campus. It could be that the students living on-campus feel that walking or cycling to a store, post office, bank or other destination is feasible and convenient. A
student living off-campus, however, might be more likely to make the trip in a vehicle because of long or inconvenient routes to commercial venues from their subdivision or apartment complex. Non-motorized means of transport may be perceived as problematic, time-consuming or even dangerous without pedestrian-friendly facilities.

Interestingly, none of the environmental variables were predictive of the walk/cycle-moderate PA variable. The operational definition used may have been a poor measure of this type of moderate activity. The question asked the participants to report on how many days in the past week they had walked or cycled for 30 minutes at time. Any walking and cycling performed by these participants may have been underestimated because short bouts that are likely to occur on and around campuses (to, from and in-between classes) may have gone unreported.

Reed and Phillips (2005) proposed that perceived inconveniences, travel problems, and distance to facilities associated with not living on-campus may contribute to lower PA levels in the students living off-campus. In the present study traffic safety emerged as the only environmental predictor of PA for the students living off-campus accounting for a small but significant amount of variance in the prediction of vigorous and regular PA. These results suggest that students are likely to be active more often if they perceive their neighborhood streets to have lighter traffic and to be safe for joggers or cyclists. In contrast, students perceiving neighborhood traffic as a problem may see this as a barrier to PA. Other studies have reported that African American females were more likely to be insufficiently active if they perceived more traffic in their neighborhoods (Ainsworth, Wilcox, & Thompson, 2003; Young, & Voorhees, 2003). In this study, females and non-Caucasians had lower levels of moderate activity than males and Caucasians. Thus, improvements in neighborhood traffic safety issues could make PA more appealing and attainable for subgroups that are at greater risk of being sedentary.
It is difficult to compare these findings with previous studies that have assessed physical environmental influences on PA using different populations, different PA measures and different analyses. Therefore, this section of the discussion will be limited to studies that used either the original or modified NEWS instrument. Atkinson et al. (2005) reported significant associations between objective measures of adults’ total and vigorous PA and connectivity, and self-reported vigorous PA and residential density. However, in that study demographical and individual influences were not examined. In contrast to the present study, Sallis et al. (1997) found in a small sample of undergraduates that beyond demographics, none of the neighborhood environmental variables explained any additional variance in walking or vigorous PA. On the other hand, De Bourdeaudhuij et al. (2003) reported that beyond demographics, the amount of variance accounted for by physical environmental variables ranged from 3 to 9% depending on the type of PA (walking, moderate, and vigorous). The amount of variance attributed to the environmental variables in this study was comparable and similar to their findings. Diversity still accounted for 3% of the variance beyond gender and ethnicity. Likewise, traffic safety explained a significant amount of the variance in the prediction of vigorous (4%) and regular PA (5%) above demographics.

An Ecological Perspective

The overall purpose and unique aspect of this study was the use of an ecological model to examine multi-level influences that might impact PA behavior in very young adults. The goal was to examine the relative influence of neighborhood characteristics on PA behavior in addition to the influence attributed to personal traits and individual beliefs regarding PA. Beyond the influence of individual and cognitive factors, diversity of the neighborhood remained a significant contributor for the on-campus group explaining 3% of the variance in lifestyle PA of moderate intensity. For the off-campus group, however, traffic safety was no longer significant.
in the prediction of regular or vigorous PA after demographic and cognitive determinants were considered.

Another group of researchers also implemented a social ecological approach in two recent studies (Giles-Corti & Donovan, 2002, 2003). The populations, instruments and methodology, statistical analyses, environmental determinants, and operational definitions of the TPB and PA variables were different from the present study; however, the findings were somewhat similar. Using summary scores for the individual, social, and physical environmental variables, the authors found environmental determinants to be secondary to individual factors in relation to exercising as recommended in the first study (Giles-Corti & Donovan, 2002). Intentions, PBC, and the number of exercise partners were strong predictors of participating in recommended levels of exercise (Giles-Corti & Donovan, 2002). Similarly, in the present study, intention and PBC accounted for approximately one-third to one-half of the variance in vigorous and regular PA across all participants and attenuated the effect of traffic safety.

However, the research to date has shown that the ability to predict PA behavior may be improved when the correspondence between specific PA outcomes and specific environmental constructs is greater (Giles-Corti, et al., 2005). For example, Giles-Corti and Donovan (2003) found in the same cohort previously mentioned (Giles & Donovan, 2002) that the influence of physical environmental determinants on walking for recreation and transport was significant and similar to the individual and social factors. Sallis and colleagues (Hovell, et al., 1989; Sallis, 1989; Sallis, et al., 1990) have reported that walking, but not vigorous PA was positively associated with the neighborhood environment and that vigorous activity was related to the density of commercial exercise facilities, but not free facilities (e.g. parks and public recreation facilities). In the present study, diversity and intentions were significant predictors of moderate intensity activity on-campus, whereas, traffic safety was predictive of regular and vigorous
activity off-campus. These findings support previous research and also suggest that the weight of the environmental influence on PA behavior may have been relative to the type of PA performed and specific to the behavior setting.

The relationship between physical environmental factors and PA behavior is supported by a diverse body of literature (Atkinson, et al., 2005), however, these data were only moderately supportive. The mean NEWS scores tended to be lower than those reported by adults in earlier studies (Saelens, Sallis, Black, et al., 2003) and only two of the environmental factors were related to PA behaviors. The participants in the present study are growing up during a time when PA is often performed in exercise-specific facilities using special equipment. Furthermore, much of their daily PA is technology-based (occupational and transport). Therefore, the participants in this study may have been less in tune with physical characteristics addressed in the NEWS instrument. It could be that middle-aged and older adult populations are more aware of the physical characteristics of the environment as it relates to PA. Growing up they may have engaged in PA outdoors more often and had fewer health clubs to attend.

**Relationship between Individual and Environmental Constructs**

Although the canonical correlation between the two sets of predictor variables was not significant, sample size may have been a factor in that analysis. Using a small undergraduate sample from the same university as a pilot (N = 76), significant gender-specific associations (p < .05) were found between some of the cognitive determinants and physical environmental variables. For females only, ATT-walking/cycling (r = 0.32), ATT-aesthetics (r = 0.53), PBC-crime safety (r = 0.34), PBC-walking/cycling (r = 0.36), and regular PA-land use mix-access (r = 0.32) relationships were revealed.

In the present study, after adjusting for demographics, two of the environmental variables explained a relatively small amount of the variance in PA. Only one remained significant beyond
cognitive influences. DeBourdeaudhuij et al. (2003) also found low correlations and proposed that using a hierarchical statistical model may underestimate the contribution of environmental variables. For example, in this study, if there was any shared variance between the cognitive variables and traffic safety, it may have been assigned to the former, which was entered into the regression model first. If this is true, the influence of environmental variables may actually be mediated through perceptions and beliefs about PA. Because this area of PA research is still in the exploratory stages, relationships between cognitive and environmental variables warrants further investigation.

The cognitive determinants in this study explained approximately 50% of the variance in PA participation while the environment explained less than 6%. This does not mean, however, that environmental variables should be dismissed as not important. Previous research has shown that targeting individual and social influences alone is not sufficient to sustain PA levels (Sallis & Owen, 2002). Moreover, psychosocial interventions tend to affect only a limited number of people on a temporary basis. In contrast, small changes like constructing paths and trails separate from traffic that provide a more pedestrian and cycle friendly environment are more likely to be multiplied over entire populations on a daily basis and over longer periods of time (DeBourdeaudhuij, et al., 2003; Sallis, et al., 1997). Thus, further investigations of the interaction and reciprocal nature of individual and social influences and physical attributes of the environment that support participation in regular PA are warranted.

Other studies of undergraduates have reported that access to home equipment and convenience and proximity to exercise facilities are related to PA participation (Leslie, et al., 1999; Reed & Phillip, 2005; Sallis, et al., 1997). The majority of the students in this study were already active so the items addressed in the survey instrument used may not have been relevant to their activity choices. These data did, however, provide some evidence that perceptions about
the diversity of the neighborhood may have some influence on decisions to incorporate moderate forms of activity into daily life. It seems plausible that the type of physical activities that might be encouraged in high-walkability neighborhoods (e.g. recreational and transport-related) would be more likely to target the proportion of the student body who are less likely to enroll in a PA class or use the student recreational center. Therefore, identifying features within the student’s behavior settings that serve as enablers of choice for the less active student could be an important step in addressing the increasing sedentary lifestyles of university students.

Limitations

Limitations of this study included a small number of non-Caucasian participants and the response bias. Because of the technological difficulties during the administration of the on-line survey, an accurate account of the number of students who received the survey could not be determined. According to size of the freshmen population and the number of participants from which data was obtained, the response rate was 6%. Although validated questionnaires were used in this study, the use of self-reported PA and perceptions of the environment is also a limitation. Another limitation is that the cross-sectional design that does not allow causal relationships to be determined.

As with any theoretical framework, improper operationalization and measurement of the constructs may have compromised the validity and reliability of a model's predictability of PA behavior (Godin, 1993; Godin & Kok, 1996; Hausenblas, et al., 1997; Sutton, 1998). There are some specific concerns regarding conceptual and methodological issues and the efficacy of the TPB in predicting PA behavior (Culos-Reed, et al., 2001). For example, the operationalization of PBC has been a topic of debate among researchers. Several investigators indicate that PBC is comprised of perceived control and self-efficacy acting as two conceptually distinct constructs and should be measured as such (Armitage & Conner, 2001; Bandura, 1986; Trafimow, Sheeran,
Ajzen (2002) contends that the two are a part of the PBC construct, but are not independent of one another. In this study the reliability of the PBC coefficient was low and accounted for none of the variance in intention and only a small amount in PA behavior compared to other studies. Both constructs in addition to a “difficulty” item were included in the PBC measure using only one item each. Perhaps more items would have produced higher levels of reliability (Gable & Wolf, 1993).

In addition, the lack of scale correspondence between the cognitive predictors (intention and PBC) and three of the PA outcome measures may have limited the ability to detect associations between variables. The behavior of interest should be defined in terms of target, action, context, and time (TACT) and all predictor variables must be directly compatible with these elements (Ajzen, 1988). In this study, the operational definitions for vigorous, walk/cycle- and lifestyle-moderate PA were adopted from other surveys and lacked specific correspondence with the terminology used in the intention and PBC items. These items were worded to correspond with “participation in regular PA,” which represented more of an overall activity level, whereas the others addressed specific types and intensities of activity. In addition, the operational definition of walking and cycling used may have compromised the measurement of that type of PA in this population.

This is one of only three studies that have included the TPB constructs in the assessment of physical environmental influences on PA behavior. In this study, the TPB model was extended to integrate physical environmental constructs into the model, thus the lack of correspondence between cognitive and environmental factors, in addition to the PA outcome measures, may have also limited the overall predictability of the model.
Conclusion

These findings suggest that the diversity of the physical environment may be related to participation in some moderate intensity PA for students living on-campus, whereas, traffic appears to be somewhat influential on participation in PA participation for those living off-campus. Students living on-campus reported that the campus setting provided a physical environment that was overall more conducive to PA than the surrounding neighborhoods. Land use mix-diversity emerged as the only aspect of that environment that influenced participation in lifestyle PA of moderate intensity.

For the freshmen students living off-campus issues of safety, but not structural design of neighborhoods, appeared to be somewhat influential in their decisions to be active. However, for that group traffic had little influence compared to their intentions and PBC about being active. More research is needed to further examine relationships and interactions between environmental and cognitive determinants of PA behavior of inactive students.

Research in this area is limited and has primarily focused on vigorous activity or the influence of home equipment and convenience of exercise facilities on PA behavior in university populations (Leslie, et al., 1999; Reed & Phillip, 2005; Sallis, et al., 1997). The relationships that emerged in this study suggesting perceptions about features of the neighborhood environment may influence different types of PA depending on the residential status of university students have not been reported. Moreover, few physical environment-PA studies have implemented a multi-level ecological approach. Although the relationships and the amount of variance accounted for in this study are small, there is some indication that for older adolescents regular, vigorous, and moderate forms of PA are encouraged in neighborhoods that are safer and within closer proximity to destinations.
**Future Directions**

In adults, neighborhood design and physical features are related to participation in moderate-intensity activity, such as walking and cycling. These are often performed within a neighborhood or surrounding community, are activities that most students can perform, and are recommended for sedentary and less fit individuals.

Although a large proportion of this sample met or exceeded minimum PA recommendations, most of the PA literature indicates that approximately one-half of university students are not active enough to reap health benefits (Irwin, 2004). Given the number of insufficiently active and sedentary college students, more studies are needed to identify characteristics of the campus, neighborhoods, and surrounding community that might influence walking, cycling and other types of activity that at risk students would or could perform (Leslie, et al., 2001).

Previous research and the findings in this study, support the basic principle of the ecological approach that each behavior setting has unique features that are relevant to specific purposes or types of PA (Owen, 2004;). Therefore, separate conceptual models are needed for different types of PA behavior (Pikora, Giles-Corti, Bull, Jamrozik, & Donovan, 2003). In addition, a survey instrument with cognitive and environmental predictors that correspond with specific PA behaviors and behavior settings is needed. Few studies have examined physical environmental factors that influence cycling (Pikora, et al., 2002), and less have addressed walking or cycling behavior in college students. In light of the relationship between the diversity of the campus environment and moderate activity in this sample, further examination is warranted.

Many environmental studies have not addressed ethnic diversity or did not include it in the data analysis (Saelens, Sallis, & Frank, 2003). Therefore, little is known about how specific
environmental characteristics may impact PA habits in diverse populations at higher risk for sedentary lifestyles, obesity, and other chronic diseases. Although the size of the subgroup limits generalizations beyond this sample, given the ethnicity differences and interactions that emerged in this study, future investigations should include a more diverse sample of non-Caucasian university students.

Higher associations between the neighborhood environment and physical activity have been found with objective measures of the environment and PA. There is a need for more studies that include objective measures of PA to investigate and substantiate relationships between the physical environment, PA behavior, and obesity. User-friendly community audit tools have been developed and should be incorporated into future studies (Brownson, Hoehner, et al., 2004). Few ecological studies have assessed PA levels using pedometers (King, et al., 2003) or accelerometers (Saelens, Sallis, Black, et al., 2003), and none have used objective assessments of body composition.
CHAPTER 3: EXAMINING VALIDITY OF OBESITY INDICATORS AND RELATIONSHIPS WITH THE BUILT ENVIRONMENT IN UNIVERSITY STUDENTS

Introduction

Overweight and obesity rates have risen to epidemic proportions in the United States (US) over the past twenty years with approximately 65% of American adults now classified as overweight and almost one-third considered obese (Flegal, Carrol, Kuczmarski, & Johnson, 1998). This increase in the prevalence of obesity spans all ages, genders, and ethnicities. According to the 1998 Behavioral Risk Factor Surveillance System data, ([BRFSS], Mokdad, et al., 1999) the largest magnitude of increase was noted for 18 to 29 year olds (7.1% to 12.1%) and college-educated individuals (10.6% to 17.8%). Furthermore, with approximately one in three university students classified as overweight or obese (American College Health Association-National College Health Assessment [ACHA-NCHA], 2005), a renewed interest in the etiology of weight gain in this population has emerged among national health organizations (Butler, Black, Blue, & Gretebeck, 2004). Paralleling the Healthy People 2010 objectives, physical activity (PA) and prevention of obesity are the top two priority health indicators in the Healthy Campus 2010 initiative (ACHA, 2000).

Obesity and the Built Environment

Research indicates that structural and technological aspects of the physical environment have substantially reduced domestic, occupational, and leisure time physical activities in recent decades (Sparling, Owen, Lambert & Haskell, 2000). Accordingly, less participation in PA on a daily basis has significantly disrupted normal physiological function, thereby contributing to energy imbalances, increased obesity rates and related diseases (Rowland, 1998; Sparling, et al., 2000). In fact, significant associations between specific attributes of the physical environment, also known as the “built environment,” and certain types of PA for specific purposes have been
documented in the literature (Humpel, Owen, & Leslie, 2002; McCormack, et al., 2004; Owen, Humpel, Leslie, Bauman, Sallis, 2004). The built environment includes all buildings, spaces, and products created or modified by humans (e.g. homes, schools, businesses, neighborhoods, streets, electronic devices, etc.).

A recent focus in studies examining the relationship between the built environment and physical activity (PA) has been the downstream affects on obesity (Ewing, 2005). Only a limited number of studies have assessed the link between the built environment and related health outcomes (Ewing, 2005). Some studies have reported that perceptions of poor neighborhood safety and aesthetics, and the absence of an infrastructure conducive to walking and overall PA were associated with being overweight or obese in adult populations (Catlin, Simoes, & Brownson, 2003; Giles-Corti, Macintyre, Clarkson, Pikora, & Donovan, 2003; Saelens, Sallis, Black, & Chen, 2003). On the other hand, data from studies examining the direct influence of urban sprawl (low population density and street connectivity) and land-use mix on obesity have been conflicting. Most studies have shown that individuals living in areas that have less urban sprawl and high land-use mix have low BMI’s compared to individuals living in neighborhoods that are more sprawling with low land-use mix (Ewing, Schmid, Killingsworth, Zlot, & Raudenbush, 2003; Frank, Martin, Andreson, & Schmid, 2005; Giles-Corti, et al., 2003; Saelens, Black, et al., 2003). Two studies, however, have reported that individuals living in areas of high population density and land-use mix were more likely to be overweight or obese (Reddy, Prabhakaran, Shan, & Shan, 2002; Rutt & Coleman, 2005).

Some research indicates that a large proportion of college students develop sedentary lifestyles while in college (Dinger, 1999; Pinto & Marcus, 1995). It has been suggested that the transition from high school to college and the new physical and social environment may trigger many of the lifestyle changes related to overweight and obesity in this subgroup (Anderson,
Sharpiro, & Lundgren, 2003; Butler, et al., 2004; Leslie, Sparling, & Owen, 2001). Moreover, there is some evidence that significant weight gain occurs during the freshman year, although findings in this area have been inconsistent (Anderson, et al., 2003; Hovell, Mewborn, Randal, & Fowler-Johnson, 1985)

Limitations of Self-reported Height and Weight

Body mass index (BMI), calculated from self-reported height and weight, is the most common criterion measure used to monitor obesity at the population level (Smalley, Knerr, Kendrick, Colliver, & Owen, 1990), and to date has been the primary outcome measure in built environment-obesity studies (Catlin, et al., 2003; Ewing, et al., 2003; Frank, et al., 2005; Giles-Corti, et al., 2003; Rutt & Coleman, 2005; Saelens, et al., 2003). The few studies that have examined relationships between the physical environment of university students and their PA behavior have primarily focused on access to home equipment and exercise facilities (Leslie, et al., 1999; Reed & Phillips, 2005), but did not report BMI. No studies have investigated the influence of the campus or neighborhood infrastructure on health outcomes such as obesity in this population. However, before inferences can be made regarding any relationships, there are inherent limitations associated with the use of self-reported data and BMI as an indicator of obesity that should be considered.

Pearson correlations are often reported between self-reported and measured height and weight (Elgar, Roberts, Tudor-Smith, & Moore, 2005; Fonseca, Faerstein, Chor, & Lopes, 2004; Spencer, Appleby, Gwyneth, Davey, & Key, 2001). While these findings show the strength of a relationship between the two measures, it does not indicate whether or not the two measures have good agreement (Bland & Altman, 1986). In fact, it is not uncommon for self-reported weight to be underestimated and height to be overestimated (Elgar, et al., 2005; Kuczmarski, Kuczmarski, & Najjar, 2001; Paccaud, Wietlisbach & Rickenbach, 2001; Spencer, et al., 2002). It has been
reported that heavier individuals tend to underestimate weight and lighter individuals, to overestimate weight (Kuskowska-Wolk, Karlsson, Stolt, & Rossner, 1989). Furthermore, perceptions of overweight appear to vary according to age (Anderson, Sharpiro, & Lundgren, 2003), gender (Paeratakul, White, Williamson, Ryan & Bray, 2002) and ethnicity (Paeratakul, et al., 2002). Thus, bias in subjective data and subgroup discrepancies could influence the overall validity of BMI assessments and classification of weight risk status (Paccud, et al., 2001).

**Relationship between Body Mass Index and Percentage of Body Fat**

Body mass index is easy to obtain and is the most common method for initial estimation of body fatness and obesity at the population level (Steinberger, et al., 2005). There is evidence that the relationship between body fat percentage (%BF) and BMI differs according to age, gender and ethnicity (Deurenberg, Deurenberg-Yap, Foo, Schmidt, & Wang, 2003; Rush, et al., 2004). Strong associations between percentage of body fat and BMI have been reported in older men and women (Blew, et al., 2002), whereas, others have found BMI to be a poor indicator of percentage fat in adolescents between the ages of 8-19 years old (Himes & Bouchard, 1989), especially those who were at risk of being overweight or were overweight (Malina & Katzmarzyk, 1999). BMI as a measure of adiposity in youth is more limited than in adults because it varies with age, gender, and maturation (Guo, Chumlea, Roche, & Siervogel, 1997). Therefore, some researchers question its accuracy in predicting %BF, making the validity of BMI as a diagnostic tool of obesity debatable (Wickramasinghe, Cleghorn, Edmiston, Murphy, Abbott, & Davies, 2005).

Studies have shown that BMI scores based on self-reported height and weight tend to underestimate the prevalence of overweight in adolescents (Brener, et al., 2003; Himes & Story, 1992). Recent evidence suggests that self-reported measures of height and weight may not be acceptable proxies for measured values in university students and are thus an unreliable estimate.
of obesity in this population (Arroyo, et al, 2004; Clemente, et al, 2004). More research is needed to investigate the efficacy of self-reported height and weight data to calculate BMI and the use of BMI to estimate percentage of body fat in university students. After all, it is the amount of excess fat, not just weight that determines the health risks associated with obesity (World Health Organization [WHO], 1998). There is still controversy regarding a standard reference point for identifying overweight and obesity in this age group. Furthermore, despite the reduction in PA levels and increases in weight noted when students enter college, little information is available regarding physical aspects of the student’s neighborhood or campus environment that might influence health outcomes.

One purpose of this study was to compare measured and self-reported height and weight of university freshmen in order to examine the validity of BMI calculated from self-reported data in a sample of university freshmen. A second purpose was to determine the association between BMI and %BF in this sample. The final purpose of this study was to examine the relationships between university students’ perceptions of the built environment and their %BF.

Based on previous literature it was hypothesized that:

1. Mean self-reported height for both males and females would be overestimated when compared to the mean measured height (Elgar, et al., 2005; Kuczmarski, Kuczmarski, & Najjar, 2001; Paccaud, Wietlisbach & Rickenbach, 2001; Spencer, et al., 2002).
2. Taller males and females would underreport height and shorter males and females would over-report height (Giles & Hutchinson, 1991).
3. Mean self-reported weight for both males and females would be underestimated when compared to the mean measured weight (Elgar, et al., 2005; Kuczmarski, Kuczmarski, & Najjar, 2001; Paccaud, Wietlisbach & Rickenbach, 2001; Spencer, et al., 2002).

5. Body mass index calculated from self-reported height and weight would be underestimated compared to BMI calculated from measured height and weight.

6. Using BMI calculated from self-reported height and weight as compared with the measured variable would result in misclassification of weight risk.

7. Body mass index would be strongly correlated with DXA %BF.

8. Students with lower perceptions of the physical environment would have higher %BF.

Method

Participants

Participants were selected from a larger sample of university freshmen (N = 308) who completed an on-line survey of about individual, cognitive, and physical environmental influences on PA behavior. Respondents who were interested in receiving a free body composition assessment indicated so by including their email addresses with the submitted survey. That information was used by the primary investigator to select participants for the present study. Females who were pregnant and individuals over 19 years of age were excluded from participating. Due to the weight limit requirements of the Prodigy Pro DXA device, individuals weighing more than 250 pounds did not participate.

Seventy subjects (35 males; 35 females) were selected using a quasi-stratified random sample stratified by gender and race to participate in the body composition assessments. Sixty-one of the 70 students completed the testing (M age = 18.59 years, SD = 0.56). Twenty-eight of the participants were male (25 Caucasian; 3 non-Caucasian) and 33 were female (23 Caucasian; 10 Non-Caucasian). Approximately two-thirds of the participants lived on campus. Nine subjects
did not show up for their body composition assessments (2 non-Caucasian females, 4 non-Caucasian males, and 3 Caucasian males).

**Procedures/Instrumentation**

An appointment for the laboratory assessments was scheduled for the participants who received an email and returned contact information. Pre-assessment instructions were given to all participants prior to testing. Participants were instructed to drink plenty of water and wear lightweight, loose fitting clothes. They were told not to exercise, drink more than one cup (8 oz.) of any caffeine-containing beverages, wear jewelry or have any metal on their clothing on the day of testing. The research protocol was approved by the university institutional review board and all participants signed statements of informed consent prior to the assessments.

After the participants removed their shoes, two direct measures of height (inches) and weight (pounds) were obtained by trained lab technicians using a Shorr stadiometer (Shorr Productions, Olney, MD) and Secca digital scale (Secca Corporation, Hanover, MD). If height differed more than 0.5 inch or weight more than 0.5 pounds a third measure was made. Prior to each testing session, the digital scale was calibrated using two 5 kg weights. Self-reported height and weight had been previously obtained from the on-line survey data. Body mass index was calculated as weight in kilograms divided by the square of height in meters (kg/m²).

Immediately following the height and weight measurements, a DXA total body scan was conducted to determine percentage of body fat using a Prodigy Pro apparatus (GE Medical Systems, Madison, WI). Quality assurance measurements for the DXA were performed prior to each testing session and all assessments were taken by two trained lab technicians. Participants were scanned in the supine position with the scan speed set to automatically adjust based on the estimated size of the individual. The DXA test was non-invasive, caused no discomfort and required no physical effort on the part of the individual.
Overweight and obesity were defined using the revised CDC-US growth charts that provide reference BMI percentiles for single months of age, expressed as the midpoint of the month (Kuczmarski, et al., 2000). At risk for overweight was defined as at or above the 85<sup>th</sup> percentile, but less than the 95<sup>th</sup> percentile of the sex-specific BMI-for-age. Overweight was defined as at or above the 95<sup>th</sup> percentile.

The participants’ perceptions of their current built environments or neighborhoods were assessed using the Neighborhood Environment Walkability Scale (NEWS; Saelens, Sallis, Black, & Chen, 2003). The NEWS consists of eight subscales designed to assess residential density, land use mix-diversity, land use mix-access, connectivity, walking/cycling facilities, aesthetics, traffic safety, and crime safety. Residential density was computed as a summary score. Likert response scales were used for all other subscales. Higher scores indicate a more positive perception of the physical characteristic. For example, a large residential density score indicates greater concentration of residents in a given area. High diversity scores indicate the perception of living close to several different types of facilities. High traffic and crime safety values indicate these are not considered to be problems in the neighborhood. High scores for access to facilities, connectivity of streets, walking/biking paths, and aesthetics represent more positive perceptions about these features. Details of the scoring protocol can be found in Chapter 2. The participants’ responses to the NEWS items were taken from the original survey and used in this study.

**Statistical Analyses**

All descriptive information was reported as mean values and standard deviations (M ± SD). Because the relationship between BMI and adiposity differs in males and females during growth, all data were analyzed by gender (Daniels, Khoury, & Morrison, 1997; Lindsay, et al., 2001). Modified Bland-Altman plots (1986) were used to identify the estimation error and systematic patterns between the measured (criterion) and self-reported height, weight, and BMI
values. Agreement between the measures was determined by regressing the difference (measured minus self-reported values) on the criterion or measured values. Limits of agreement for all data represent ± 2 SD from the mean difference. A negative difference represented an overestimation of self-reported values and a positive difference represented an underestimation of self-reported values. A zero slope for the line of regression indicated that the differences between methods did not vary in any systematic way across the subjects. As suggested by Bland-Altman (1986), the level of significance of the mean differences is a subjective interpretation on the part of the researcher or reader. Misclassification of weight risk indicated a meaningful difference.

The validity of using BMI to identify individuals at risk for being overweight was tested. Pearson correlations were conducted to examine the association between the measured BMI and the percentage of body fat determined by DXA.

The next step was to examine the relationship between features of the neighborhood environment and the criterion measure of %BF and the self-reported BMI data. Because of the small size and exploratory nature of this aspect of the study, Pearson correlations were performed with the alpha level set at $p < .10$

Results

In Table 3.1 participants’ anthropometric and obesity measures (M ± SD) are shown by gender. The average self-reported BMI for the two females that did not participate was comparable to the mean of those who did participate (22.43 kg/m²). The average BMI for the males that did not complete the testing (n = 7) was slightly lower than the male participants in the study (21.23 kg/m²).

Reliability of Self-reported Height and Weight

The intra-class coefficient correlations (ICC) between measured and self-reported height (ICC = 0.96), weight (ICC = 0.99) and BMI (ICC = 0.98) were very high for males. Likewise,
measured and self-reported height (ICC = 0.93), weight (ICC = 0.98) and BMI (ICC = 0.97) were very high for females. Modified Bland-Altman plots were used to identify the agreement between measured and self-reported height, weight BMI, and significant trends in the way the participants reported their data.

Table 3.1.

Participants Anthropometric and Dual-energy X-ray Absorptiometry Measurements.

<table>
<thead>
<tr>
<th>Measure</th>
<th>Males (n = 28) M ± SD</th>
<th>Females (n = 33) M ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measured Height (cm)</td>
<td>177.17 ± 5.94</td>
<td>162.41 ± 5.07</td>
</tr>
<tr>
<td>Self-reported Height (cm)</td>
<td>178.71 ± 6.28</td>
<td>163.41 ± 5.68</td>
</tr>
<tr>
<td>Measured Weight (kg)</td>
<td>78.05 ± 12.64</td>
<td>60.26 ± 7.81</td>
</tr>
<tr>
<td>Self-reported Weight (kg)</td>
<td>79.03 ± 13.17</td>
<td>60.59 ± 7.26</td>
</tr>
<tr>
<td>Measured BMI (kg/m²)</td>
<td>24.87 ± 3.89</td>
<td>22.86 ± 2.86</td>
</tr>
<tr>
<td>Self-reported BMI (kg/m²)</td>
<td>24.72 ± 3.85</td>
<td>22.70 ± 2.61</td>
</tr>
<tr>
<td>DXA fat (%)</td>
<td>17.75 ± 8.63</td>
<td>32.33 ± 5.98</td>
</tr>
</tbody>
</table>

On average, both males and females over-estimated height and weight as noted in Table 3.1 and by the negative mean difference in Table 3.2. These findings are also depicted in the figures (3.1, 3.2, 3.4, 3.6) by the middle horizontal line (mean difference between methods) falling slightly below the zero point. The zero point represents no difference between the measured and self-reported data. The mean BMI calculated from self-reported height and weight was underestimated for males and females which is consistent with previous research (Brener, McManus, Galuska, Lowry, & Wechsler, 2003; Himes & Story, 1992) and supports the fifth hypothesis (Figures 3.3 and 3.8).

The overestimations in height by males and females support the first hypothesis, and are consistent with previous findings (Paccaud, et al., 2001; Spencer, et al., 2002). The second
hypothesis, that taller participants would overestimate height and shorter participants would underestimate height was not supported by these data. The overestimation in height may have contributed to the slight underestimation of BMI for both gender groups (Table 3.1 and Table 3.2).

The overestimations in weight do not support the third hypothesis of this study that individuals would typically underestimate their weight. This is inconsistent with previous research. In addition, systematic trends in self-reported weight and BMI appeared to be gender-specific and race-specific within the female group lending only partial support for the fourth and fifth hypotheses (Table 3.2). Because there were only two African American males in this sample, analyzing the data by race was not feasible for this group.

Table 3.2.
Mean difference and limits of agreement for measured and self-reported height, weight, and BMI.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Difference</td>
<td>Limits of Agreement</td>
</tr>
<tr>
<td>Measured – self-reported height (cm)</td>
<td>-1.53</td>
<td>-6.35, 3.29</td>
</tr>
<tr>
<td>Measured - self-reported weight (kg)</td>
<td>-0.98</td>
<td>-6.77, 4.82</td>
</tr>
<tr>
<td>Measured – self-reported BMI (kg/m²)</td>
<td>0.16</td>
<td>-1.81, 2.12</td>
</tr>
</tbody>
</table>

Males. The relatively flat regression lines noted in Figure 3.1 indicate there was no systematic bias in the manner that the males reported their height ($F [1, 26] = .01, p = .77$). In addition, no uniformed patterns were observed in weight ($F [1, 26] = 0.13, p = .72$), or BMI data ($F [1, 26] = .71, p = .41$) for male participants (Figures 3.2 and 3.3). These findings are in contrast to the third and fourth hypotheses and inconsistent with previous literature (Giles & Hutchinson, 1991).
Figure 3.1. Estimation errors in height for male participants.

Figure 3.2. Estimation errors in weight for male participants.

Figure 3.3. Estimation errors in BMI for male participants.
Females. Figure 3.4 indicates that no systematic trends were revealed across females as a group in the reporting of height ($F[1, 31] = 0.01, p = .91$). However, for females there did appear to be some evidence that the Caucasians ($n = 23$) and African Americans ($n = 10$) reported their height and weight differently as shown in Figures 3.5 and 3.7.

![Figure 3.4. Estimation errors in height for female (n = 33).](image)

African American Females

Caucasian Females

![Figure 3.5. Estimation errors in height for females by race.](image)

The tendency for the taller African American females to underestimate their height ($F[1, 8] = 5.89, p = .04$), however, was the result of one subject underestimating her height by approximately 10 cm (Figure 3.5). Removing the outlier from the dataset yielded a $p$ value of
.43. For the Caucasian females (Figure 3.5), the systematic trend in the data appeared to be in the opposite direction, suggesting that taller females overestimated their height while shorter females underestimated their height, although the possibility of attributing this to chance could not be ruled out. \(F [1, 21] = 3.64, p = .07\). However, the small number of participants in these subgroups limits the generalization of these findings beyond this sample.

The positive slope in the regression line in Figure 3.6 denotes that with the total group of females heavier individuals underestimated their weight and the lighter females overestimated their weight \(F [1, 31] = 7.45, p = .01\). This finding supports the fourth hypothesis and previous research for females (Spencer, et al., 2002).

Further examination of the data revealed that the bias in the reporting of weight appeared to be race-specific (Figure 3.7). No trends were observed in the way heavier and lighter African American females reported their weight \(F [1, 8] = 0.15, p = .71\). Furthermore, the slope of the regression line increased for the Caucasian females when the data were separated \(F [1, 21] = 7.91, p = .01\).

---

![Figure 3.6. Estimation errors in weight for females (n = 33).](image-url)
Figure 3.7. Estimation errors in weight for female participants by race.

It was also hypothesized that BMI calculated from self-reported height and weight would underestimate BMI calculated using objective measures. Figure 3.8 demonstrates a similar trend in the total group of females \((F[1, 31] = 6.90, p = .01)\) and when separated by race (Figure 3.9) there was a tendency for Caucasians with higher measured BMI to have lower self-reported BMI values and those with lower measured BMI to have higher self-reported BMI values \((F[1, 21] = 9.10, p = .01)\). Again, no significant trends were found in the BMI data for the African American females \((F[1, 8] = 2.03, p = .19)\).

Figure 3.8. Estimation errors in BMI for females (n = 33)
Classification for Weight Risk

The sixth hypothesis predicted that the use of self-reported data would result in misclassification of weight risk when compared to the measured values. According to the BMI-for-age percentile growth charts, 26.3% of the total sample was at or above 85\textsuperscript{th} percentile when using measured height and weight data. In contrast, 21.3% were at or above the 85\textsuperscript{th} percentile based on the self-reported information. Table 3.3 shows the percentage of males and females that fell into the at-risk for overweight (≥ 85\textsuperscript{th} percentile) or overweight (≥ 95 percentile) categories.

<table>
<thead>
<tr>
<th>Method</th>
<th>Males % (n = 28)</th>
<th>Females % (n = 33)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>At Risk</td>
<td>Overweight</td>
</tr>
<tr>
<td>Measured</td>
<td>32.1 (9)</td>
<td>7.1 (2)</td>
</tr>
<tr>
<td>Self-reported</td>
<td>21.4 (6)</td>
<td>10.7 (3)</td>
</tr>
</tbody>
</table>

The discrepancy between the measured and self-reported height and weight resulted in 8% (n = 5) of the participants being misclassified for weight risk based on the self-reported BMI scores supporting the sixth hypothesis. Three were incorrectly classified as not at risk, one
incorrectly classified as at risk for obesity, and one incorrectly classified as underweight using the two methods.

Body Mass Index and Percent Body Fat

It was also hypothesized that the measured BMI would be strongly correlated with DXA %BF. According to the Pearson correlations a moderate association was found between measured BMI (kg/m²) and DXA %BF for the males \((r = 0.74, p < .01)\) and females \((r = 0.71, p < .01)\). Interestingly, when the gender groups were divided based upon race, the associations between measured BMI and %BF increased. When the data from the two African American participants were removed from the male group leaving only Caucasian males, the correlation coefficient increased to \(r = 0.81\). Slight increases were also noted for the Caucasian females \((r = 0.78)\) and African American females \((r = 0.73)\).

Environmental Variables, %BF and BMI

Based on previous studies reporting associations between the physical environment and BMI, it was hypothesized that neighborhood variables would be associated with %BF. Table 3.4 shows the mean values for the neighborhood environment variables and the correlations with self-reported %BF and BMI. In this sample, %BF was negatively correlated with accessibility to different types of residential and commercial destinations, crime safety, and connectivity of streets for the males. This suggests that the male participants perceiving that their neighborhoods had low crime rates, good access to destinations, and that streets were well connected tended to have lower percentages of body fat. Interestingly, different relationships between the neighborhood environment and BMI calculated from self-reported height and weight were found (Table 3.4). No significant associations were found for the females for %BF or BMI. Analysis of the females’ data by race did reveal a strong correlation between crime safety and %BF for the African American females \((r = -0.85)\).
Table 3.4

Correlations between neighborhood environment variables and %BF and self-reported BMI

<table>
<thead>
<tr>
<th>NEWS Variable</th>
<th>Males</th>
<th>%BF (DXA)</th>
<th>BMI (self-report)</th>
<th>Females</th>
<th>%BF (DXA)</th>
<th>BMI (self-report)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M ± SD</td>
<td>r</td>
<td>r</td>
<td>M ± SD</td>
<td>r</td>
<td>r</td>
</tr>
<tr>
<td>Density</td>
<td>81.0 ± 26.99</td>
<td>0.14</td>
<td>0.04</td>
<td>75.18 ± 26.55</td>
<td>0.15</td>
<td>0.08</td>
</tr>
<tr>
<td>Diversity</td>
<td>2.64 ± 0.82</td>
<td>0.09</td>
<td>-0.07</td>
<td>2.91 ± 0.90</td>
<td>0.09</td>
<td>0.03</td>
</tr>
<tr>
<td>Access</td>
<td>2.68 ± 0.37</td>
<td><strong>-0.37</strong></td>
<td>-0.31</td>
<td>2.87 ± 0.52</td>
<td>-0.03</td>
<td>-0.07</td>
</tr>
<tr>
<td>Connectivity</td>
<td>2.41 ± 0.77</td>
<td>*-0.32</td>
<td>*-0.37</td>
<td>2.78 ± 0.59</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td>Walk/cycle</td>
<td>2.41 ± 0.92</td>
<td>-0.16</td>
<td>-0.19</td>
<td>3.09 ± 0.86</td>
<td>0.01</td>
<td>0.07</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>2.89 ± 0.69</td>
<td>-0.26</td>
<td>-0.29</td>
<td>3.27 ± 0.53</td>
<td>-0.02</td>
<td>-0.06</td>
</tr>
<tr>
<td>Traffic Safety</td>
<td>2.59 ± 0.40</td>
<td>-0.29</td>
<td>*-0.35</td>
<td>2.84 ± 0.41</td>
<td>-0.14</td>
<td>-0.10</td>
</tr>
<tr>
<td>Crime Safety</td>
<td>3.12 ± 0.39</td>
<td>*-0.36</td>
<td>-0.18</td>
<td>3.20 ± 0.42</td>
<td>-0.19</td>
<td>-0.21</td>
</tr>
</tbody>
</table>

*p < 0.10; **p < 0.05

Discussion

There is evidence suggesting that the reductions in PA and increases in weight that occur in university students may be related to the physical environment (Wallace, et al., 2000). However, despite the prevalent use of self-reported data in population based studies, there is some controversy in the literature regarding the use of self-reported height and weight to estimate prevalence of obesity, and the relationship between BMI and percentage of body fat in younger populations (Arroyo, et al., 2004). The purpose of this study was to investigate the validity of these measures in a small sample of freshmen.

Reliability of Self-reported Data

Similar to previous studies using older adolescents (Elgar, et al., 2005) and adults (Fonseca, et al., 2004; Kuczmarski, et al., 2001; Niedhammer, et al., 2000; Spencer, 2002), high correlations (ICC > 0.90) were found between the measured and self-reported height, weight, and

68
BMI data for this sample. Using Bland-Altman plots, the difference between the self-reported and criterion measured height and weight, and the unique trends in the misreporting of these data, were revealed.

**Discrepancies in Height.** While the majority of studies indicate that self-reported height is overestimated when compared to measured data, the magnitude of difference between the methods varies across studies (Spencer, et al., 2002). The mean overestimation of height by the young males in this study was comparable to adult males in other studies (Paccaud, et al., 2001; Spencer, et al., 2002), but up to three times larger than the differences found by some researchers (Fonseca, et al., 2004; Neidhammer, et al., 2000; Nieto-Garcia, et al., 1990). These data suggest that older adolescent males may overestimate their height to a higher degree than middle-aged and older males. As age increases height decreases and errors in self-reported height have been shown to be correlated with increasing age (Nieto-Garcia, et al., 1990). It has been suggested that these decreases in height may not yet be perceived by some older individuals (Spencer, et al., 2002). It should be noted that the overestimations in height by the participants in the present study appeared to be consistent across participants as there were no systematic patterns in the way tall or short individuals reported their height.

The mean overestimation in height for the females in this study was about 0.05 to 1.0 cm smaller than studies in younger adolescent (Abraham, et al., 2004) and adult females (Fonseca, et al., 2004; Paccaud, et al., 2001). On the other hand, it was approximately 0.40 to 0.60 cm larger than others (Neidhammer, et al., 2000; Spencer, et al., 2002). Some authors have reported larger differences in height for males compared to females (Nieto-Garcia, et al., 1990). Although more recently, larger overestimations by females have been reported (Fonseca, et al., 2004; Paccaud, 2001). Consistent with Neidhammer et al. (2000), males and females in this sample overestimated their height about the same amount. In addition, there was no significant
slope in the regression line, indicating there was no specific pattern in the way taller and shorter individuals reported their height. This is in contrast to previous findings suggesting that height is more likely to be overestimated by shorter individuals (Giles & Hutchinson, 1991). Although chance could not be ruled out with such a small sample in this study, the systematic differences found in the way African American and Caucasian females report their height warrants further investigation.

**Discrepancies in Weight.** Across adolescent (Elgar, et al., 2005; Himes & Story, 1992) and adult populations (Neidhamer, et al., 2000; Paccaud, et al., 2001; Spencer, et al., 2002) weight is generally underestimated by males and females. Previous research indicates that 20% or more of the adult population underestimate their weight by at least two kilograms (Palta, Prineas, Berman, & Hanna, 1982). It has been suggested that individuals may be reporting their preferred rather than actual weight (Ziebland, Thorogood, Fuller, & Muir, 1996). The overestimation of approximately one kilogram by the males in this sample is in contrast to most of the literature and does not support the third hypothesis, but is in agreement with a recent large cross-sectional study of US adults. Using NHANES III data (N = 15,944; ages 17+ yr), Villanueva (2001) found that adult males overestimated their weight by approximate half a kilogram.

On average, the females in this study also overestimated their weight. This was unexpected and does not support the third hypothesis. These results differ from other studies indicating that underestimations in weight are more likely to be observed in females, be more pronounced in females than in males (Neidhamer, et al., 2000; Paccaud, et al., 2001), and on average be about one and a half kilograms below actual values (Villanueva, 2001). It could be that these females perceived themselves as weighing more than they actually did as a result of the social pressures and unrealistic norms in our society to be an ideal weight (Paeratakul, et al.,
In addition, there is some evidence that individuals with higher education and income are more likely to perceive themselves as overweight (Paeratakul, et al., 2002). Abraham et al. (2004) found some evidence that young females in the lowest BMI values slightly overestimated their weight. Most of the females in the present study had normal BMI values, although two were slightly below 18.5 kg/m².

Because this sample represents only first year freshmen students, the overestimations in weight may have been a reflection of a common belief that students gain 15 pounds during their first year of college, known as the “Freshman 15” (Hodge, Jackson, & Sullivan, 1993). Although no studies have actually substantiated such a large weight gain during the freshmen year, Anderson, Sharpio, & Lundgren (2003) did report modest, but significant, weight changes during the first year of college that resulted in a twofold increase in the number of students classified as overweight or obese. On the other hand, Graham and Jones (2002) found that the concern about the “Freshman 15” was not related to actual weight gain, but that it was related to an overestimation of the amount of weight gain reported. These data were collected at the end of the student’s freshman year. Thus, it is possible that the perception of weight gain may have been anticipated and contributed to the overestimation. Also, the laboratory tests were offered as a reward for completing an online survey so the participants that claimed the reward represented a biased sample of individuals who were willing to undergo the body composition assessments.

As demonstrated by the analyses, the use of intra-class correlation coefficients to answer the research question as to how accurately university freshmen report their weight did not provide all of the information. Had the analyses in this study stopped with the correlations, the systematic tendency for the heavier Caucasian females to underreport their weight and the lighter ones to over-report their weight would have gone undetected. These data were also analyzed by race, given the known differences in body composition and perceptions about weight between
ethnic groups (Paeratakul et al., 2002). The lack of any uniformed tendency in the reporting of weight by the African American females may be related to research suggesting that African American females tend to be less concerned about their weight or the need to lose weight, and are more satisfied and accepting about being overweight (Powell & Kahn, 1995; Kemper, Sargent, Drane, Valois, & Hussey, 1994). Therefore, they may have been more truthful and thus more accurate in their reporting. The results support the notion that their perceptions of their body weight were more accurate than Caucasians.

Discrepancies in Body Mass Index. As hypothesized, BMI calculated from self-reported height and weight was underestimated compared to BMI calculated from measured height and weight. The mean difference in the underestimation of BMI was small compared to other studies reporting differences ranging from 0.29 to 2.6 kg/m² (Brener, McManus, Galuska, Lowry, & Wechsler, 2003; Clemente, et al., 2004; Elgar, et al., 2005; Niedhammer, et al., 2000). Although the mean difference was the same for males and females, the race-specific systematic bias noted in the reporting of weight for females also manifested in the BMI values. The use of the BMI values calculated from the self-reported data reduced the accuracy of determining students at risk for overweight and obesity in the larger sample of university freshmen. Although the small number of participants in this sample limits the generalization of the findings to other university populations, gender and race specific trends in this population should be further examined.

Body Mass Index and Weight Risk Classification

There is evidence that the use of BMI based on self-reported height and weight may underestimate the prevalence of overweight in adolescents (Brener, et al., 2003) and adults (Paccaud, Wietlisbach, & Rickenbach, 2001; Spencer, et al., 2002). Underestimations have ranged from 6% in adolescents (Elgar, et al., 2005) and 15% to 30% in adults with rates typically higher for females (Kuskowska-Wolk, Karlsson, Stolt, & Rossner, 1989; Niedhammer, Bugel,
Bonafant, Goldberg, & Leclerc, 2000; Spencer, Appleby, Davey, & Key, 2002). Although the underestimations in the mean BMI values (0.16 kg/m²) were small, and the intra-correlations between the measured and self-reported data were high, meaningful differences were noted between the two methods such that the discrepancies in the reported data altered the weight risk classification for some participants.

In the present study, when compared to the measured data, the use of self-reported BMI scores resulted in 8% (n = 5) of the participants being misclassified for weight risk. These findings are comparable to the 7% misclassified in a sample of 653 university students (Arroyo, 2004). While this could be considered a small error in classification of weight risk, when multiplied at the population level relying on self-reported data alone could delay the detection of students who are at higher risk for complications related to body fatness. In addition, establishing relationships with environmental factors using BMI as the indicator for body adiposity could be misleading.

**Relationship between Body Mass Index and Percent Body Fat**

Body mass index has been used extensively to indicate obesity risk in epidemiological studies and serves as a useful and valuable screening tool (Spencer, et al., 2002), but it may not compare well with actual percent body fat levels. Health complications associated with being overweight or obese are related to increased levels of body fat rather than body weight alone. In this study, the criterion measure of %BF was moderately correlated with measured BMI as a continuous variable in males and females. Eisenmann, Heelan, and Welk (2004) found similar correlations between the BMI and estimated DXA %BF in very young children. Given that only about 50% of the variance is accounted for in the prediction of body fat, BMI appears to be a weak indicator of obesity risk in this sample. This finding supports other studies reporting BMI as a poor predictor of body fatness in university students (Arroyo, et al., 2004).
Relationship between Neighborhood Environment and Percentage of Body Fat

Male participants in the current study who perceived their neighborhoods as having low crime, better access to destinations within walking distance, and street networks that are connected and more conducive to walking also had less body fat. This supports previous research suggesting that the safety and infrastructure of neighborhoods may indeed be related to risk for being overweight or obese. However, because the relationships between the neighborhood variables and BMI and neighborhood and %BF differed in this study, previous research establishing correlations between urban form and land-use mix should be interpreted with caution (Catlin, et al., 2003; Frank, et al., 2004; Giles-Corti, Macintyre, et al., 2003).

In the present study, the associations were found for the males and African American females only. In a recent study by Frank et al. (2004), significant associations between BMI and urban form (land use mix, connectivity, residential density) were reported for whites, but not blacks, and were stronger for males than females. Catlin, et al. (2003) also reported that residents perceiving their neighborhoods to be unsafe and unpleasant were 56% more likely to be overweight. Giles-Corti, Macintyre, et al. (2003) found that poor access to sidewalks, shopping, and facilities was related to obesity in health sedentary adults.

None of the environmental characteristics were associated with %BF or BMI for the Caucasian females in this sample. This could be attributed to the fact that there was less variability in the amount of body fat for the females compared to the males. The follow-up analysis of the data by race did reveal a high correlation between crime safety and %BF for the African American females. Other studies have reported a lack of personal or neighborhood safety as environmental barriers to PA for African American women (Ainsworth, Stolarzcyk, Hootman, & Leven, 1999; Eyler, et al., 2003; Nies, Vollman, & Cook, 1999), yet little is known about the link between the physical environment and subsequent health outcomes for this population.
The cohort in the present study was a subgroup of a larger sample of university freshmen who completed an online survey investigating the relationship between the neighborhood environment and PA. Height and weight were also reported in that survey. Based on previous literature, it was anticipated that neighborhood features would be related to %BF. In light of the inaccuracies in the reporting of height and weight, misclassifications of weight risk using self-reported BMI, moderately weak association between measured BMI and %BF, and differences in %BF and BMI correlations with the environmental factors, it seems premature to make predictions about relationships between the environment and obesity in the larger group of university students. On the other hand, the correlations between the physical environment variables and percentage of body fat for the males and African American females in this small sample is a unique finding and warrants further investigation.

Conclusion

Body mass index is often used in health risk screenings as a marker for overweight and obesity risk and it is typically calculated from self-reported data. Inconsistencies in the way participants in this study reported their height and weight resulted in underestimations in BMI and misclassifications in the prevalence of overweight. Because bias and incongruent trends in the reporting of height and weight could result in subgroups at greater risk being overlooked, these data indicate that self-reported data in this population should be interpreted cautiously.

Moreover, the objective measure of BMI was not strongly correlated with the percentage of body fat for this sample of freshmen students, suggesting BMI may not be a good indicator of adiposity for this population. Furthermore, discrepancies in the self-reported data, and the associations between the environmental variables and %BF, appear to be gender- and race-specific. More variability existed in the self-reported weight and BMI data compared to the
measured data and none of the environmental variables were associated with %BF for the Caucasian females.

There is a growing body of evidence indicating that urban sprawl, land use-mix, and residents’ perceptions about neighborhood features and safety are related to reductions in PA and subsequent increases in obesity (Ewing, 2003, 2005; Frank, et al., 2004; Giles-Corti, Macintyre, et al., 2003; Rutt & Coleman, 2004; Saelens, et al., 2003). A limitation of these studies has been that they have all relied on BMI based on self-reported height and weight. This is the first study to investigate the relationship between physical features of the neighborhood environment and percentage of body fat, and the first to explore these relationships in university freshmen.

Limitations

A larger sample size is needed to determine if these discrepancies are representative of the limitations in the use of self-reported height and weight information or are unique to these individuals. A more diverse group of students is needed to further explore the race and gender differences that emerged. The selection bias is a limitation because those students who are overweight might not have volunteered. Participants who volunteered for this phase of the study considered the assessments as a reward and therefore represented a biased sample of individuals who were willing to undergo the body composition assessments. A random sample is needed to more accurately represent the population that is being studied.

The limitations of BMI as a measure of adiposity in youth are larger than those in adult populations because BMI varies with age, gender, and maturation (Guo, Chumlea, Roche & Siervogel, 1997). More work is needed to establish the association between %BF and BMI in this population.
CHAPTER 4: SUMMARY

It is well established that personal attributes significantly influence PA behavior. Research has emerged over the past decade establishing the relationship between PA behavior and the physical environment (Giles-Corti, Timperio, Bull, & Pikora, 2005). Moreover, specific types of PA are influenced by different aspects of the physical environment and vary according to population demographics (De Bourdeaudhui, Sallis, & Saelens, 2003). However, which aspects are the most influential on specific health outcomes such as obesity remains less clear (Srinivasan, O’Fallon, & Dearry, 2003). Despite emerging evidence supporting the notion that multilevel ecological approaches are needed to bring about significant and sustainable improvements in population health (Sallis & Owen, 2002), there has not been a concerted effort to investigate the influence of the physical environment on PA behaviors in university student populations.

The purpose of this dissertation was to investigate relationships between individual and psychosocial factors, the physical environment, and PA behaviors in a sample of university freshmen students. A second purpose was to examine the reliability of self-reported BMI as a valid indicator of weight risk and explore associations between physical environmental variables and percentage of body fat in a sub-sample of the original cohort of university freshmen.

This study consisted of two projects. The model used in the first study was an integration of the Theory of Planned Behavior and an ecological framework for determinants of PA and eating habits proposed by a panel of experts from public and private sectors (Booth, et al., 2001). In the first phase, 308 university freshmen completed an on-line questionnaire regarding their cognitive beliefs about participation in PA, perceptions of physical characteristics of their neighborhood environment, and engagement in PA. In the second phase, a quasi-stratified random sample, stratified by gender and race, was used to select volunteers from the pool of
students that completed the survey to participate in body composition assessments. Sixty-one students completed laboratory tests to examine the reliability of self-reported height and weight to determine BMI and percentage of body fat using DXA.

Demographic Factors

The preliminary analyses performed in the first phase of this study revealed that some of the cognitive determinants of PA, perceptions of neighborhood characteristics, and PA behaviors varied according to gender, ethnicity, and residence location. For example, compared to females, males had stronger intentions to be active and perceived they had more control over participating in regular PA. They also reported participating in vigorous and lifestyle-moderate activities more often than females. Perceptions about the physical environment did not appear to be gender-specific in this sample of students.

Ethnicity differences were noted for PA behaviors only. Caucasians reported that they participate in regular PA more often, and had accumulated at least 30-minutes of lifestyle-moderate activities on more days during the week prior to the survey than non-Caucasians. Cognitive determinants of PA and perceptions of the neighborhood environment did not differ relative to ethnic background.

Students living on-campus indicated, more so than the students living off-campus, that important others tended to be active and were supportive of them being active. Students living on-campus also had higher perceptions of control regarding participation in regular PA and more positive perceptions about their neighborhood environment. There was a residence by ethnicity interaction for participation in regular PA. Caucasians living off-campus reported that they were more active on a regular basis than non-Caucasians. The interaction was not seen in the on-campus group.
Relationships among Variables

An interesting finding in this study was the lack of support for the TPB model in the prediction of PA intention across participants. As expected the majority of the variance was attributed to ATT and, to a lesser degree, SN. Perceived behavioral control, on the other hand, was not a significant predictor for either group. The TPB constructs did, however, account for a large proportion of variance in the prediction of regular PA behavior, suggesting that PBC was a more important influence on actual behavior. However, in this sample of freshmen, demographics (gender and ethnicity) appeared to be more important than PBC in determining regular PA behavior for the off-campus participants.

These data support the basic principle of the ecological theory that each behavior setting has environmental characteristics that are relevant to specific types or purposes of PA (Sallis & Owen, 2002). For students living within the campus environment, diversity of the neighborhood appeared to have some influence on participation in activities of moderate intensity. This suggests that a high-walkability neighborhood may encourage moderate forms of activity even in very young adults. Then again, traffic safety was a predictor of regular and vigorous PA for those students living in community neighborhoods. It could be that if those students consider traffic to be a barrier to PA, they may choose to workout in an exercise facility that is more conducive to vigorous types of activity. However, examining environmental constructs in isolation can be misleading (Giles-Corti, et al., 2005).

Overall, the associations that were found between the environmental variables and PA behavior in this sample were modest, but similar to other studies (DeBourdeaudhuij, et al., 2003). The scale and context correspondence between the PA measures adopted from other surveys and the physical environment variables in the NEWS was not optimum. This may have reduced the capacity of the models to predict PA behaviors in this sample of university students.
As proposed by Pikora et al (2003), separate frameworks specific to walking or cycling for recreational or utilitarian purposes and other moderate or vigorous activities may be needed to discern existing relationships.

The focus of this study was to use an ecological, or more global, approach to examine the contribution of individual and environmental variables simultaneously in the prediction of university students’ participation in different types of PA. When demographic and cognitive factors were considered, diversity of the campus environment remained the only significant predictor of any type of PA in this sample. It explained only a small amount of the variance in lifestyle-moderate PA for on-campus residents. Similar to what others have found (Giles-Corti, et al., 2002), these findings suggest that aspects of the physical environment may contribute to the prediction of PA behavior of university students, but do not explain as much of the variance as individual factors.

Furthermore, the canonical correlation revealed no significant associations between the cognitive and environmental variables for either group, although the sample size may have been a limiting factor in that analysis. It has been suggested environmental correlates may affect PA behavior through individual and pyschosocial mediators known to be predictors of PA behaviors (Ajzen & Fishbein, 1980).

The use of an ecological approach to investigate the multifaceted relationships among individuals, their physical environment, PA behaviors and health outcomes, introduces numerous confounders. Multivariate models, as used in this study, are unable to account for confounders, mediators, and moderators all at once and may have compromised the ability to predict PA behaviors in this sample (Masse, Dassa, Gauvin, & Giles-Corti, 2002). More recently, researchers in this field have begun to use structural equation modeling to examine relationships
between the built environment, PA behavior, and obesity because this technique can account for confounding, mediating, and moderating variables simultaneously (Rutt & Coleman, 2005).

Assessing Obesity

There is a growing body of research suggesting that aspects of the physical environment related to transport and utilitarian PA, such as walking and cycling, may also influence risk for obesity (Ewing, 2005). This area of research is in the exploratory stages and there are several limitations. Researchers suggest that discrepancies among studies may be due to comparisons using different measures and different populations (Rutt & Coleman, 2005). Moreover, most of these studies have relied on BMI calculated from self-reported height and weight as the primary assessment of obesity risk.

The purpose of the second project was to evaluate the reliability of self-reported height and weight collected from a sub-sample of the freshmen who completed the environmental survey on-line. Laboratory assessments of height and weight were conducted. Bland-Altman plots were used to examine the agreement between the measured and self-reported height and weight, and to determine if there were any systematic trends in the way the students reported these data. In addition, the validity of using BMI as an indicator of adiposity was tested using a criterion measure of percentage of body fat (DXA) and associations between percentage of body fat and the environmental variables used in the survey were also explored.

On average, males and females in this sub-sample over-estimated their height and weight. Mean BMI calculated from self-reported height and weight was underestimated for males and females. The overestimation of height and underestimation of BMI is consistent with previous research (Paccud, et al., 2001); the overestimation of weight was not (Kuczmarski, et al., 2001; Spencer, et al., 2002).
No systematic bias was detected in the way males reported their height or weight. However, heavier Caucasian females tended to underestimate their weight and lighter Caucasian females overestimated their weight. These trends were not found in the African American females. It also appeared that Caucasian and African American females may report their height differently, although chance could not be ruled out. Measured BMI was only moderately correlated with the percentage of body fat for this sample of freshmen students. This suggests that for this population BMI may not be an accurate measure to use in subsequent investigations of the relationship between physical environmental correlates and obesity.

Some of the most interesting findings in this study were the relationships found between the neighborhood environment variables and %BF determined by DXA. For males, land use mix-access, street connectivity, and crime safety showed modest associations with %BF. However, a high association between crime safety and %BF was revealed for the African American females.

Conclusion

These data provide some support for the argument that land use and neighborhood design may affect health and health-related behaviors. Although the number of relationships and the magnitude of those relationships were relatively small, the findings do offer two unique contributions to the literature.

First, evidence is provided regarding the relative influence of individual, psychosocial, and physical environmental correlates on specific types of PA in an understudied population who are at risk for developing a sedentary lifestyle. As noted in this study and others, the TPB tends to account for relatively large amounts of variance in the prediction of PA behavior (Culos-Reed, et al., 2001; Hagger, et al., 2002). However, few interventions based on these models have resulted in significant and sustained changes in PA and health at the population level.

82
(Eastabrooks, et al., 1996). Whereas, small changes in the physical environment can impact a large proportion of a population and have important implications for public health (Rose, 1985).

Second, the relationships found between the criterion measure of percent body fat (DXA) and the students' perceptions of their neighborhood environment, provide support for previous studies showing relationships between the physical environment and risk for obesity using BMI (Catlin, et al., 2003; Ewing, et al., 2003; Frank, et al., 2005; Giles-Corti, et al., 2003; Saelens, Sallis, Black, et al., 2003). Although the small sample size limits generalizations of these findings to other populations, the gender- and race-specific differences in the self-reported data and the relationships between body fat and the environment warrant further investigation.

Implications

The findings in this study suggest that compared to neighborhoods outside of campus, students perceive the infrastructure of the campus as an environment that is pleasant, safe, conducive to walking or cycling, and provides easy access to destinations without the use of motorized transportation. In fact, in this sample of students, close proximity to a variety of businesses and other facilities appeared to encourage participation in moderate forms of PA. In addition, concerns about traffic safety in neighborhoods off-campus were predictive of participation in vigorous activities.

Studies have shown that during the freshmen year significant declines in overall and vigorous activity occur with concurrent increases in body weight and percentage of body fat in the absence of increases in dietary energy intake (Butler, et al., 2004). Some of this has been attributed to today’s technological changes that have resulted in students spending a considerable amount of time in sedentary behaviors and less time engaged in leisure time physically activities, many of whom are preparing for sedentary occupations (Sparling, 2003).
As young adults enter college and gain more independence and control over their lives, lifestyle choices about PA may be influenced by a new social and physical milieu (Dinger, 1999). For example, trying to schedule time to workout at the recreational center or participate in intramural sports may not be feasible with the social and educational demands placed on them. Furthermore, many universities have dropped requirements for completion of physical activity courses in their curricula (Sparling, 2003). Thus, it is not surprising that decreases in participation in vigorous activities occur.

Studies have consistently identified previous and current PA patterns as influential predictors of future behavior (Malina, 1996; Wallace, Buckworth, Kerby, & Sherman, 2000). In fact, almost one-half of recent college alumni report a decrease in PA following graduation (Calfas, Sallis, Lovato, & Campbell, 1994). Therefore, PA patterns that are being established by our college students need to be addressed because it is likely that they will persist or even decline in the years following graduation (Sparling & Snow, 2002).

Although many college campuses have expanded their fitness centers and wellness programs over the past decade, these changes may only be relevant for those individuals who are already exercising. Given the number of insufficiently active and sedentary students in the US, it is important to further investigate specific environmental factors that are likely to influence distinct PA behaviors in populations that are at risk, particularly less active students, rather than catering to students who are already active (Leslie, et al., 2001).

The findings from this study also provide insight concerning the use of self-reported BMI to assess risk for overweight. Body mass index has been used extensively in population-based studies to estimate the incidence of obesity in individuals across the lifespan. This use of BMI in this manner has been largely driven by matters of practicality, as self-report BMI data is very economical to collect. Although at the surface level, the results of this study can be interpreted as
providing some support for the use of these measures, given that the intraclass correlation coefficients between self-reported data and measured BMI were quite high. More sophisticated and in depth analyses, however, revealed systematic basis in the manner in which subgroups reported their heights and weights. Furthermore, the correlation between BMI and percent body fat were moderate, but not strong. Despite the widespread acceptance use of BMI as the primary indicant of obesity, the data reported in this study point out the inherent weakness in that approach, and suggest that, especially with regard to specific subgroups, that BMI data be interpreted cautiously.

Taken together, the two phases of this project provide important insight with regard to steps that can be taken to promote physically active lifestyles in the college-aged population. The findings provide some evidence that in addition to cognitive beliefs about PA, the physical environment in which university freshmen live may also encourage or discourage participation in PA. Changes made in neighborhoods and communities could provide opportunities and more incentives for insufficiently active students to incorporate moderate forms of activity into their daily lives. Establishing good habits now may serve them well as they enter the workforce or graduate school where stress levels and time demands will be even greater. Additionally, it is important that college-aged students are educated concerning how BMI should be interpreted, and understand that this measure is a screening tool rather than a precise measure of body composition. Some specific strategies that are recommended include:

- Make more university campuses “walking campuses”
- Provide walking and bicycling paths that feed into the campus from surrounding communities
- Provide campus-wide incentives and interventions that target cognitive and environmental changes aimed at incorporating more lifestyle PA into their daily routines
- Incorporate physical activity health course into university general education requirements
REFERENCES


Giles-Corti, B., & Donovan, R.J. (2002). The relative influence of individual, social and physical environment determinants of physical activity. *Social Science and Medicine, 54*, 1793-1812.


APPENDIX A: A REVIEW OF THE LITERATURE

Despite the strides in medical science and technology in combating diseases and disorders, cardiovascular disease (CVD) remains the number one cause of death in the United States (US; American Heart Association, 1999). Furthermore, obesity, a major risk factor for CVD and other detrimental health outcomes, rose 66% from the early 1960's to the early 1990's reaching epidemic proportions (Flegal, Carrol, Kuczmarski, & Johnson, 1998). Today nearly 65% of the population in the US is classified as overweight (body mass index [BMI] ≥ 25 kg/m²) and 31% as obese (BMI ≥ 30 kg/m²) (Flegal, Carroll, Ogden, & Johnson, 2002). Although the degree of change may vary, all age, racial/ethnic, and socioeconomic groups are affected (Mokdad, Serdula, & Dietz, 1999).

While the cause of many chronic diseases is often attributed to genetics, there is no evidence that the human genetic makeup has changed over the past 200 years (Booth, Gordon, et al., 2000). However, an increase in the prevalence of chronic disease has occurred (Eaton & Konner, 1985). Furthermore, dramatic changes in the environment have taken place and the incidences of most chronic diseases are profoundly affected by environmental influences (Booth, Gordon, et al., 2000).

There is good evidence that environmental factors have both direct and indirect influences on physical activity patterns (PA) (Humpel, Owen, & Leslie, 2002; McCormick, et al., 2004; Saelens, Sallis, & Frank, 2003). PA is a complex behavior determined by a multitude of factors that have become more convoluted as technology and scientific advances continue to change our daily lives (Sparling, Owen, Lambert & Haskell, 2000). The human body was biologically designed to be active; however, domestic, occupational, and leisure time activities have been substantially reduced by our so-called improvements in modern technology. These reductions significantly disrupt normal physiological function and contribute to energy imbalances (Rowland, 1998; Sparling, et al., 2000),
which can lead to a multitude of physiological complications. It has become clear that obesity and many associated health consequences (e.g. CVD, diabetes, hypertension) are related to an environment that discourages PA and promotes excessive food intake (French, Story, & Jeffery, 2001; Sparling, et al., 2000)

Physical Inactivity and Health.

Epidemiological investigations, clinical trials, and laboratory research have provided convincing evidence that increasing PA levels has numerous beneficial effects on physical health, psychological well-being, and overall quality of life (United States Department of Health and Human Services [USDHHS], 1996; Sparling, et al., 2000). Physical inactivity was identified as an independent major risk factor for CVD in the 1996 Surgeon General's Report (SGR [USDHHS], 1996). Many of the protective effects of PA against CVD and premature mortality are related to its positive impact on hypertension, diabetes mellitus, and obesity.

Although obesity rates have reached epidemic proportions, and CVD remains the number one cause of death, disability and health care costs in the US, a majority of adults remain sedentary or are physically active at levels below the threshold to reap substantial health benefits (USDHHS, 1996). Moreover, while there is good evidence demonstrating that risk factors for obesity and CVD track from childhood to adolescence and into adulthood, the medical and scientific communities have primarily focused on secondary and tertiary treatments (Booth, Gordon, et al., 2000). However, with more evidence indicating that "diseases of inactivity" may begin in the second and third decades of life (Strong, et al., 1999), public health officials are eliciting the promotion of PA as a primary prevention strategy and the use of a multifaceted approach to better understand the complexity and dynamics of health-related behaviors encompassing intrapersonal, social and physical environment factors (Powell, Kreuter, &
Stephens, 1991). This paradigm has become known as the new public health (Ashton & Seymor, 1988)

**Trends in College Populations**

Despite well-documented evidence regarding the negative consequences of physical inactivity, a rapid decrease in PA occurs between 18 and 24 years of age. A large proportion of young adults on college campuses have sedentary lifestyles (Pinto & Marcus, 1995), are not meeting current PA recommendations, and are developing poor eating habits (Dinger, 1999). Results from the 1995 National College Health Risk Behavior Survey (Centers for Disease Control [CDC], 1997b), indicate that 43% of college undergraduates in the US do not participate in moderate (walked/cycled) or vigorous PA (made you sweat and breathe hard) at recommended levels, and that approximately 21% are overweight (≥ 27 kg/m²). Gender and ethnic group differences were noted for PA and overweight, with rates for females and minority populations being significantly worse (Douglas, et al., 1997).

In a recent review of 19 studies, representing 35,747 university students, Irwin (2004) reported that when using the CDC/American College of Sports Medicine's (ACSM) minimum guidelines for PA as a standard, more than 50% of American and Canadian university students are insufficiently active and do not meet the threshold for health benefits. Once more females, and especially African American females, were among the least active. Furthermore, findings from a national survey indicated that the proportion of obese 18-29 year olds increased by more than 70% between 1991 and 1998, which was the largest magnitude of increase across all age groups (Mokdad, Serdula, & Dietz, 1999). Increased body weight reflects lifestyle changes. For example, new social and physical environments young adults are introduced to when they leave home for college represents such a lifestyle change (Butler, Black, Blue, & Gretebeck, 2004). Often this transition results in significant increases in weight and percentage of body fat during
the freshman year (Hovell, Mewborn, Randle, & Fowler-Johnson, 1985). For example, according to one study college freshman females were as much as five times more likely to gain 15% or more above their ideal weight than community females of the same age (Hovell, et al., 1985). Similarly, significant increases occurred in weight, BMI, and percent of body fat during the freshman year. There were no changes in energy intake that would account for the increases, suggesting that the changes in body parameters occurred as a result of the significant reductions reported for leisure, sport, occupational and total PA (Butler, et al., 2004).

Studies have consistently reported previous PA patterns as an indicator of current and future behavior (Malina, 1996; Wallace, Buckworth, Kerby, & Sherman, 2000). Therefore, with less than 10% of high schools nationwide requiring physical education (PE) in grades 10, 11, and 12 (CDC, 1997a), it is not surprising that some of the strongest declines in PA are seen between 15-18 years of age with these patterns continuing through young adulthood (Sallis, 2000). In fact, approximately 47% of recent college alumni report a decrease in PA following graduation (Calfas, Sallis, Lovato, & Campbell, 1994), indicating that PA patterns established as a college student may persist or even decline in the years following graduation (Sparling & Snow, 2002).

A Public Health Approach

The primary goals of public health in the U.S. are to increase individual’s lifespan and the quality of those added years by encouraging the development of healthier lifestyles (Corbin, Welk, Lindsey, & Corbin, 2003). An essential component of new public health is health promotion (Diez Riox, 2003). Health promotion is a process by which communities and individuals are empowered to improve their health by gaining control over the determinants of health (Rootman, et al., 2001). Changes in one's lifestyle are considered the best way to improve health, combat premature mortality and morbidity, and improve overall quality of life. Regular PA and good nutritional habits are considered priority healthy lifestyle changes (Corbin, et al.,
2003) and have been targeted as two primary objectives in national health initiatives such as Healthy People 2010 (USDHHS, 2000).

It is well known that environments directly affect health (MacIntyre & Ellaway, 2000). Determining how the environment affects health presents an enormous challenge because of the nature, intricacy, and interrelationships of the multi-level, multi-structural, multi-factorial, and multi-institutional influences it can impose (Baranowski, Cullen, Nicklas, Thompson, & Baranowski, 2003). Like most human behaviors, PA is a complex behavior influenced by numerous environmental and psychosocial factors. Further investigations are needed to determine and better understand how the modern day environment might act to enhance or constrain PA. Models that explore whether the environment affects behavior directly or through unidentified variables are warranted (Stokols, 1996).

**Targeting Young Adults.** Recently, public health officials identified individuals aged 18-25 years as a neglected but important population for PA research and public health promotion initiatives addressing lifestyle changes to decrease health risks and improve physical and psychological well-being. Healthy Campus 2010 (American College Health Association [ACHA], 2000), a national initiative designed to encourage colleges and universities make health objectives a priority, emphasizes the importance of targeting this subgroup. Physical activity is designated as the number one health indicator followed by overweight and obesity in this population (ACHA, 2000; Buckworth, 2001). In line with this and other public health initiatives, three intervention studies have recently been implemented investigating PA behaviors among college-level students using a social cognitive approach (Calfas, et al., 2000; Leslie, Fotheringham, Weitch, & Owen, 2000; Wallace, et al., 2000). However, the assessment of physical environmental influences on PA in this population was limited in scope.
During the transition from high school to college, and post graduate endeavors, many lifestyle choices are explored, tested, and made. Although most university settings offer an environment conducive to PA, with today’s technological advances, students spend a considerable amount of time in sedentary behaviors and many are being prepared for sedentary occupations (Sparling, 2003). Previous studies have shown that accessibility to places to facilities (natural and built) is associated with being physically active (Humpel, et al., 2002; McCormick, et al., 2004). Subsequently, as young adults enter college and gain more independence and control over their lives, lifestyle choices about PA may be influenced by the new sociophysical milieu (Dinger, 1999).

Approximately 15 million young adults were enrolled in US colleges and universities in 1998. One half of those are aged 18-24, representing 25% of the total population for that age group (Gerald & Hussar, 2000). During this time period critical decision made and many lifestyle behaviors will be established and carry over into adulthood. Thus, understanding PA patterns of this young population during these key formative years seems imperative (Irwin, 2004). Targeting this group of young adults is important because of the immediate and long term health benefits these individuals will gain. Furthermore, this population represents our nation's researchers, health professionals, business leaders, and policy makers of tomorrow (Leslie, et al., 2001). Therefore, future societal norms and values regarding health and PA behavior may be influenced by the habits, beliefs, and attitudes adopted by this important subgroup (Leslie, et al., 1999).

Limitations in public health research. The development and analyses of sound theoretical models to examine the determinants of and adherence to PA are essential prerequisites for establishing effective interventions and strategies that lead to healthier lifestyle behaviors (Stokols, 1992, 1996). Limitations of existing cognitive-behavioral theoretical frameworks
exploring individual psychosocial and biological variables to predict PA behavior have led public health professionals to expand the scope of their focus to emphasize the role of the environmental influences on PA patterns (Owen, Leslie, Salmon, & Fotheringham, 2000).

According to the Surgeon General's Report (USDHHS, 1996), PA interventions which are individual-focused are unlikely to make significant or sustained changes in PA behavior, or subsequent health outcomes, unless considerations and modifications are made regarding the environment in which the behavior takes place. However, environmental factors are not as related to behavior as individual characteristics, thus environmental changes alone are unlikely to effect behavior (Baranowski, et al., 2003). It has been suggested that future research is needed to examine how constructs from different theoretical models might relate to one another and serve complementary roles in changing PA behavior. Pintrich (2003) contends that by integrating research approaches the dynamics and potential mediating and moderating roles of different constructs could become clearer. Baranowski et al. (2003) proposed such an integration of models, suggesting that the determinants of PA behavior be examined from a social ecological perspective using the Theory of Planned Behavior (TPB) model.

In accordance with the national research agenda to promote the utilization of a dual-level framework to investigate the influence of the built environment and behavioral determinants on PA and health, the purpose of this literature review is to synthesize the existing literature with the goal of integrating these approaches to identify critical issues for future research. I will discuss aspects of an ecological and the TPB and review the relevant literature for both paradigms. I will follow up with a summary of the results and discuss future research based on those findings.
Ecological Model

Theoretical Perspective

Ecological models have been used to investigate interrelations between the environment and human behavior across a variety of health-related behaviors including smoking (Rimer, Glanz, & Lerman, 1991), eating behaviors (Jeffrey French, Raether, & Baxter, 1994), and injury prevention (Simons-Morton, et al., 1989). Recent reviews present findings from studies implementing an ecological approach to better understand the interrelationship between people, their environment, and PA behavior (Humpel, et al., 2002; McCormick, et al., 2004).

The term "ecology" represents the study of interrelations between organisms and the environment in which they live (Hawley, 1950; Stokols, 1992, 1996). A central focus of ecological models is the role of the physical environment, recognizing that environmental and behavioral interactions are shaped by social and organization influences (Humpel, et al., 2002). Within the public health domain, an ecological model provides a means of exploring the dynamic interplay among individuals, groups, and their sociophysical milieus to provide practical guidelines for health promotion (Stokols, 1996). Thus, an ecological approach serves to integrate personal efforts with environmental interventions to enhance physical and social surroundings to modify an individual's health behavior (Green, Richard, & Potvin, 1996).

Physical aspects of the environment are identified as either natural (weather, geography) or constructed elements. The influence constructed elements have on health outcomes has recently gained considerable public health attention (Srinivasan, Fallon, & Dearry, 2003). Constructed elements, referred to as the built environment, encompass everything that is created or modified by humans. This includes all buildings, spaces, and products that impact indoor and outdoor physical environments, social environments, health, and quality of life (Health Canada, 2002). The definition of "environmental health" in Healthy People 2010 (USDHHS, 2000) has
been expanded to include influences of the "built environment" representing the application of an ecological approach within the public health (Srinivasan, et al., 2003).

Ecological Perspective in Health. Although an ecological perspective, which can be traced back to the teachings of Darwin, is not a new concept to public health the emphasis placed on the physical environmental influences has changed over time (Green, et al., 1994). The current attention in ecological approaches to health behavior has evolved from several historical trends (McLeroy, Bibeau, Steckler, & Glanz, 1988; Stokols, 1992, 1996). Beginning with the identification of the cholera organism and host-agent-environment analyses of infectious disease, the focus of public health remained primarily on biological, chemical, and physical environments for nearly 200 years. However, as chronic diseases became the focal point during the 1960's, concerns began to shift more toward individual behavioral determinants of health (Green, et al., 1996).

McLeroy et al. (1988) presented an ecological framework as a means of better understanding human behavior and its role in the causation and prevention of lifestyle chronic diseases. This model summarized multilevels of influence on health-related behaviors. Within this model, intrapersonal characteristics and processes, primary groups, institutional factors, community factors, and public policy determine health behaviors and are conceptualized as intervention targets (McLeroy, et al., 1988).

Stokols (1992, 1996) emphasized the need to adopt an ecological approach for health promotion and health behavior research. His proposal outlined four major assumptions: (a) many components of the social and physical environment influence health; (b) environments are multidimensional with social and physical attributes, both actual and perceived; (c) human and environment interactions can be cumulative across several levels such as individuals, families, organizations, etc. and; (d) feedback occurs across different levels of people and environments to
influence behavioral settings, which then influence health behaviors. He argued that health promotion initiatives should change aspects of the environment which serve to encourage or discourage healthy behaviors (Stokols, 1996). This supports The World Health Organization's "Ottawa Charter for Health Promotion" (1986) emphasizing the importance of developing supportive public policies and environments for healthy lifestyles.

There is good evidence that in order to bring about critical population improvements in health status, multilevel models are warranted to examine the reciprocal determinism of the relationship among people, their environment, and health (Gauvin, Levesque, & Richard, 2001; Sallis & Owen, 2002; Stokols, 1992, 1996). Recognition of the need and importance of multilevel interventions is noted in national initiatives such as Healthy People 2010 (USDHHS, 2000) and the Institute of Medicine's report on promoting health behavior (Smedley & Syme, 2000). Therefore, emphasis is being placed on the importance and need for extensive evaluation of the operationalization and application of the model specific to health behavior changes and to appraise the effectiveness of multilevel interventions (Sallis & Owen, 2002).

**Ecological Perspective and PA.** Based on the conceptual frameworks of McLeroy et al. (1988), Stokols (1992, 1996) and other ecological analyses of behavior within the psychology domain (Bronfenbrenner, 1979; Bandura, 1986; Moos, 1980), ecological models identifying interpersonal, intrapersonal, social, and broader aspects of the environment specific to PA were presented (Bauman, Sallis, & Owen, 2002; Sallis & Owen, 1997, 1999). Sallis and Owen (2002) developed seven principles to direct and strengthen ecological approaches to research and interventions, and suggested application of ecological models to PA as described below:

1. **Multiple Types of Influence on Behaviors.** Integrate known modifiable determinants of PA such as intrapersonal correlates (e.g. self-efficacy, age), sociocultural factors (e.g.
social support), and physical environmental aspects (e.g. climate, season) that can be targeted.

2. **Multiple Types of Environmental Influences.** Identify influential variables of the built environment such as urban design (e.g. sidewalks), aesthetics (e.g. trees), and facilities (e.g. parks, open spaces).

3. **Behavior-Specific Ecological Models.** Identify settings which are conducive to specific types of PA (e.g. walking in neighborhoods vs vigorous exercise training in health clubs).

4. **Multilevel Interventions.** Provide convenient facilities and programs for communities that encourage use of the resources (e.g. changes made through educational, environmental, and policy efforts).

5. **Multilevel Interventions and Multisectoral Groups.** Pursue the involvement of several segments of the society (e.g. parks and recreation, urban planners, schools, public health) in the efforts.

6. **Monitoring Implementation and Change at Multiple Levels.** Measures are needed to identify perceived environmental facilitators and barriers to PA, obtain objective assessments of environmental variables, and define and evaluate perception and support of policies.

7. **Political Dynamics.** Identify laws and policies that may have indirectly or unintentionally negative impact PA behavior and opportunities to make change.

The ecological framework presented by Sallis and Owen (1997, 2002) and a more recent framework developed by Pikora, Giles-Corti, Bull, Jamrozik, & Donovan (2003) specific to the assessment of environmental determinants of walking and cycling have been useful in PA
research to identify and explain how some environments may restrict, while others promote or encourage, active lifestyles.

**Measurement Issues.** Recent reviews identify a relatively small number of studies that have applied an ecological approach to investigate the association between objective and perceived physical environmental attributes and PA behaviors (Humpel, et al., 2002; McCormick, et al., 2004). However, conceptualization and operationalization of the theory has yet to be established and only recently have empirical data been reported (Humpel, et al., 2002).

Much of the earlier research on the effects of the environment on PA behavior focused on the natural environment with consistent associations found between climate or season and overall levels of PA (Sallis & Owen, 1999). Research over the past decade has expanded the scope of the environment but has primarily targeted early-middle-aged adults (Owen, et al., 2000). More recently some investigators have used ecological approaches to explore activity levels and environmental influences in older adults (Cunningham & Michael, 2004), women, (King, et al., 2003), adolescent girls (Dunton, Jamner, & Cooper, 2003) and influence on overweight obesity (Catlin, Simoes, & Brownson, 2003; Ewing, Schmid, Killingsworth, Zlot, & Raudenbush, 2003; Giles-Corti, Macintyre, Clarkson, Pikora, & Donovan, 2003). Investigations of university student populations have been scarce with limited assessment of environmental domains (Buckworth, 2001; Leslie, et al., 1999) and only partial support for the reliability and validity of the self-report instruments used (Sallis, Johnson, Calfas, Caparosa, & Nichols, 1997).

The vast majority of existing studies utilizing an ecological approach have been cross-sectional. Only two studies were identified using prospective designs that included environmental influences on changes in PA (Humpel, Marshall, Leslie, Bauman, & Owen, 2004; Sallis, Hovell, & Hofstetter, 1992). Additional empirical data are needed to substantiate a causal
relationship to further advocate health promotion interventions and public health policies that provide more and better PA opportunities across populations (Humpel, et al., 2002).

Various physical activity outcome variables have been used including overall levels of PA, non-walking moderate and vigorous intensity PA, (McCormick, et al., 2004; Humpel, et al., 2002), and walking for recreation, exercise and transport (Owen, Humpel, Leslie, Bauman, & Sallis, 2004; Saelens, Sallis, & Frank, 2003). Most studies have used self-reported information, although pedometers (King, et al., 2003) and accelerometers (Saelens, Sallis, Black, & Chen, 2003) have been incorporated to quantify and substantiate subjective PA data.

Relatively new subjective and objective assessment instruments have been developed to explore factors in the physical environment that may influence PA behavior. Test-retest reliability of three questionnaires assessing the perceived environment in urban and rural populations was established using nationwide telephone surveys (Brownson, Chang, et al., 2004). The instruments included were The San Diego Instrument (Saelens, Sallis, Black, et al., 2003), The South Carolina Instrument (Ainsworth, et al., 2000), and The St. Louis Instrument (Brownson, Baker, Housemann, Brennan, & Bacak, 2001). All three surveys displayed good reliability across diverse adult samples (Brownson, Chang, et al., 2004). Systematic comparisons of perceived environments with objective measures of the environment are needed for a clearer understanding of the role of environmental supports for PA (Brownson, et al. 2001).

More objective audit and researcher-observed methods assessment instruments for collecting physical environment data have been developed (Emery, Crump, & Bors, 2003; Kirtland, et al., 2003; Pikora, et al., 2002). These techniques have assisted in overcoming some of the known methodological limitations of self-reported information. Furthermore, access indices using geocoding of locations and Geographic Information Systems (GIS) (Korte, 1997), a mapping tool used in urban planning and transportation research, have provided objective
measures of the environment and allowed researchers to better quantify items such as residence, physical distance, and facility accessibility (Sallis, et al., 1990; Troped, et al., 2001).

Although the principles of the social ecological approach are considered promising regarding a better understanding of PA and other health behaviors, researchers agree that much work is needed to establish the efficacy and operationalization of such a complex conceptual model (Green, 1996). Ironically, the very reason public health and PA promotion professionals are drawn to the ecological view (i.e. a broader lens encompassing behavioral and environmental interactions influencing health) also presents limitations in the ability to evaluate the operationalization of the model (Sallis & Owen, 2002). For example, Green et al. (1996) argue that because the units of analysis do not lend themselves to random assignment to experimental and control groups nor to manipulation as independent variables, some traditional means of analysis appear insufficient to evaluate this model. Thus, further development and analysis of the methods and instrumentation measuring factors in the environment that may impact PA behavior is needed (Sallis, et al.1998).

**Research Findings**

While PA interventions are generally effective during implementation of the program, few result in long-term maintenance of PA levels (Eastabrooks, Courneya, & Nigg, 1996). In fact, half of the individuals beginning an exercise program drop out within six months (Dishman, 1994). Many suggest that poor maintenance of behavioral changes may be related to the fact that most PA studies and interventions have focused primarily on individually oriented social and psychological influences (Sallis & Owen, 2002) with limited regard to environmental factors that may serve to facilitate or discourage participation within the context the behavior is performed (Stokols, 1996). Furthermore, individual and small group interventions are not likely to impact changes on a large scale, whereas environmental and policy interventions are designed to target
communities and populations (Sallis, et al., 1998). Subsequently, there has been an increased interest in the role of the physical environment regarding increases in community PA since the late 1980's.

**Urban Planning and Transportation.** Some of the most conclusive evidence supporting the impact of the physical environment on PA behavior comes from the urban planning and transportation literature. For years researchers in this field have recognized that the way land is used and neighborhoods are designed and developed influence the choices people make regarding modes of transportation (Saelens, Sallis, & Frank, 2003). Findings from this literature indicate that transportation choices are based on proximity (distance) and connectivity (directness) of travel. More recently attention has been drawn to walking and cycling as a form of non-motorized travel (Saelens, et al., 2003).

Numerous transportation studies indicate that walking and cycling are augmented in what is considered a "traditional" or high-walkable/bikable neighborhood as opposed to more modern constructed neighborhoods with designs that are less user-friendly (i.e. low-walkable/bikable) (Cervero & Kockelman, 1997; Handy, 1996). High-walkable neighborhoods are characterized by closeness and connectivity to destinations, land use mix (residential and commercial mixed), high population density, pedestrian-friendly (e.g. sidewalks, street lighting, bike paths) and more aesthetic (e.g. trees, clean) (Frank & Pivo, 1994).

After controlling for sociodemographic variables (e.g. age, income, owning an automobile), correlational and regression analyses revealed that higher rates of walking were associated with greater population density (Cervero, 1996), good land use mix with close proximity to destinations (Kockelman, 1997), and adequate infrastructure for walking and cycling (bike paths, sidewalks) (Kitamura, et al., 1997). Frank and Pivo (1994) reported that
approximately 31-35% of the variance in walking trips related to work and shopping could be attributed to population density and mixed land use.

To assess differences in walking and cycling rates among residents, several transportation studies have used quasi-experimental designs to compare the activity of the residents within neighborhoods of varying environmental characteristics (Cervero & Gorham, 1995; Handy, 1992, 1996; Handy & Clifton, 2001; Kitamura, et al., 1997; Parsons & Douglas, 1993). Results from these investigations indicate that residents of high-walkable neighborhoods participate in approximately two times as many walking trips per week as compared to their counterparts in low-walkable neighborhoods (Cervero & Gorham, 1995; Cervero & Radisch, 1996; Handy, 1996; Handy & Clifton, 2001). The difference between the walkability of the neighborhoods appears to be dependent on the reason for the trip. Walking to work or for shopping purposes was reported as the main source of the overall difference between the neighborhoods. No differences were noted in walking specifically for exercise in these studies (Handy, 1996).

There is strong and consistent evidence of a relationship between environmental factors and non-motorized transportation for work and shopping-related purposes (Saelens, Sallis, & Frank, 2003). However, according to public health researchers a limitation of the urban planning and transportation literature is the focus on PA in relation to transportation choices only which may not adequately represent estimates of PA per se (Frank, 2001). It is still unclear how specific attributes of the physical environmental might influence PA for reasons other than utilitarian purposes (i.e. exercise or leisure time PA and recreation) (Diez Roux, 2003). Prior to 2000, relatively few studies existed in the PA literature investigating environmental determinants of adult PA. However, results from recent reviews indicate that aesthetic features, supportive community infrastructure, and accessibility to destinations have a positive relationship with
higher levels of walking, moderate and vigorous activity, and overall PA (McCormick, et al., 2004; Owen, et al., 2004).

Broadening the perspective of the urban planning research, Pikora et al., (2003) developed a conceptual framework grouping environmental attributes into four features: destinations, functionality, safety, and aesthetics (Table 1). Within this model, the built environment is open to public policy modification and is believed to consist of three primary interacting characteristics that influence physical activity behavior including use patterns, urban design characteristics, and the transportation system (Frank, Engelke, & Schmid, 2003). I examined the public health literature from the past two decades focusing on the influence of physical environmental factors on specific PA behaviors and will discuss the relevant findings within the context of the constructs of the model.

Table 1.

Conceptual Framework for Environmental Attributes*

<table>
<thead>
<tr>
<th>Features</th>
<th>Elements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Destination</td>
<td>availability (access) of community and commercial facilities; impact of destinations include perceived and actual measures of accessibility (presence or absence), spatial distribution (density), desirability, and the convenience of the destination</td>
</tr>
<tr>
<td>Functionality</td>
<td>condition of paths or trails, the volume and speed of traffic, and directness or connectivity of routes to destinations</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>presence and condition of natural sights and/or architectural design (trees, parks, gardens); pollution</td>
</tr>
<tr>
<td>Safety</td>
<td>personal (lighting/surveillance); traffic (crossings)</td>
</tr>
</tbody>
</table>

Destination or access variables include built and natural facilities and are reflected in some of the earliest exploration of environmental influences on PA (Pikora, et al., 2003). Findings indicate that the influences of some environmental variables on PA behavior may depend on the type of activity, gender, and context, and differ according to the stage of PA. In one of the earliest assessments of environment determinants of PA, Sallis (1989) measured the influence of perceived environmental attributes on the frequency of vigorous activity in a large sample of male and female adults. Similar to other studies, a significant association existed for home equipment (Jackicic, Wing, Butler, & Jeffery, 1997; Leslie, et al., 1999), but not for convenience of facilities or a simplistic neighborhood environment variable defined as ease of exercising and seeing others exercise (Sallis, et al., 1989). However, when this same cohort was followed for two years, all three environmental constructs were predictors of increases in vigorous PA for males, but not females (Sallis, et al., 1992). In addition, walking for exercise was assessed at baseline in this same group of participants and a significant association with the neighborhood environment measure was found (Hovell, et al., 1989), however, at a two year follow-up no relationship was reported.

Sallis et al. (1997) subsequently developed and assessed the reliability and construct validity of a self-report measure measuring the relationships between vigorous PA, strength exercise, and walking for exercise and perceived environmental factors on PA in a small sample of university students. A significant relationship between strength exercise and home equipment was evident. Vigorous exercise was related to home equipment and convenient facilities but not after controlling for socioeconomic status (Sallis, et al., 1997). The researchers suggested that the lack of a significant correlation for walking for exercise may be due to the poor test-retest reliability of the neighborhood construct and/or students misreporting walking to classes as walking for exercise (Sallis, et al., 1997).
More objective measures of the environment have supported self-reported data. Using grid maps to code respondents' addresses and plot the distance between homes and exercise facilities, frequency of vigorous exercise was significantly associated with proximity of commercial, but not community, recreational facilities (Sallis, et al., 1990). Bauman, Smith, Stoker, Bellew, and Booth (1999) used neighborhood location of Australian adults to investigate environmental characteristics and found that those living near the coast were more likely to meet PA recommendations and 38% more likely to be vigorously active than residents who were further inland.

**PA Recommendations and the Environment.** Substantial evidence indicating the significant health benefits gained from moderate forms of PA was presented in the Surgeon General's Report (USDHHS, 1996). Subsequently, promoting vigorous intensity activity became less prominent and public health research and recommendations began emphasizing the need for all individuals to incorporate moderate-intensity activities into their daily lives (USDHHS, 1996). Furthermore, many researchers began adopting an ecological approach to investigate the relationship between the physical environment and meeting recommended levels of PA and more moderate forms of exercise.

Recent studies using self-reported measures of overall PA indicate a relationship between meeting recommended guidelines and perceived environmental supports related to the destination construct. In agreement with earlier investigations (Sallis, et al., 1992), significant correlations were reported for perceived access to indoor exercise facilities and home equipment with meeting recommended levels of PA (Brownson, et al., 2001) and with vigorous PA (DeBourdeaudhuij, Sallis, & Saelens, 2003). Conversely, GIS (Korte, 1997) access indices for recreational facilities were not related to vigorous activity in Australian adults (Giles-Corti & Donovan, 2002).
Others have documented significant associations between achieving recommended PA guidelines and perceived access to neighborhood or community supports such as public parks, sidewalks (Brownson, Baker, Housemann, Brennan, & Bacak, et al. 2001; Sharpe, Granner, Hutto, & Ainsworth, 2004), worksite supports (Sharpe, et al., 2004), private recreational facilities (Addy, et al., 2004), and designated routes or trails for activity (Sharpe, et al., 2004; Huston, Evenson, Bors, & Gizlice, 2003). Safety (Sharpe, et al., 2004), good lighting, neighbor trust (Addy, et al., 2004), enjoyable scenery, hills, heavy traffic (Brownson, et al., 2001) and condition of sidewalks (Sharpe, et al., 2004) have been reported as significant environmental influences.

Assessing distance from destinations using GIS (Korte, 1997) indicated an inverse relationship for the use of community trails in a predominately Caucasian population (Troped, et al., 2001) and shopping facilities for older women (King, et al., 2003). Participants also indicated that steep hills and busy streets in route to rail-trail further reduced the likelihood of using the facility (Troped, et al., 2001). Likewise, spatial access to coastal areas was associated with vigorous activity for Australian adults. The relationship was also noted for those living in higher SES areas and reporting a more aesthetic environment (Giles-Corti & Donovan, 2002b). Similar results have been reported for older adults. One study found sufficiently more active older Australians, based on the ≥ 800 kcals per week threshold recommendation, reported accessibility to a park, golf course, swimming pool, cycle path or a recreation center (Booth, Owen, et al., 2000).

It appears that environmental safety and aesthetics have a significant effect on physical activity behavior in older adults. Balfour and Kaplan (2002) found that excessive noise, poor lighting, and heavy traffic within the neighborhood were indicated by senior adults over 55 years of age at greater risk for deterioration in physical function. King et al. (2000) assessed self-
reported moderate and vigorous activity as a dichotomous PA variable (active or inactive) in middle to older aged women defined as more than 40 years of age and found that the presence of hills, unattended dogs, and a lack of enjoyable scenery was associated with physical inactivity. In addition, seeing others being active in the neighborhood was positively related to PA for the African-American women in this cohort (King, et al., 2000). Similarly, Wilcox, Castro, King, Houseman, & Brownson (2000) found that the absence of enjoyable scenery and not seeing others being active was associated with physical inactivity for older women in urban and rural areas.

Sternfeld, Ainsowrth, and Quesenbery (1999) examined patterns of occupational, household, sport, exercise, and recreational PA in a group of ethnically diverse women between 20 and 60 years of age and found that correlates of PA vary according to the context in which the behavior occurs. The lack of equipment and facilities were only related to sport and exercise activity. Although many of determinants of PA are similar across ethnic groups of women, there are some unique barriers that could impact the effectiveness of interventions (Eyler, et al., 2002). Ainsworth, Wilcox, and Thompson (2003) reported an association for the presence of sidewalks, lighter traffic, and seeing others active in the neighborhood and meeting recommendations or participating in some PA in African American women. Earlier studies identified a lack of personal or neighborhood safety for African American women (Nies, Vollman, & Cook, 1999) and safety concerns and lack of places to be active for American Indian women as environmental barriers to PA (Fischer, et al., 1999; Henderson, Ainsworth, Stolarzcyk, Hootman, & Leven, 1999).

Walking. Substantial evidence indicating the significant health benefits gained from moderate forms of PA was presented in the Surgeon General's Report (USDHHS, 1996). Walking is the most common type of moderate PA for adults (Siegal, Brackhil, & Heath, 1995),
and has become a priority on the public health agenda. Furthermore, given that walking and other moderate forms of PA, such as cycling, are often performed within a neighborhood or surrounding community, the built environment is believed to have an important influence on increasing these types of PA behavior (Owen, et al., 2004). Public health researchers have had particular interest in investigating walking for recreation/exercise, total or recommended levels, and transport or utilitarian purposes.

Results from two earlier studies support Sallis and Owen's (2002) advocacy for the need to implement specific ecological models for specific types of PA behavior. Data from two studies using the same participants reported that walking (Hovell, et al., 1989) but not vigorous PA (Sallis, 1989) had a positive relationship with the neighborhood environment, indicating that each behavior setting may have unique features that are relevant to specific purposes or types of PA (Owen, et al., 2000).

Positive associations between walking for exercise (Ball, Bauman, Leslie, & Owen, 2001), total walking (Carnegie, et al., 2002), and recommended levels of walking have been revealed for perceived convenience of destinations and aesthetic environments (Ball, et al., 2001; Carnegie, et al., 2002; Giles-Corti, & Donovan, 2002b). Walking to meet PA recommendations was related to access to parks (Powell, Martin, & Chowdhury, 2003), sidewalks, and malls with the presence of active neighbors indicated as a significant contributor (Addy, et al., 2004).

Adopting a neighborhood comparison study similar to some of the urban design research, Berrigan and Trojano (2002) distinguished traditional neighborhoods from modern neighborhoods based on the age of the homes and found that those residents living in older homes (pre-1973) had a positive association with total walking.

Recently, researchers in Australia examined the influence of perceived environmental attributes and location of residence on neighborhood walking, walking for specific purposes, and
changes in walking behavior over time. They identified some gender-specific associations. In a group of faculty and staff at an Australian university, men were significantly more likely to do neighborhood walking if they lived near the coast, and had high ratings for aesthetics and access to facilities. In contrast, women with high ratings for access were significantly less likely to walk in the neighborhood. For both males and females high ratings for convenience of facilities was associated with neighborhood walking (Humpel, Owen, Leslie, et al., 2004).

In another study, walking for specific purposes was examined in a group of insurance company employees over the age of 40 (Humpel, Owen, Iverson, Leslie, & Bauman, 2004). Weather and aesthetics were associated with walking neighborhood walking for exercise. Accessibility was related to neighborhood walking and walking for pleasure. Safety was an important factor for walking for pleasure only. Objective measures of location indicated that total minutes of walking were significantly greater for those living in costal regions as opposed to those residing inland. In addition, Humpel, Marshall, Leslie, Bauman, and Owen (2004) conducted the first prospective study exploring the relationship between changes in perceived environmental features and changes in walking behavior over a period of ten weeks. They reported that males and females with positive changes in perception of convenience were two times more likely to increase walking levels than those whose perceptions did not change. Positive changes in perception of aesthetics for males led to increases in walking two times greater than those without changes in perception. The direction of changes in walking in relation to changes in perception of traffic appeared to be positive for women but negative for men. These finding are consistent with cross-sectional associations of neighborhood walking and perceived traffic problems (Humpel, Owen, Leslie, et al., 2004).

Walking is identified as an important form of PA among people age 65 and older (CDC, 2002). King et al. (2003) measured PA levels of older women using self-reported and
pedometer data. Consistent with Saelens, Sallis, Black, et al. (2003), favorable neighborhood surroundings (aesthetics) were related to higher pedometer and self-reported PA levels with older adults. Likewise, according to the findings from the Behavior Risk Factor Surveillance Survey (CDC, 1999), a low perception of neighborhood safety was associated with physical inactivity for older adults. Booth, Owen, et al. (2000) found that access to safe footpaths was associated with walking enough to be considered sufficiently active in a group of Australian adults over 60 years of age.

Given that walking, and other forms of moderate PA, such as cycling, are often performed within a neighborhood or surrounding community, and that these are activities that most individuals can perform, it stands to reason that the built environment can have a significant impact on facilitating or hindering PA behavior and subsequently population health. Yet studies investigating the relationship between the community infrastructure and specific health outcomes such as overweight and obesity remain scarce.

**Obesity and the Built Environment.** Four studies in 2003 examined relationships between environmental and policy factors and the prevalence of overweight/obesity using BMI based on self-reported height and weight as the indicator of obesity. One group used a sprawl index to measure urban form dimensions (population density, land use mix, degree of centering, and street accessibility) in counties across the US (Ewing, et al., 2003). These researchers found that residents living in areas characterized by low density, separation of residential and commercial structures, lack of strong downtowns, and poor connectivity of roads reported doing less leisure time walking and were more likely to be obese and have hypertension based on self-reported information (Ewing et al., 2003). However, the PA indicator did not take into account occupational, household, or transportation related-activity.
Catlin, Simoes, and Brownson (2003) used a composite score to indicate residents’ perceptions of the community and found a significant dose-response relationship between safety and pleasantness and the risk of being overweight, such that those perceiving the neighborhood to be both unsafe and unpleasant were 56% more likely to be overweight. The relationship between PA and environmental perceptions and infrastructure was not analyzed. Other studies, however, have found associations between physical inactivity and a lack of enjoyable scenery in women (King, et al., 2000), and low safety ratings in older individuals (CDC, 1999). Similarly, Brownson, et al. (2001) found increased PA associated with pleasant aesthetics in lower-income groups.

Using GIS (Korte, 1997) to assess spatial access of environmental supports, Giles-Corti, Macintyre, Clarkson, Pikora, and Donovan (2003) found that residents with poor access to sidewalks and recreational facilities were more likely to be overweight or obese. Furthermore, those who perceived no convenient walking/cycle paths or shops within walking distance were more likely to be overweight and obese, respectively. According to Brownson et al. (2000), that people who accessed and used walking paths increased their amount of walking by 55%. Moreover, female and lower SES populations, populations at higher risk for obesity, were two times more likely to increase their amount of walking.

Interestingly, and in contrast to previous studies (Sallis, et al., 1989), Giles-Corti and Donavan (2002a) reported that even vigorous activity was associated with perceived access to sidewalks whereas spatial access to recreational facilities was not. They indicated that creating a neighborhood environment supportive of moderate PA could increase participation among those persons engaging in vigorous activity and may subsequently have a reciprocal effect on others. For example, King, et al. (2000) found that seeing others being active had a positive relationship with PA in African American women further supporting the importance of adopting an
ecological approach that considers the influence of personal, social as well as physical environmental supports on PA behavior.

Also adopting the neighborhood comparison design, and using CSA (Computer Science and Applications, Inc.) accelerometers to quantify PA over a seven day period, Saelens, Sallis, Black et al. (2003) found that residents living in high-walkability neighborhoods engaged in approximately 70 more minutes of total PA (75% moderate-intensity) than those in the low-walkability neighborhoods. Based on BMI scores a significantly greater percentage of those living in low-walkability neighborhoods were overweight, even after controlling for age and education level. Residents in the high-walkability neighborhoods reported better aesthetics, pedestrian and traffic safety, connectivity of streets, residential density, and land use mix diversity and walking more for transport purposes (Saelens, Sallis, Black, et al. 2003).

Theory of Planned Behavior

There is clear evidence from the studies using ecological models as a framework to investigate the determinants of PA that the built environment plays an influential role in the decisions that people make about engaging in PA. It is also clear, however, that much variation in PA behaviors is also attributed to individual differences within the environment, and that the investigation of individual behavior change is also an important component in efforts to design effective interventions that will initiate and sustain long-term behavior change.

Theoretical Perspective

No one behavior change model is dominant in terms of its ability to predict behavior. Moreover, there are limitations that need addressing in all of them, however the Theory of Planned Behavior (TPB) seems to be consistent in its ability to account for more variance in PA intention and behavior (Hagger, Chatzisarantis, & Biddle, 2002). Furthermore, the efforts to investigate limitations of the model, make modifications by exploring a variety of innovative
constructs, and delve into issues to better explain variability in results, lends the TPB as a leading framework for empirically identifying factors on which PA intervention efforts can focus (Armitage & Conner, 2001; Hagger, et al., 2002).

Two theories often used to examine determinants of health-related behaviors from an attitudinal perspective that have received a considerable amount of attention are the Theory of Planned Behavior (TPB; Ajzen, 1985, 1988, 1991), and its predecessor the Theory of Reasoned Action (TRA; Ajzen & Fishbein, 1980). Both have frequently been applied in PA research and appear to be efficacious frameworks in this domain (Godin, 1994). Furthermore, many researchers posit that the TPB is more successful than TRA within a physical activity context (Blue, 1995; Culos-Reed, Gyurcsik, & Brawley, 2001; Hagger, et al., 2002; Hausenblas, Carron, & Mack, 1997). Thus, TPB has been applied more often in recent years (Culos-Reed, et al., 2001).

The TRA was designed to explain the attitude-behavior relationship making the assumption that individuals are goal directed, capable of rational decisions about their behavior, and able to consider consequences of those decisions (Ajzen & Driver, 1992). Within this model, intention is considered the cornerstone of behavior reflecting an individual's level of effort and motivation to participate. An individual’s attitude and subjective norm serve as determinants of intention and thereby have an indirect influence on target behavior (Ajzen & Fishbein, 1980).

Attitude represents an individual's disposition toward participating in a behavior (Ajzen, 1991). It is a function of the strength of behavioral beliefs about the outcome of doing the behavior and extent to which they positively or negatively value those outcomes (Ajzen & Fishbein, 1980). Subjective norm is an interactive function of normative beliefs which are beliefs about expectations of significant others and the desire to please or comply with people of
importance (Ajzen & Fishbein, 1980). Although the TRA framework has been successful in predicting behaviors under volitional control, not all behaviors are under complete control (e.g. environmental constraints on performing PA).

To better address situations in which people may have, or perceive they have, less control over behavior, the TPB extended the TRA to include a new construct, perceived behavioral control (PBC; Ajzen, 1985, 1988, 1991). According to TPB, PBC is determined by control beliefs concerning the presence or absence of resources and opportunities, and of barriers to perform the behavior. In addition, the perceived power or impact of each factor to facilitate or inhibit the behavior, and past experience with the behavior are a consideration (Ajzen, 1991). This extension of the TRA attempts to explain why intentions can not always predict behavior in situations with behavioral constraints (Armitage & Conner, 2001; Terry & O'Leary, 1995). PBC may have an indirect influence on behavior through intentions (Ajzen, 1988, 1991) or serve as a direct determinant of nonvolitional behaviors independent of the intention-mediated effect, reflecting the magnitude actual barriers can have on intention to perform a behavior (Ajzen & Madden, 1986).

**Efficacy of the Theory of Planned Behavior Model**

There is good empirical support for the success of the TPB model in explaining intention and behavior across a variety of behaviors. Numerous narrative (Ajzen, 1991; Blue, 1995; Culos-Reed, et al., 2001; Godin, 1993; Godin & Kok, 1996; McCauley & Courneya, 1993) and statistical reviews (Armitage & Conner, 2001; Hagger, et al., 2002; Hausenblas, Carron, & Mack, 1997; Notani, 1998; Sutton, 1998) have consistently reported the substantial ability of the TPB to predict exercise and PA intentions and behavior. Across reviews, the TPB constructs typically account for 40-60% and 20-40% of the variance in intention and behavior, respectively (Culos-Reed, et al., 2001). A recent meta-analysis of 72 studies in the PA context (Hagger, et al.,
further supports these findings and corroborates the analytical results reported by Hausenblaus et al. (1997), who concluded that the TPB model was as a stronger predictor for PA intentions and behaviors than the TRA model. According to their study, the TPB accounted for approximately 45% of the variance, as compared to 27% accounted for by the TRA.

**Prediction of Intention.** Applications of the TPB in the PA domain indicate that attitude and PBC consistently serve as significant predictors of behavioral intentions. More often than not, PBC is equal to (McCauley & Courneya, 1993) or enhances the prediction of behavioral intentions when included with attitude (Ajzen, 1991; Blue, 1995; Culos-Reed, et al., 2001; Godin, 1993, 1994; Godin & Kok, 1996). Godin and Kok (1996) reported in a review of 76 studies across a variety of health-related behaviors that on average PBC accounted for an additional 13% of the variance in intention beyond attitude and 17% in studies specifically addressing exercise intentions.

The contribution of subjective norm to the prediction of intention has been more variable. In a narrative review of 23 studies of exercise behavior using TRA and TPB, Blue (1995) found that subjective norm was a nonsignificant predictor of intention in most studies. Godin (1993) reported that 30% of the variance in exercise intentions could be attributed to attitude and subjective norm; however, attitude was the more influential predictor. Other reviews have reported inconsistent and mixed results across studies (Ajzen, 1991; Culos-Reed et al., 2001; Godin & Kok, 1996).

Similar findings are reported in two meta-analyses supporting the narrative reviews favoring TPB over TRA in predicting exercise intentions. In a comparison of the predictive ability of the two models, Hausenblaus et al. (1997) reported attitude having the largest effect (ES = 1.22) on exercise intentions with the influence of subjective norm being more moderate (ES = .56). Furthermore, PBC had a large effect size (ES = .97) on intention suggesting this
construct is an important contributor in the prediction of exercise intention. Likewise, Hagger et al. (2002) found that attitude and PBC were significant and the strongest predictors of intention. Subjective norm was less influential but still a significant contributor. This model accounted for more variance in intention than the TRA. In addition, a significant attenuation effect on the attitude-intention pathway occurred with the inclusion of PBC. This supports the contention that the contribution by PBC may be as substantial as that of attitude on intentions. There is some conceptual overlap, taken together these findings suggest that some elements of attitude are directly related to PBC (Hagger, et al., 2002).

**Prediction of Behavior.** Although the results tend to vary, in most reviews intention is reported as the most important variable in the prediction of PA behaviors as compared to the other TPB constructs (Godin, 1993, 1994; Godin & Kok, 1996; Hagger, et al., 2002; Hausenblas, et al., 1997; McCauley & Courneya, 1993; Notani, 1998). Although it is consistently a significant contributor, the efficacy of PBC in predicting PA behaviors varies. Godin and Kok (1996) reported a significant contribution for PBC above intention in about one-half of the 41 studies reviewed, which accounted for 11.5% of the 34% explained by the model. Subsequently, a meta-analysis by Hausenblas et al. (1997) found a large effect size of (ES = 1.01) for the PBC-behavior relationship, although intention remained the stronger predictor of behavior with an effect size of 1.09. These findings are consistent with a more recent analysis (Hagger, et al., 2002) in which PBC had a significant direct effect on behavior, which accounted for 27.4% of the variance. Furthermore, the direct PBC-intention pathway significantly increased the goodness of fit. However, no change was seen in the intention-behavior pathway with the addition of PBC to the model. Notani (1998) found PBC to be useful in the prediction of behavior under some conditions, but intentions remained the stronger predictor. Interestingly, for student populations PBC was a strong predictor for intentions but not behaviors. This review,
however, included various study contexts and did not specify contributions in relation to exercise or PA behaviors (Notani, 1998).

Whereas intention and PBC are considered to be the primary predictors, attitude can have a significant effect as a predictor of behavior (Hausenblas, et al., 1997; McAuley & Courneya, 1993). According to an earlier narrative review, in seven studies attitude had a stronger influence on the prediction of exercise and PA behavior than subjective norm (McAuley & Courneya, 1993). These findings were corroborated in a more recent statistical analysis, reporting no effect for subjective norm but a significant relationship for attitude (Hausenblas, et al., 1997)

PA Intentions and Behaviors of University Students

A substantial number of individual research articles have examined exercise or PA intentions and behaviors in undergraduate populations. Similar to the findings in other populations, the majority have supported the superiority of the TPB over TRA to predict PA intention and participation (Ajzen & Driver, 1992; Bagozzi & Kimmel, 1995; Dzewaltowski, Noble, & Shaw 1990; Gatch & Kendzierski, 1990; Madden, Ellen, & Ajzen, 1992).

Attitude-Intention Pathway. Attitude has prevailed as a significant contributor in the prediction of intention in studies of varying time intervals using a variety of self-reported measures including meeting recommended guidelines of moderate PA (Blanchard, et al., 2003), kcal expenditure from a 7-day recall (Dzewaltowski, et al., 1990), participation in exercise in general (aerobic) (Bagozzi & Kimmel, 1995; Gatch & Kendzierski, 1990; Madden, et al., 1992; Terry & O'Leary, 1995; Yordy & Lent), resistance exercise (Bryan & Rochelleau, 2002) and leisure activities (Ajzen & Driver, 1992; Courneya, Bobick, & Schinke, 1999; Okun, Karoly, Lutz, 2002; Rhodes & Courneya, 2004). More specifically, Coureya & McAuley (1994) used
the Borg RPE Scale (6-20) with a group of aerobic class participants and found that attitude had a unique contribution to intended frequency and duration of PA, but not intensity.

More recently researchers have begun investigating extended versions of the TPB to address variables that might influence the predictability of the model in the PA domain. For example, some have delved deeper into the aspect of attitude by exploring the influence of affective (e.g. enjoyable or unenjoyable, relaxing or stressful) and instrumental (e.g. useful or useless, beneficial or harmful) forms of attitude on intentions as separate constructs. Using a model that factored in personality traits, Rhodes and Courneya (2003) found that extraversion influenced the prediction such that instrumental, but not affective attitude had a significant effect on intention to participate in leisure activities. In a subsequent study, using similar participants and procedures, these researchers found that affective, but not instrumental was a significant predictor when motivation was held constant (Rhodes & Courneya, 2004).

Furthermore, Blanchard et al. (2003) reported an interesting interaction effect for ethnicity and gender. Affective attitudes appeared to predict intention to accumulate at least 30 minutes of moderate PA on at least 5 days per week for three months for Caucasian females and African American males; whereas instrumental attitudes were stronger predictors for Caucasian males and African American females. Ethnicity and gender did not have a significant effect on subjective norm or PBC.

**Subjective Norm-Intention Pathway.** Subjective norms have contributed significantly to the prediction of intention in some studies, although to a lesser extent than attitude and PBC (Gatch & Kendzierski; 1990; Madden, et al., 1992; Yordy & Lent, 1993). Findings from other studies, however, have suggested that subjective norm is not related to intention (Baggozzi & Kimmel, 1995; Blanchard, et al., 2003; Dzwaltowski, et al., 1990; Terry & O'Leary, 1995)
In an early study investigating intentions in relation to five leisure activities, subjective norms made a significant contribution to the prediction of intentions for jogging, mountain climbing, and boating, but not going to the beach or biking (Ajzen & Driver, 1992). More recently, Bryan et al. (2002) found a significant effect on intention for aerobic as well as resistance exercises. Rhodes and Courneya (2004) concluded subjective norm was a significant influence on intention to exercise regularly when motivation was held constant, although to a much smaller degree than attitude and PBC.

Some researchers suggest that the inconsistency in findings regarding the effect of subjective norm may be due to the type of normative influence evaluated. As recommended by Godin and Kok (1996), Okun et al. (2002) incorporated an assessment of descriptive norm (what others actually do) as well as injunctive norm (what others ought to do) for leisure time exercise. In addition these measures were evaluated relative to family and friends. Consistent with previous research (Godin, 1994), family and friend injunctive norms were not significant; however, friend but not family descriptive norm did emerge as a significant contributor.

Findings from another study examining the relationship between personality and TPB indicated neither descriptive nor injunctive norms were significant influences on intention of leisure time exercise (Rhodes & Courneya, 2003).

**Intention-Behavior Pathway.** The majority of studies assessing the intention-behavior relationship have found intention to be a significant predictor of PA and exercise (Ajzen & Driver, 1992; Bryan & Rocheleau, 2002; Courneya, et al., 1999; Dzewaltowski, et al., 1990; Madden, et al., 1992; Okun, et al., 2002; Rhodes & Courneya, 2003; Terry & O'Leary, 1995; Yordy & Lent, 1993). However, the magnitude of the relationship between PA intentions and actual behavior has varied across studies which may be due methodological issues that appear to moderate the relationship (Culos-Reed, et al., 2001). For example, longer periods of time
between the measure of intention and behavior or participants with high rates of behavior at baseline can compromise the strength of the relationship (Yordy & Lent, 1993).

**PBC-Intention and Behavior Pathways.** Numerous studies have reported that PBC added significantly to the prediction of exercise and PA intention contributing to between 25-52% of the variance (Ajzen & Driver, 1992; Bagozzi & Kimmel, 1995; Blanchard, et al., 2003; Bryan & Rocheleau, 2002; Dzewaltowski, et al., 1990; Gatch & Kendzierski, 1990; Okun, et al., 2002; Rhodes & Courney, 2004). Ajzen and Driver (1992) reported activities with a significant amount of the additional variance attributed to PBC, ranging from 5-17% for leisure time activities. In fact, increases in the prediction of exercise intentions above that of the TRA model in the amount of 4% (Madden, et al., 1992), 5% (Bagozzi & Kimmel, 1995; Gatch & Kendzierski, 1990) and 9% (Dzewaltowski, et al., 1990) have been noted with the inclusion of PBC. However, PBC was not a significant contributor to the prediction of exercise intentions in two studies (Yordy & Lent, 1993; Terry & O'Leary, 1995).

The nature and assessment of PBC has drawn a considerable amount of attention in recent years (Ajzen, 2002). Several researchers have shown that self-efficacy may act as an independent (Courneya & McAuley, 1994) and stronger predictor than perceived controllability for intention (Dzewaltowski, et al., 1990; Terry & O'Leary, 1995) and exercise behavior (Rhodes & Courneya, 2003). To explore this issue, PBC was assessed using separate measures of self-efficacy and perceived controllability. Terry and O'Leary (1995) found that self-efficacy had a strong significant effect on intentions whereas perceived controllability did not while the reverse was true in the prediction of exercise behavior. Self-efficacy, nor perceived control, contributed to prediction of exercise behavior when personality (extroversion) was factored into the model (Rhodes & Courneya, 2003). Also, in a comparison of the social cognitive theory and TPB,
Dzewaltoski et al. (1990) found that perceived control was not a significant contributor to behavior compared to self-efficacy.

The TPB has been identified as a particularly useful tool for examining PA intentions and actual behavior across populations. According to this review of studies using college students, the TPB appears to be a valuable conceptual framework for assessing PA behavior in this population as well.

Conceptualization and Operationalization Issues

The TPB constructs have been assessed using both quantitative and qualitative measures. The vast majority of investigations on exercise and PA have been cross-sectional and prospective using self-reported questionnaires to investigate the applicability of TPB.

As with any theoretical framework, improper operationalization and measurement of the constructs may compromise the validity and reliability of a model's predictability of behavior (Godin, 1993; Godin & Kok, 1996; Hausenblas, et al., 1997; Sutton, 1998). There are some concerns regarding conceptual and methodological issues and the efficacy of the TPB in predicting PA behavior (Culos-Reed, et al., 2001).

Correspondence between Constructs. Ajzen and Fishbein (1980) clearly defined the measurement of the TPB model components and causal relationships among the constructs. The behavior of interest should be defined in terms of target, action, context, and time (TACT) and that all predictor variables must be directly compatible with these elements (Ajzen, 1988). Also, specificity and generalization of the TACT elements must be addressed. For example, the ability to make inferences may be enhanced with aggregation of the time element or targeting the specific behavior context (Ajzen, 1988).

When using Ajzen’s (1985) formulation to construct an instrument and when conducting analysis, consistency across measurement of components must be considered as the amount of
variance accounted for can vary depending on the numerical scale (Culos-Reed, et al., 2001).

Violation of theoretical assumptions and ambiguous predictions are suspect in many studies as a result of poor scale correspondence. In addition to the TPB constructs being measured similarly with regard to the TACT, frequencies, magnitudes, or response formats should be the same for correspondence to occur (Ajzen & Fishbein, 1980).

**Time Interval.** Measurement inconsistencies in the time interval between intention and behavior should be considered. Ajzen and Fishbein (1980) indicate that as the time period between measurement of intention and behavior increases, the predictive power of intention is weakened. In a recent review, Downs and Hausenblas (in press) reported that larger associations between intention and behavior were seen when time interval measurements were within one week or less compared to intervals greater than one month. However, no differences were reported for time intervals of different length in an earlier review (Hausenblas, et al., 1997).

**Elicitation Studies.** Ajzen and Fishbein (1980) maintained that a pilot study to elicit salient beliefs about a particular behavior of the population under investigation is a critical step in applying the TPB model. For example, Terry and O'Leary (1995) asked a small sample of the student population to indicate their beliefs regarding behavioral consequences of exercising regularly. From this information, the most frequently occurring responses were then used to develop the instrument for the main study.

In a recent review, larger intention-behavior and PBC-control behavior were found in the 47 studies implementing an elicitation study compared to those that did not. Results indicated that salient beliefs accounted for 34-56% of the variance in attitude, subjective norm, and PBC, supporting the importance of including this step when using the TPB to explore exercise behavior (Downs & Hausenblas, 2005).
**Wording and Construct Distinction.** Problems related to the wording of questions or statements can result in the assessment of outcome measures different from what was being targeted, particularly in relation to the PBC (Ajzen & Madden, 1986). For example, phrases such as "I do not like the way I feel when I exercise" may actually be an indication of the affective component of attitude instead of the intended PBC. Also, slight variations in the wording of statements may cause the same construct to be measured by two different variables. For example, if intention is measured as "I intend, or I will, exercise regularly" and PBC is assessed as "I am determined to exercise regularly" interpretations of the relationship may be compromised (Culos-Reed, et al., 2001).

A considerable amount of attention has been given to PBC because of its multidimensional characteristics and the variation in methods of assessment across studies. Several investigators indicate that PBC is comprised of perceived control and self-efficacy acting as two conceptually distinct constructs (Armitage & Conner, 2001; Bandura, 1986; Trafimow, Sheeran, Conner, & Finlay, 2002). While Ajzen (2002) agrees that the two are a part of the PBC construct, he argues that the perceived control and self-efficacy are not independent of one another. PBC has been conceptualized using a measure of self-efficacy (Conner & Armitage, 1998) and perceived barriers in early TPB studies (Culos-Reed, et al., 2001). The use of both methods is supported in the literature (Godin, 1993). Caution should be used, however, when comparing findings across studies because results are influenced and interpreted according to the measure (Brawley, Martin, & Gyurcsik, 1998).

Often intention and expectation are used interchangeably; however there is a clear need to distinguish between the two constructs. An intention is a formulated plan, whereas an expectation is an estimation of the likelihood of future behavior (Courneya & McAuley, 1993). In a contrast of studies, a stronger relationship between the expectation and behavior was found
as compared to the intention and behavior relationship, indicating that expectation may be a better predictor for exercise behavior (Hausenblas, et al., 1997).

**Extended Theory**

As suggested by Ajzen (1991), to address the predictive validity of the TPB and adherence to account for PA intention and behavior, some researchers have extended the model to include other constructs to further evaluate conceptualization. Some of the variables that have been investigated within the model are descriptive norm, personality, self-efficacy, and past behavior.

**Descriptive Norms.** Subjective norm has consistently been a weaker predictor of PA behavioral intention than PBC and attitude (Hagger et al., 2002). Based on the strength of the construct to predict other health behaviors, it could be that within the context of PA, significant others are not as influential for those individuals who are already participating in the behavior (Gauvin, et al., 2001). As previously discussed, operationalization of the construct may be responsible for the weak associations. However, some investigators propose that the relationship between subjective norm and intent may be moderated by an individual's type or source (intrinsic or extrinsic) of motivation (Chatzisarantis & Biddle, 1998). Others suggest the strength of the relationship may be related to the specific type of social norm, injunctive or descriptive (Godin & Kok, 1996). There is some evidence that in the PA domain, descriptive norms may be a better predictor of intention and behavior (Godin & Kok, 1996; Okun, et al., 2002). More clarification is needed regarding the role social influences of significant others contribute to PA intention and behavior.

**Personality.** The limited temporal stability of exercise intentions are known and it is considered a weakness of the TPB (Ajzen, 2002), whereas temporal stability of personality has been well established. While the addition of personality to the TPB model may augment
predictive power by increasing temporal stability, the value is more of a practical sense rather than theoretical, suggesting that consideration of an individual's personality may benefit interventions (Rhodes & Courneya, 2003)

**Self-efficacy.** The strength of self-efficacy in the TPB model relative to PA intentions and behavior has been the target of investigation in recent reviews and meta-analysis (Downs & Hausenblas, in press; Hagger et al., 2002; Trafimow, Sheeran, Conner, & Finlay, 2002). Trafimow et al. (2002) noted that a self-efficacy item cluster was a stronger predictor of intention and behavior than a controllability item cluster. Future investigations are needed to explore the strength of self-efficacy and direct prediction of behavior (Hagger, et al., 2002).

**Past Behavior.** Ajzen (1988) asserted that past behavior moderates the relationship between PBC and behavior when perceptions of control are accurate. Several studies investigating the independent influence of the frequency of past PA behavior support the inclusion of this variable to increase the TPB model's ability to account for the variance in PA intention and behavior (Jackson, Smith, & Conner, 2003; Norman, Conner, & Bell, 2000; Yordy & Lent, 1993). A number of studies have observed attenuation effects on PA behavior with the inclusion of past PA behavior (Bagozzi & Kimmel, 1995; Dzewaltoski, et al., 1990; Hagger, et al., 2002).

**An Integrated Approach**

Ecological models can assist in the integration of known modifiable correlates at the intrapersonal, sociocultural, and physical-environmental that influence PA behavior (Sallis & Owen, 2002). We also know that investigations using the TPB have identified individual variables that account for a significant portion of the variation in PA behaviors. It is important to pursue a research agenda using an integrated approach that will inform efforts to modify built environment to elicit the individual variables that are associated with active lifestyles.
An example of how that can be accomplished is found in the literature. A recent project, The Study on Environmental and Individual Determinants of Physical Activity (SEID; Giles-Corti & Donovan, 2002a, 2002b, 2003), was implemented to investigate the influences of and integration between individual, social, and environmental factors on participating in planned recreational PA and exercising to meet recommendations. A social ecological approach was applied using GIS measures to objectively assess spatial access to recreational facilities. Perception of environmental attributes and individual and social factors were also measured using an instrument developed by the investigators based on constructs from the Theory of Planned Behavior (TPB; Ajzen, 1988, 1991). Walking as recommended, for recreation, and for transport had a positive correlation with access to the beach for high SES, and with public open spaces regardless of SES (Giles-Corti & Donovan, 2002b). However, further analysis showed that only 17.2% walked enough to actually meet recommendations (Giles-Corti & Donovan, 2003). Indicating that walking for more than one purpose (transport or recreation) may be required in order to reap health benefits from this type of PA (Giles-Corti & Donovan, 2003). Interestingly, exercising as recommended was augmented by a positive individual and social environment whereas access to facilities had a significant but more moderate effect. The authors suggest that access to facilities conducive to PA participation are a necessary support, but alone may not be enough to ensure that recommended levels of PA would be met (Giles-Corti & Donovan, 2002) supporting the importance of a comprehensive assessment of variables that may influence participation and subsequent adherence to regular PA.

Implications for Future Research

The dramatic increases in sedentary lifestyles and obesity rates over the past two decades have been attributed to behavioral, social, and environmental factors. As Baranoski et al. (2003) indicated, "behavior- and ecology-based problems require behavior- and ecology-based solutions
However, extensive evaluation of the operationalization of comprehensive ecological models specific to health behaviors is needed before the effectiveness of multilevel interventions can be determined (Green, et al., 1996).

In order to conduct research studies to assess the ecological model specific to PA behavior, it is imperative that the measurement of the variables be improved. Most studies have used measures of perceived environment attributes, self-reported PA, and height and weight to determine BMI. Recently, inexpensive and relatively user-friendly community audit tools have been developed (Brownson, Hoehner, et al., 2004), but additional reliability of these measures is needed. Only two ecological studies identified in this review of literature have assessed PA levels using pedometers (King, et al., 2003) or accelerometers (Saelens, Sallis, Black, et al., 2003), and none have used objective assessments of body composition. There is a need for more studies that include objective measures of physical activity to investigate and substantiate relationships between the physical environment, PA behavior, and obesity.

Despite the potentially important role of the physical environment in promoting healthy lifestyles, studies investigating the relationships between community infrastructure, PA, and obesity are scarce (Catlin, et al., 2003). Furthermore, while recent reviews and data from national surveys indicate that many students living on college campuses may be more susceptible to sedentary lifestyles than their community counterparts (Irwin, 2004), little emphasis has been placed on the role this distinct built environment may play in lifestyle choices and health outcomes of this population. Given that this is believed to be a critical time in the formation of health behaviors that will extend across the lifespan, it is especially important to investigate how to structure the environment in such a way to facilitate engagement in physical activity.

Ethnic differences have consistently been reported in PA literature; however, many environmental studies have not addressed ethnic diversity or did not include it in the data.
analysis (Saelens, Sallis, & Frank, 2003). Therefore, little is known about how specific environmental characteristics may impact PA habits in diverse populations at higher risk for sedentary lifestyles, obesity, and other chronic diseases. In light of the fact that these populations are at higher risk for physical inactivity and the health problems associated with it, it is important that this concern be addressed.

The construction of new walkways, improvements of existing paths, and the development of walking/bike paths connecting the LSU campus with the downtown area have recently taken place in an effort to enhance the safety and convenience of pedestrians and cyclists in the LSU and surrounding community. In line with the national research agenda supporting collaborative efforts between public health researchers, policy makers, and urban planners, assessments of the built environment and its influence on activity choices, PA levels, and related health outcomes could be used to make recommendations to city and university planners regarding policy decisions pertinent to the future planning.

In addition, some methodological concerns surrounding the TPB have emerged and warrant further investigation (Downs & Hausenblas, in press). For example, it has been suggested that studies in the PA domain should include past behavior and self-efficacy to enhance the predictability of the model (Hagger, et. al., 2002) and may be especially relevant in this population. Also, the subjective norm construct has consistently been a weak predictor of PA. It has been suggested that descriptive norm may be a better predictor within an undergraduate population, and the source of the social influence may vary as autonomy increases (Okun, et al., 2002).

Summary

There is mounting evidence indicating that the built environment encourages sedentary lifestyles often resulting in life-threatening health consequences (Sparling, et al., 2000).
Discovering ways that communities can encourage healthy lifestyles has become a national research agenda and the focus of many health promotion initiatives. The role that certain environmental characteristics play and the impact they might have on PA behaviors has not been well defined. Consequently, it remains unclear which aspects are the most influential on specific health outcomes (Srinivasan, et al., 2003). Therefore, efforts to identify mechanisms and modify elements in the physical environment that facilitate or hinder PA have become a priority among researchers and public health officials over the past decade (Owen, et al., 2000; Saelens, Sallis, & Frank, 2003).

In accordance with the shift toward promoting PA across the lifespan and the emergence of public policy reform regarding the built environment, researchers have begun to employ ecological models to better understand the influence of public policies, and the physical and social environment on moderate intensity PA (Giles-Corti & Donovan, 2002a; Sallis, et al. 1998). Although only a small number of studies using an ecological approach to examine PA behavior exist in the literature, recent findings have identified aspects of the physical environment (e.g. access, functionality, aesthetics and safety) that appear to have a significant effect on leisure-time or recreational PA and walking for multiple purposes (Pikora, et al., 2003).

Research indicates that more than one-half of all students in US colleges and universities are not sufficiently active to achieve health benefits (Irwin, 2004). Significant reductions in PA and increases in weight seem to occur during the freshman year (Butler, et al., 2004). Moreover, lifestyle behaviors established during these formative years are likely to persist. There is evidence that students' who leave college campuses as sedentary individuals are unlikely to adopt a physically active lifestyle upon entering the workforce (Wallace, et al., 2000). Therefore, it is not surprising that public health officials have identified young adults aged 18-25 years of age as a neglected but important population for PA research. There is increasing interest in health
promotion initiatives to address lifestyle changes that will decrease health risks and improve physical and psychological well-being (ACHA, 2000).

Despite emerging evidence supporting the notion that multilevel ecological approaches are needed to bring about significant and sustainable improvements in population health (Sallis & Owen, 2002), there has not been a concerted effort to investigate the influence of the built environment on PA behaviors in university student populations. Only one study was identified that specifically applied an ecological model exploring PA behaviors in university students. The findings in this study, however, were of limited significance, as the construct validity of the questionnaire was weak, the sample was small, and subgroup differences were not examined (Sallis, et al, 1997).

Many college campuses have expanded their fitness centers and wellness programs over the past decade. It has been suggested that these changes may only be relevant for those individuals who are already exercising. Given the number of insufficiently active and sedentary students, it is important to pursue innovations that target the population that is at risk, rather than catering to individuals who are already active (Leslie, et al., 2001). Different individuals are interested in different kinds of PA for different reasons, and different types of activity are typically performed in specific settings (Owen, et al., 2000). Therefore, specific environmental factors are likely to influence distinct PA behaviors (Sallis & Owen, 2002). Furthermore, factors contributing to, or facilitating, sedentary lifestyles are abundant within the university environment. Over the past few years, technology has entered almost every aspect of students' daily living. Significant increases in computer use and the internet have occurred resulting in students spending increased amounts of time sitting. Transportation alternatives to walking and cycling within and to campus are more readily available. However, our understanding of the PA
behaviors of today's postsecondary education population within the context of a changing built environment is limited (Leslie, et al., 2001).

Although the importance of considering the built environment is evident, understanding physical activity choices at the individual level continues to be a critical component in developing strategies that will have a positive impact. Across health-related behaviors, including PA, the TPB constructs have consistently demonstrated strong positive relationships with intentions and behavior (Culos-Reed, et al., 2001). On average, the TPB model accounts for significant amounts of the variance in exercise and PA intentions and behavior (Hausenblas, et al., 1997; Hagger, et al., 2002). The TPB has been used extensively with college students and appears to be an efficacious framework to evaluate exercise and PA behaviors in this population.

In accordance with national public health initiatives emphasizing population-wide increases in energy expenditure through moderate forms of PA, researchers have been encouraged to use an ecological approach to augment the explanation of individual variations in PA by concurrently evaluating environmental variables with psychosocial correlates of PA (Saelens, Sallis, & Frank, 2003). Based on previous research, it appears that the TPB is an appropriate framework to use within a social ecological model to systematically examine university student's individual behavioral, normative, and control beliefs toward PA intentions and actual behavior within the built environment in which they live.
ADDITIONAL REFERENCES


Giles-Corti, B., & Donovan, R.J. (2002b). Socioeconomic status differences in recreational physical activity levels and real and perceived access to a supportive physical environment. *Preventive Medicine, 35*, 601-611.


APPENDIX B: PILOT STUDY

Recent national initiatives have been put forth indicating the need to assess and monitor physical activity (PA) levels of college students. Moreover, there is evidence that the physical environment may influence PA levels and risk for obesity during young adulthood. The primary purpose of this pilot study was to examine psychometric properties and the utility of an instrument to examine individual and environmental influences on PA levels in a sample of university students.

Method

Participants

The participants were a convenience sample of 76 Kinesiology students enrolled in three sections of a principles of conditioning course (35 males, 41 females, mean age 19.97 years). They signed statements of informed consent prior to participation. The ethnic distribution of the sample was 62 European Americans (Caucasian), nine African Americans (AA), three Hispanics, and two participants indicating other. Because of the disproportionate number of subjects across ethnic groups, AA, Hispanics, and Others were pooled to form a non-Caucasian group. Therefore, the two groups used for analyses were Caucasians (N = 62) and Non-Caucasians (N = 14). Eighteen of the participants lived on-campus (residential or fraternity/sorority housing), the remaining 54 reported living off-campus (apartment, house, home with parents/guardian).

A follow-up assessment to more closely examine instrument reliability and use of facilities by gender was also conducted (N = 74). Seven students had not participated in the initial data collection but were included in these analyses because adding them did not alter the results.
Design

A cross-sectional and descriptive design was used to analyze self-reported survey data. The survey was comprised of three previously validated questionnaires and questions constructed by the investigators based on variables that have been deemed theoretically significant in the literature. The survey was conducted during class time. The questions addressed demographics, perceptions of the neighborhood physical environment, individual determinants for participating in regular PA, and PA behavior. The follow up questions targeted use of facilities.

Instrumentation

Physical Environment. The students’ perception of their current physical environment was assessed using seven of the eight subscales from the Neighborhood Environment Walkability Scale (NEWS; Saelens, Sallis, Black, & Chen, 2002). An additional measure from the Survey on Recreation and Use of Community Facilities was used to assess the likelihood of using neighborhood and community facilities to participate in regular PA (SEID project; Giles-Corti & Donovan, 2002).

Individual Factors. Individual psychosocial determinants of PA in this pilot study were based on the Theory of Planned Behavior (TPB; Ajzen, 1991). Using Ajzen’s guidelines for constructing a TPB questionnaire, a total of seventeen questions measuring attitude (ATT; 8 questions), subjective norm (SN; 4 questions), perceived behavioral control (PBC; 3 questions), intention (INT; 1 question) and behavior (BEH; 1 question) were developed by the investigators. The reliability of the ATT, PBC, and SN measures used in this study was assessed. It should be noted that the PBC item used in this survey to capture the participant’s sense of self-efficacy began with the phrase, “I am confident that I can…” instead of the traditional wording, “if I wanted to I could…”
All of the questions targeting individual psychosocial factors were relative to participation in regular PA defined as “the accumulation of 30 or more of moderate intensity activity on at least five or more days per week (increased heart and breathing rate above resting levels) or at least 20 minutes of vigorous intensity activity on three or more days per week (sweating and large increases in heart and breathing rate).”

**Physical Activity.** Four PA items from the NCHRBS reflecting participation in vigorous, moderate, strengthening, and stretching PA served as dependent variables. A 4-part walking item developed for the SDHEP was used to assess total walking and walking for exercise.

**Risk for Obesity.** Body mass index (BMI) was measured using self-reported weight relative to height, and was calculated by dividing weight (kg) by height (meter) squared. The NCHRBS definition of BMI $\geq 27.3$ kg/m$^2$ for females and 27.8 kg/m$^2$ for males was used to classify subjects as overweight.

**Statistical Analyses**

All data were analyzed using Statistical Package for the Social Sciences (SPSS) for Windows™ version 11.0 (SPSS Inc. 1989-2001). All responses to the attitude, subjective norm, and perceived behavioral control items were calculated and examined for internal consistency using Chronbach's alpha. Pearson correlation coefficients were used to analyze relationships between physical environment, individual determinants of PA, participation in specific types of PA, and BMI. Gender differences were assessed using one-way analysis of variance (ANOVA). The level of significance was set at $p < 0.05$.

**Results**

These data yielded a Cronbach's alpha of .81 for the ATT measure, .54 for the PBC, and .53 for the SN measure. During the previous semester, a sample of kinesiology students ($N = 89$) enrolled in the same course with similar demographics and PA levels, completed a web-based
version of the questionnaire. The items measuring ATT, SN, and PBC used in that survey were also evaluated for internal consistency. The ATT and SN questions were the same, however, the traditional wording was used for the PBC items as mentioned previously. These data produced an alpha of .82, .71, and .59 for ATT, PBC, and SN, respectively.

Given the inconsistencies reported for SN in the literature, and the low alpha found in both of these data sets, the SN measure was reassessed using a subgroup of the present sample (N = 74). In the follow-up questionnaire, the original four questions were used plus an additional descriptive norm question. An alpha of .80 was found for those five SN items.

**Reported Physical Activity**

In response to the survey items about participation in PA over the seven days prior to the survey, 82.9% of the subjects reported participating in vigorous activities on three or more days (M = 3.99, SD = 1.43), and 15.7% reported participating in moderate activities on five or more days (M = 2.38, SD = 1.88). At least 55.3% indicated they had participated in strengthening activities (M = 3.12, SD = 1.39) and 71.1% in stretching activities and on three or more of the seven days (M = 3.43, SD = 1.73). Using reported height and weight, 17.11% of the subjects were classified as overweight. In addition, a mean of 196.24 ± 140.96 total minutes of walking and 42.05 ± 58.75 minutes of walking for exercise were reported for the seven days prior to completing the survey.

Across all subjects, none of the NEWS subscale scores were associated with the four PA measures (NCHRBS and walking items) or BMI. However, significant associations were revealed for the PA measures and six specific neighborhood attributes assessed within the subscales. Only the items significant at the p < .05 level are displayed in Table 1. All but one of these relationships was negative in direction.
Table 1.

Correlations between NEWS subscale items and PA and Individual factors.

<table>
<thead>
<tr>
<th>NEWS subscale items</th>
<th>VIG</th>
<th>MOD</th>
<th>Walk-Ex</th>
<th>Total Walk</th>
<th>ATT</th>
<th>INT</th>
<th>BEH</th>
</tr>
</thead>
<tbody>
<tr>
<td>can shop locally</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.241</td>
</tr>
<tr>
<td>poor store parking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.359</td>
<td></td>
<td></td>
</tr>
<tr>
<td>transit stops easy to reach</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.271</td>
</tr>
<tr>
<td>no hilly streets</td>
<td>-.258</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.270</td>
</tr>
<tr>
<td>few dead-ends</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.228</td>
<td></td>
</tr>
<tr>
<td>alternate routes available</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.248</td>
</tr>
<tr>
<td>sidewalks maintained</td>
<td>-.267</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.254</td>
<td></td>
</tr>
<tr>
<td>cars between sidewalk/street</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.239</td>
<td></td>
</tr>
<tr>
<td>slow traffic on streets</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.285</td>
<td>-.298</td>
</tr>
<tr>
<td>walkers/bikers seen</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-.259</td>
</tr>
<tr>
<td>seeing others when walking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>.256</td>
</tr>
</tbody>
</table>

The walkability measure was significantly related to the ATT (r = .259, \( p = .02 \)) and PBC measures (r = .229, \( p = .04 \)). Furthermore, six of the neighborhood items were associated with ATT, INT, or BEH (Table 1).

Considering the similarities in the definition used for participation in regular PA for the TPB and NCHRBS items, the relationships between these measures were also examined. Participation in vigorous activity was significantly related to ATT, PBC, INT and BEH, whereas, moderate activity was related to SN, INT, and BEH (Table 2). All of the individual behavioral factors were significantly related to one another (Table 2).

**Gender Differences**

For the week (seven days) prior to the survey, males reported having engaged in strengthening activities more often than females, whereas, females spent more time (minutes) walking for exercise (Table 3). In addition, females reported having significantly better land use
mix-access than their male counterparts and, although not significantly different, tended to report better neighborhood aesthetics ($F = 3.92, p = .072$) (Table 3).

Table 2.

**Individual determinants of regular PA and PA behavior**

<table>
<thead>
<tr>
<th>Measure</th>
<th>ATT</th>
<th>SN</th>
<th>PBC</th>
<th>INT</th>
<th>BEH</th>
<th>VIG</th>
<th>MOD</th>
</tr>
</thead>
<tbody>
<tr>
<td>ATT</td>
<td>.275*</td>
<td>.594**</td>
<td>.445**</td>
<td>.435**</td>
<td>.391**</td>
<td>.173</td>
<td></td>
</tr>
<tr>
<td>SN</td>
<td>.256*</td>
<td>.292*</td>
<td>.268*</td>
<td>.219</td>
<td>.248*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PBC</td>
<td>.367**</td>
<td>.390**</td>
<td>.378**</td>
<td>.120</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INT</td>
<td></td>
<td>.837**</td>
<td></td>
<td>.764**</td>
<td>.247*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BEH</td>
<td></td>
<td></td>
<td></td>
<td>.837**</td>
<td>.282*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*p<.05; **p<.001

Table 3.

**Perception of the physical environment and PA behavior by gender**

<table>
<thead>
<tr>
<th>Measure</th>
<th>Males (n = 35)</th>
<th>Females (n = 41)</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Access (score)</td>
<td>2.75</td>
<td>.46</td>
<td>2.96</td>
<td>.35</td>
</tr>
<tr>
<td>Strengthening (days)</td>
<td>3.46</td>
<td>1.63</td>
<td>2.83</td>
<td>1.07</td>
</tr>
<tr>
<td>Walk for exercise (min)</td>
<td>27.46</td>
<td>47.64</td>
<td>54.51</td>
<td>64.79</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>25.08</td>
<td>3.84</td>
<td>23.03</td>
<td>3.69</td>
</tr>
</tbody>
</table>

Within group correlations were such that females total walking time was significantly associated with access to services ($r = -.416, p = .007$) and walkability of the neighborhood ($r = -.313, p = .046$). For males, access to services approached significance for walking for exercise ($r = .324, p = .057$) and total walking time ($r = .33, p = .052$) with both in a positive direction.

Use of facilities measures also yielded some gender differences (Table 4). Females indicated a greater likelihood of using parks, sidewalks, trails, and tennis courts to participate in
regular PA, whereas males were more likely to use golf courses. Not surprising, males had significantly higher BMI’s than females, and eight males and five females were identified as overweight according to NCHRBS guidelines. There were no gender differences for individual determinants of PA.

Table 4.

Use of Facilities by Gender

<table>
<thead>
<tr>
<th>Follow-up survey variables</th>
<th>Males (n = 34)</th>
<th>Females (n = 40)</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Parks</td>
<td>2.88</td>
<td>1.70</td>
<td>3.88</td>
<td>1.94</td>
</tr>
<tr>
<td>Sidewalk</td>
<td>3.47</td>
<td>1.58</td>
<td>4.75</td>
<td>1.66</td>
</tr>
<tr>
<td>Trails</td>
<td>3.41</td>
<td>1.76</td>
<td>4.83</td>
<td>1.81</td>
</tr>
<tr>
<td>Tennis</td>
<td>2.50</td>
<td>1.60</td>
<td>3.45</td>
<td>2.02</td>
</tr>
<tr>
<td>Golf</td>
<td>2.65</td>
<td>1.82</td>
<td>1.68</td>
<td>1.23</td>
</tr>
</tbody>
</table>

Discussion

In response to a national initiative, over the past five years relationships between the built environment and public health have become the focus for many research endeavors. There is evidence that the built environment can influence decisions made about being active. However, the methodology and instrumentation are still being developed and little is known about influences relative to specific populations. The goal of this pilot study was to examine our methodology, instrument reliability, and utility of an instrument to investigate individual and environmental correlates of PA behavior in university students.

Although the data were not presented, a similar web-based version of the survey used in this study was administered to students in the fall to examine methodological issues surrounding the feasibility of that type of design. Based on feedback from the students taking the web-based
survey, revisions were made and included in the paper and pencil format used in this study. In addition, internal consistency of the TPB measures was examined for both versions.

The ATT items showed good internal consistency across both surveys. The wording of the items to capture PBC and SN varied slightly between the two versions, subsequently reliability coefficients differed. The Chronbach’s alpha for the PBC and SN items in the present study were unacceptable. However, the three traditional PBC items from the web-based version and the five SN items used in the follow-up questionnaire were in the acceptable to good range. One purpose of piloting a questionnaire is to determine the most reliable instrument to be used with a certain population. Therefore, any subsequent investigation of individual determinants of PA in this university population should consider using the combination of items which yielded the stronger reliability coefficients.

Reported Physical Activity

It is not surprising that 98.6% of this sample reported meeting or exceeding ACSM PA recommendations. In addition to being kinesiology majors, all of the students serving as subjects in this study were enrolled in a course that required participation in a monitored comprehensive (aerobic, strengthening, and flexibility exercises) circuit training lab at least two days per week. They were also responsible for at least one other day of comparable training outside of class. Furthermore, although confidentiality was assured, because participation in this training lab was considered part of the student's grade, even if they were not fulfilling the requirement it is unlikely they would report not doing so under the circumstances. Therefore, due to sample bias, these data may not be representative of typical relative PA behavior in a university population. Furthermore, because weight lifting is part of the training protocol, the subject’s weight may represent more lean mass than found in the average student, therefore, BMI values may not be a valid indicator of risk for obesity in this sample. A better indicator would be percentage of body
fat using skinfold measures and/or more objective assessments such as dual-energy x-ray absorptiometry (DXA).

Two recent studies using university students included assessments of walking time. Johnson et al. (2000) reported a mean of 246 minutes for total walking time per week (4-item measure) and 58 minutes for walking for exercise. Similarly, Sallis et al. (1997) reported 53 minutes walked for exercise. Our walking times of 196 minutes and 42 minutes for total and exercise walking, respectively, were somewhat lower compared to these earlier studies. Given that the majority of our subjects were involved in vigorous forms of activity on four or more days per week, it is likely that this particular sample of students were not as aware of their walking behavior as others might be. Research indicates that vigorous PA is recalled more accurately than lower intensity activities such as walking (Sallis & Saelens, 2000). Nevertheless, the average of 200 minutes per week reported by this sample is adequate for meeting recommendations of accumulating 30 minutes or more of moderate activity on most days of the week.

**Physical Environment and Physical Activity Behavior**

Although research in this area is still relatively new, there is clear evidence that certain aspects of the built environment influence PA behavior (Saelens, et al., 2002; McCormick, et al., 2004). In this study, however, the physical characteristics of the neighborhood environment represented by subscale composite scores were not associated with any of the PA measures. Humpel, Owen, and Leslie (2002) indicated in their review that when a number of physical environmental variables are combined, it is likely that possible associations may be concealed. This could be the case with these data since specific aspects of the environment were significantly correlated with vigorous activity, moderate activity, and both measures of walking time.
Interestingly, however, these relationships were in a negative direction and somewhat perplexing.

The negative associations could suggest that the more positive one’s perceptions are about the neighborhood characteristics the less active they are or even if an individual perceives the neighborhood to be poor aesthetically, unsafe, etc., they would still be physically active. Taking into account the high levels of PA for this sample and lack of variability in the number of days or time reported, the latter is more likely the case. In other words, regardless of their perception of the neighborhood physical environment, this group of active individuals participated in PA.

It should be noted that negative relationships for environmental factors and PA measures have been reported in other populations (Humpel, Owen, et al., 2004, King, et al., 2000) and warrant further examination. In addition, the assessment and reporting of explicit details may be important to identify environmental predictors relative to different populations.

**Physical Environment and Individual Determinants of Physical Activity**

The finding that a student's perception of facilities available for walking and cycling, such as sidewalks and pedestrian/bike trails (walkability) is a positive correlate for ATT and PBC about PA is unique. Most investigators have not integrated assessments of how the physical environment may impact cognitive influences on PA into their studies. Determining if and how the environment influences an individual’s attitude and beliefs about their support system and control over their ability to be active could be significant for those who are sedentary. Identifying physical supports or barriers in the environment that influence how someone feels or believes about becoming active or sustaining activity levels could enhance policy makers and educators ability to provide effective supports.
Individual Determinants and Physical Activity Behavior

In the present study, all of the individual factors were related to at least one type of PA supporting previous research indicating ATT, PBC, and to a lesser degree SN, as determinants of INT to participate in PA and PA behavior. These findings also indicate that different types of PA may be influenced by different individual psychosocial factors in university populations. For example, the more positive the attitude toward PA and PBC the more days per week the students participated in vigorous, strengthening, and stretching activities. Normative beliefs were related to participation in moderate forms of PA.

Our finding that individual factors were more related to participation in PA than the physical environment variables is somewhat similar to Giles-Corti & Donovan (2002). They reported that the influence of the physical environment on exercising as recommended was relatively weak and secondary to individual and social determinants. The authors suggested that access to facilities is a necessary support for PA participation, but alone may not be enough to ensure that recommended levels of PA would be met (Giles-Corti & Donovan, 2002), thereby supporting the importance of a comprehensive assessment of variables that may influence participation and subsequent adherence to regular PA.

Gender Differences

In this sample of university students, females reported a more positive perception of neighborhood accessibility and indicated that they were more likely to use less formal facilities (e.g. parks, sidewalks, trails) to be active than males. In addition, correlations between environmental variables and PA measures differed by gender. Similar to Humpel, Owen, Leslie, et al. (2004), perceived accessibility was negatively associated with total walking time for females and positively associated for males. Neighborhood walkability was also negatively associated with total walking time for females. Other studies have reported environmental
correlates of PA in the unexpected direction for middle-aged females, but not for their male counterparts, (Humpel, Owen, Leslie, et al., 2004) and for diverse samples of older women (King, et al., 2000). These data suggest that as we continue to explore and better define environmental variables that are of influence on decisions about PA, identifying specific aspects relative to targeted subgroups may be important for policy and educational supports to be effective. 

Limitations

The findings in this pilot study were limited by several factors. The small sample size and disproportionate number of subjects within subgroups limited the ability to generalize results to other populations. This was a sample of convenience with PA levels greater than a typical group of college students limits the interpretation of correlations and group differences. A much larger sample of university students need to be randomly selected. Only correlational analyses were conducted which did not allow for causal interpretation of the data. Multilevel modeling analyses should be employed to further investigate relationships and contributions of the variables within the model.

Summary

Across all subjects there was no association between the overall neighborhood environment measures and PA in this sample of active students. Walkability of the neighborhood did emerge as a correlate for ATT and PBC toward PA. This could suggest that while identifying and modifying aspects of the physical environment that either encourage or discourage PA are needed, without consideration of known individual factors (e.g. psychosocial or demographics) that influence PA behavior little change in health behaviors are apt to occur at the community or society level. Thus, more investigations utilizing a social ecological approach are appropriate and needed.
The main purpose of this pilot study was to determine the reliability and feasibility of using the instrument with university students. The TPB items constructed for this survey demonstrated acceptable internal consistency. The validity of the PA and environmental measures used has been determined in previous studies.

The significant association between the physical environmental and individual determinants of PA depicted in this study is encouraging and represents a new application of the NEWS relative to motivation to participate in regular PA. The negative correlations between PA and specific physical environment items found for this sample of active individuals, in particular the females, is similar to findings in other populations. These findings suggest that the instrument may be useful in a larger more diverse sample of university students and sensitive to the behavior and perceptions of specific subgroups.
## STUDENT PHYSICAL ACTIVITY AND EATING HABITS SURVEY

### SECTION A: Demographics

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. What is your age?</td>
<td>_______ years</td>
</tr>
<tr>
<td>2. What is your height without shoes? (5 ft. = 60 in.; 6 ft. = 72 in.) e.g. 5 ft. 8 in. = 68 inches</td>
<td>_______ inches</td>
</tr>
<tr>
<td>3. How much do you weigh without shoes? (1 kg = 2.2 lbs.)</td>
<td>_______ pounds</td>
</tr>
<tr>
<td>4. How much did you weigh when you entered LSU as a freshman (e.g. at the beginning of last fall)</td>
<td>_______ pounds</td>
</tr>
<tr>
<td>5. Gender: 1. Male 2. Female</td>
<td>1. Male 2. Female</td>
</tr>
<tr>
<td>7. What is your current living arrangement? 1. On Campus (dorm or residential hall) 2. On-Campus (fraternity/sorority housing) 3. Off-Campus (apartment, house, etc.) 4. Off-Campus (home with parents/guardian)</td>
<td>1. On Campus (dorm or residential hall) 2. On-Campus (fraternity/sorority housing) 3. Off-Campus (apartment, house, etc.) 4. Off-Campus (home with parents/guardian)</td>
</tr>
<tr>
<td>8. What is the zip code of your current residence? (on-campus residents use zip code for your P.O.Box)</td>
<td></td>
</tr>
<tr>
<td>9. How long have you lived at your current residence, including this semester and summers? 1. One semester 2. Two semesters 3. Three semesters 4. Four or more semesters</td>
<td>1. One semester 2. Two semesters 3. Three semesters 4. Four or more semesters</td>
</tr>
<tr>
<td>12. On average, how many hours per week (7 days) do you typically work a semester? 1. 10 hrs. or less 2. 11-20 hrs 3. 21-30 hrs. 4. 31-40 hrs. 5. 41 or more hrs. 6. I do not work during the semester</td>
<td>1. 10 hrs. or less 2. 11-20 hrs 3. 21-30 hrs. 4. 31-40 hrs. 5. 41 or more hrs. 6. I do not work during the semester</td>
</tr>
</tbody>
</table>
15. What is the estimated annual income of your family?

<table>
<thead>
<tr>
<th>1. &lt; $20,000</th>
<th>2. $20,001-$40,000</th>
<th>3. $40,001-$60,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>4. $60,001-$80,000</td>
<td>5. $80,001-$100,000</td>
<td>6. $ &gt;100,000</td>
</tr>
</tbody>
</table>

16. Do you have a physical disability or chronic disease that keeps you from being able to participate in regular physical activities?

<table>
<thead>
<tr>
<th>1. Yes</th>
<th>2. No</th>
</tr>
</thead>
</table>

**SECTION B: Your Neighborhood Environment** (see definitions below).

**NEIGHBORHOOD**: If you live "on-campus", the LSU campus is considered your neighborhood. If you live "off-campus", your neighborhood is defined as a half-mile radius or a 10-minute walk from your apartment, house, etc.

**RESIDENCE**: Your campus housing or your apartment, house, etc. depending on where you currently live.

### Part 1. How common are the following types of residences in your neighborhood?

<table>
<thead>
<tr>
<th>1. Detached single-family homes</th>
<th>2. Townhouses or row houses</th>
<th>3. Apartments or condos</th>
</tr>
</thead>
</table>

### Part 2. Using the following scale, select the answer that best describes the way you perceive your current neighborhood relative to the definition above. Local and/or within walking distance mean within a 10-15 minute walk from your residence.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>4. I can do most of my shopping at local stores.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>5. Stores are within easy walking distance of my home.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>6. Parking is difficult in local shopping areas.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>7. There are many places to go within easy walking distance of my home.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>8. It is easy to walk to a transit stop (bus, train) from my home.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>9. The streets in my neighborhood are hilly, making my neighborhood difficult to walk in.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>10. There are many canyons/hillsides in my neighborhood that limit the number of routes for getting from place to place.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>11. The streets in my neighborhood do not have many, or any, cul-de-sacs (dead-end streets).</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>12. There are walkways in my neighborhood that connect cul-de-sacs to streets, trails, or other cul-de-sacs.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>13. The distance between intersections in my neighborhood is usually short (100 yards or less; the length of a football field or less).</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>14. There are many four-way intersections in my neighborhood.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>15. There are many alternative routes for getting from place to place in my neighborhood. (I don't have to go the same way every time.)</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>16. There are sidewalks on most of the streets in my neighborhood.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>17. The sidewalks in my neighborhood are well maintained (paved, even, and not a lot of cracks).</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>18. There are bicycle or pedestrian trails in or near my neighborhood that are easy to get to.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>19. Sidewalks are separated from the road/traffic in my neighborhood by parked cars.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>20. There is a grass/dirt strip that separates the streets from the sidewalks in my neighborhood.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>21. There are trees along the streets in my neighborhood.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>22. Trees give shade for the sidewalks in my neighborhood.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>23. There are many interesting things to look at while walking in my neighborhood.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>24. My neighborhood is generally free from litter.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>25. There are many attractive natural sights in my neighborhood (such as landscaping, views).</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>26. There are attractive buildings/homes in my neighborhood.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>27. There is so much traffic along the street I live on that it makes it difficult or unpleasant to walk in my neighborhood.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>28. There is so much traffic along nearby streets that it makes it difficult or unpleasant to walk in my neighborhood.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>29. The speed of traffic on the street I live on is usually slow (30 mph or less).</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>30. The speed of traffic on most nearby streets is usually slow (30 mph or less).</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>31. Most drivers exceed the posted speed limits while driving in my neighborhood.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>32. There are crosswalks and pedestrian signals to help walkers cross busy streets in my neighborhood.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>33. The crosswalks in my neighborhood help walkers feel safe crossing busy streets.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>34. When walking in my neighborhood, there are a lot of exhaust fumes (such as from cars, buses).</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>35. My neighborhood streets are well lit at night.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>36. Walkers and bikers on the streets in my neighborhood can be easily seen by people in their homes.</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
37. I see and speak to other people when I am walking in my neighborhood. | 1 2 3 4 
38. There is a high crime rate in my neighborhood. | 1 2 3 4 
39. The crime rate in my neighborhood makes it unsafe to go on walks during the day. | 1 2 3 4 
40. The crime rate in my neighborhood makes it unsafe to go on walks at night. | 1 2 3 4 
41. Stores are within easy biking distance of my home. | 1 2 3 4 
42. There are many places to go within easy biking distance of my home. | 1 2 3 4 
43. It is safe to ride a bike in my neighborhood. | 1 2 3 4 

**SECTION C:** PLEASE READ THE FOLLOWING DEFINITION BEFORE COMPLETING THIS SECTION:

**REGULAR PHYSICAL ACTIVITY** can be: the accumulation of 30 minutes or more of moderate intensity activity on at least 5 or more days per week *(increased heart and breathing rate above resting levels)* OR at least 20 minutes of vigorous activity per day on 3 or more days per week *(sweating and large increases in heart and breathing rate).*

| 1. If I wanted to, I could easily participate in regular physical activity. | Strongly Disagree | Strongly Agree |
| 2. Most people who are important to me think I should participate in regular physical activity. | Strongly Disagree | Strongly Agree |
| 3. Participating in regular physical activity is: | Extremely Useless | Extremely Useful |

*Please insert only one number between 0 and 7.*

4. I participate in regular physical activity ________ days per week.

5. Participating in regular physical activity is: | Extremely Boring | Extremely Interesting |

6. How much control do you have over participating in regular physical activity? | Very Little Control | Complete Control |

7. Most people who are important to me participate in regular physical activity. | Strongly Disagree | Strongly Agree |

8. Participating in regular physical activity is: | Extremely Harmful | Extremely Beneficial |

9. Participating in regular physical activity is: | Extremely Unpleasant | Extremely Pleasant |

10. For me to participate in regular physical activity is: | Extremely Difficult | Extremely Easy |
11. Most people who are important to me support me participating in regular physical activity.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

12. Participating in regular physical activity is:

<table>
<thead>
<tr>
<th>Extremely Foolish</th>
<th>Extremely Wise</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

13. Participating in regular physical activity is:

<table>
<thead>
<tr>
<th>Extremely Unenjoyable</th>
<th>Extremely Enjoyable</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

14. Most people whose opinions I value participate in regular physical activity.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

15. I intend to participate in regular physical activity ________ days per week.

16. Participating in regular physical activity is:

<table>
<thead>
<tr>
<th>Extremely Bad</th>
<th>Extremely Good</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

17. Participating in regular physical activity is:

<table>
<thead>
<tr>
<th>Extremely Stressful</th>
<th>Extremely Relaxing</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

18. Most people who are important to me approve of me participating in regular physical activity.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

SECTION D: Facilities in Your Neighborhood

Part 1. Let's say you decided to WALK to the nearest businesses or facilities listed below. About how long would it take to get to them from your current residence (dorm, apartment, house, etc.)?

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 31 min or more</td>
<td>2. 21-30 min</td>
<td>3. 11-20 mi</td>
<td>4. 6-10 min</td>
<td>5. 5 min or less</td>
<td>6. Don't Know</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

168
<table>
<thead>
<tr>
<th></th>
<th>Facilities</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>17.</td>
<td>pharmacy/drug store</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>18.</td>
<td>salon/barber shop</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>19.</td>
<td>the building that your first class of the day and week is in at LSU</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>20.</td>
<td>bus or transit stop</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>21.</td>
<td>park</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>22.</td>
<td>public recreation center</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>23.</td>
<td>gym or fitness facility (health club)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>24.</td>
<td>golf course</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>25.</td>
<td>trails or paths for cycling, walking, or jogging</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>26.</td>
<td>swimming pool</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>27.</td>
<td>tennis courts</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>28.</td>
<td>playing field (soccer, softball, etc.)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>29.</td>
<td>lake or river</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>30.</td>
<td>sidewalk</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td></td>
</tr>
</tbody>
</table>

**Part 2. Using the scale below, indicate how likely is it that you would use the following facilities to participate in regular physical activity?**

<table>
<thead>
<tr>
<th>Facilities</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td>31. park</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>22. public recreation center</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>33. gym or fitness facility (health club)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>34. golf course</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>35. trails or paths for cycling, walking, or jogging</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>36. swimming pool</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>37. tennis courts</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>38. playing field (soccer, softball, etc.)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>39. lake or river</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>40. sidewalk</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
</tr>
</tbody>
</table>

**SECTION E: Discretionary Time**

1. **How many total hours during an average school week (M-F) do you spend watching television and/or videos?**
   
   ________ total hours

2. **How many total hours during an average weekend (Sat-Sun) do you spend watching television and/or videos?**
   
   ________ total hours

3. **How many total hours during an average school week (M-F) do you spend studying?**
   
   ________ total hours
4. How many total hours during an average weekend (Sat-Sun) do you spend studying?

__________ total hours

5. How many total hours during an average school week (M-F) do you spend on the computer doing school work?
   (e.g. writing papers, preparing presentations, etc.)

__________ total hours

6. How many total hours during an average weekend (Sat-Sun) do you spend on the computer doing school work?
   (e.g. writing papers, preparing presentations, etc.)

__________ total hours

7. How many total hours during an average school week (M-F) do you spend on the computer emailing, playing games, surfing the web, etc.?

__________ total hours

8. How many total hours during an average school week (Sat-Sun) do you spend on the computer emailing, playing games, surfing the web, etc.?

__________ total hours

---

**SECTION F. NCHRBS**

1. On how many of the past 7 days did you participate in vigorous physical activities for at least 20 minutes that made you sweat and breathe hard?
   (e.g. running/jogging, swimming laps, fast bicycling, tennis, basketball or similar aerobic activities)

0 1 2 3 4 5 6 7

2. On how many of the past 7 days did you walk or bicycle for at least 30 minutes at a time?
   (including to or from class or work)

0 1 2 3 4 5 6 7

3. On how many of the past 7 days did you do stretching activities?
   (e.g. toe touching, knee bending, leg stretching, yoga, etc.)

0 1 2 3 4 5 6 7

4. On how many of the past 7 days did you do physical activities to strengthen or tone your muscles?
   (e.g. push-ups, sit-ups, weight lifting, Therabands®, etc.)

0 1 2 3 4 5 6 7

5. Apart from what you have already reported, on how many of the past 7 days did you accumulate within a day at least 30 minutes of any moderate intensity activity that raised your heart and breathing rate above resting levels?
   *include occupational work, yard work, and any recreational activities not included in 1-4*

0 1 2 3 4 5 6 7

6. During this school year, have you been enrolled in a physical education (activity) class?

1. No 2. Yes

7. During this school year, on how many college/university sports teams have you participated? (e.g. varsity, intramural, club sports)

0 1 2 3 or more

8. During the past 7 days, how many total minutes did you spend walking to and from school or work?
   (include to and from classes)

__________ total minutes

9. During the past 7 days, how many total minutes did you spend walking during breaks or lunch at school or work?

__________ total minutes
10. During the past 7 days, how many total minutes did you spend walking as part of errands performed outside your home and yard?

| __________ total minutes |

11. During the past 7 days, how many total minutes did you spend walking for exercise at a moderate to hard pace for a duration of at least 10 min at one time. (brisk walks of at least 3.5 miles/hr)

| __________ total minutes |

12. During the past 7 days, how many total minutes did you spend walking to or from bus or transit stops?

| __________ total minutes |

### SECTION F: Nutrition

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1 time</th>
<th>2 times</th>
<th>3 or more times</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Yesterday, how many times did you eat fruit?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Yesterday, how many times did you drink fruit juice?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(e.g. orange, grapefruit, or tomato)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Yesterday, how many times did you eat green salad?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Yesterday, how many times did you eat cooked vegetables?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Yesterday, how many times did you eat hamburger meat, hot</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>dogs, or sausage?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Yesterday, how many times did you eat french fries or potato</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>chips?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Yesterday, how many times did you eat cookies, doughnuts,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>pie, or cake?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Yesterday, how many times did you drink milk?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(include flavored milks)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Yesterday, how many times did you eat cheese?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Yesterday, how many times did you eat yogurt?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Yesterday, how many times did you eat or drink something</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>that was fortified with calcium? (e.g. orange juice, milk)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Yesterday, how many times did you eat food from a fast</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>food restaurant? (such as Arby’s, McDonald’s, Popeyes, Raising</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Canes, Taco Bell, etc.)?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Yesterday, how many times did you drink a soft drink, soda,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>or pop?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. When you drink a soft drink, soda, or pop, how much do you</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>usually drink?</td>
<td>1. More than 16 ounces or more than 1 can or bottle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. 12 to 16 ounces or 1 can or bottle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Less than 12 ounces or less than 1 can or bottle</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. I do not drink soft drinks (sodas)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. What kind of soft drink, soda, or pop do you usually drink?</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Sweetened with caffeine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. Sweetened without caffeine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Diet with caffeine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>4. Diet without caffeine</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Question</td>
<td>Options</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------------------------------------------------------------------------</td>
<td>---------------------------------------------------------------------------------------------</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. I do not drink soft drinks (sodas)</td>
<td>1. 3 or more refills 2. 2 refills 3. 1 refill 4. no refills 5. I do not order/drink soft drinks (sodas)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. When eating out at restaurants, how many soft drink, soda, or pop refills do you usually have?</td>
<td>1. Most of the time I eat on campus 2. Most of the time I eat out (off campus) 3. Most of the time I eat home-cooked meals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Which of the following best applies to you since you became a student at LSU?</td>
<td>1. Most of the time I eat on campus 2. Most of the time I eat out (off campus) 3. Most of the time I eat home-cooked meals</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. On average, how likely is it that you would &quot;super-size&quot; a fast food meal?</td>
<td>Very Likely 1 2 3 4 Not Very Likely</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. On average, how likely is it that you would choose to eat in a restaurant because it offers an “all you can eat” buffet?</td>
<td>Very Likely 1 2 3 4 Not Very Likely</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. On average, how likely is it that you would take leftovers home from a restaurant?</td>
<td>Very Likely 1 2 3 4 Not Very Likely</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. On average, when eating out at a restaurant how likely is it that you would eat everything served on your plate?</td>
<td>Very Likely 1 2 3 4 Not Very Likely</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. On average, how likely is it that you would take a snack from a vending machine instead of eating a meal?</td>
<td>Very Likely 1 2 3 4 Not Very Likely</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. Keeping in mind that your answers are confidential, please respond to the following statement: Reading &quot;Fast Food Nation&quot; or hearing the author, Eric Schlosser, speak last fall has had an influence on my eating habits and/or choices.</td>
<td>1. Did not read book or hear speaker 2. Strongly Disagree 3. Disagree 4. Agree 5. Strongly Disagree</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
1. **Study Title:** Examining Environmental Factors that Influence Physical Activity and Eating Habits within a University Population

2. **Performance Site:** Louisiana State University and A&M College

3. **Investigators:** The following investigators are available for questions about this study, M-F, 8:00 am–4:30 pm: Lisa G. Johnson, M.A. 225-578-3552, Melinda Solmon, Ph.D., and Rebecca Gardner, Ph.D.

4. **Purpose of the Study:** The purpose of this study is to identify relationships between behavioral, psychological, and environmental influences on physical activity and eating habits within a university population.

5. **Subject Inclusion:** Volunteers from the student body and Louisiana State University community 18 years of age and older

6. **Number of subjects:** 1000+

7. **Study Procedures:** A questionnaire will be distributed via mail, website, and/or selected classes to incoming freshman students and other members of the university community. The questionnaire will inquire about previous and current physical activity and nutrition behavior. The student/participant may voluntarily complete and return the questionnaire.

8. **Benefits:** The study may yield beneficial information about personal physical activity and nutritional habits that could be targeted for intervention to gain a healthier lifestyle.

9. **Risks:** There is no known risk to the participant. Every effort will be made to maintain the confidentiality of participant’s records. Files will be kept in secure cabinets to which only the investigators have access.

10. **Right to Refuse:** Participants may choose not to participate or to withdraw from the study at any time without penalty or loss of any benefit to which they might otherwise be entitled.

11. **Privacy:** Results of the study may be published, but no names or identifying information will be included in the publication. Subject identity will remain confidential unless disclosure is required by law. If the subject chooses to voluntarily provide contact information for future studies, only the primary investigators will have access to this information.
12. **Signatures:** The study has been discussed with me and all my questions have been answered. I may direct additional questions regarding study specifics to the investigators. If I have questions about subjects' rights or other concerns, I can contact Robert C. Mathews, Institutional Review Board, (225) 578-8692. I agree to participate in the study described above and acknowledge the investigator's obligation to provide me with a signed copy of this consent form.

___________________________________   _________________________
Signature of Subject                                      Date

THE FOLLOWING INFORMATION IS **NOT** REQUIRED TO PARTICPATE IN THE SURVEY:

If you are interested in volunteering for participation in follow-up studies relative to the information addressed in this questionnaire, please provide contact information. Providing this information does **NOT** obligate the student to participate.

Name:_____________________________  PAWS email:_________________________

Phone: (Home)_______________ (Cell)______________ (Other)___________________

174
Study Title: Investigating Relationships between the Built Environment, Health Behaviors, and Obesity in University Students.

Performance Site: Nutrition and Health Assessment Laboratory, 252 Knapp Hall, Louisiana State University, Baton Rouge, LA.

Contacts: The following investigators are available to answer questions about this project:
Dr. Georgianna Tuuri, 225-578-1722
Ms. Lisa Johnson, 225-578-3552
Dr. Melinda A. Solmon, 225-578-2639

Purpose of the Study: The purpose of the study is to study the relationship between characteristics of the physical environment and your physical activity, eating habits and risk for obesity.

Subjects: In order to participate in this research study you must be at least 18 years of age, a registered LSU student, and in good health. If you are on medication, please share this with the principal investigator. Females who are pregnant and individuals weighing more than 250 pounds cannot participate in the laboratory body composition testing.

Study Procedures: Please come to the Nutrition and Health Assessment Laboratory in 252 Knapp Hall, LSU AgCenter, on the LSU campus. On the day of testing, please don’t exercise, and drink plenty of water, but don’t drink more than one cup (8 oz.) of any caffeine-containing beverages. Wear lightweight, loose fitting clothes that won’t interfere with our taking skinfold thickness measurements of you calf or arm (short sleeve cotton shirts and jogging shorts preferred). You will have to remove your jewelry for some of the tests. It will take about 45 minutes to complete all of the measurements. The time for you to come in for testing will be arranged between you and the researchers.

On the day of testing:
1. You will be asked to read and sign the Subject Informed Consent and complete some short questionnaires.
2. Your height and weight will be measured, and we’ll calculate your body mass index (BMI).
3. We will measure your waist circumference with a flexible, non-stretchable tape.
4. Using a slide-gauge anthropometer, we will measure your thickness from your front to your back at the level of your navel (belly button).
5. We will take six skinfold thickness measurements. Each will take about two to four seconds. It doesn’t hurt and you will only feel a slight pinch.
6. Next you will take a bioelectrical impedance analysis (BIA) test to estimate how much body water you have. Before we start, you will be asked to remove your
jewelry and to rest quietly on your back for a few minutes. Two sticky tapes will be placed on you right hand and two will be placed on you right foot, and the BIA machine wires will be attached to them. We’ll then turn the machine on but you won’t feel a thing while the test is going on. It will take less than 5 minutes.

7. You will also take a dual-energy X-ray absorptiometry (DXA) test. This DXA test is called a total body scan. It will tell us about your bone mineral content and density, your lean tissue mass, and your total and percent body fat. You will not have to change your clothes as long as they are loose fitting and do not contain any metal. You will be asked to remove all your jewelry and to lie quietly on your back on the DXA table while the machine scans. The DXA scan will take about 5 minutes. There are no side effects of having a DXA test, it will cause no discomfort, and it is totally non-invasive. You will be given a copy of your DXA report after the scan is completed.

Benefits: You as a participant in this study will have the opportunity to learn about your own body composition and bone mineral density. You will receive a free bone density test (DXA) and printouts which will show you your estimated percent body fat, and grams of lean, fat, and bone tissue.

Risks/Discomforts/ Measures Taken to Reduce Risk:

You should experience no discomfort when answering the questions about yourself. If you do not want to answer a question, you may skip that question. For the DXA test you will have to remove your jewelry, and if you have metal on your clothing you will have to wear a hospital gown. None of the measurements will hurt. The only risk is that during the DXA test you will be exposed to a very small level of ionizing radiation. The X-ray dose for a total body DXA scans is 250 times smaller than a dental X-ray and 2500 times smaller than the yearly dose considered safe by The Louisiana Department of Environmental Quality Regulatory Code. In addition, all personnel operating the standard DXA and the peripheral DXA machines have been properly trained and are licensed to safely perform DXA scans. You should not participate in a total body DXA scan any more frequently than once every 6 months. You must be 18 years of age or older and not pregnant to participate in these tests.

If you wish to discuss these risks or any other possible discomforts you might experience you may call the Project Director listed on this form.

Right to Refuse/ Withdrawal: Your participation in this study is entirely voluntary. You may change your mind and withdraw from the study at any time without penalty or loss of any benefit to which your may otherwise be entitled. Should you not finish all the procedures, you will be given information about all the measurements that you have completed.

Privacy: All records and information you give us permission to keep will be filed in the office of the investigator and kept confidential. However, the LSU Institutional Review Board
(who oversees university research with human participants) may inspect and/or copy the study records. Your results may be published, but your name or any other identifying information will be not included in the publication. This will be possible because participants will be assigned a code so they cannot be personally identified during the analyses. Other than as set forth above, your identity will remain confidential unless disclosure is legally compelled.

**Financial Information:** There is no cost to you for participating, nor will you be paid for participating in the study.

**Withdrawal:** You may choose to withdraw from the study at any time without prejudicing your standing with LSU, penalty or loss. Should you not finish all the procedures, you will be given information about all the measurements that you have completed.

**Removal:** The project director reserves the right to remove a subject from the research if he/she fails to meet the requirements of the study protocol.

**Signatures:**
The study has been discussed with me and all my questions have been answered. I may direct additional questions regarding study specifics to the investigators. If I have questions about participants’ rights or other concerns, I can contact Robert C. Matthews, Chairman, LSU Institutional Review Board, 225-578-8692. I agree to participate in the study described above and acknowledge the researchers’ obligation to provide me with a copy of this consent form if signed by me.

Participant Signature______________________________________________________________

Date ______________________
VITA

Lisa G. Johnson received her Bachelor of Science in health, physical education, recreation, and dance from Mississippi University for Women in December of 1982, and her Master of Arts in kinesiology from Southeastern Louisiana University in May of 1997. Her education continued at Louisiana State University (LSU), in pursuit of a doctorate from the Department of Kinesiology with degree requirements to be completed in May of 2006. Lisa holds a position on the Board of Directors for the Louisiana Association for Health, Physical Education, Recreation, and Dance (LAHPERD) and Southside YMCA in Baton Rouge. She is a member of the American College of Sports Medicine (ACSM), American Alliance of Health, Physical Education, Recreation and Dance (AAHPERD), LAHPERD, and an honorary member of the Louisiana Association for Exercise Physiologists (LAEP). Lisa has published articles in national and international professional journals and has made presentations at ACSM, Southeast ACSM, AAHPERD, LAHPERD, and LAEP conferences. Lisa has been an instructor and coordinator of the Fitness Studies Concentration in the Department of Kinesiology at LSU for nine years, and received the Tiger Athletic Foundation Undergraduate Teaching Award for 2000 and 2003. Lisa plans to continue teaching at the university level and remain active in research endeavors. At the May 2006 commencement she will receive her Doctor of Philosophy in kinesiology.