The Contributions of Psychosocial, Environmental, and Policy Variables on Meeting Physical Activity Recommendations in Working Women

by

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Abstract

The purpose of this dissertation was to identify psychosocial, worksite policy, and environmental factors that facilitate adherence to physical activity among employed women. One hundred three employed women (age 23-65 years) from two neighboring towns in the southeastern United States participated in the study.

Measures included physical activity levels by accelerometry with location of physical activity by global positioning systems. Personal variables, physical activity history, self-efficacy, social support for physical activity, outcome expectancies, self-regulation skills, perception of worksite policies, and perception of the neighborhood built environment to support physical activity were assessed by questionnaire.

Cases, women who met the minimum physical activity recommendations, had significantly lower percentages of sedentary time compared to women who did not perform enough physical activity to meet public health recommendations (43.9% vs. 50%, $p<.001$). Cases performed an average of 271.0 minutes of moderate to vigorous physical activity (MVPA) over one week of monitoring with 1.3 bouts ($\geq$ 10 minutes) of MVPA per day over seven days. The average distance between MVPA locations and home and work was 6.6 km and 7.4 km respectively, for all subjects. Cases had significantly higher scores for self-efficacy, outcome expectancies, self-regulation, friend social support, perception of neighborhood land-use mix diversity, and number of MVPA bouts using the built environment. There was no significant difference between cases and controls for perception of worksite policies to support physical activity. Meeting weekly physical activity recommendations was associated with higher self-regulation scores, perception of higher land-use mix diversity, perception of lower infrastructure and safety for walking in the home neighborhood, and use of the built environment for physical activity.

The results show working women achieve recommended levels of activity through use of the built environment, self-regulation skills, and more than one bout of MVPA on an average day. Perception of the neighborhood built environment to support physical activity is also predictive of consistent engagement in physical activity. Working women who meet physical activity recommendations spend less time in sedentary behavior compared to women who do not meet recommendations. Overall the findings suggest interventions to promote physical activity for working women may want to incorporate strategies to use the built environment, develop self-regulation skills, and aim for more than one bout of MVPA on an average day to achieve physical activity recommendations.

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Chapter 1

Introduction

Physical activity is associated with multiple health benefits including reduced risk for chronic diseases, such as cardiovascular disease (Thompson et al., 2003), Type 2 diabetes (Knowler et al., 2002), osteoporosis (Vuori, 2001), depression (Pollock, 2001), breast cancer (Breslow et al., 2001), colon cancer (Slattery & Potter, 2002) and reduced risk for total, ischemic, and hemorrhagic stroke (Lee, Folsom, & Blair, 2003). There is evidence that participation in leisure time physical activity affords protection against functional limitations associated with aging (Huang et al., 1998), and all-cause mortality after controlling for genetic and familial factors (Blair et al., 1989; Kujala et al., 1998). Participation in regular physical activity has also been shown to attenuate the risks associated with obesity (Blair & Brodney, 1999).

In addition to health benefits, there are significant costs associated with physical inactivity. Using a conservative definition of inactivity, the absence of leisure time physical activity, it has been estimated that the direct costs are approximately 24 billion dollars or 2.4% of the health care expenditures in the U.S. (Colditz, 1999). A study looking at the direct and indirect costs of sedentary lifestyle among Americans estimated the cost to be greater than $150 billion for incidences in 1987 (Pratt et al., 2000). A 2002 report from the President's Council on Physical Fitness and Sports calculated that 15% of the US healthcare budget is required to address the sequelae of physical inactivity (Booth & Chakravarthy, 2002).

Despite the known benefits associated with regular physical activity, the majority of Americans do not achieve recommendations. Adults 18 years or over should engage in a minimum of 30 minutes of moderate physical activity five days a week, or 20 minutes of vigorous activity three days a week or a combination of the two (Haskell et al., 2007). Based on results of the Behavioral Risk Factor Surveillance System (BRFSS) from the Centers for Disease Control (CDC) it is estimated that 49.5% of Americans in 2007 met the recommended levels for physical activity, with 22.6% reporting no leisure-time activity. Additionally, an examination of long-term trends reveals a declining rate in physical activity in the U.S. (Brownson, Boehmer, & Luke, 2005), particularly among adult women. When the BRFSS data was broken down by sex, only 47% of females met recommended levels for physical activity and 24.5% indicated no participation in leisure-time physical activity. During 2003-2006 the National Health and Nutrition Examination Survey (NHANES) study collected data on physical activity from both self-report and accelerometer recordings in a subset of participants. Overall, the accelerometer data showed that females were less physically active than males and less than 5% of the adults monitored achieved minimum recommendations (Troiano et al., 2007). Also, based on a sample of 6,329 subjects with NHANES accelerometer data, Matthews et al. (2008) found 59.4% of their time was spent in sedentary activities. Breakdown by sex showed that females spent significantly more time in sedentary behavior compared to males (7.70 hours in a day vs. 7.63, $p=0.001$). These studies show that women are less physically active and more sedentary than men, which aligns with previous studies (Casperson &

Merritt, 1995; CDC, 1995; HHS, 1996) but also show that questionnaire data may not accurately reflect true measures of physical activity, especially in women.

Previous studies have attempted to link specific "life stages" to changes in physical activity levels in women. Physical activity levels have been shown to decrease in women during the transition from school/college to the workplace (Anderssen et al., 1986; Caspersen, Pereira, & Curran, 2000; Gordon-Larsen, Nelson, & Popkin, 2004). Changes in family such as marriage and having children are also associated with a decrease in intensity and structure of physical activity in women under the age of 49 (Scharff et al., 1999). In studies examining perceived barriers to physical activity among working women, the most common reason cited was the time constraints associated with fulfilling multiple roles (e.g., employee, caregiver, spouse, parent) and responsibilities (Marcus et al., 1994; Tavares, Plotnikoff, & Loucaides, 2009). In 2009, surveillance from the Bureau of Labor Statistics found 59% of working age women were employed in the civilian labor force with projected increases of 9% by 2018. Previous studies have described barriers to physical activity for this population, and the complexities of time constraints limiting participation in physical activity. Yet, despite the majority of women being engaged in some type of employment, factors that specifically enable this population to meet physical activity recommendations have not been described.

Initial studies examining barriers and correlates of physical activity adherence in women evaluated demographic variables and psychosocial constructs related to behavior (Brownson et al., 2000; Sallis, Hovell, & Hofstetter, 1992; Sternfield, Ainsworth, & Quesenberry, 1999). Both social support and self-efficacy have emerged most consistently as positive correlates of physical activity adoption and maintenance in adult and older women (Sharpe et al., 2008; Sternfield et al., 1999; Trost et al., 2002). There is also some evidence showing a positive association between outcome expectancy (Conn, 1997; Williams, Anderson & Winett, 2005) and self-regulation (Stadler, Oettingen, & Gollwitzer, 2009; Titze, Stronegger, & Owen, 2004) and physical activity behavior in women. Despite positive associations, these constructs failed to explain the majority of variance in participation in consistent physical activity.

Based on the relative success of reducing acceptance of tobacco use through environmental and policy interventions, researchers in physical activity looked to factors outside of demographics and psychosocial constructs to explain physical activity behavior in a more comprehensive way. Expanding on the social ecological perspective, perception of the built environment, and to a lesser extent the influence of policy, was included in studies examining determinants of physical activity (Burton et al., 2005; De Bourdeaudhuij et al., 2003; Giles-Corti & Donovan, 2002). The findings from these studies showed that although environmental variables were related to physical activity, the amount of variance explained by the environmental variables was low. For example, De Bourdeaudhuij et al. found that 5-13% of the range of physical activity variance was explained by demographic and environmental variables. The model by Burton et al. included variables assessing psychological, social, and environmental correlates, which explained 43% of the variation in total activity. Giles-Corti and Donovan found the influence of the physical environment was secondary to individual and social environmental determinants. However, these types of studies were limited by the use of self-report for quantification of physical activity levels, and questionnaires to assess the neighborhood built environment to support physical activity.

As software for the geospatial analysis of the built environment became more accessible, researchers were able to incorporate more objective measures of the built environment. Examples of the types of features measured include presence of sidewalks, relative location of parks and recreational facilities to subjects' home residences, mixed use land development (i.e., proportion of use by residential, commercial, business, and institutional entities for a specific area), street connectivity (i.e., the density of connections in a road network), and shade cover (McGinn et al., 2007; Rutt et al., 2005; Witten et al., 2008). While these studies objectively described the built environment, the actual location of where subjects participated in physical activity was not made available. In other words, the underlying assumption to these studies was that physical activity rates would be correlated to the specific features of the residential neighborhood built environment. However, as physical activity may occur in multiple locations, limiting the analysis to one location, such as the neighborhood of residence, may lead to an underestimation of the exposure to multiple environments (Kerr, Duncan, & Schipperjin, 2011).

More recent research has used objective measures of both physical activity and the built environment. A pilot study by Rodriguez, Brown, and Troped (2005) found that portable global positioning system (GPS) units were sufficiently precise to track an individual's movements and, in combination with accelerometry, to help clarify where physical activity occurs. GPS allows for more precise identification of where people perform physical activity and the particular attributes of those places (e.g., use of built environment features for physical activity, access to a park or recreational facility close to work or home). Furthermore, with this technology it is possible to more accurately identify how regular exercisers meet recommendations (i.e., one bout vs. multiple bouts; one mode vs. multiple modes).

Currently, few studies have used the combined technology of objective physical activity monitoring with GPS to study physical activity. The study of free-living physical activity using objective monitoring of physical activity and location has primarily been conducted in children (Fjortoft, Kristoffersen, & Sageie, 2009; Mackett et al., 2007). Mackett et al. looked at how children's physical activity behaviors, and in particular travel behavior, vary in the presence or absence of adults. Fjortoft et al. investigated how 6-year old school children utilize outdoor space during school recess in an urban and rural environment. The combined use of GPS with accelerometry allowed the researchers to see how boys preferred the asphalt areas for running and soccer play whereas girls favored a small forested area, though overall physical activity was similar between the rural and urban environments. In one of the few studies using GPS with accelerometry to study free-living physical activity in adults, Troped et al. (2010) examined associations between built environment variables within 50-m and 1-km home and work buffers and moderate-to-vigorous physical activity (MVPA). Of particular note, the authors found that subjects accumulated a daily average of 61.1 minutes of MVPA, but only an average of 14 minutes was completed within the 1-km home buffer. These findings suggest that studies measuring only the home neighborhood built environment for correlation with physical activity may not capture the environment where physical activity is actually performed.

Social ecological models propose that health behaviors are influenced across multiple domains which include the personal, interpersonal, environment, and policies. Furthermore, the models posit that these variables from each domain interact across the domains to effect behavior. While correlates of physical activity have been identified from these multiple domains (Trost et al., 2002), few studies have compared these correlates in the study of adults, and fewer still have utilized objective measures of physical activity and the built environment.

Most studies of physical activity adherence draw on previously sedentary people who participated in a structured exercise program as part of a research intervention (Dunn, Andersen, & Jakicic, 1998; Huberty et al., 2008). A few studies have recruited from populations more likely to be regular exercisers, such as users of trails in a park (Troped et al., 2010), and women running a "fun run" (Titze, Stronegger, & Owen, 2005). Troped et al. targeted users of trails in parks for the purpose of studying associations between built environment variables and location-based physical activity within 1 km of home and work. The mean amount of MVPA accumulated per day over 4 days of monitoring was 61.1 minutes, indicating a fairly active subject pool. Titze et al. studied middle-aged women over 2 years to examine individual, social, and environmental factors predicting adoption of and regression from regular leisure-time running. While this study is commendable for its longitudinal design, by limiting the focus to running, it is difficult to extrapolate the findings to women who engage in other modes of physical activity, and in particular more moderate modes of activity. Britton et al. (2000) recruited 1,501 female subjects age 20-44 from the control group of a multi-center, population-based study of breast cancer for the purpose of exploring characteristics associated with recreational exercise. While they were able to divide the population based on “higher” versus “lower” levels of exercise, they did not measure or describe how many subjects actually met minimum levels of recommended physical activity; therefore, it is not known how much of the population could be classified as regular exercisers.

Although a majority of the United States adult population is inactive, there is a subset of the population who maintains regular exercise. Knowledge of how these individuals utilize environmental resources and psychosocial variables may enable researchers to better understand regular exercise behavior in a free-living environment and implement effective intervention strategies. Further research is needed on women who are "regular exercisers" (i.e., have met recommendations for at least 6 months) to develop a greater understanding of how they differ from women who do not meet physical activity recommendations in terms of psychosocial variables, use of the built environment, and perception of the built environment and worksite policies to support physical activity. By gaining insight into the variables that contribute to exercise adherence in working women, future interventions to promote physical activity may be able to incorporate these findings and achieve longer term impact.

Statement of Purpose

The purpose of this study was to determine the contributions of potential psychosocial, worksite policy, and environmental factors that may facilitate adherence to regular physical activity among employed women including: 1) contribution of social cognitive constructs to the variance in MVPA, 2) contribution of physical activity resources such as parks, neighborhoods, work sites, or private facilities where women engage in MVPA with respect to home and work location, 3) associations between MVPA and built environment characteristics such as distance from work and home, facilities (e.g., open space, courts, exercise equipment), and terrain such as sidewalks or trails, and 4) contribution of perceived worksite policies to the variance in MVPA.

Research Questions and Hypotheses

Research Question #1: What is the difference in the percentage of sedentary time between cases (women who meet recommendations) versus controls (women who do not meet recommendations)?

Hypothesis #1: Cases will have less sedentary time, defined by accelerometer counts between 0 and 100, as compared to controls.

Research Question #2: Public health recommendations allow for discontinuous bouts of physical activity to achieve recommended levels. Do employed women achieve recommendations through more than one daily bout of physical activity on average?

Hypothesis #2: Cases are more likely to perform physical activity in a single session, (e.g., $\geq$20 minutes of vigorous activity or $\geq$30 minutes of moderate activity), rather than two or more bouts of short duration (e.g., 10-15 minute bouts interspersed throughout the day).

Research Question #3: How far from home and work do employed women travel in order to perform MVPA?

Hypothesis #3: Employed women are more likely to perform MVPA in locations close (within 8 KM) to home or work.

Research Question #4: Are there differences in personal level variables (social cognitive measures) between cases and controls?

Hypothesis #4. Cases will have higher scores for self-efficacy, self-regulation strategies, outcome expectancies, and social support than controls.

Research Question #5: Do employed women meet recommendations by using features of the built environment?

Hypothesis #5: Cases will utilize features of the built environment, such as sidewalks, roads, free access or municipal recreational facilities, and open spaces, to perform physical activity more than women who do not meet weekly MVPA recommendations.

Research Question #6: Are there differences in perception of the built environment between cases and controls?

Hypothesis #6: Cases are more likely than controls to perceive the neighborhood built environment as supportive for physical activity, as identified from the Neighborhood Environment Walkability Scale, and the Physical Activity

Neighborhood survey. Supportive environments include perception of low traffic, and perception of low crime.

Research Question #7: Are there differences in perception of worksite policies between cases and controls?

Hypothesis #7: Cases are more likely than controls to perceive worksite policies as supportive for physical activity, as identified from the index of employer policies modified from the Neighborhood Quality of Life Study (2004).

Definition of Terms

Accelerometer counts: Dimensionless units that can be converted by equations and cutoffs to predict the energy expenditure and intensity of activity (Troiano 2006).

Behavioral Risk Factor Surveillance System (BRFSS): The BRFSS is an on-going telephone health survey system, tracking health conditions and risk behaviors in the United States yearly since 1984. The System is a state-based system of health surveys that collects information on health risk behaviors, preventive health practices, and health care access primarily related to chronic disease and injury. (http://www.cdc.gov/brfss/about.htm)

Geographic Information System (GIS): A software program used to integrate data from multiple sources (e.g., accelerometer, GPS device, & base maps) for capturing, managing, analyzing, and displaying all forms of geographically referenced information.

Inactive or sedentary: Physical activity beyond baseline activity (the usual light or sedentary activities of daily living). For example, standing and sitting are classified as inactive (HHS, 2008). As measured by accelerometry, inactivity or sedentary behavior is defined as counts between 0 and 100 (Healy et al., 2007).

Light-intensity activity: Activities beyond baseline such as standing, walking slowly, lifting lightweight objects (HHS, 2008). This is also equivalent to activities that are completed at less than 3 METs (Ainsworth et al., 2011).

Metabolic equivalent (MET): A unit of measurement that describes the energy expenditure of different modes of physical activity. For example, one MET is the resting metabolic rate during which no activity is performed (Ainsworth et al., 2011).

Mixed Land Use: Relative proximity of different land uses within a given area. For example a mixed-use neighborhood would include homes, stores, offices, parks, and schools. The measure of mixed land use is not standardized (Handy et al., 2002).

Moderate-intensity physical activity: Bodily movement that results in energy expenditure of 3-6 METS (Haskell et al., 2007).

Physical activity: Any bodily movement produced by the contraction of skeletal muscle that increases energy expenditure above a basal level. (HHS, 2008).

Physical activity recommendations: The minimum amount of physical activity recommended for adults in order to achieve health benefits. Current recommendations included 30 minutes of moderate physical activity 5 days per week, 20 minutes of vigorous physical activity 3 days per week, or a combination of the two (Haskell et al., 2007).

Street connectivity: the directness and availability of alternative routes from one point to another within a street network. It can be measured by the number of intersections within a certain area or by the average block length (Handy et al., 2002).

Vigorous-intensity physical activity: Bodily movement that results in energy expenditure of greater than 6 METS (Haskell et al., 2007).

Limitations

Limitations associated with this study included:

1. Previous research has shown that seven days of objective monitoring is sufficiently representative of physical activity behavior, however, external events such as inclement weather, alterations in the normal work schedule, illness, and holidays may alter a subject's typical pattern.

2. While attempts were made to recruit women from multiple employers and equally from throughout Auburn and Opelika, AL, it is possible the sample recruited for the study may not be representative of the population of the two cities.

3. Subjects were specifically recruited from two small cities and therefore the findings may not be generalizable to other types of geographic areas (e.g., more rural or more urban).

4. GPS data loss may have occurred due to conditions associated with particular subject characteristics (failure to charge batteries, failure to wait for initial fix, signal

drop-out in certain environmental conditions). This particular data loss may result in nonrandom missing data which could lead to bias in the study results.

5. Accelerometers measure whole body and lower extremity movement but do not capture upper body movement in isolation or accurately measure energy expenditure with strength training or flexibility. Additionally, accelerometers cannot accurately measure MVPA in water or on bicycles.

Delimitations

The delimitations of this study were:

1. Women who work primarily in the fitness industry were excluded from participating in the study.
2. Women between the ages of 19 and 65.
3. Women who work less than 30 hours per week were excluded from participating in the study.
4. Only women who reside in the city limits of Auburn and Opelika, AL were included in the study. Women who work within city limits, but commute from elsewhere, were excluded from participating in the study.
5. Only women who are capable of engaging in physically activity were included in the study.

Chapter 2

Review of Literature

The purpose of this dissertation study was to examine associations between psychosocial, worksite policy, and built environment enablers of moderate-to-vigorous physical activity (MVPA) among employed women. In particular, this study tested the ability of built environment features, workplace policies, and psychosocial constructs to explain adherence to exercise recommendations in the study population. The purpose of this literature review is to describe and provide evidence for the choice of study population, the variables of study, and the methodology employed for the study. Topics included in this literature review include physical activity determinants including personal, psychosocial, policy, geospatial and built environments determinants, and measurement of physical activity.

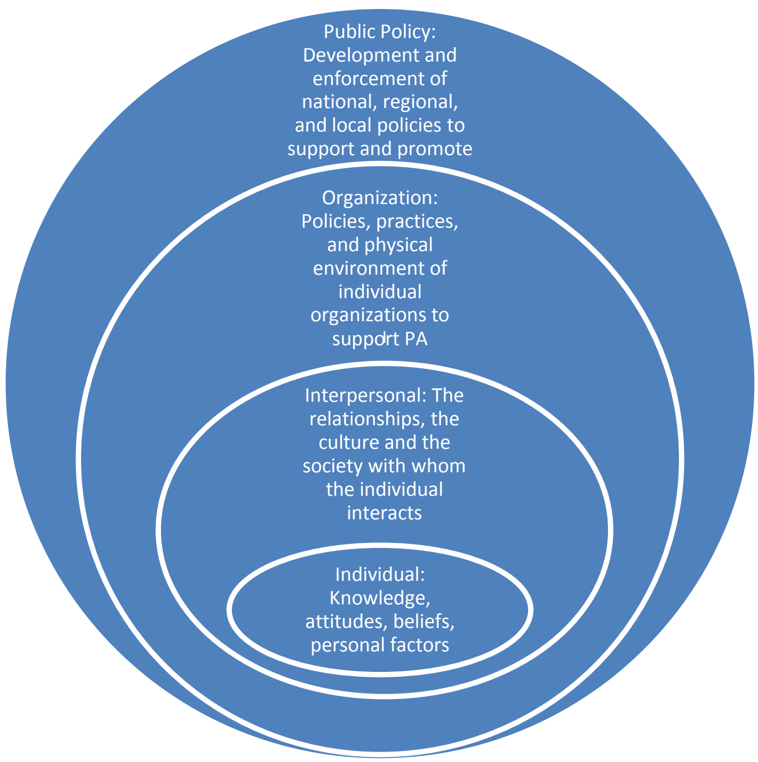
Social Ecological Theory

As described by Sallis et al. (2006) dominant frameworks to describe influences on physical activity behavior focused on psychological and social influences. However, interventions based on these models have shown small to moderate effect sizes, modest recruitment rates, and poor maintenance of behavior change following the interventions. As noted by Fleury and Lee (2006) most models and theories do not adequately account for social and environmental factors to influence physical activity behavior. Furthermore, these models and interventions initially focused on leisure-time physical activity alone. In the late 1990s, collaborations between experts in physical activity, as well as, other disciplines such as urban designers, community planners, and transportation planners led to a broader concept of physical activity called "active living" that included exercise, active transportation, leisure-time activity, occupational, and household activities. Social ecological models were adapted for physical activity behavior to encompass personal, psychological, social and environmental correlates that contribute to active living. A key concept of social ecological models is that behavior has multiple influences (i.e., environmental, social, psychological) and these influences interact across different levels (e.g., personal, social, organizational, physical, community, and policy; Sallis, Owen, & Fisher, 2008). Of note, the social ecological models include many of the same components of behavioral frameworks as other psychological models, such as self-efficacy, and social support along with the addition of environmental and policy factors.

One of the early theorists of social ecology, Bronfenbrenner (1994) proposed a model for the social ecological theory, as applied to child development, which described influences on behavior as a series of embedded layers or systems. Bronfenbrenner described the four systems as 1) microsystems: the immediate systems in which people live and interact, 2) the mesosystem: the location where microsystems interact, 3) the exosystem: the external systems that influence the microsystem, and 4) the macrosystem: the larger sociocultural context in which a person resides and which encompasses all other systems. As applied to physical activity, theorists have replaced the terminology of “systems” with levels which include the individual level, social or interpersonal level, organizational level, community level, and public policy level. A model with descriptions of these multiple levels as they relate to physical activity is presented in Figure 1. Despite different designs or terms for various models, the overriding principles remain the same:

1) Individual health behaviors are influenced by multiple factors from the intrapersonal, interpersonal, organizational, community, and public policy levels; 2) Factors that influence behavior interact across the levels or systems; 3) Effective interventions target the specific behavior via multiple levels (Sallis, Owen, & Fisher, 2008). Prior to evaluating how the constructs potentially interact across levels to influence behavior, it is worthwhile to review how the constructs are associated at the individual levels. The following sections describe factors from each of these levels and how they correlate to physical activity in working women.

Figure 1. Adaption of the Social Ecological Model for Physical Activity



Correlates of Physical Activity

The benefits of physical activity have been consistently and continuously described in the literature (Blair, et al., 1989; Haskell et al., 2007; Thompson, et al., 2003). Despite diverse efforts to convey this information to the public, the rates of physical activity remain relatively low with 22.6% of the U.S. adult population reporting no participation in leisure-time physical activity and less than half of the population meeting recommended levels for physical activity (CDC, 2007). Rates of participation in physical activity are consistently lower in women as compared to men across age groups and ethnicities (Matthews et al., 2008; Troiano et al., 2007). Based on longitudinal research it has also been shown a large percentage (40%) of adult women will have a change in activity status (inactive to active, and active to inactive) indicating a fluidity to physical activity adherence and non-adherence (Brown & Trost, 2003). Employed women in particular have described barriers to physical activity associated with the complexities of managing multiple roles responsibilities as employees, spouses, mothers (Marcus et al., 1994; Tavares, Plotnikoff, & Loucaides, 2009). An examination of the correlates of physical activity in general and adult women in particular may help to elucidate how and why these patterns exist.

Personal Correlates of Physical Activity

Sex

Physical activity rates for adult women are consistently lower than rates for adult men at all ages. In 2009 findings from the CDC showed that 49% of women met minimum physical activity requirements compared to 53% of men. This difference in levels between men and women is consistent with findings in Australia, Brazil, Hong Kong, and New Zealand as described by Bauman et al. (2009). Longitudinal and intervention based studies have also reported higher physical activity rates for males at all ages (Annear, Cushman, & Gidlow, 2009; Burton, Shapiro, & German, 1999; Dowda et al., 2003; Salmon et al., 2000). Women have also been shown to spend more time in sedentary activities compared to men. Using accelerometer data Matthews et al (2008) found that females spent significantly more time in sedentary behavior compared to males (7.70 hours in a day vs 7.63, p=0.001). This sex disparity exemplifies the need for interventions, policies and programs that facilitate women to engage in regular physical activity.

Age

Age consistently has an inverse relationship with physical activity behavior (Trost et al., 2002). Studies in the U.S., Europe, Asia, and Australia have all reported declines in physical activity with increasing age (Booth et al., 2000; Brownson et al., 2000; Leslie et al., 1999; Lian et al., 1999; Sjöström et al., 2006). BRFSS data from the CDC in 2009 showed a linear decline in physical activity with increasing age. Sixty-one percent of 18-24 year olds reported participating in at least 30 minutes of moderate physical activity five or more days per week or 20 minutes of vigorous activity three or more days per week compared to 52% of people age 35-44 and 47% in people age 55-64.

Race/Ethnicity

Previous studies have described higher rates of physical activity in whites as compared to non-white counterparts with some variation for specific groups (Brownson et al. 2000; Clark 1999; Sternfield et al, 1999). Overall 52% of non-Hispanic whites met recommended physical activity levels compared to 40% of blacks and 42% of Hispanics. A breakdown of the BRFSS 2007 results showed that 50.1% of non-Hispanic white women, 36.3% of black women and 41.8% of Hispanic women met physical activity recommendations. Hispanic women and Black women reported similar levels of inactivity with 21.9% reporting no leisure time activity, whereas 17.9 % of white women reported no leisure-time physical activity. In contrast to the previous data, Hawkins et al. (2009) analyzed 2003-2006 NHANES accelerometer data and found that middle age Hispanic women (age 40-59 years) were significantly more active than white and black women of the same age, otherwise levels followed the same pattern as described by the BRFSS survey results.

Socioeconomic status including education

Similar to age and sex, Trost et al. (2002) found socioeconomic status (SES), occupational status, and education level to all be consistent correlates of physical activity. Low SES has been shown to be negatively associated with physical activity behavior. Results from the 2007 BRFSS confirm these findings with rates of 40% meeting physical activity recommendations in the group with a median yearly income less than $15,000 compared to 47% in the $25,000-34,999 income group and 56% in the group with a median yearly income greater than $50,000. In a breakdown by education and gender, 53% of women with a college degree met physical activity recommendations compared to 37% who did not complete high school and 44% of those who did obtain a high school diploma. Sjöström et al. (2006) found similar differences in Europe where individuals with 16-19 years of education had a 20% increased chance of meeting recommendations compared to those who reported 15 years or less of education. In a longitudinal study of youth aged 7-15 recruited in 1985, Cleland et al. (2009) completed a follow-up study after 19.6 years and found that females who improved their socio-economic position were 38% more likely to increase their physical activity levels than to remain inactive.

BMI/Obesity

Obese weight status has consistently been shown to be negatively associated with physical activity levels (Brownson et al, 2000; Ruchlin & Lachs, 1999; Salmon et al., 2000; Sternfield et al., 1999). CDC data shows 54% of people who are in the normal weight range achieve recommended levels of physical activity compared to 41% of individuals classified as obese. In a study of physical activity correlates for young women in the U.S. age 18-30, Dowda et al. (2004) found a significant negative correlation between MVPA and BMI. In a study conducted in the European union, Martinez-Gonzalez et al. (1999) reported subjects in the highest quintile for leisure-time physical activity were approximately 50% less likely to be obese than those in the lowest quintile for physical activity, after controlling for age, sex, education, sedentary time, marital status, smoking, and education. Kaplan et al. (2001) evaluated a sample of older adults in Canada and found frequent participation in physical activity decreased as BMI increased. To date, obesity and increased weight status are consistently associated with decreased physical activity levels for both men and women and across age groups.

Marital Status

There are mixed findings on the association between marital status and physical activity behavior. King et al. (1998) examined a cohort of men and women over ten years and did not find any difference in physical activity rates between marital states (i.e. married vs. single; 10% changed marital status). The authors did note an initial decrease in physical activity during the "pre-marriage" phase which was followed by a net increase in activity compared to remaining single. In other words the transition from a single to a married state resulted in significant increases in physical activity. Interestingly, the transition from a married state to a single state, as compared to those who remained married, did not result in a decrease in physical activity levels. Martinez-Gonzalez et al. (2001) reported lower physical activity levels among participants who were married, cohabitating, or widowed/divorced compared to their single counterparts. Results from the Nurses Health Study showed women who were divorced, widowed, or remained single had higher rates of physical activity compared to those who remained married (Lee et al., 2004). Scharff et al. (1999) also found becoming married to be associated with a decrease in intensity and structure of physical activity in women under the age of 49. Studies conducted in Australia (Brown & Trost, 2003), and Poland (Kaleta & Jeiger, 2007), also showed higher rates of physical inactivity in married women. Despite some contrary findings, there is evidence to support an inverse relationship between marriage and physical activity.

Parenthood

There is growing evidence to support a consistently negative relationship between parenthood and physical activity behavior. The results of a longitudinal study by Brown and Trost (2003) showed evidence for increased risk of lower rates of physical activity upon having a child among the youngest cohort of women. By examining a national U.S. health survey, Nomaguchi and Bianchi (2004) also found that participants with no children engaged in more physical activity than those with children. Based on a meta-analysis of previous studies, Bellow-Riecken and Rhodes (2008) found a significant negative relationship (Cohen's d=0.41 to 0.48) in physical activity involvement in parents compared to non-parents. The authors also looked at studies examining the combined effect of parenthood status and employment but found conflicting results. For example Nomaguchi and Bianchi (2004) found that married people, parents and full-time employees spend less time doing physical activity. Sallis et al. (2001) also found increases in mothers' physical activity correlated with fewer hours of work. However in a longitudinal study among young women looking at physical activity, employment status, relationship status, and motherhood, Bell and Lee (2005) found the group least likely to be physically active was married mothers who did not work outside the home.

The demographic factors of sex, age, race/ethnicity, SES, and BMI have all consistently been correlated with physical activity across the majority of populations, and to a lesser extent change in life-stage such as marriage and parenthood. However, there are subgroups of the population with correlates that are negatively associated with physical activity engagement that consistently meet physical activity recommendations. Analysis of people from the subgroups who do meet physical activity recommendations despite being, for example female, and/or overweight, and/or higher age, may help to better understand how to target physical activity messages and interventions for others with similar demographics.

Psychosocial Correlates of Physical Activity

There is a growing body of evidence to support our understanding of psychosocial correlates of physical activity. In a review of these correlates Trost et al. (2002) found strong positive associations for physical activity behavior and the enjoyment of exercise, self-efficacy, social support, and self-motivation. Described below are some of the more consistent psychosocial correlates with physical activity behavior.

Self-efficacy

Self-efficacy, defined as "the conviction that one can successfully execute the behavior required to produce the outcomes" (Bandura 1997) is a construct utilized in multiple theories of behavior change, including social cognitive theory, theory of planned behavior, and the transtheoretical model. Self-efficacy has been shown to be predictive of adoption and maintenance of physical activity in adults (Sallis et al., 1986; Sallis et al., 1992; Strachan et al., 2005) and in women in particular (Kaewthummanukul et al., 2005; Sternfield et al, 1999; Wilbur et al., 2003). In a study of employed women with and without young children, Tavares et al. (2009) examined constructs from multiple social-cognitive theories for predicting physical activity behavior. Consistent with other studies, self-efficacy emerged as the strongest predictor of physical activity behavior in this population. Ainsworth et al. (2003) found a positive correlation between physical activity behavior and self-efficacy in a group of African American women. In a study of primarily minority women, Eyler et al. (2003) also found self-efficacy to be correlated with physical activity levels wherein those who were confident in their ability to be active were five times more likely to meet recommendations than those with low confidence. In a comparison of correlates of physical activity among African American and white women, Sharpe et al. (2008) found self-efficacy to be the only significant correlate among both African American and white women.

Social support

Social support has also emerged as a consistent correlate of physical activity behavior for women (Eyler et al., 2002; Kahn et al., 2002; Sternfield et al., 1999). Social support has been defined as the functional content of relationships that can be categorized by four types of supportive behavior including emotional support, instrumental support, informational support, and appraisal support (Heaney & Israel, 2008). Of note, social support is distinguished from other aspects of social relationships by always being intentionally helpful, as perceived by the provider, and consciously provided. An example of this would be, a woman encouraging a friend to exercise as opposed to criticizing for not being physically active. There is evidence to show a positive association with social support and physical activity behavior across age groups (Kaplan et al., 2001; Leslie et al., 1999; Plotnikoff et al., 2004), SES (Kamphuis et al., 2008; Sternfield et al., 1999) and racial/ethnic groups (Castro et al., 1999; Eyler et al., 2003; Wilcox et al., 2000).

Self-regulation

Self-regulation, defined as skills used to carry out exercise intentions and to overcome personal and situational barriers, has been shown to be associated with physical activity behavior in multiple studies. Anderson et al. (2006) used structural equation modeling to test social cognitive determinants of physical activity in adults (66% female). Self-regulation was found to exert the strongest effect on physical activity. In a work-site physical activity intervention based on social cognitive theory variables, Hallam and Petosa (2004) found that exercise in the intervention group was mediated by self-regulation. A randomized control trial for women aged 30-50 of cognitive-behavioral strategies found that the women who learned self-regulation were significantly more physically active compared to those women who received information only (Stadler et al., 2009). In a work-site study, Petosa found significant associations between regular physical activity and the constructs of self-regulation including time-management, goal-setting, relapse prevention, self-monitoring, reinforcement, and social support (Petosa, 1993).

Outcome Expectancies

Fewer studies have considered the role of outcome expectancies on physical activity behavior though there is mixed evidence of a positive correlation with physical activity. In a review of the construct of outcome expectancy in physical activity research, Williams, Anderson, and Winett (2005) found positive outcome expectancy to be more predictive of physical activity behavior in older adults than middle-aged and young adults. They also found evidence of relations between outcome expectancy and other theoretical constructs such as stage of change and self-efficacy. Carels et al. (2005) evaluated the relationship of self-monitoring, outcome expectancies, and difficulties with exercise on physical activity in a behavioral weight loss program in obese sedentary participants. Findings included greater weight loss during weeks that participants reported more positive outcome expectancies and greater difficulty with exercise. In a study of adults age 18-92 (66% female) Anderson et al. (2006) did not find evidence to support the inclusion of outcome expectancies in a structural equation model for physical activity levels. No studies to date have evaluated for an association between outcome expectancy and physical activity for employed, adult women.

Health Behaviors

Participation in physical activity as an adult has been linked with other health behaviors such as a past history of engagement in sports or exercise and history of smoking. Multiple studies have shown a positive association between adoption and maintenance of physical activity with previous exercise participation (Bozionelos & Bennett, 1999; Brenes, Strube, & Storandt, 1998; Oman & King, 1998). A longitudinal study conducted in Finland found that participation in sports at least two times a week during adolescence was associated with engaging in physical activity in adulthood (Tammelin et al., 2003). A five year longitudinal study conducted in the U.S. found those who participated in organized sports in high school reported higher weekly participation in physical activity during adulthood regardless of SES or sex.

For the most part previous research has shown a negative association between smoking and participation in physical activity across age groups (Johnson et al., 1998; Paavola, Vartiainen, & Haukkala, 2004; Poortinga, 2007; Ruchlin & Lachs, 1999). One study looking at smoking and physical activity behavior in women found a similar pattern (Brownson et al., 2000), while another study of a "diverse group" of women did not have findings to support this association (Sternfield et al., 1999).

Previous studies and reviews provide consistent evidence for an association between certain psychosocial constructs and adoption and maintenance of regular physical activity, in particular self-efficacy, social support, self-regulation, and to a lesser extent outcome expectancies and other health behaviors. In addition, most of these constructs are included in multiple theories of health behavior lending further support for their inclusion in studies of physical activity in adults. Despite their consistency in being correlated to physical activity, they still do not fully explain the variance in adherence to physical activity recommendations. Therefore, while there is sufficient evidence to include these constructs in future studies, it is also necessary to build upon these constructs in search of additional evidence that explains the factors that allow adults, and employed women in particular, to adhere to regular physical activity.

Policy Correlates of Physical Activity

Despite the inherent difficulties of isolating the effects of organizational or community policy from other correlates there is some evidence to suggest that policy strategies may be beneficial in the promotion of physical activity. A review by Matson-Koffman et al. (2005) found interventions with the strongest influence on physical activity utilized prompts for stair-use, provided access to places and opportunities for physical activity or, in combination with comprehensive programs of health promotion, provided education, employee and peer support for physical activity and incentives. In a qualitative study of African American women ages 20-50 in a rural community in Alabama, Sanderson et al. (2002) identified "inflexible work environments" as a primary barrier to participation in physical activity and attributed this barrier to worksite policy. Brownson et al. (2001) conducted a study of environmental and policy determinants of physical activity in the U.S. and found a majority of subjects (71%) believed employers should provide time during the workday for physical activity, however, no assessment of worksites with this type of policy was included. In a study of worksite physical activity policies and employee physical activity, Crespo et al. (2011) found those subjects who met minimum physical activity recommendations had a higher mean worksite promotion index (i.e. more supportive worksite policies) than those who did not meet recommendations for MVPA. While not worksite related, it is worth noting national policies that have influenced physical activity levels. For example in countries such as the Netherlands, Germany, and Denmark there are specific policies and programs to promote and support bicycling for transportation. This has resulted in equivalent cycling rates for males and females and across age and income groups. Additional evidence for the effect of these particular polices is evident in cycling rates: in Denmark and the Netherlands 18% and 27% of trips are taken by bicycle respectively, versus 1% in the U.S., Australia, and the U.K. (Pucher & Buehler, 2008).

Built Environment Correlates of Physical Activity

Early research on determinants of physical activity focused on demographic and psychosocial factors however, for the past 15 years there has been more inclusion of built environment determinants of physical activity. Features of the built environment related to physical activity include, but are not limited to, presence and accessibility of recreational facilities such as parks, trails, bike paths, sidewalks, and fitness centers, safety, aesthetics, traffic, land use, residential density, and street connectivity.

Sidewalks

There is mixed evidence to support the theory that the presence of sidewalks promotes physical activity for adults. In a study of predominantly females (67%), Brownson et al. (2001) found a positive association between the presence of sidewalks and MVPA. In a study of Belgian adults Bourdeauhuij et al. (2003) found that performance of walking and moderate physical activity, but not vigorous physical activity, was associated with the quality of neighborhood sidewalks. Similarly, in a study of Belgian and Portuguese adults, Bourdeauhuij et al. (2005) found a significant association between availability of sidewalks and walking in leisure time. In a multi-site study of women from diverse racial/ethnic groups, investigators evaluated personal, social and physical environment correlates of physical activity (Eyler et al., 2003). The presence of sidewalks was found to be significantly associated with meeting physical activity recommendations in only one of the seven sites (African American women in mixed rural/urban areas in South Carolina). In a study of predominantly Hispanic (79%) females (71%) Rutt and Coleman (2005) utilized structural equation modeling to evaluate relationships between the built environment and physical activity. Sidewalks, as identified by aerial photographs, did not contribute to participation in light, moderate or vigorous physical activity. Bengoechea et al. (2005) compared perceived environmental correlates of physical activity in men and women. After adjusting for age, income, education, and place of residence there was no correlation between presence of sidewalks and participation in leisure-time physical activity among women. Interestingly, in a review of 47 publications for potential environmental determinants of physical activity in adults, Wendel-Vos et al. (2007) found that availability of sidewalks was found to be positively associated with physical activity in men, but not for women.

Given that physical activity using sidewalks is primarily limited to walking and running, it may be worthwhile to consider studies that have primarily looked at walking and running rather than the broader category of MVPA that may not be able to be performed on sidewalks (i.e. biking, swimming, group fitness classes etc). Addy et al. (2004) evaluated association of perceived social and physical environmental supports with walking behavior and found access to sidewalks to be positively associated with regular walking. In a study looking at correlates of walking for transportation versus recreation purposes, Lee and Moudon (2006) found that presence of sidewalks was associated with recreational walking but not walking for transportation. In a review of built environment correlates of walking, Saelens and Handy (2008) also found evidence for a correlation between sidewalks and walking. While the evidence is mixed for an association between MVPA and presence of sidewalks in the neighborhood of residence, it is more positive for leisure-time walking and sidewalks. This suggests it may be important to consider the type or mode of exercise subjects perform in evaluating for associations with the built environment rather than just generalized MVPA. Additionally it may be worthwhile to assess if and how sidewalks assist with accumulation of additional physical activity for those who utilize other resources such recreational facilities, group classes, or parks.

Aesthetics

Humpel et al. (2002) performed a review of environmental factors associated with adult participation in physical activity and, of the four studies reviewed that included perception of neighborhood aesthetics or attractiveness, all reported a significant association with physical activity. Additional studies published after the review corroborate this finding of the perception of "attractiveness" of a neighborhood or public open space contributing to participation in physical activity (Bourdeauhuij et al., 2005; Brownson et al., 2001; Burton et al., 2005; Giles-Corti et al., 2005; Saelens et al., 2003). Pikora et al. (2006) evaluated built environment correlates of walking near home and found no association between aesthetics and self-reported walking for leisure or transportation near home (400m radius). In a review of environmental influences of walking, Owen et al. (2004) cites three studies that found a significant relationship between "aesthetic pleasantness" and walking for exercise or recreation, with one of those studies noting the relationship held for men but not for women. In the same review, two studies evaluated did not find a significant association between neighborhood aesthetics and walking to get to and from places while three studies describe a significant relationship for total walking time and neighborhood aesthetics. In summary, there is more evidence for neighborhood aesthetics and recreational walking than walking for purpose or transportation.

Spatial Access

Multiple studies have evaluated the association between physical activity and spatial access to recreational facilities, parks, open space, and areas with mixed land use (residential, commercial, business, institutional). The majority of studies evaluating access with relation to subjects' residences and subjects' perception of proximity of facilities found a positive association (Giles-Corti et al., 2002; Giles-Corti et al., 2005; Kirtland et al., 2005; Troped et al., 2011). In a study that utilized objective measures of proximity to recreational facilities, Diez Roux et al. (2007) also found associations between availability of recreational resources within 1 and 5 miles of the home residence and physical activity levels. In a study with predominantly female subjects (71%) Rutt and Coleman (2004) found that proximity to recreational facilities, as measured utilizing GIS, was positively correlated with vigorous physical activity but not for moderate physical activity. By contrast, in a study from New Zealand, Witten et al. (2008) did not find any correlation between physical activity and access to open spaces (parks and beaches) as minutes taken by a car, calculated using GIS. Duncan and Mummery (2004) utilized GIS to objectively measure distance from home residence to nearest footpath and found those with a footpath network more than 400m from home were 69% less likely to walk in the previous week as compared to those who did have a footpath within the same distance from home.

Urban Features

Certain features of the built environment associated with urban areas have been evaluated for association with physical activity in multiple studies. These features include mixed land-use, street connectivity, and relative proximity to shopping and public transportation. Studies have shown varying degrees of a positive correlation between physical activity and mixed land-use (Bourdeaudhui et al. 2003; Bourdeaudhui et al. 2007; Li et al., 2008; Saelens et al., 2003; Troped et al., 2011), street connectivity

(Bourdeaudhui et al. 2005; Li et al. 2008; Saelens et al. 2003) and proximity to shopping and public transportation (Bourdeaudhui et al., 2003; Li et al., 2008; Troped et al., 2011). It should be noted that to date, evaluation of these features in particular have been predominantly carried out in urban environments only. While it may be worthwhile to evaluate if these features contribute in areas other than large cities, they would not be expected to be the principal correlates of physical activity in small towns or rural areas. These particular features of the built environment, being associated with urban and metropolitan areas, are not predominant features of towns, small cities, rural areas, and in many instances suburban areas; therefore they are only available to a small percentage of the population who live in these types of areas.

Suburban Features

While more is known about access to physical activity resources in urban areas and to a lesser extent in rural areas, there has been little research on access in "sub-urban" or small cities, characterized as having a population of 50,000-999,000. A case study by Nicholls (2001) examining equity to open spaces and outdoor recreation in a small city (population 65,660) found that while access for all neighborhoods was low, there was no inequity of access for any particular type of neighborhood. In a study examining differences in availability and accessibility to physical activity resources by neighborhood SES in a small city (population 133,046), Estabrooks et al. (2003) found that low and medium SES neighborhoods had significantly fewer free-for-use facilities compared to high SES neighborhoods. Duncan and Mummery (2004) examined psychosocial and environmental factors associated with physical activity with walking in a small city (population ~75,000) and found self-efficacy, social support, perception of neighborhood tidiness, and having a higher number of active people within a 1-km radius of home to be strong predictors of attaining recommended levels of physical activity. Contrary to common findings of studies in urban areas, this study showed that the people with parks beyond a distance of 0.6 km from home and those with "unacceptable" route directness to the nearest park were 41% more likely to achieve recommended physical activity levels. The authors hypothesized that this unexpected finding could be due to the ability of those who engage in regular physical activity to overcome barriers such as distance to recreational facilities. Another possibility is that these subjects who do participate in regular physical activity may use facilities other than parks and open space. The authors recommended future research include characteristics on the types of facilities, such as a park, gym, or trail, where people engage in physical activity, the type of activity performed and distance to these facilities to add clarification to these findings. Furthermore, significant predictors of recreational walking included social support, having a footpath within 0.4km from home, and agreeing that the neighborhood footpaths were not in good condition. Explanations offered for this unexpected finding about footpath condition was that people who use footpaths on a regular basis may be more cognizant of their condition or that these same people use areas outside of the neighborhood for recreational walking. This highlights the limitations of correlating residential neighborhood conditions with recreational walking without knowledge of where the subjects actually perform physical activity.

While features of the built environment have shown some consistent correlations with physical activity the effect sizes have been modest. Part of the difficulties in evaluating the built environment for influence on physical activity has been the primary use of the neighborhood of residence as the location for built environment evaluation. This does not take into consideration other places where people engage in physical activity such as the work environment and neighborhood or facilities along frequently traveled commutes. There have also been inconsistencies in the definition of "home neighborhood" in terms of extent and direction for different studies with no real consensus on how to define neighborhood boundaries. Future research examining where people perform physical activity and types of activity associated with different locations will help to better elucidate how the built environment contributes to physical activity adherence. Recent advances in new technologies that allow for more objective measures of both physical activity and the environment will contribute to this research direction.

Measurement of Physical Activity

Options for measurement of physical activity in adults include surveys and mechanical monitors such as accelerometers and pedometers. While other options such as calorimetry, use of doubly labeled water, and direct observation exist, these methods are limited by financial and time restraints and may not always capture free-living activity or differentiate between light, moderate, and vigorous physical activity. The most commonly used methods to measure free-living physical activity include questionnaires, pedometers, and accelerometers.

Numerous questionnaires have been developed to capture short term and long term recall of physical activity. While the majority of studies examining associations between the built environment and physical activity utilize questionnaires, these have been shown to have less accuracy for moderate intensity activities (Bassett, Cureton, & Ainsworth, 2000) and range in validity depending on weight status (Timperio et al. 2003). A review of 10 questionnaires by Jacobs et al. (1993) found little correlation between accelerometer data and questionnaire responses. The authors concluded that none of the 10 questionnaires accurately captured physical activity data related to occupational activity, one questionnaire had measures correlated to physical activity related to household activities, and few captured performance of light or moderate activity. In a more recent review of survey instruments for evaluation of physical activity (Sallis & Saelens, 2000), the authors conclude that most studies show that self reports do not provide accurate data with respect to absolute amounts of physical activity but that when used in combination with objective measures, they may provide important information related to context and the type of physical activity performed.

In addition to the limitations of quantifying physical activity by self report, others have proposed that many physical activity questionnaires do not accurately assess the physical activity of women (Ainsworth, 2000; Masse et al., 1998). Based on the analysis and results of multiple studies these authors argued that women are more likely to under report bouts of physical activity that occur as part of housework, occupational, and family care activities as surveys historically have only asked about physical activity in relation to sports and conditioning activities. Additionally the authors proposed that the questionnaires typically used to assess physical activity were not as relevant to minority women.

In the last 10 years the use of pedometers in research on physical activity has increased as the cost has been reduced and the accuracy and availability of pedometers has increased. A study by Tudor-Locke et al. (2001) describes the drawbacks and advantages in the use of surveys, accelerometers, and pedometers. Consistent with other studies, the authors argue that despite the ease of use and efficiency of questionnaires, the data obtained is not always valid whereas accelerometers and pedometers have shown consistent validity for the measurement of free-living activity. A study by Leenders et al. (2000) compared 4 methods for measuring physical activity simultaneously on 11 women. Subjects recorded physical activity over a 7 day period using an accelerometer, pedometer, activity monitor, and the physical activity recall questionnaire at the end of the 7 days. Results showed the Physical Activity Recall (PAR) to be significantly correlated with all of the objective measures (range 0.82-0.94, $p<0.001$). However, in contrast to other studies, the subjects in this study overestimated physical activity on the PAR compared to the other measures. Based on the results the authors recommend use of the accelerometer and activity monitors in subjects who perform physical activity via methods other than walking and the pedometer in situations where ambulation is the primary mode of physical activity. In describing considerations for device selection, Trost et al. (2005) describe the advantages of accelerometers compared to pedometers to quantify number of bouts of physical activity over a specific period, as well as, slightly higher validity coefficients for multiple axis units as compared to uniaxial models.

In a study assessing the validity of accelerometry for assessment of free-living physical activity, the findings from Hendelman et al. (2000) supported previous studies showing highly correlated linear associations between accelerometry and energy costs. Wagner et al. (2011) utilized accelerometry and online daily physical activity diaries to assess free-living physical activity following a behavior change intervention. Findings included greater accuracy for measuring sedentary behavior with the accelerometer but the diaries helped to identify modes of moderate and vigorous physical activity that could not be captured by accelerometers such as swimming.

The majority of studies validating uniaxial accelerometers (measurement in the vertical plane) and defining activity count cut-points for light, moderate, and vigorous activity have done so using the modes of walking and running (Freedson, Melanson, & Sirard 1998; Nichols et al., 2000; Welk, 2004). The development of the triaxial accelerometer (measurement in the vertical, anterior-posterior, medio-lateral planes) has added the option to use the vector magnitude of activity counts from all three planes to measure physical activity which occurs in more than one plane (e.g., aerobics, tennis, dancing). Sasaki, John, and Freedson (2011) recently established cut-points to classify moderate and vigorous physical activity using the vector magnitude of all three axes on the GT3X+ (Moderate: 2690-6166, Vigorous: 6167-9642 counts/min). It was not established if it is more advantageous to use the vertical plane activity counts versus the tri-planar vector magnitude activity counts. However, it has been acknowledged that triaxial accelerometers are expected to be better able to detect free-living activity better than a uniaxial sensor (Butte et al., 2012). Previous studies have also shown higher correlations with energy expenditure for the triaxial accelerometer in adults (Hendelmen et al., 2000; Yoshida et al., 1994). The use of objective monitors to assess physical activity, in particular accelerometers, allows for clearer differentiation of light, moderate and vigorous physical activity than any other option currently available. This unique ability to discriminate activity level intensity not only allows for verification of time spent in moderate and/or vigorous physical activity but also provides more detailed information of how subjects meet activity recommendations (i.e., time of day, identification of bouts, and identification of patterns in daily activities).

Global Positioning Systems (GPS)

In recent years GPS has been utilized in physical activity research to objectively track locations of individuals. These studies have shown greater accuracy as compared to self-reported travel surveys or activity diaries when used in combination with accelerometry (Badland et al., 2010; Duncan & Mummery, 2007; Maddison & Mhurchu, 2009). The addition of this technology to behavior research allows researchers to move beyond analysis of specific locations, e.g. the neighborhood of residence, and even single behaviors (Kerr et al., 2011). Used in combination with accelerometry it can help identify not only the location based physical activity but mode of activity as well, such as biking versus running. Quigg et al. (2010) were able to identify the percentage of children's physical activity which took place in parks with playgrounds, and Mackett et al. (2007) were able to differentiate children's physical activity behavior in the presence of an adult compared to behavior in the absence of adults by using accelerometry with GPS. This combined type of assessment allowed Troped et al. (2010) to show how only a small percentage of daily MVPA was accumulated within 1-km of home and work. Recent improvement in technology has allowed for increased data storage, longer battery life, and greater discrimination between indoor and outdoor locations. Limiting factors include data loss due to misuse of the device or lack of adherence to the wear time protocol by participants, signal dropout, and loss during the initialization period (Krenn et al., 2011). Data loss has not been associated with sample size, age group being studied, device manufacturer, or incentives for participants. However, a relatively clear relationship has been shown between data loss and the GPS measurement period, with the longer the measurement period, the greater proportion of data lost (Krenn et al., 2011).

Summary

To date, there is consistent and relatively strong evidence for an association between certain psychosocial and personal constructs and physical activity maintenance. However, given that these do not explain all of the variance in physical activity levels, there has been an increasing interest in examining how the built environment and policies may also contribute to physical activity behavior. Few studies have incorporated the use of objective measures for measurement of both physical activity and the built environment in female adults. Furthermore, many studies have observed subjects who were previously sedentary, and then received an intervention to increase physical activity, or have evaluated for correlates in those who have exercised for less than six months (Huberty et al., 2008). Few studies have specifically recruited female regular exercisers to evaluate for correlates of physical activity across multiple levels (i.e. psychosocial, environment, policy). Recent advances in technology, such as GPS coupled with accelerometer data, now allow for more objective measures of both location and performance of physical activity. Application of these technologies to regular exercisers will allow for a greater understanding of the correlates of physical activity adherence. Specifically, the use of objective measures will help identify if and how employed, female regular exercisers utilize their environment to achieve physical activity recommendations. Additional measures will help identify the influence of perceived worksite policies, personal correlates such as education and history of participation in sports, psychosocial correlates, and perceptions of the built environment on achieving regular participation in physical activity.

Chapter 3

Method

The purpose of this study was to examine the psychosocial, built environment, and worksite policy factors contributing to meeting physical activity recommendations in adult employed women. This chapter presents the methodology for the study including an overview of research design, participant recruitment and selection criteria, instrumentation for data collection, research procedures, and data analysis.

Research Design

This study used a case-control observational design with the cases representing subjects who are regular exercisers, and controls representing subjects who are sedentary or do not exercise enough to meet physical activity recommendations. The purpose of this design was to compare characteristics and identify exposures that may contribute to differences in exercise behavior. The study used retrospective and current measures to explore the ability of major constructs of the social ecological model to describe how employed women adhere to physical activity recommendations.

Subjects

The study population was recruited from the general population of adult working women residing in the cities of Auburn, AL and Opelika, AL. Subjects were recruited through the following: posted fliers, targeted emails, active recruitment at local businesses, fitness facilities, local clubs such as running clubs, tennis courts, recreational facilities, postings in e-newsletters through the local chambers of commerce, and Facebook notices. Requirements to participate included full time employment (30 or more hours/week). Recruitment targeted two groups in particular: A) regular exercisers by the standard of performing moderate exercise for at least 30 minutes 5 days per week, or vigorous exercise for at least 20 minutes 3 days per week, or a combination of the above for at least the past six months, and B) sedentary or irregular exercisers who did not meet the standard described above. It was acceptable to achieve the physical activity requirement threshold through leisure time physical activity, work-related physical activity, or bouts of physical activity related to family and household duties, as well as traditional exercise regimens.

Incentives offered to subjects for completing the study included the following: 1. A comprehensive review of the participant's current exercise regimen with suggestions for changes based on the participant's goals. At the completion of the study, sedentary subjects were offered a progressive physical activity plan based on equipment and facilities available and personal physical activity goals. 2. All subjects were entered into a raffle for the chance to win: A) One of two checks for $50, B) One of two free Tigerfit fitness assessments (includes blood analysis; body composition; pulmonary volumes and function; cardiovascular health and fitness; muscle strength, endurance and flexibility; and a complete health and fitness report including CVD risk assessment and an individualized exercise prescription), C) One of 10 free body composition assessments via Dual X-ray absorptiometry (DEXA).

Procedures for the study were approved by the Auburn University Institutional Review Board for Research Involving Human Subjects (Protocol # 11-377). As part of the consent process a written copy of the informed consent was provided to the subjects who then received a verbal explanation of the study including the purpose, procedures, benefits (both individual and general), risks, plan for use of the data, and how confidentiality would be maintained. Contact numbers for additional information were also provided. Subjects verified they met study requirements. Subjects were made aware that participation was completely voluntary and withdrawal from the study was acceptable at any time, providing the data was identifiable. If the recruit was in agreement and wished to participate in the study, she was asked to sign the informed consent. (Refer to Appendix A for consent form).

Instruments

Demographics, Health History, and Exercise History

Subjects completed a questionnaire regarding age, height, weight, family demographics, health history, education level, race, current employment, exercise equipment at home, and exercise history including participation in sports and recreational activities as elementary, high school, and, if applicable, college students. Additional questions assessed self-efficacy to regulate exercise, self-regulation strategies for exercise, outcome expectancies for exercise, social support for exercise, stage of change for physical activity adherence, and perception of the neighborhood environment to perform exercise. Details of these sections are provided below. (See Appendix B for the full questionnaire).

Self-efficacy

Self-efficacy, defined as “the conviction that one can successfully execute the behavior required to produce the outcomes” (Bandura, 1997) is a construct utilized in multiple theories of behavior change including social cognitive theory, theory of planned behavior, and the transtheoretical model. Previous research has demonstrated positive correlations between health behaviors and self-efficacy and in particular self-efficacy has been shown to be a predictor of both adoption and maintenance of physical activity behavior (Brown et al., 2006; Kaewthummanukul et al., 2006; Sallis et al., 1992; Trost et al., 2002). The 12-item "Self-Efficacy and Exercise Habits Survey" was used for this study and has established reliability (r=.68), internal consistency (Chronbach's alpha=.85) and construct validity (Sallis et al., 1988). Subjects rate how confident they are that they can exercise in a variety of situations (e.g., ‘‘when your family is demanding more time from you,” and “when you have excessive demands at work”). Each item is rated on a scale of 1 (I know I cannot) to 5 (I know I can). The 12-item scale has two factors that were used in the analyses: "sticking to it," based on the mean of 8 items (potential score range 1-5), and "making time for exercise," based on the mean of 4 items (potential score range 1-5). A higher score indicates higher levels of self-efficacy.

Self-Regulation

Six aspects of self-regulation were measured with the PASR-12 including time-management, goal-setting, relapse prevention, self-monitoring, reinforcement, and social support (Umstattd et al., 2009). The instrument contains 12 measures on a 5 point Likert-type scale ranging from 1=never to 5=very often. The self-regulation score is calculated as the sum of the 12 responses. The minimum possible score is 12 and the maximum possible score is 60 with a higher score indicating more frequent use of self-regulation strategies for participation in physical activity. This instrument assesses the degree to which self-regulation strategies are used to support participation in regular exercise. Both structural and construct validity were established by Umstattd et al. using confirmatory factor analysis and Pearson product-moment correlation coefficients against self-efficacy and physical activity. Confirmatory factor analysis revealed a good fit with strong factor loadings (range: 0.76-0.84, CFI=0.99). Construct validity testing demonstrated correlations ranging from .79-.96 for comparison to the original 43-item self-regulation instrument developed by Petosa (1993). Moderate-to-strong bivariate relationships were found between the PASR12 with self-efficacy (r=.56) and physical activity (r=.60).

Social support

Social support for exercise was measured using the "Social Support and Exercise Survey" (Sallis et al., 1987), a 23-item questionnaire to measure three factors: family participation, family rewards and punishment, and friend participation. Answers range from 1-5 representing none, rarely, a few times, often, and very often. There is also an option to choose "does not apply." The potential score ranges from 10-50 for both family participation and friend participation, and from 3-15 for family rewards and punishment for a total potential score of 23-115. This measure has been used in multiple studies on exercise behavior which allows for comparison across studies. Test-retest and internal consistency reliability have been established along with criterion-related validity (Sallis et al., 1987; Sallis, Hovell, & Hofstetter, 1992; Sallis, Hovell, Hofstetter, & Barrington, 1992). Factor test-retest reliabilities ranged from 0.55 (for questions related to rewards and punishments from family members) to 0.79 (for exercising together with friends) with alpha coefficients for internal consistency ranging from 0.61 to 0.91. Criterion-related validity was measured by correlation with reported health habits. The correlations between the social support factors and vigorous exercise ranged from 0.23 to 0.46. While the self-regulation instrument also assesses social support, the Sallis questionnaire differentiates between support from family and friends, and measures both encouragement and criticism for exercising. By utilizing both surveys, specific forms of social support and how they enable physical activity participation can be identified.

Outcome Expectancy

Outcome expectancy was assessed using the "Expected Outcomes for Habitual Exercise" (Steinhardt & Dishman, 1989). This survey measures outcome expectations, that is, the anticipated consequences of exercise behavior, and outcome expectancies, defined as the value placed on the anticipated consequences. Item responses for outcome expectations are based on a 5-point Likert scale ranging from 1 (strongly disagree) to 5 (strongly agree). The outcome expectancy values span a 3-point scale for low, medium, and high. The questionnaire is scored by multiplying the outcome expectations score by the outcome expectancy score and then summing the scores for all items for a range of scores from 19-285. A higher score indicates positive expectations that health benefits will follow as a result of physical activity behavior. Internal consistency coefficients for the survey established by Steinhardt & Dishman (1989) ranged from .47 to .78 and test-retest reliability correlations ranged from .66 to .89. The survey also predicted free-living exercise behavior as measured by a seven-day recall questionnaire (R^2 = .12 to .24).

Perceived Neighborhood Environment

Perceptions of the neighborhood environment to support walking was assessed using the Neighborhood Environment Walkability Scale abbreviated version (NEWS-A; Cerin et al., 2006). The factorial and criterion validity were assessed with a stratified two-stage cluster sample from eight high- and eight low-walkable neighborhoods matched on socioeconomic status. Walking for transport was positively associated with six scales including diversity of destinations, residential density, walking infrastructure, aesthetics, traffic safety, and crime, whereas walking for recreation was positively associated with aesthetics, mixed destinations, and residential density. A subset of questions from the instrument was later validated using GIS measures of the built environment (Adams et al., 2009) where significant concordance was found between the NEWS-A and the GIS measures. There are seven subsections of the NEWS-A representing seven factors. A description of the factors, score range, and interpretation of each score is provided in Table 1. Given that the NEWS-A instrument is designed primarily to capture perception of the local environment for walking only and not other types of physical activity, perception of the built environment was also measured using four questions from the Physical Activity Neighborhood Survey (PANES). Both construct validity (association with meeting physical activity guidelines ORs = 1.2-1.5) and test-retest reliability (ICC = 0.55-0.77) have been established for the PANES (Alexander et al., 2006; Sallis et al., 2009).

Table 1. Perception of Built Environment Factors of NEWS-A

Factor	Score Range	Calculation	Interpretation
Land-Use Mix-diversity	1-5 min=5 6-10 min=4 11-20 min=3 21-30 min=2 31+ min =1	Mean of 22 items	Higher score= Higher Walkability
Land-Use Mix-Access	Strongly Disagree=1 to Strongly Agree=5	Mean of 3 items	Higher score= Higher Walkability
Street Connectivity	Strongly Disagree=1 to Strongly Agree=5	Mean of 2 items	Higher score= Higher Walkability
Infrastructure and Safety for Walking	Strongly Disagree=1 to Strongly Agree=5	Mean of 6 items	Higher score= Higher Walkability
Aesthetics	Strongly Disagree=1 to Strongly Agree=5	Mean of 4 items	Higher score= Higher Walkability
Traffic Hazards	Strongly Disagree=1 to Strongly Agree=5	Mean of 3 items	Higher score= Lower Walkability
Crime	Strongly Disagree=1 to Strongly Agree=5	Mean of 3 items	Higher score= Lower Walkability

Perception of Worksite Policies

Perception of employer policies to promote or support physical activity at the worksite was assessed using an index modified from the Neighborhood Quality of Life Study (2004). The questions used to create the index were adapted from a previous study with intraclass correlation coefficients ranging from 0.80 to 1.00 (Oldenburg et al., 2002). The current version of the questionnaire has been used in multiple studies which allows for comparison across studies (Crespo et al., 2011; Schwartz et al., 2007). Internal consistency for the index was assessed by Crespo et al. and found to be acceptable (Cronbach’s $\alpha = .78$). Individual item responses are Yes (value=1) or No (value=0) for a score range of 0-8 for the full index. Subjects also indicated specific incentive programs offered by their employers and whether they had participated in any of those programs in the past year.

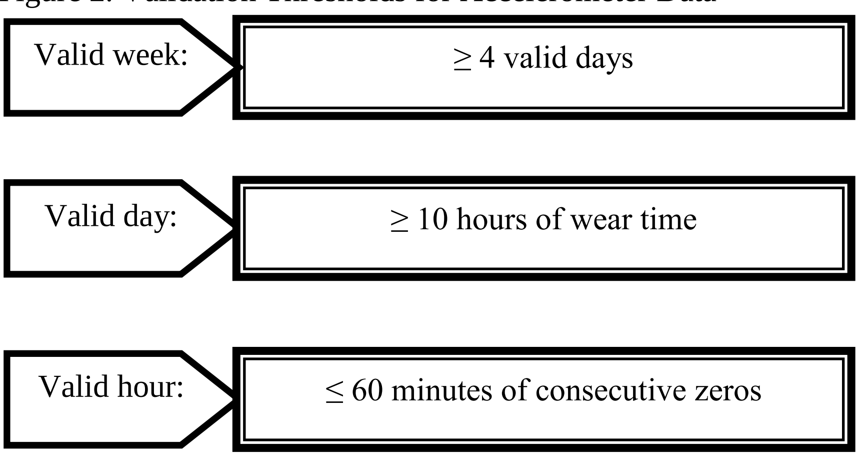
Accelerometers

Subjects wore an Actigraph GT3X+ accelerometer for seven consecutive days. This triaxial accelerometer measures activity counts in three planes in addition to position (standing, sitting, lying) and step count. The Actigraph GT3X+ uses similar technology as the previously validated CSA activity monitor (Computer Science and Applications, Inc.) which had the highest overall reliability and lowest variability compared to three other types of accelerometers (Welk, Schaben, & Morrow, 2004). Metcalf et al. (2002) found the CSA/actigraph model had a coefficient of variability (CV) of less than 2%. The memory of the Actigraph GT3X+ allows for up to 20 days of data storage along with a battery life of 20 days. This accelerometer is sealed and cannot be reset or altered manually. Subjects were provided with a clip or belt for attaching the accelerometer at their right hip/waist. Subjects were instructed to wear the accelerometer during all waking hours except during showering and aquatic activities. (See Appendix C for Participant Instructions).

In contrast to most accelerometers, the GT3X+ stores only raw data which allows the epoch to be determined post-data collection. The majority of studies on adults have used the 1-minute epoch length, and current "best practice" guidelines recommend the use of a 1-minute epoch length for adults (Cain & Geremia, 2012; Ward et al., 2004). Therefore, an epoch length of 1-minute was also chosen as the standard for the current study. A relatively new feature with the GT3X+ is the ability to choose the sampling rate per second. Traditionally the sampling rate is pre-set at 10-30 Hz, or 10-30 samples per second. The GT3X+ allows for a sampling rate between 30 and 100 in 10 Hz increments. Currently there are no best practice recommendations for sampling rate determination. Given the more common use of 30 Hz in previous studies, the sampling rate for this study was also set at 30 Hz.

Previous studies of accelerometry suggest that 3-5 days of monitoring is sufficient for adults (Hart et al., 2011; Matthews et al., 2002; Trost, McIver, & Pate, 2005) to achieve 80% reliability for total and moderate-to-vigorous intensity physical activity. As described by Matthews et al. (2012) there is relative consensus of a minimum of 10 hours per day of wear time needed for sampling "wake-time" behavior. In their summary of best practices in accelerometer-based activity research Trost et al. (2005) reported optimal placement for the accelerometer is at the hip or lower back. Consistent with other studies, "non-wear" time was defined as more than 60 minutes of consecutive zero counts (Dunton et al., 2012; Matthews et al., 2008) and excluded from analysis. See Figure 2 for a summary of the accelerometer protocol for this study.

Figure 2. Validation Thresholds for Accelerometer Data



Global Positioning System Monitors

Subjects also wore a QStarz BT-Q1000XT global position travel recorder. The memory of the QStarz GPS monitor allows up to 40 days of data storage and has a battery life up to 40 hours. These units provide 66 channels and a tracking sensitivity of 165 dBm. The device claims accuracy within 3.0 meters and acquisition times of 1-36 seconds (from hot to cold start respectively). In a study comparing reliability and accuracy among GPS units previously used for activity research, the QStarz demonstrated relatively high accuracy (ICC = 0.644) and good inter-unit reliability across a range of conditions including open sky, urban areas, and under canopies (Duncan, Oliver, & MacRae, 2011). Subjects were provided with a range of options for carrying the GPS unit including a clip, an arm band holder, and a carrying case with a belt attachment option. Subjects were asked to turn the unit to the “NAV” position at the onset of data collection, carry the unit with them throughout the day, and charge the unit each evening. The GPS units were pre-configured to stop data collection between the hours of 9:30 pm and 4:30 am to allow for 7 days of data collection without the need to download data during the week of assessment. Subjects were not required to turn the units on or off at any other point during data collection, unless they planned to participate in physical activity between the hours of 10:30 pm and 4:30 am. Subjects who worked second or third shift jobs were instructed to turn the unit to the "LOG" position during all waking hours and to turn the unit off while sleeping. The units were configured to record latitude and longitude positioning data every 10 seconds. This epoch is consistent with rates used in previous studies (Cooper et al., 2010; Cooper et al., 2010; Dunstan et al., 2012) and allowed for a reasonable compromise between data storage capabilities and optimal sampling of a 1-5 second epoch.

To enhance compliance with wearing the GPS unit for a full week, the following measures were taken:

1. Reminder messages were offered and provided to those requesting them to charge the GPS and wear both devices (mode of message based on subject's preference for email, text message, or phone call).
2. Subjects were asked to log device charging and wearing (see Appendix C).
3. Subjects were provided with written and verbal instructions explaining the importance of compliance with wear-time in order to meet minimum data collection requirements.
4. It was recommended to subjects that the GPS devices be charged in a location that would be easy to access (near cell phone, bed, coffee maker, or work computer, etc). Subjects were also asked to keep the accelerometer and log stored in the same place.

Procedure

Subjects were recruited February through May 2012. Subjects who agreed to participate were contacted by email, phone, or in person to establish the initial meeting time and place at their convenience. Subjects were given an Actigraph accelerometer with a clip or belt, depending on the subject's preference, for wearing the accelerometer at the hip. Subjects were also given a Q-Starz GPS unit and the option to carry the unit on a belt with the accelerometer, on a clip, in a separate case for wearing at the hip, or an armband carrier. The subjects were asked to wear the accelerometer and carry or wear the GPS for seven days throughout waking hours. Written and oral instructions were given to each participant regarding wearing and storage of the devices. (See Appendix C for written instructions). Subjects were given a charger for the GPS unit and instructed to charge the unit once every 24 hours. Subjects were offered the choice of reminder phone calls, texts, or emails for charging the GPS unit and wearing the devices. Subjects were given a journal sheet to record any times the accelerometer and GPS unit were put on and removed each day. Additionally, subjects were asked to record any periods of time the accelerometer or GPS units were removed and any activity performed while they were removed (See Appendix D). The subjects who self-identified as physically active were asked to record the mode of physical activity performed that day (i.e., running, biking, class, machines, etc.), or if none was performed. At the end of the seven days the principal investigator retrieved the accelerometer and GPS unit. After returning the accelerometer, GPS, and log, subjects completed the questionnaire (see Appendix B for instruments) which took approximately 30 minutes. Subjects provided height by self-report. Weight was measured with the Digital Medical Scales (Seca Floor Scale 769, SECA Corp. Hanover, MD) or collected by self report if the subject had weighed herself in the past seven days. The data stored on the accelerometer and GPS units were downloaded using proprietary programs for each device.

Data Analysis, Data Validation and Data Reduction

Initial validation of the accelerometer data was conducted using Actilife software. Specific thresholds for inclusion of data in the analysis were presented in Figure 2. Accelerometer data cut points, as determined by Sasaki, John, and Freedson (2011), were used to identify moderate (2690-6166 counts•min^{-1}), vigorous (6167-9642 counts•min^{-1}), and very vigorous (>9642 counts•min^{-1}) activity for the respective equivalent of 3.0-5.99 METs, 6.0-8.99 METs, and ≥9.0 METs. The cut points were based on the triaxial vector magnitude (VM3) calculation of $VM3=\sqrt{(VT^2+AP^2+ML^2)}$ where VT represents counts from the vertical axis, AP represents counts from the antero-posterior axis, and ML represents counts from the medio-lateral axis. Based on public health physical activity recommendations, a minimum bout of 10 minutes at ≥2690 counts• min^{-1} was required to count towards time spent in MVPA. Based on previous recommendations (Heil, Brage, & Rothney, 2012; Masse et al., 2005; Ward et al., 2005) an interruption of 1-2 minutes was allowed as long as the time-intensity threshold was achieved. The following example would classify as a bout of physical activity: subject counts were ≥2690 counts•min^{-1} for minutes 1-4, <2690 counts•min^{-1} for minute 5 and ≥2690 counts•min^{-1} for minutes 6-11. Bouts were identified with the Actilife software based on the parameters described above.

The procedures for physical activities reported but typically not captured by the accelerometer such as swimming, water aerobics, and bicycling included the following: 1) Subjects were asked to rate the intensity of the activity using the Omni perceived exertion scale including ratings for the warm-up, cool-down, and approximate time at the highest intensity (See Appendix E). This perceived exertion scale was chosen based on its applicability to a wide range of physical activities and populations (Robertson, 2004). 2) A bout of MVPA was assigned to activity rated as ≥6 on the Omni RPE scale and performed for at least 10 continuous minutes.

Cases were defined as subjects who achieved minimum physical activity levels. A subject was determined to meet activity levels by achieving one of the following over the week of monitoring: 1) ≥30 minutes of moderate activity ≥5 days, 2) ≥20 minutes of vigorous activity ≥3 days, 3) ≥ 4 days of ≥30 minutes of moderate activity or 20 minutes of vigorous activity per day, with at least 20 minutes of vigorous activity on one day. Percentage of time spent in sedentary activity was calculated based on time periods only when the accelerometer was worn. Sedentary behavior was defined as activity counts <100, consistent with the definition used in previous studies (Healy et al., 2007; Healy et al., 2008; Matthews et al., 2008).

The sum of MVPA minutes accumulated within the ≥10-minute bouts was calculated for all subjects based strictly on accelerometer counts. Minutes of MVPA accumulated in the water or on a bicycle that were not captured by accelerometry were not estimated nor included in the sum of MVPA minutes. Of note, for the purpose of identifying cases and controls, physical activity bouts recorded in the daily log, but not captured by accelerometry, were used to determine qualifications as a case or control. However, the accelerometry counts for these bouts were not available and therefore not included in the sum of MVPA minutes.

The Qstarz QTravel program was configured to filter and remove invalid values of GPS points such as spurious data points due to poor satellite signal or interference from buildings. Home and work latitude and longitude coordinates were identified within the QTravel program and confirmed against questionnaire data.

Accelerometer and GPS data were combined based on timestamps using the "GPS correlator" option within the Actilife software. The output provided latitude and longitude coordinates matched to corresponding counts for each minute available.

Location for each bout was assigned the latitude and longitude of the first minute of the bout and confirmed by a check against the activity log and a visual inspection of the geospatial coordinates.

The merged dataset of home, work, and MVPA bout locations was exported for analysis within a GIS. See Figure 3 for an example of a map with participant location by activity level and Figures 4a and 4b for examples of MVPA by location. Analysis of the combined accelerometer with GIS data identified specific environmental characteristics of the built environment where MVPA took place (e.g., sidewalk, bike lane, free public access resources, community recreational facility, open space, municipal tennis courts and trails). Additional calculations included the Euclidean distance (straight-line) between MVPA bout locations and home and work with subsequent calculation of the average distance between MVPA bout locations and home and work.

Figure 3. Example of Participant Location by Activity Level.

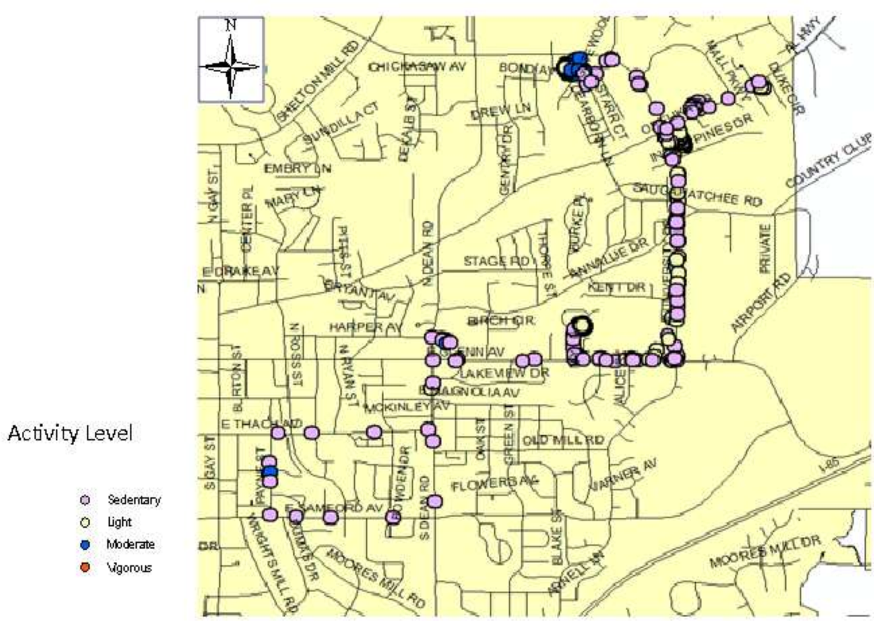


Figure 4a. Example of MVPA by location

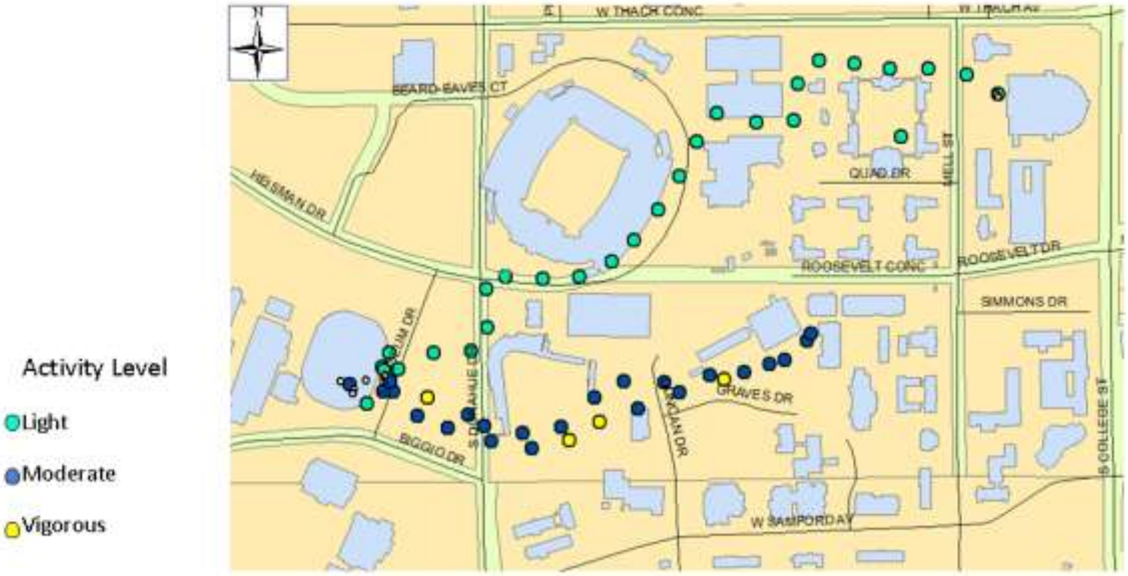
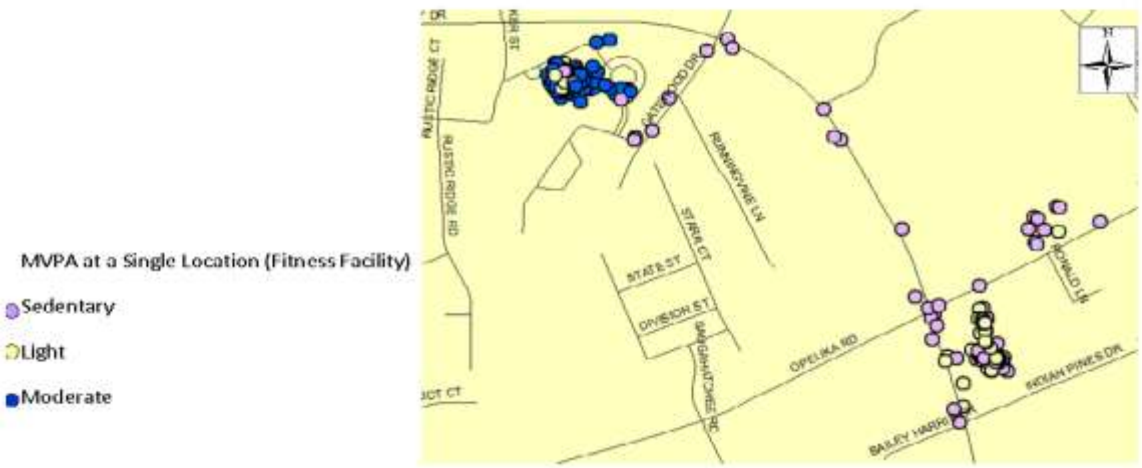


Figure 4b. Example of MVPA by Location



Data analyses were conducted using the Statistical Package for the Social Sciences, version 18.0 (SPSS, Inc., Chicago, IL) and Stata, version 5.0 (Stata Corporation, College Station, TX). Descriptive statistics calculated for each group (cases and controls) included: the sum of MVPA minutes by accelerometry, distance from work and home of site(s) where MVPA was performed, number and types of environment features utilized to perform MVPA (built environment, home, work, or facility). A univariate analysis using t-tests (for continuous variables) or chi square analysis (for categorical variables) was performed on subjects by group (meet recommendations, do not meet recommendations) comparing them for baseline demographics, exercise history, self-efficacy, social support, perception of the neighborhood, self-regulation, outcome expectancy, mean sedentary time per day, and built environment features used for physical activity. Logistical regression was performed using "meets recommended levels of physical activity" as the dependent variable to create a predictive model based on the data collected during the study. Specific analyses for each research question are presented in Table 2. The alpha level was set at .05 for all analyses.

Table 2. Data Analysis by research question

Research Question	Analysis	Variables
Differences in personal level variables case vs. control	Mean comparisons (chi square, t-test), logistic regression	Self-efficacy, self- regulation, outcome expectancies, social support, age, BMI, marital status, education, physical activity history
Differences in sedentary time	t-test	Average percentage time spent being sedentary
Are recommendations met through single or multiple bouts?	Describe number using single bouts vs. number using multiple bouts	Average number of bouts
Are features of the built environment used to meet MVPA?	Logistic Regression	Sidewalk, bike lane, free access recreational facility, open space,
Distance from work and home where MVPA performed	Describe average distance	Average distance between home and work to location where physical activity performed
Are "supportive features" correlated with MVPA?	Logistic Regression	Perceived worksite policies, perception of low traffic, low crime, aesthetically pleasing

Chapter 4

Results

The purpose of this investigation was to identify potential psychosocial, worksite policy, and environmental factors that facilitate adherence to regular physical activity among employed women. This chapter presents the results of the study relative to the research questions of interest.

One hundred fifteen subjects volunteered to participate in the study. Of the 103 subjects who completed data collection, 41 met minimum exercise recommendations as measured through accelerometry (herein referred to as cases), 35 were inactive, and 27 had insufficient activity to qualify as meeting recommendations. For the purpose of analysis, the inactive and insufficiently active were combined for one category as "not meeting recommendations" (controls). The mean age of all subjects was 44.4 (SD=11.8, range: 23-65) years with a mean BMI of 26.2 (SD=5.5, range: 18.2-43.0). See Table 3 for demographic measures by group. Subjects were recruited from 36 different employers with a variety in the types of work including teachers/school system staff (7%), healthcare workers (24%), custodial workers (3%), university employees (staff 23% and faculty 12%), self-employed (2%), bank employees (3%), and others (26%).

Table 3. Demographic Measures by Activity Status.

	Cases n=41	Controls n=62	p
Age Mean (SD)	45.1 (11.6)	43.9 (12.0)	0.64
BMI Mean (SD)	24.2 (4.5)	27.3 (6.6)	0.02
Average Hours/Week at Work Mean (SD)	43.9 (7.1)	41.9 (5.8)	0.12
Spouse/Partner (% Yes)	80.5	77.4	0.71
Children living at home (% Yes)	34.2	38.7	0.64
Hypertension (% Yes)	14.6	21.0	0.42
Current Smoker (% Yes)	2.4	6.5	0.35
Education Level (%)			0.01
High School Diploma or Less	2.4	3.2	
Some College or Associates Degree	7.3	32.3	
Bachelors Degree or Higher	90	64.5	
Race (%White)	90.2	80.7	0.19

Cases had an average of 271.0 (±105.0, range 81-527) minutes of MVPA during the week of monitoring compared to controls with an average of 50.7 (±52.2, range 0-190) minutes of MVPA ($p<.001$). The subset of insufficiently active subjects had a mean of 91.0 (±49.6, range 0-190) minutes of MVPA. Types of exercise reported by cases included running, walking, biking, elliptical, classes (zumba, circuits, body pump, boot camp, water aerobics, RPM), swimming, treadmill, recumbent bike, and tennis. A complete list of types of exercise performed by the cases and the number of subjects who performed each type is available in Appendix F. Based on responses to the "stages of change" questions, all of the cases confirmed they had been regularly physically active for the past six months.

There was an average of 6.44 valid days (range: 4-8 days) of accelerometer data for all subjects. Home and work locations were identifiable for all subjects via the GPS output and confirmed by questionnaire responses. Location coordinates were identifiable for 80% of all MVPA bouts. Seventeen control subjects had no MVPA bouts and 17 (7 cases, 10 controls) had some missing location data for MVPA bouts including one subject, with a single bout during the week of data collection, with no location data. A complete description of the percentage of identifiable locations of MVPA per number of subjects is presented in Table 4.

Table 4. Availability of location data for all subjects with bouts of MVPA

n	Percent Location Data Available
69	100
9	80-99
3	71-75
4	50
1	0

Sedentary Time

Research Question #1: What is the difference in the percentage of sedentary time between cases versus controls?

Hypothesis #1: Cases will have less sedentary time, defined by accelerometer counts between 0 and 100, as compared to controls.

Subjects who met physical activity recommendations had a mean of 43.9% (range: 30-55%) of the day in sedentary behavior (accelerometer counts <100 counts•min^{-1}) compared to a mean of 50.0% (range 29-64%) for controls. As tested by the two-sample t-test this difference was significant at $p<.0001$ ($t=4.007$ with equal variances, $d=.80$, $r=.37$). A comparison of cases to the subset of controls with insufficient activity levels but self-identifying as exercisers (n= 27) also showed a statistically significant difference between groups for sedentary time (43.9% vs. 47.6%, $p=0.05$). The hypothesis that cases would have less sedentary time compared to controls was upheld.

Bouts of Physical Activity

Research Question #2: Public health recommendations allow for discontinuous bouts of physical activity to achieve recommended levels. Do employed women achieve recommendations through more than one daily bout of physical activity on average?

Hypothesis #2: Cases are more likely to perform physical activity in a single session, (e.g., ≥20 minutes of vigorous activity or ≥30 minutes of moderate activity), rather than two or more bouts of short duration (e.g., 10-15 minute bouts interspersed throughout the day).

Among cases, the majority (76%) performed more than one bout of MVPA per day for an average of 1.3 bouts/ day (±0.31, range 1-2.3). Over all days measured, 22.8% of the days included 2 or more bouts of physical activity. The days with more than one bout were compared against the daily log to identify if all the bouts in a day were "intentional" (i.e., a bout with a clear description of the activity in the daily log), or if at least one of the bouts could be classified as "unrecorded" based on lack of an entry in the daily log. A breakdown of descriptions of the bouts is presented in Table 5. The length of the unrecorded bouts ranged from 10-16 minutes with the majority at 10-11 minutes. A comparison of cases to the subset of subjects with insufficient activity levels also showed a statistically significant difference between groups for average number of bouts (1.3 vs. 1.1 bouts/day, $p=0.002$). Twenty-six percent of those with insufficient activity had at east one day with more than one bout of MVPA compared to 76% of cases ($p<.001$, $r=.37$).

Table 5. Categorization of Bouts of MVPA from Days with >1 Bout.

n (%)	Description of extra bout
11 (27%)	Intentional extra bout
11 (27%)	Unrecorded
3 (7%)	Both intentional extra bouts and unrecorded extra bouts
10 (24%)	No extra bouts
3 (7%)	No log

The hypothesis that employed women who meet physical activity recommendations are more likely to perform physical activity in a single bout was not upheld.

Distance

Research Question #3: How far from home and work do employed women travel in order to perform MVPA?

Hypothesis #3: Employed women are more likely to perform MVPA in locations close (within 8 KM) to home or work.

Results of this analysis are provided with outliers included and excluded. Four subjects were identified as outliers for average distance traveled for MVPA (see Boxplots in Appendix F). One case traveled a long distance for personal reasons during the week of testing and had 2 bouts of MVPA in this location leading to a skewed average distance from both home and work locations. The other three subjects (controls) had single bouts of MVPA in places traveled to on weekends and outside of work obligations. Upon direct questioning, these subjects confirmed that these were singular excursions and not "typical behavior." The average distance traveled between home and MVPA locations and work and MVPA locations for all subjects, respectively, was 6.6 km (SD=8.1) and 7.4 km (SD=7.5) with the outliers excluded and 13.5 (SD=34.1) and 12.7 km (SD=29.9) with the outliers included. Table 6 provides a breakdown of average distances traveled for cases compared to controls. There was no significant difference in distances traveled for cases compared to controls to MPVA locations.

Table 6. Average distances between home and work to MVPA bout locations.

	Cases Mean (SD)	Controls Mean (SD)	p
Home to MVPA, outliers excluded	5.1 (5.4)	8.0 (10.0)	0.11
Work to MVPA, outliers excluded	6.6 (5.6)	8.3 (8.9)	0.31
Home to MVPA, outliers included	9.5 (28.2)	17.3 (38.8)	0.29
Work to MVPA, outliers included	6.6 (5.6)	18.2 (40.4)	0.07

Of note, 35% of cases performed MVPA in locations closer to work than home on average. Forty-nine percent of all subjects had MVPA bouts in locations closer to work than home on average. The hypothesis that employed women are more likely to perform MVPA in locations within 8 KM of work and home was upheld.

Personal Factors and Physical Activity

Research Question #4: Are there differences in personal level variables (social cognitive measures, physical activity history) between cases and controls?

Hypothesis #4. Cases will have higher scores for self-efficacy, self-regulation strategies, outcome expectancies, social support, and a higher percentage will have a history of physical activity than controls.

Mean scores for self-efficacy, self-regulation, outcome expectancies, and social support are presented in Table 7. There was a significant difference between cases and controls with cases scoring higher on all social cognitive measures that were assessed except for social support by "family participation" and by "family rewards and punishment." There was no significant difference between cases and controls for history of family encouragement to engage in physical activity or history of physical activity participation in school (See Table 8). Based on univariate comparisons, the hypothesis was upheld for social cognitive measures and including these measures in a logistic model is warranted. The hypothesis that cases would differ for physical activity history compared to controls was not upheld.

Table 7. Social Cognitive Measures by Group

	Cases n=41 Mean (SD)	Controls n=62 Mean (SD)	Levene's Test of Equality of Variances F (sig)	p	r
Self-efficacy: Making Time for Exercise (Range: 1-5)	4.3 (0.6)	3.9 (0.9)	3.0 (.08)	0.006	0.27
Self-efficacy: Sticking to It (Range: 1-5)	4.2 (0.7)	3.5 (0.8)	1.8 (.18)	<0.001	0.43
Self-regulation (Range: 12-60)	47.1 (7.7)	33.5 (13.8)	11.1 (.001)	<0.001†	0.49
Outcome Expectancies (Range:19-285)	160.3 (44.2)	122.2 (45.7)	002 (.97)	<0.001	0.39
Social Support: Family Participation (Range: 10-50)	21.8 (8.2)	20.5 (8.0)	.17 (.69)	0.46	NA
Social Support: Family Rewards and Punishment (Range: 3-15)	4.3 (1.8)	3.7 (1.4)	5.6 (.02)	0.08†	NA
Social Support: Friend Participation (Range: 10-50)	25.8 (11.5)	20.6 (8.8)	6.7 (.01)	0.02†	0.27

†Equal variances not assumed

Table 8. Physical Activity History by Group

	Cases n=41 %	Controls n=62 %	p
Family Encouragement to be Active			
Never/Rarely	29.3	23.0	0.47
Sometimes/Often	70.7	77.0	
Recreational Sports in Elementary School			
Never/Rarely	34.2	33.9	0.98
Sometimes/Often	65.8	66.1	
Competitive Sports in Elementary School			
Never/Rarely	68.3	57.4	0.27
Sometimes/Often	31.7	42.6	
Recreational Sports in High School			
Never/Rarely	26.8	34.4	0.42
Sometimes/Often	73.2	65.6	
Competitive Sports in High School			
Never/Rarely	39.0	45.9	0.49
Sometimes/Often	61.0	54.1	
Recreational Sports in College			
Never/Rarely	51.2	59.7	0.41
Sometimes/Often	48.8	40.3	
Competitive Sports in College			
Never/Rarely	86.0	85.0	0.89
Sometimes/Often	14.0	14.0	

Built Environment and Physical Activity

Research Question #5: Do employed women meet recommendations by using features of the built environment?

Hypothesis #5: Cases will utilize features of the built environment, such as sidewalks, roads, free access or municipal recreational facilities, and open spaces, to perform physical activity more than women who do not meet weekly MVPA recommendations.

Cases utilized the built environment for MVPA on 49.7% of all physical activity bouts. Looking at use of the built environment over a week, cases used the built environment for physical activity on 57.8% of all the days with any MVPA. For example, a subject with seven complete days of accelerometer data used the built environment, on average, four out the seven days. Use of the built environment for MVPA. out of all physical activity bouts, was significantly higher for cases compared to controls (49.7% vs. 28.2%, p=.006, r=0.27). Calculation of the use of the built environment over all days measured (as compared to only days with any MVPA) was conducted for the purpose of a comparison between groups. Controls used the built environment on 12.2% of all days measured with accelerometry and GPS compared to 53.1% for cases (p<.001). Based on the univariate analysis, the hypothesis that cases utilize features of the built environment more than controls was upheld.

Perception of the Built Environment

Research Question #6: Are there differences in perception of the built environment between cases and controls?

Hypothesis #6: Cases are more likely to perceive the neighborhood built environment as supportive for physical activity, as identified from the Neighborhood Environment Walkability Scale, and the Physical Activity Neighborhood survey. Supportive environments include perception of low traffic, and perception of low crime.

Results of the independent sample t-tests for perceived neighborhood built environment to support physical activity are presented in Table 9. Equality of variances for the t-tests were assumed based on non-significant results of the Levene's test on all of the built environment variables. There was a significant difference between cases and controls for perception of more land-use mix diversity within walking distance of home, such as grocery stores, the post office, banks, parks, and restaurants (effect size r=0.20). Of note, all subjects, on average, "disagreed" that their neighborhoods provided infrastructure and safety for walking.

Table 9. Perception of the neighborhood built environment to support physical activity.

	Cases n=41 Mean (SD)	Controls n=62 Mean (SD)	p
PANES (0-4)	2.4 (1.1)	2.0 (1.1)	0.08
Land Diversity (1-5)	2.3 (1.0)	1.9 (0.9)	0.04
Aesthetics (1-5)	3.1 (0.7)	2.8 (0.8)	0.16
Land Use Mix-Access (1-5)	2.4 (1.2)	2.0 (1.2)	0.07
Infrastructure and Safety for Walking (1-5)	2.0 (0.8)	2.1 (0.9)	0.63
Street Connectivity (1-5)	2.5 (1.0)	2.4 (1.1)	0.56
Crime (1-5)	2.2 (0.4)	2.2 (0.3)	0.68
Traffic Hazards (1-5)	2.4 (0.6)	2.3 (0.8)	0.63

Overall, the hypothesis of the neighborhood built environment was not upheld, based on univariate comparisons, except for significant differences in perception of land-use mix diversity.

Perception of Worksite Policies

Research Question #7: Are there differences in perception of worksite policies between cases and controls?

> Hypothesis #7: Cases are more likely than controls to perceive worksite policies as supportive for physical activity, as identified from the index of employer policies modified from the Neighborhood Quality of Life Study (2004).

The mean score for the worksite policy index was not significantly different between cases and controls (2.9 ±2.3 vs. 2.2 ±2.2, p=0.09). Results of the independent sample t-tests for perceived individual worksite policies to support physical activity are presented in Table 10. There were no significant differences in the perception of individual worksite policies between groups.

Table 10. Perception of individual worksite policies to support physical activity

	Cases n=41 % Yes	Controls n=62 %Yes	p
Exercise facilities	29.3	29.0	0.98
Regular exercise programs	56.1	37.1	0.06
Shower facilities	34.2	24.2	0.27
Safe bicycle storage	39.0	24.2	0.11
An exercise specialist or activity coordinator available for employees	29.3	29.0	0.98
Policies that encourage exercise or biking	29.3	25.8	0.70
Employer provides paid time for you to exercise	2.4	3.2	0.82
Employer offers incentives to be physically active	39.0	25.8	0.16

The hypothesis that there would be differences in the perception of worksite policies to support physical activity was not upheld.

Predictors of Physical Activity

Based on the results of the analysis for research questions #4, #5, and #6, logistic regression was used to identify differences in cases and controls using demographic, psychosocial, perceived worksite policy, and perceived built environment variables as the independent variables. A test of the full model against a constant only model was statistically significant, indicating that the predictors as a set reliably distinguished between cases and controls (chi square = 53.751, $p < .001$ with df = 4). Nagelkerke's R^2 of .55 indicated a moderately strong relationship between prediction and grouping. Prediction success was relatively high overall at 80% (82 % for controls and 78% for cases). The Wald criterion demonstrated that four variables, perception of neighborhood land diversity, perception of neighborhood infrastructure and safety for walking, self-regulation, and use of the built environment for physical activity, made significant contributions to prediction. The logistic regression results are presented in Table 11. Goodness of fit was shown to be acceptable with a Homer-Lemeshow Test (χ^2=5.513, df=8, p=.70). There was no indication of multi-collinearity with the lowest tolerance at 0.53 and the highest variance inflation factor for all variables in the model at 1.90.

Table 11. Model to Predict Meeting Physical Activity Recommendations

	B	SE	Wald	Odds Ratio	p	Confidence Interval
Self-regulation	.13	.03	15.40	1.13	<.001	1.06, 1.21
Use of Built Environment for MVPA	2.00	.61	10.66	7.35	.001	2.22, 24.33
Land Use Mix Diversity	.94	.36	6.97	2.56	.008	1.27, 5.14
Infrastructure and Safety for Walking	-.91	.39	5.37	.40	.02	.19, .87

The odds of meeting physical activity recommendations increased 13% for every 1 point increase in the self-regulation scale (range: 12-60). For every one point increase in the perception of land-use mix diversity (range:1-5) in the neighborhood of residence a subject was 2.6 times more likely to meet physical activity recommendations. Conversely, subjects who met recommendations perceived their neighborhoods to have lower infrastructure and safety for walking. For every one point increase in the perception of safety and infrastructure for walking, the odds of meeting physical activity recommendations decreased 60%. Subjects who used the built environment for MVPA were 7.4 times more likely to achieve recommended levels of physical activity. The model did not change when adjusted for age, BMI, race, and education level.

Hypotheses #4 and #6 were partially upheld by the logistic regression model. Self regulation skills were significantly different between cases and controls and were significant in the model to predict physical activity adherence. The other social cognitive measures including social support, self-efficacy, and outcome expectancy did not contribute significantly to the model when holding all of the other predictors constant. The perception of increased land mix diversity was significantly higher for cases compared to controls and remained as a significant predictor for physical activity adherence when holding the other predictors constant. In a simple univariate comparison, perception of neighborhood infrastructure for safety and walking was not significantly different between cases and controls; however, when holding the other predictors constant, this perception was a significant predictor of physical activity adherence. Hypothesis #5 was upheld by the logistic regression model. Use of the built environment for physical activity is a significant predictor of physical activity adherence when the other predictors are held constant.

Chapter 5

Discussion

Across age groups, women consistently have lower rates of participation in physical activity, and in particular MVPA, compared to men (Brownson et al., 2005; (Troiano et al., 2008). Women also demonstrate higher rates of sedentary time compared to men (Matthews et al., 2008). Previous research has identified barriers to participation in physical activity, as well as correlates of women adopting a more physically active lifestyle. However, factors associated with long term, consistent participation in physical activity among women, and in particular working women, have not been clearly identified. Nor have objective measures of MVPA been utilized. A better understanding of these factors is needed for program development and intervention design to have influence on physical activity levels. The purpose of this investigation was to identify potential psychosocial, worksite policy, and environmental factors that facilitate adherence to regular physical activity among employed women. This chapter presents an interpretation and discussion of the study's findings along with recommendations for future research.

Sedentary Time

Studies of sedentary behavior have established associations between time spent being sedentary and decreased health outcomes including increased risk for metabolic syndrome (Healy, Dunstan et al., 2008; Healy, Wijndaele et al., 2008), cardiometabolic risk factors including insulin, glucose, triglyceride and LDL concentrations (Celis-Morales et al., 2012), hypertension (Pardee et al., 2007), depression (Tychenne et al.

2010), and obesity (Sugiyama et al., 2008). A study by the American Cancer society found that women who sit more than 6 hours daily during leisure time, compared to those who sit less than 3 hours, had a 40% higher all-cause mortality rate, independent of leisure time physical activity levels (Patel et al., 2010). Sugiyama et al. found similar risk for overweight and obesity in subjects who had sufficient levels of physical activity but also spent more time in sedentary behaviors compared to those who were insufficiently active but spent less time in sedentary behavior. The results of the current study showed that women who meet physical activity recommendations have significantly lower rates of sedentary time (43.9% vs. 50.0%) and suggests that women who engage in MVPA on a consistent basis are also less likely to engage in sedentary behavior. It cannot be deduced from the data if this additional activity above the sedentary level is spontaneous or planned. It is possible that women who engage in MVPA on a regular basis experience the physical and psychosocial benefits of physical activity and therefore, whether consciously or not, seek more opportunities to be less sedentary. It is also likely that the time spent in MVPA, predominantly during "leisure-time," reduces the time available for sedentary activities. It is worth investigating if interventions that seek to increase physical activity have a cumulative effect whereby health benefits are achieved through both increasing MVPA and decreasing sedentary time. Further research is needed to understand how interventions to reduce sedentary behavior may influence physical activity behavior and vice versa, and how each approach can move women along the continuums of more activity and less sedentary time, thereby exerting positive benefits to overall health. Additionally, research is needed to understand the factors influencing sedentary behavior and specifically how participation in MVPA potentially alters sedentary behavior.

There has been some evidence to suggest that children may compensate for increased periods of physical activity (e.g., school-based interventions to increase physical activity) by being more sedentary at other times during the day (Donnelly et al., 1996; Mallam et al., 2003). King et al. (2007) proposed compensation as a barrier to weight loss in adults who adopt or increase physical activity. That is, individuals become less active as a response to exercise induced energy expenditure. The present findings, however, show that women who meet physical activity recommendations do not compensate with more sedentary activities. Therefore, compensation may not occur in regular exercisers, and, engagement in physical activity may promote increased activity overall.

The inaccuracies associated with self-report for sedentary behavior have been previously described (Marshall & Ramirez, 2011; Owen et al., 2010; Pate et al., 2008). Accelerometry offers an objective means to capture sedentary behavior over the course of a full day thereby capturing the full extent of sedentary behavior including work-related and leisure-time sedentary activities. However, the current standard of using a cut-off of <100 counts•min^{-1} has limitations. To date the <100 counts•min^{-1} cut-off is fairly standard across studies. It has been argued that sedentary behavior is best operationalized as sitting and refers to behavior that entails sitting and energy expenditure less than 1.5 METs (Marshall & Ramirez, 2011; Pate et al., 2008). At the same time, no other studies have reported positional status (i.e., standing, sitting, or lying), in identifying sedentary time. It is certainly feasible for an accelerometer to measure (or a person to accumulate) <100 counts•min^{-1} while a person is standing. In the current study, sedentary time with standing time eliminated was calculated on a subset of randomly chosen subjects (n=21, 20%). The average sedentary time with standing included was 45.8% compared to 37.1% with sedentary standing time removed (p=<.001). Therefore, it is necessary to consider if sedentary time is being overestimated by not excluding time spent standing at counts of <100•min^{-1}. Further research is needed to quantify how to best capture sedentary behavior with current technology and differentiate between lack of movement during sitting and standing activities. In addition, further research is needed to understand what types of sedentary behavior (i.e., sitting vs. standing) contribute to poor health.

Overall percentages of sedentary time were lower in the current study sample compared to percentages from population-based studies (48% vs. 57% for men and women ages 30-97 in Healy et al., 2007, and 55% for men and women in Matthews et al., 2008). While it is possible the current sample was more active overall, more likely this can be attributed to the use of all three axes and the vector magnitude to calculate activity levels. Both the NHANES accelerometer studies and the studies by Healy et al. used uniaxial accelerometers thereby measuring activity only in the vertical plane. The tri-axial accelerometer also captures horizontal and perpendicular activity. A subject in the current study could have <100 counts•min^{-1} on Axis 1, (i.e., would be designated as sedentary in other studies), but also have counts > 100 on Axis 2 and/or 3, thereby not qualifying as sedentary. This difference in measurement does not allow for the sedentary behavior of the subjects in the current study to be comparable to other studies, however, the additional information captured by using a triaxial accelerometer may help further refine how to identify and capture sedentary time. Just as accelerometers provided a substantial improvement in capturing sedentary behavior over self report, triaxial accelerometers which include positional status allow for more accurate definition and measurement of true sedentary time.

Bouts of Exercise

Evidence has shown that exercise accumulated in bouts of ≥10 minutes to achieve physical activity recommendations is as beneficial as a single, prolonged bout of similar intensity (Haskell et al., 2007). Therefore, current recommendations allow for this variation in MVPA duration to achieve the 20-30 minutes of recommended activity. The option to achieve the needed minutes in bouts throughout the day is often promoted and incorporated into physical activity promotion programs and interventions (e.g., Take10, Exercise is Medicine, CDC Physical Activity for Everyone), however, to date it has not been reported if women actually utilize this option in order to achieve recommendations. In other words, while it is appealing to be able to say, "you don't need a full 30 minutes, you just need 10 minutes at three different times over the course of the day" to encourage women to be more physically active, it is not known if this is a practical way for people to achieve recommendations, nor is it known if it is put into practice by consistent exercisers. This study examined how women incorporate physical activity into a daily schedule (i.e., number and location of MVPA bouts), to better understand how employed women meet physical activity recommendations.

The majority of cases (76%) had at least one day with more than one bout of activity. The average of 1.3 bouts of activity per day for cases suggests that women who achieve physical activity recommendations do perform physical activity in a singular prolonged bout the majority of the time, but also have additional bouts on some days, interspersed over a week. Given the significant difference in number of MVPA bouts between cases and controls, and in particular between cases and the subset of controls who were active but not enough meet minimum recommendations (26% vs. 76% with at least one day with more than one bout), these additional bouts may play an important role in helping women get sufficient activity. This finding is important for physical activity promotion in that additional bouts ≥10 minutes of MVPA over the course of a week will help to achieve the weekly recommended amount of MVPA needed for health benefits.

Cases had significantly higher scores for self-efficacy, self-regulation, social support from friends, and outcome expectancies for physical activity. These higher scores may be reflected in the higher number of average bouts in that those with higher self-efficacy, social support, and outcome expectancies have the confidence and the interest in incorporating physical activity into a day whether through an additional planned bout or through a more spontaneous situation, such as walking to get places or playing sports or games with their children. The self-monitoring or time management aspect of self-regulation may "trigger" these cases to engage in extra bouts of MVPA to ensure the behavior is accomplished. The cross-sectional study design does not allow for a determination of the direction of the relationship, that is, do the psychosocial constructs influence the activity levels, or do the higher activity levels influence psychosocial outcomes? Regardless of the direction, these additional bouts may also help with achieving increased health benefits. There is a dose-response relationship between physical activity and health, with increasing amounts of MVPA reducing risk for chronic diseases and disabilities (Garber et al., 2011; Haskell et al., 2007). The additional bouts performed by the cases in this study not only helped them achieve recommendations but allowed them to accumulate additional activity above the suggested minimum.

A strength of this study was the use of the 10-minute bout as the threshold to count towards MVPA. Previous studies utilizing accelerometry often used a gross sum of total MVPA minutes over the course of the day (Saelens et al., 2003; Troped et al., 2010), however, the recommendations specifically state that physical activity bouts should reach a 10-minute minimum (Garber et al., 2011; Haskell et al., 2007). This aspect of the guidelines is based on studies showing improved cardiovascular fitness and reduced blood pressure from MVPA bouts of at least 10 minutes with little evidence this occurs from bouts of less than 10 minutes (Garber et al., 2011). An exception to the 10-minute minimum may be appropriate when measuring the transition from a completely sedentary lifestyle to some or any accumulation of moderate or vigorous minutes. While evaluation of the total MVPA minutes may be relevant in studies that aim to reduce sedentary behavior, the evidence does not currently exist to support using these procedures to examine cardiovascular and weight benefits from bouts of less than 10 minutes. The practice of using 150 minutes of MVPA over a week to evaluate correlates of physical activity may lead to spurious conclusions if the subjects accumulated minutes over the course of a day without engaging in any sustained aerobic exercise resulting in an increased heart rate. In other words, if these subjects do not engage in purposeful and sustained MVPA, can we associate their psychosocial profiles and built environment perceptions as correlates of physical activity behavior? As demonstrated by Troiano et al. (2007), one of the only accelerometry studies to use the 10-minute bout criterion, less than five percent of the U.S. population meets physical activity recommendations by this standard. This low percentage makes it more difficult to find subjects who meet physical activity recommendations, however it is necessary to move to the stricter criterion of the 10-minute bout to further develop the knowledge base of correlates of physical activity adherence.

Distance

Studies examining the relationship between physical activity and the built environment have asked subjects about the perception of their residential neighborhood (Giles-Corti et al., 2005; Kirtland et al., 2003), or assessed the built environment within a predefined distance of homes and cited associations with physical activity levels as indicative of the influence of the built environment on physical activity (Diez Roux et al., 2007; Duncan & Mummery, 2004; Rutt & Coleman, 2005). This approach may attribute any and all physical activity behavior to the neighborhood of residence, without measurement of the actual location of the physical activity, thereby obfuscating the relationship between the built environment and physical activity. To date, two studies have evaluated associations between the worksite neighborhood environment and walking for adults (Schwartz et al, 2009; Troped et al., 2010). Relating physical activity behavior to only the worksite neighborhood may lead to the same measurement errors as the studies looking only at home neighborhoods. Troped et al. used GPS to identify physical activity performed within a 1-km network buffer of both work and home and found approximately 14% and 25% of MVPA was performed within 1 km of home and work, respectively. This finding indicates that evaluation of associations between the built environment and physical activity may be better served by considering a larger geographical area than an arbitrary home or work neighborhood delineation. In the current study, working women, on average, engaged in MVPA 6.6 km from home and 7.4 km from work. While some activity did occur at or close to home and work locations, a significant amount took place in locations well outside the home or work vicinity. This finding corroborates the recent call to evaluate the full range of environmental exposures, without limit of an arbitrary buffer distance for associations with physical activity (Duncan & Mummery, 2004; Hurvitz & Moudon, 2012).

One of the underlying assumptions in examining the neighborhood built environment is that people will use facilities (i.e., parks, trails, bike paths, recreational centers) within walking distance of home for physical activity. While this may have some credence in dense metropolitan areas, there is no data to support this assumption in other types of areas. The majority of the locations where MVPA occurred in the current study were reached by motor vehicle. It is worth considering that in areas such as the cities under study (small cities) people typically use a motor vehicle for transportation. A "walkable" destination may not be as important to women, as much as characteristics of the drive to exercise locations (e.g., on the way home from work, near the location where children participate in after school activities, near day care, etc.). The average distances of 6.6 and 7.4 km indicate that although the subjects traveled outside of the home or work neighborhood to engage in MVPA, they did not drive long distances from either of these locations, except under special circumstances (typically weekend or holiday excursions).

Further research is needed to determine how this average distance varies for metropolitan, suburban, and rural settings and across populations including men and women, varying age groups, and minority populations. This type of information would be useful not only for community planning (e.g., new facility locations) but also for physical activity interventions. Understanding patterns of consistent exercisers may help women who fail to achieve recommended levels of MVPA with adherence. For example, finding a location for physical activity closer to work or along the commute path to/from work may be more conducive to physical activity adherence than other locations, even those closer to home. Alternatively, capitalizing on opportunities to use the built environment encountered over the course of a typical day, such as walking between buildings or from vehicles to buildings before, during, or after work, and not just the home neighborhood built environment, may be useful to include in physical activity promotion.

In the current study, distance was calculated by "straight-line" or Euclidean measures without accounting for the road network. Apparicio et al. (2008) found strong correlations between Euclidean distance and network distances (Pearson correlation > 0.95) across a metropolitan area, with a decrease in correlation for more suburban areas of a major metropolitan area. In a study evaluating of 66,000 locations in the 50 states of the United States, Boscoe, Henry and Zdeb (2012) compared straight-line and travel driving distance to hospitals and found the measures to be highly correlated with $r^2 > 0.9$. While the road network distance may provide greater accuracy for the actual distance traveled by the study subjects, it still does not account for construction detours and traffic patterns. Use of the Euclidean measure allowed for distance calculations outside of the area of study and, based on the previous research cited, offers a relatively solid picture of the distances working women travel to perform MVPA in a small city. Further research on commute patterns and temporospatial patterns between home, work and physical activity locations, in the context of a work day, is needed to provide a more detailed illustration and understanding of how a subset of working women are able to meet physical activity recommendations.

GPS

Previous physical activity studies using GPS and accelerometry have reported data loss from GPS devices from 2.5% to 92% (Krenn et al., 2011). Eighty percent of all MVPA locations were identified through a combination of GPS with supplementation by a daily log, representing a comparatively high rate of data acquisition. A critical feature for obtaining such a high rate was utilization of the time programmer on the GPS unit which stopped data collection during late evening through early morning hours, except for second or third shift workers. Memory space for seven days of data collection was preserved, while reducing potential data loss through subject noncompliance with turning the unit on and off each day. The addition of a simple log to record wear times, battery charging on the GPS, and physical activity performed each day, provided confirmatory data for the accelerometer and GPS outputs as well as back-up data collection for GPS data loss, despite adding to subject burden. As with other studies, it is difficult to ascertain why some subjects had higher rates of data loss than others. Subjects were given multiple options for wearing or carrying the GPS unit which may have influenced acquisition rates. This was a planned compromise as many subjects were not willing to wear the unit on a belt for seven continuous days. The decision to provide subjects with the option of wearing or carrying the unit in a bag or pocket was a calculated risk to enhance compliance with a potential risk for loss of data without a standardized plan for wearing the units. Unlike some other GPS units, the QStarz BT-Q1000XT does not have an external display except for a small light that indicates a satellite fix by flashing. Subjects may be more inclined to see if the GPS is acquiring data with an external display that provides a map indicating location, speed, and latitude and longitude coordinates. Future research is needed to determine if this feature influences compliance with the research protocol and location data acquisition.

The addition of GPS monitoring for assessment of free-living physical activity has significant advantages, in spite of the risk of inconsistent data acquisition across subjects and locations. In particular, visual analysis of the GPS data combined with accelerometry output was used to eliminate spurious MVPA minutes captured by accelerometry based on acceleration in a motor vehicle. GPS also allows researchers to capture the types of locations where MVPA occurs, reducing the need for recall or self-report while illustrating the variety and nuance of where and when MVPA occurs. New technologies such as the ability to download GPS information from mobile phones for analysis will reduce subject burden for data collection and enhance understanding of the geospatial relationships between the physical activity, the built environment, availability of physical activity resources and how home, work, and commutes may influence MVPA behavior.

Personal Factors and Physical Activity

Several of the personal factors shown to be correlates of physical activity in previous studies, such as age, marriage status, parenthood, education level, history of engagement in sports or exercise, and weight status, did not contribute to the predictive model, and none except BMI and education level were significantly different between groups. A possible explanation as to why these factors did not emerge as correlates is the specific population recruited in the current study. By limiting recruitment to employed women, the population of the current study may not be comparable to the more general adult populations used in other studies. The findings of no differences between groups for these personal factors suggests that they need not be considered "barriers" to engagement in physical activity. For example, women without a history of engagement in sports or women with children living at home can and do meet current physical activity recommendations. Interventions to promote physical activity may take these factors into consideration for tailoring of programs, but should still target these populations for physical activity behavior change.

Predictors of Physical Activity Adherence

The logistic regression model reveals some associations with physical activity that have not been identified clearly in past research. Research findings on the association between the built environment and physical activity have been mixed. This is the first known study to quantify how much women actually use the built environment for MVPA in relation to facilities, home equipment, and work-related MVPA. The finding that women who used the built environment were 7.4 times more likely to meet physical activity recommendations could indicate that women who meet recommendations are doing vigorous activities such as running, biking, tennis, hiking, fast walking, or other sports that are typically performed using the built environment. That is, the variable of built environment could be a proxy for more intensive or vigorous activities which allows these women to meet recommendations more readily. An alternative interpretation is that those who use the built environment are more likely to meet recommendations because it is more readily available and is accommodating to physical activity. In other words, women who use the built environment for physical activity are not dependent on getting to a specific facility, or attending an exercise class at a specific time, thereby reducing the chances they will not engage in MVPA in a day when events prevent them from getting to a facility or class. Similarly, women who plan to use home exercise equipment are limited to doing physical activity in a single environment which has competing interests such as family and home responsibilities in addition to leisure options. The increased chance of meeting physical activity recommendations by use of the built environment is important for future policy development and interventions to promote physical activity. The results of the current study suggest municipal infrastructure for physical activity, including sidewalks, trails, bike paths, recreational facilities such as tennis courts, and parks or open space are key components to achieving physical activity recommendations. Development, maintenance, and promotion of these options for physical activity may help more women with physical activity adherence.

The psychosocial variables that were consistently correlated with MVPA in previous studies, including self-efficacy, social support, and to a lesser extent outcome expectances, failed to predict exercise participation in the current sample. Cases had significantly higher scores on all of the psychosocial constructs except for two measures of social support (family participation and family rewards and punishment) with univariate analysis. However, when all of the other predictors were held constant these relationships did not significantly contribute to the model predicting meeting of physical activity recommendations, except for self-regulation. This suggests that the factors that predict short term behavior change may not do so in the context of long term behavior change and behavior maintenance. For example, social support has consistently been regarded as a positive correlate of physical activity, particularly for women (Eyler et al., 2002; Kahn et al., 2002; Sternfield et al., 1999). However, based on the current results, it may be important in supporting the initial behavior change, but once the behavior is integrated, then it may have less relevance to behavior maintenance.

It was hypothesized that self-efficacy for physical activity would be a significant contributor to working women meeting physical activity recommendations based on previous studies of adult women (Kaewthummanukul et al., 2005; Sternfield et al., 1999; Wilbur et al., 2003). The finding that it did not contribute to the model was unexpected but not without precedent. A prospective study by Oman and King (1998) found self-efficacy to be predictive of early adoption of exercise behavior, but not for early maintenance or long-term exercise adherence except in the specific circumstance of subjects in a supervised home-based exercise condition. Similar to social support, cases had significantly higher self-efficacy scores compared to controls in a singular comparison. However, the lack of significant contribution to the model, in the context of the other variables measured, suggests that these other variables such as self-regulation, living in an area with land-use mix diversity, and use of the built environment for MVPA are more relevant factors for long term exercise adherence compared to self-efficacy.

Self-regulation was a significant predictor of physical activity adherence in the current study. This aligns with previous studies showing associations between self-regulation and physical activity behavior (Anderson et al., 2006; Hallam & Petosa, 2004) and in particular for adult women (Stadler et al., 2009). Self-regulation encompasses six skills used to overcome personal and situational barriers for the purpose of carrying out exercise intentions including time-management, goal-setting, relapse prevention, self-monitoring, reinforcement, and social support. Given that other psycho-social constructs did not contribute to the predictive model, it appears the women who met physical activity recommendations rely on self-regulation skills versus external stimuli (friend and family social support) and perceptions (outcome expectancies) for physical activity adherence. This is consistent with social cognitive theory (Bandura, 1985) which posits that maintenance of behavior change is a result of self-regulation and that motivation and willpower are not enough to sustain consistent physical activity behavior over the long-term without the implementation of self-regulation. Furthermore, the environment becomes a key factor in helping to regulate the behavior, which is consistent with the results of this study. A closer examination of the self-regulation constructs reveals the time-management aspect was a key component in relation to the other skills. Although it is limiting to look at each self-regulation skill because the questionnaire assesses each skill with two questions, it is worth noting its predominance in increasing the odds for physical activity adherence. The cases have internalized physical activity behavior to the level that it is not a question of "will they exercise?" but "how will they get it done?" and time management is a key aspect of assuring the behavior will be maintained. This coincides with Bandura's (1985) explanation of the final level of self-regulation in which rewards and motivation are intrinsic in nature. Further research is needed to determine how interventions can target specific aspects of self-regulation, and development of these skills, to improve physical activity adherence in working women.

The findings of an inverse relationship between perception of the home neighborhood infrastructure and safety for walking were not predicted. However, Duncan and Mummery (2004) had similar findings in a study of the built environment and physical activity, where a significant predictor of recreational walking in adults was the perception that footpaths near home (0.4 km) were not in good condition. Presumably, people who use the built environment, such as the cases in the present study, are more cognizant of the conditions available for physical activity. Additionally, the average distance of 5.1 km traveled for exercise indicates the cases did not use the neighborhood of residence as the primary location for exercise and therefore their perception of the infrastructure does not need to align with physical activity levels. In other words, if they do not use the neighborhood environment, their perception of it will not necessarily influence physical activity, but being regular exercisers, and in particular users of the built environment, makes them more aware of the local built environment. Alternatively, some of the cases do use their neighborhood for physical activity and, through first-hand knowledge, know that the infrastructure could be better.

The perception of neighborhood land-use mix diversity was predictive of meeting physical activity recommendations. The control subjects had an average score on this measure of 1.9 (±0.9) which on the five-point scale represents a perceived average time to walk to a wide range of facilities (schools, restaurants, parks, stores, etc.) as 21 or more minutes. The cases had a mean score of 2.3 (±1.0), which also averages out to a walk of 21 or more minutes to the same types of facilities, but with more perceived to be within a 20-minute walk of home. There was little indication the cases used active transportation (walking, cycling, running) to access the facilities in the neighborhood, that is, used the perceived land-use mix diversity to achieve MVPA recommendations, however, additional data would be needed to confirm this observation. Further research is needed to discern if cases, being more physically active, merely perceive the various facilities as being closer to walking distance compared to controls, or if women who live in neighborhoods with greater land-use mix diversity are more likely to adhere to physical activity guidelines.

Perception of Worksite Policies

There were no differences in perceptions of worksite policies to support physical activity between cases and controls. Overall, the average for the worksite policy index was relatively low (2.47 ±2.25) on an eight-point scale. A previous study by Crespo et al. (2011) of working men and women, using the same measure, found those who met physical activity guidelines had an average index of 3.34 (±2.51) compared to an average index of 2.63 (±2.27) for subjects who did not meet MVPA guidelines ($p<.01$). This suggests that the policies for employees in the current study may not have been sufficient to influence physical activity levels; and the lack of variance in the index scores makes it difficult to detect worksite policy influences on physical activity. Despite the low perception of worksite policies cases met MVPA recommendations, indicating they were able to capitalize on other factors, such as self-regulation and the use of built environment, to achieve recommended physical activity levels. Given the overall perception of a lack of supportive employer policies, the data is not conclusive to speculate that worksite policies do or do not influence activity levels. This study did not assess employer policies and therefore it is not known if the perceptions of the subjects are congruent with what is actually offered to them in the workplace. Additional research is needed to determine how worksite policies influence employee participation in MVPA, differences between perception of policies and actual policies in place, and how discrepancies between perception and reality of policies influence MVPA.

Summary

The results of this study show that working women achieved recommended levels of activity through use of the built environment for MVPA, whether as the sole choice of environment for MVPA, or in addition to home and private facilities. Additional bouts of MVPA over the course of a week were needed to meet minimum physical activity recommendations. Among the women who perceived themselves as physically active, those who did not achieve the recommended levels had significantly fewer additional bouts of MVPA (i.e., more than one bout in a day) compared to those who met recommendations. Self-regulation, and in particular time management, was a significant predictor of maintaining exercise adherence in working women. Perception of the neighborhood built environment to support physical activity, particularly land-use mix diversity, was also associated with consistent engagement in physical activity. However, the perception of poorer infrastructure and safety for walking in the home neighborhood did not preclude working women from MVPA adherence. The results also indicated that, overall, working women travelled outside of their home and work neighborhoods to engage in MVPA. Finally, working women who met physical activity recommendations were less sedentary compared to those who did not meet recommendations.

Conclusions and Research Recommendations

Conclusions

1. To help women achieve the recommended amount of MPVA, the exercise prescription should include recommendations for additional bouts of MVPA interspersed over the course of a week.
2. Self-regulation is a critical aspect of physical activity adherence. Interventions seeking to promote physical activity, and in particular maintenance of the behavior, will need to address how these skills are developed and implemented.
3. The built environment plays a key role in meeting physical activity recommendations. Interventions seeking to promote physical activity can capitalize on this finding in helping working women find ways to include physical activity as a regular behavior.

4. Working women's physical activity behavior is influenced by both psychosocial and environmental factors. Exclusion of either of these factors from a physical activity intervention will limit both effectiveness and reach of the intervention.

Research Recommendations

1. Additional research is needed to understand the dynamic relationship between sedentary behavior and physical activity and how to maximize intervention potential to reduce sedentary behaviors and increase engagement in MVPA.
2. Further research is needed to clarify how engagement in consistent physical activity influences perceptions of the built environment and how these perceptions in turn influence behavior maintenance.
3. Further research is needed to delineate how self-regulation skills enhance management and use of the external environment to maintain exercise behavior.
4. Associations between the built environment and physical activity need to be evaluated in locations beyond the home neighborhood.

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Appendices

Appendix A—Consent Forms

AUBURN UNIVERSITY

COLLEGE OF EDUCATION
KINESIOLOGY

The Auburn University Institutional Review Board has approved this document for use from 1/3/13 to 1/2/13 Protocol # 11-377 EP 1201

(NOTE: DO NOT SIGN THIS DOCUMENT UNLESS AN IRB APPROVAL STAMP WITH CURRENT DATES HAS BEEN APPLIED TO THIS DOCUMENT.)

INFORMED CONSENT for a Research Study entitled "PSYCHOSOCIAL AND BUILT ENVIRONMENT FACTORS ASSOCIATED WITH PHYSICAL ACTIVITY IN WORKING WOMEN"

You are invited to participate in a research study to examine how the built environment and personal factors contribute to helping working women be physically active. Specifically, the data will be used to assess the factors that help working women achieve regular physical activity. The study is being conducted by Nancy Gell, a graduate student, under the direction of Danielle Wadsworth, Assistant Professor, in the Auburn University Department of Kinesiology. You were selected as a possible participant because you are a female who is employed at least 30 hours/week, live in Auburn or Opelika, AL and are age 19 or older.

What will be involved if you participate? You will be asked to complete a health history form, personal and family demographic questions (for example: age, education level, occupation, number of children), and a questionnaire to assess self efficacy to perform exercise, self-regulation strategies, outcome expectancies, perception of the environment being supportive of physical activity, social support and exercise history. Physical activity and location information will be collected over 1 week with an accelerometer and a global positioning system (GPS) device. Accelerometers are small devices that are attached to a belt or clip and need to be worn at the waist/hip area. These devices record activity counts and the total number of steps accumulated over the course of each minute the device is worn. The GPS unit continuously records your position on the face of the earth (in latitude and longitude) as you move about during the day. We are asking you to wear this unit so that we can learn more about what environments women are physically active in. You will be asked to wear the accelerometer and the GPS unit for a total of seven (7) continuous days during all waking hours. You will be asked to provide your cell phone number to the principal investigator (Nancy Gell). Participants agree to receive reminder emails, phone calls and/or text messages to their personal mobile phone and incur all costs associated with receiving reminders via text message. You should expect to receive approximately 7-14 messages (either email, voice, or text) over 7 days as part of the project. You will also be asked to record the mode of activities you engaged in (for example walking, aerobics, biking, exercise machines, etc) and the time of day the devices were first put on and last taken off.
Your total time commitment will be approximately 2 hours.

Are there any risks or discomforts? There are no foreseeable risks or discomforts associated with participating in this study. To preserve confidentiality, all names and other recognizable information will be removed from all information collected (i.e., data will be recorded confidentially).

301 Wire Road
Telephone: 334-844-4483
Fax: 334-844-1467
www.auburn.edu

Participant's initials ________ Page 1 of 2

Are there any benefits to yourself or others? If you participate in this study, you can expect to be provided with written feedback on current activity levels and exercise regimens. It is anticipated that the results of this project can be used to guide interventions targeted to help sedentary women overcome barriers to regular physical activity. We cannot promise you that you will receive any or all of the benefits described

Will you receive compensation for participating? To thank you for your time, once you complete data collection you will be entered in a raffle for the following: $50 Visa gift card (2 available), body composition analysis via DEXA scan (10 available), Tigerfit Fitness Assessment (2 available). The anticipated odds of winning are approximately 1 in 7.

Are there any costs? There are no costs for participating in the research study.

If you change your mind about participating, you can withdraw at any time during the study. Your participation is completely voluntary. If you choose to withdraw, your data can be withdrawn as long as it is identifiable. Your decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University or the Department of Kinesiology.

Your privacy will be protected. Any information obtained in connection with this study will remain confidential. The data collected will be protected by securing the data on a password protected computer. Information obtained through your participation may be used for publication and presentation but will be reported anonymously and in aggregate.

If you have questions about this study, *please ask them now or* contact Nancy Gell at 334-844-4483 or gellnan@auburn.edu or Dr. Danielle Wadsworth (334-844-1836 or wadswdd@auburn.edu). A copy of this document will be given to you to keep.

If you have questions about your rights as a research participant, you may contact the Auburn University Office of Human Subjects Research or the Institutional Review Board by phone (334)-844-5966 or e-mail at hsubjec@auburn.edu or IRBChair@auburn.edu.

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE WHETHER OR NOT YOU WISH TO PARTICIPATE IN THIS RESEARCH STUDY. YOUR SIGNATURE INDICATES YOUR WILLINGNESS TO PARTICIPATE.

Participant's signature Date Investigator obtaining consent Date

Printed Name Printed Name

Co-Investigator Date Printed Name

The Auburn University Institutional Review Board has approved this document for use from 1/3/12 to 1/2/13 Protocol # 11-377 EP 1201

AUBURN
UNIVERSITY

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Participant's initials __________

Are there any benefits to yourself or others? If you participate in this study, you can expect to be provided with written feedback on current activity levels and exercise regimens. It is anticipated that the results of this project can be used to guide interventions targeted to help sedentary women overcome barriers to regular physical activity. We cannot promise you that you will receive any or all of the benefits described

Will you receive compensation for participating? To thank you for your time, once you complete data collection you will be entered in a raffle for the following: $50 Visa gift card (2 available), body composition analysis via DEXA scan (10 available), Tigerfit Fitness Assessment (2 available). The anticipated odds of winning are approximately 1 in 7.

Are there any costs? There are no costs for participating in the research study.

If you change your mind about participating, you can withdraw at any time during the study. Your participation is completely voluntary. If you choose to withdraw, your data can be withdrawn as long as it is identifiable. Your decision about whether or not to participate or to stop participating will not jeopardize your future relations with Auburn University or the Department of Kinesiology.

Your privacy will be protected. Any information obtained in connection with this study will remain confidential. The data collected will be protected by securing the data on a password protected computer. Information obtained through your participation may be used for publication and presentation but will be reported anonymously and in aggregate.

If you have questions about this study, *please ask them now or* contact Nancy Gell at 334-844-4483 or gellnan@auburn.edu or Dr. Danielle Wadsworth (334-844-1836 or wadswdd@auburn.edu). A copy of this document will be given to you to keep.

If you have questions about your rights as a research participant, you may contact the Auburn University Office of Human Subjects Research or the Institutional Review Board by phone (334)-844-5966 or e-mail at hsubjec@auburn.edu or IRBChair@auburn.edu.

HAVING READ THE INFORMATION PROVIDED, YOU MUST DECIDE WHETHER OR NOT YOU WISH TO PARTICIPATE IN THIS RESEARCH STUDY. YOUR SIGNATURE INDICATES YOUR WILLINGNESS TO PARTICIPATE.

Participant's signature	Date	Investigator obtaining consent	Date
Printed Name		Printed Name	
Co-Investigator	Date	Printed Name	

The Auburn University Institutional Review Board has approved this document for use from 1/3/12 to 1/2/13 Protocol # 11-377 EP 1201

Appendix B: Questionnaire

1. Date of Birth:_____________

2. Height:__________________

3. Weight:__________________

4. Do you smoke? ☐Yes ☐No

5. Have you been diagnosed with high blood pressure? ☐Yes ☐No

6. Have you been diagnosed with diabetes? ☐Yes ☐No

7. How often do you visit a physician?

☐Once a year ☐Twice a year ☐Three times a year ☐Once a month

☐Other_________

8. Do you have or have you had any disease or condition requiring medication, regular physician's care, surgery, or other treatment? ☐Yes ☐No

If yes, please list: ____
____

9. Do you take any medication(s) on a regular, on-going basis? ☐Yes ☐No

If yes, please list: ____
____

10. Occupation:____

11. Employer:____

12. Average number of hours/week at work:______________________

13. Number of years employed:___________________

14. Spouse/Partner: ☐Yes ☐No

15. Do you have children: ☐Yes ☐No If Yes: How Many? ________
Ages:___________________

16. Childcare (Mark all that apply): ☐ N/A ☐ Within your home ☐ Childcare Facility

☐ After school program ☐Other:______________________

17. What is the highest level of education that you have completed?

☐ 12th grade or less (did not graduate high school)
☐ High School graduate or equivalent
☐ Some college, but no degree
☐ Associates Degree, two-year degree (academic or occupational)
☐ Bachelors Degree, four-year degree
☐ Graduate or Professional Degree

18. In which group do you consider yourself?

☐ White, Non-Latino
☐ Asian, Pacific Islander
☐ Black, African-American
☐ Native American (American Indian)
☐ Hispanic, Latino
☐ Other (specify) ___________________________________

19. Were you encouraged by your family to be active while growing up?

☐ Never ☐ Rarely ☐ Sometimes ☐ Often

20. Did you participate in **recreational** sports/activity programs during **elementary school** years? (For example: Ballet, Gymnastics, and Swimming)

☐ Never ☐ Rarely ☐ Sometimes ☐ Often

If Yes, please list the sports/activities: ____
____

21. Did you participate in **competitive** sports/activity programs during **elementary school** years? (For example: Soccer, Baseball, Softball, Tennis)

☐ Never ☐ Rarely ☐ Sometimes ☐ Often

If Yes, please list the sports/activities: ____
____

22. Did you participate in **recreational** sports/activity programs during **high school**?

☐ Never ☐ Rarely ☐ Sometimes ☐ Often

If Yes, please list the sports/activities: ____
____

23. Did you participate in **competitive** sports/activity programs during **high school**?

☐ Never ☐ Rarely ☐ Sometimes ☐ Often

If Yes, please list the sports/activities: ____
____

24. Did you participate in **recreational** sports/activity programs during **college**?

☐ Never ☐ Rarely ☐ Sometimes ☐ Often

☐Not Applicable

If Yes, please list the sports/activities: ____
____

25. Did you participate in **competitive** sports/activity programs during **college**?

☐ Never ☐ Rarely ☐ Sometimes ☐ Often ☐Not Applicable

If Yes, please list the sports/activities: ____
____

26. Do you currently exercise at a facility outside of home? ☐ Yes ☐ No

If Yes, what is the name of the facility? ________________________________

27. Do you use exercise equipment at home? ☐ Yes ☐ No

If Yes, please list the exercise equipment you use at home:
____
____

28. Do you use exercise videos/DVDs at home? ☐ Yes ☐ No

29. What forms of transportation do you use to get to and from work? (mark all that apply) and how many days per week do you use each?

☐ car /auto _______ days

☐ walk _______ days

☐ bicycle _______ days

☐ other please specify __________ _______ days

30. Shops, stores, and markets are within easy walking distance of my home:

☐ Yes ☐ No

31. My **neighborhood** has free or low-cost recreation facilities, such as parks, walking trails, bike paths, recreation centers, playgrounds, public swimming pools, etc.

☐ Yes ☐ No

32. My **worksite** has free or low-cost recreation facilities, such as walking trails, bike paths, fitness facilities, recreation centers, etc.

☐ Yes ☐ No

33. There are sidewalks on most of the streets in my neighborhood:

☐ Yes ☐ No

34. The crime rate in my neighborhood makes it unsafe to walk at night:

☐ Yes ☐ No

For each of the following questions, please mark Yes or No. Physical activity or exercise includes activities such as walking briskly, jogging, bicycling, swimming, or any other activity in which the exertion is at least as intense as these activities.

36A. I am currently physically active. ☐ Yes ☐ No

36B. I intend to become more physically active in the next six months. ☐ Yes

☐ No

For activity to be **regular**, it must add up to a total of 30 minutes or more per day and be done at least five days per week. For example, you could take one 30-minute walk or take three 10-minute walks for a total of 30 minutes.

37A. I currently engage in **regular** physical activity. ☐ Yes ☐ No

37B. I have been **regularly** physically active for the past six months. ☐ Yes ☐ No

Part B. EXERCISE CONFIDENCE SURVEY

Below is a list of things people might do while trying to increase or continue regular exercise. We are interested in exercises like running, swimming, brisk walking, bicycle riding, or aerobics classes.

Whether you exercise or not, please rate how confident you are that you could really motivate yourself to do things like these consistently, for at least six months.

Please circle one number for each question.

How sure are you that you can do these things?	I know I cannot		Maybe I can		I know I can	**Does not apply**
38. Get up early, even on weekends, to exercise	1	2	3	4	5	N/A
39. Stick to your exercise program after a long, tiring day at work	1	2	3	4	5	N/A
40. Exercise even though you are feeling depressed	1	2	3	4	5	N/A
41. Set aside time for a physical activity program; that is, walking, jogging, swimming, biking, or other continuous activities for at least 30 minutes, 3 times per week	1	2	3	4	5	N/A
42. Continue to exercise with others even though they seem too fast or too slow for you	1	2	3	4	5	N/A
43. Stick to your exercise program when undergoing a stressful life change (e.g., divorce, death in the family, moving)	1	2	3	4	5	N/A
44. Attend a party only after exercising	1	2	3	4	5	N/A
45. Stick to your exercise program when your family is demanding more time from you	1	2	3	4	5	N/A
46. Stick to your exercise program when you have household chores to attend to	1	2	3	4	5	N/A
47. Stick to your exercise program even when you have excessive demands at work	1	2	3	4	5	N/A
48. Stick to your exercise program when social obligations are very time consuming	1	2	3	4	5	N/A
49. Read or study less in order to exercise more	1	2	3	4	5	N/A

Part C. People use various techniques to help them exercise on a regular basis. Recalling your exercise activities performed in the last four (4) weeks, please answer the following questions regarding techniques you may have used to help you exercise. If you did not exercise during this time period, select "never".
On the scale provided next to each item, circle the number that best represents how often you used the specified technique in the past four (4) weeks.

	Never	**Rarely**	**Some times**	**Often**	**Very Often**
50. I mentally kept track of my exercise activities.	1	2	3	4	5
51. I mentally noted specific things that helped me exercise.	1	2	3	4	5
52. I established short term goals (daily or weekly) related to how often I exercise.	1	2	3	4	5
53. I established exercise goals that focused on my health (e.g. improved fitness).	1	2	3	4	5
54. I asked someone for advice or demonstration of exercise activities.	1	2	3	4	5
55. I asked an exercise expert/health professional for advice or demonstration of exercise activities.	1	2	3	4	5
56. After I exercised, I focused on how good I felt.	1	2	3	4	5
57. I reminded myself of positive health benefits of exercise (e.g. lose weight, tone body).	1	2	3	4	5
58. I mentally schedule my time periods to exercise.	1	2	3	4	5
59. I rearranged my schedule of other activities to ensure I had time to exercise.	1	2	3	4	5
60. I purposely planned ways to exercise when I was on trips away from home.	1	2	3	4	5
61. I purposely planned ways to exercise during bad weather.	1	2	3	4	5

Part D

Please complete the phrase I exercise to . . . for each item. Please circle a number that represents how often (FREQUENCY) ***and*** the value (IMPORTANCE) for each item:

EXAMPLE:	FREQUENCY					IMPORTANCE		
I exercise to:	never	rarely	some times	often	very often	low value	med value	high value
Build muscle strength	1	2	(3)	4	5	1	2	(3)
	FREQUENCY					IMPORTANCE		
I exercise to:	never	rarely	some times	often	very often	low value	med value	high value
62. Improve my health	1	2	3	4	5	1	2	3
63. Stay in shape	1	2	3	4	5	1	2	3
64. Release tension	1	2	3	4	5	1	2	3
65. Maintain/lose weight	1	2	3	4	5	1	2	3
66. Enhance my self-image and appearance	1	2	3	4	5	1	2	3
67.Improve my physical attractiveness	1	2	3	4	5	1	2	3
68. Feel a positive psychological effect	1	2	3	4	5	1	2	3
69. Experience a sense of accomplishment	1	2	3	4	5	1	2	3
70. Enjoy the activity	1	2	3	4	5	1	2	3
71. Improve metal alertness	1	2	3	4	5	1	2	3
72. Cope with life's pressures	1	2	3	4	5	1	2	3
73. Have fun/enjoyment	1	2	3	4	5	1	2	3

	FREQUENCY					IMPORTANCE		
I exercise to:	never	rarely	some times	often	very often	low value	med value	high value
74. Feel younger	1	2	3	4	5	1	2	3
75. Spend time with friends	1	2	3	4	5	1	2	3
76. Be a member of a team	1	2	3	4	5	1	2	3
77. To earn the respect of others for my skills	1	2	3	4	5	1	2	3
78. Spend time with family	1	2	3	4	5	1	2	3
79. Feel the thrill of victory	1	2	3	4	5	1	2	3
80. Feel the thrill of competition	1	2	3	4	5	1	2	3

You are MORE than half-way done. Great Job!

Part E. SOCIAL SUPPORT AND EXERCISE SURVEY

Below is a list of things people might do or say to someone who is trying to exercise regularly. Please rate each question twice. Under family, rate how often anyone living in your household has said or done what is described during the last three months. Under friends, rate how often your friends, acquaintances, or coworkers have said or done what is described during the last three months.

Please write *one* number from the following rating scale in each space:

None	Rarely	A few times	Often	Very often	Does not apply
1	2	3	4	5	NA

During the past three months, my family (or members of my household) or friends:

	Family	Friends
81. Exercised with me		
82. Offered to exercise with me		
83. Gave me helpful reminders to exercise ("Are you going to exercise tonight?)		
84. Gave me encouragement to stick with my exercise program		
85. Changed their schedule so we could exercise together		
86. Discussed exercise with me		
87. Complained about the time I spend exercising		
88. Criticized me or made fun of me for exercising		
89. Gave me rewards for exercising (Bought me something or gave me something I like)		
90. Planned for exercise on recreational outings		
91. Helped plan activities around my exercise		
92. Asked me for ideas on how they can get more exercise		
93. Talked about how much they like to exercise		

Part F. Please indicate which of these items are available at your work. Please circle an answer for each item.

	Yes	**No**	**Don't Know**
94. Exercise facilities (e.g. workout room/gym, exercise equipment, walking path/PAR course)	□	□	□
95. Regular exercise programs (e.g. aerobic classes, team sports, walking groups, etc.)	□	□	□
96. Shower facilities that you can use	□	□	□
97. Safe bicycle storage	□	□	□
98. An exercise specialist or activity coordinator available for employees	□	□	□
99. Policies that encourage exercise or biking	□	□	□
100. Employer provides paid time for you to exercise	□	□	□
101. Employer offers incentives to be physically active	□	□	□

102. If you answered yes to the previous question, please check the following programs that are offered to you and which of these programs you have used or participated in, in the past year:

☐ Not Applicable

	Program Offered	Program Used
Reduced health insurance premiums	☐	☐
Subsidized gym membership	☐	☐
Seasonal programs	☐	☐
Programs with cash or other prize incentives	☐	☐
Other: ____________________________	☐	☐

Almost There!! Keep it up ☺

Part G. We would like to find out more information about the way that you perceive or think about your neighborhood. Please answer the following questions about your neighborhood and yourself. Please answer as honestly and completely as possible and provide only one answer for each item. There is no right or wrong answer and your information is kept confidential.

Part 1. Stores, facilities, and other things in your neighborhood
About how long would it take to get from your home to the nearest businesses or facilities listed below if you **walked** to them? Please put only one check mark (√) for each business or facility.

	1-5 min	6-10 min	11-20 min	21-30 min	31+ min	don't know
example: gas station				√		
103. convenience/small						
104. grocery store						
105. supermarket						
106. laundry/dry cleaners						
107. hardware store						
108. clothing store						
109. fruit/vegetable market						
110. post office						
111. library						
112. elementary school						
113. other schools						
114. book store						
115. fast food restaurant						
116.coffee place						
117. bank/credit union						
118. non-fast food restaurant						
119. video store						
120. pharmacy/drug store						
121. your job						
122. park						
123. recreation center						
124. gym or fitness facility						

Access to services: Please mark the answer that best applies to you and your neighborhood. Both local and within walking distance mean within a 10-15 minute walk from your home.

	1	2	3	4
	strongly disagree	somewhat disagree	somewhat agree	strongly agree
125. Stores are within easy walking distance of my home.	□	□	□	□
126. There are many places to go within easy walking distance of my home	□	□	□	□
127. The streets in my neighborhood are hilly, making my neighborhood difficult to walk in.	□	□	□	□
Streets in my neighborhood: Please mark the answer that best applies to you and your neighborhood.				
	1	2	3	4
	strongly disagree	somewhat disagree	somewhat agree	strongly agree
128. The distance between intersections in my neighborhood is usually short (100 yards or less; the length of a football field or less).	□	□	□	□
129. 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.)	□	□	□	□
Places for walking and cycling: Please mark the answer that best applies to you and your neighborhood.				
	1	2	3	4
	strongly disagree	somewhat disagree	somewhat agree	strongly agree
130. There are sidewalks on most of the streets in my neighborhood.	□	□	□	□
131. My neighborhood streets are well lit at night.	□	□	□	□
132. Sidewalks are separated from the road/traffic in my neighborhood by parked cars.	□	□	□	□
133. There is a grass/dirt strip that separates the streets from the sidewalks in my neighborhood.	□	□	□	□
Neighborhood surroundings: Please mark the answer that best applies to you and your neighborhood				
	1	2	3	4
	strongly disagree	somewhat disagree	somewhat agree	strongly agree
134. There are trees along the streets in my neighborhood.	□	□	□	□

135. There are many interesting things to look at while walking in my neighborhood.	□	□	□	□
136. My neighborhood is generally free from litter.	□	□	□	□
137. There are many attractive natural sights in my neighborhood (such as landscaping, views).	□	□	□	□
138. There are attractive buildings/homes in my neighborhood.	□	□	□	□
Safety from traffic: Please mark the answer that best applies to you and your neighborhood.				
	1	2	3	4
	strongly disagree	somewhat disagree	somewhat agree	strongly agree
139. There is so much traffic along nearby streets that it makes it difficult or unpleasant to walk in my Neighborhood	□	□	□	□
140. The speed of traffic on most nearby streets is usually slow (30 mph or less).	□	□	□	□
141. Most drivers exceed the posted speed limits while driving in my neighborhood.	□	□	□	□
142. There are crosswalks and pedestrian signals to help walkers cross busy streets in my neighborhood.	□	□	□	□
Safety from crime: Please mark the answer that best applies to you and your neighborhood.				
	1	2	3	4
	strongly disagree	somewhat disagree	somewhat agree	strongly agree
143. There is a high crime rate in my neighborhood.	□	□	□	□
144. The crime rate in my neighborhood makes it unsafe to go on walks during the day.	□	□	□	□
145. The crime rate in my neighborhood makes it unsafe to go on walks at night.	□	□	□	□

Appendix C—Written Instructions for Accelerometer and GPS

Instructions for wearing the Accelerometer

This small activity meter records general movement and allows us to get a better idea of your overall activity level. We will **not** be able to tell what kind of specific activity is happening. At first, the belt may feel slightly awkward, but after a few hours, you will probably get used to it and not notice it as much. It is **extremely** important for our study that you wear the accelerometer properly. Please follow these instructions carefully:

1. Wear the meter attached to the belt around your waist, just above your **right** hipbone. You can wear it either underneath or on top of your clothing.

2. Wear the meter **snug** against your body. If you have to, you can adjust the belt by pulling the end of the strap to make it tighter. Or, to loosen the belt, push more of the strap through the loop. **Wear the belt tight enough so that the meter does not move when you are being active.**

3. Please **put it on first thing in the morning --** either just after you get out of bed or just after you shower or take a bath in the morning.

4. Keep the activity meter on all day (unless swimming or in the water).

5. At night, **take it off right before you go to bed**.

6. Do not let anyone else wear it.

7. There is no “ON” or “OFF” switch that you need to worry about turning on or off every day. The activity meter runs on a battery and is programmed to run continuously without you needing to turn it on. Please do not try to open the activity meter.

8. Do not wash the monitor or the belt. The belts will be cleaned when they are returned.

Questions? Call or text (334) 559-4321 If there is no answer, please leave a message and your call will be returned.

<u>Instructions for wearing and charging the GPS</u>

GPS refers to Global Positioning System. The GPS unit will continuously record your position on the face of the earth as you move about during the day. We are asking you to wear this unit so that we can learn more about what environments people are physically active in. Here is a list of things that will help you remember what to do:

1. The Auburn Researcher will assist you to ensure that your device is turned on and working at each of your scheduled appointments.
2. Take the unit with you wherever you go.

3. Clip the unit directly to your clothing or movement meter belt, or carry it in your pocket, backpack or purse.

4. Don't let the GPS device get wet or bumped hard.

You must charge the GPS battery each evening.
1. Charge the GPS unit near your cell phone so that you remember to pick it up in the morning.

2. You can leave the GPS device in its pouch while charging.

3. Use the cable provided.

4. Plug the cable into the slot on the side of the GPS device (there is only 1 slot).

5. A green light indicates the battery is in charging mode

6. You do not need to move any switches on the device while charging.

HOW TO WEAR THE DEVICE BELT

RED device BLACK device

For this study we will ask you to wear 2 devices attached to a belt.

- the **RED device** measures the movement of your hips;
- the **BLACK device** measures location, speed and the distance you travel.

At first the belt may feel slightly awkward, but most people soon forget about it. It's extremely important that you wear the device belt whenever you are awake.

WEAR the device belt. . .

for AT LEAST 12 hours a day

Proper Placement

The belt should be worn snug around your waist either over or under your clothing (whichever is more comfortable).

1. Position the **RED device** just above your RIGHT hip bone. (RED = RIGHT)
2. Position the **BLACK device** just above your LEFT hip bone. (BLACK = LEFT)

You can check the correct placement of both devices by letting your arms hang down by your sides. Each device should be in line with your arms, just touching your forearms

REMOVE the device belt. . .

for water based activities

when you go to bed at night

Tips for Wearing the Device Belt

- **Put it on first thing in the morning** -- either just after you get out of bed or just after you shower or take a bath in the morning.
- **Do not get it wet** (take it off while swimming, bathing, etc.)
- At night, take it off right before you go to bed and **charge the BLACK device.**
- There is no "ON" or "OFF" switch on either device.
- **Wear the belt for at least 12 hours every day** for the entire week. (If it is not worn long enough we will ask you to re-wear it).
- **Do not let anyone else wear the belt.** The devices have been programmed to work on you.

CHARGE the BLACK device . . .

Every night

Plug device into charger Plug charger into outlet

Charging the BLACK Device (every night)

- Leave the BLACK device on the belt inside the case.
- Plug charger into outlet and plug device into charger.
- In the morning, unplug the device from the charger.

What To Do if You Have Questions

- **Call us at (858) 822-3311**, if you have any questions.
- Please leave a message if you reach the voice mail, and someone will return your call.

Appendix D—Activity, Accelerometer, and GPS Log

Device and Activity Log

Wear both devices for seven (7) consecutive days. If you are unable to wear both devices for seven (7) consecutive days, add additional days at the end of the week. Please fill out the log daily. An example entry is provided. If you take the accelerometer or GPS off for more than 5 minutes, such as showering, record when you take it off and put it back on, and any activity you performed while not wearing.

Questions? Just call or text: 334-559-4321 or email: gellnan@auburn.edu

	Time On:	Time Off:	Activity while not wearing:	Location:	Charge GPS? (√)
Example	6:00 am	7:00 am	Showered and changed after walking in a.m.	home	9-11am
	7:30	9:30 pm			
	Exercise performed: walked				

	Time On:	Time Off:	Activity while not wearing:	Location:	Charge GPS? (√)
Day 1					
	Exercise performed:				

<table>
<tr><td rowspan="5">Day 2</td><td>Time On:</td><td>Time Off:</td><td>Activity while not wearing:</td><td>Location:</td><td>Charge GPS? (√)</td></tr>
<tr><td></td><td></td><td></td><td></td><td rowspan="4"></td></tr>
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<tr><td></td><td colspan="5">Exercise performed:</td></tr>
</table>

<table>
<tr><td rowspan="5">Day 3</td><td>Time On:</td><td>Time Off:</td><td>Activity while not wearing:</td><td>Location:</td><td>Charge GPS? (√)</td></tr>
<tr><td></td><td></td><td></td><td></td><td rowspan="4"></td></tr>
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<tr><td></td><td></td><td></td><td></td></tr>
<tr><td></td><td colspan="5">Exercise performed:</td></tr>
</table>

	Time On:	Time Off:	Activity while not wearing:	Location:	Charge GPS? (√)
Day 4					
	Exercise performed:				

You're more than half way! Great job-just 3 more days to go

	Time On:	Time Off:	Activity while not wearing:	Location:	Charge GPS? (√)
Day 5					
	Exercise Performed:				

<table>
<tr><td rowspan="5">Day 6</td><td>Time On:</td><td>Time Off:</td><td>Activity while not wearing:</td><td>Location:</td><td>Charge GPS? (√)</td></tr>
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</table>

<table>
<tr><td rowspan="5">Day 7</td><td>Time On:</td><td>Time Off:</td><td>Activity while not wearing:</td><td>Location:</td><td>Charge GPS? (√)</td></tr>
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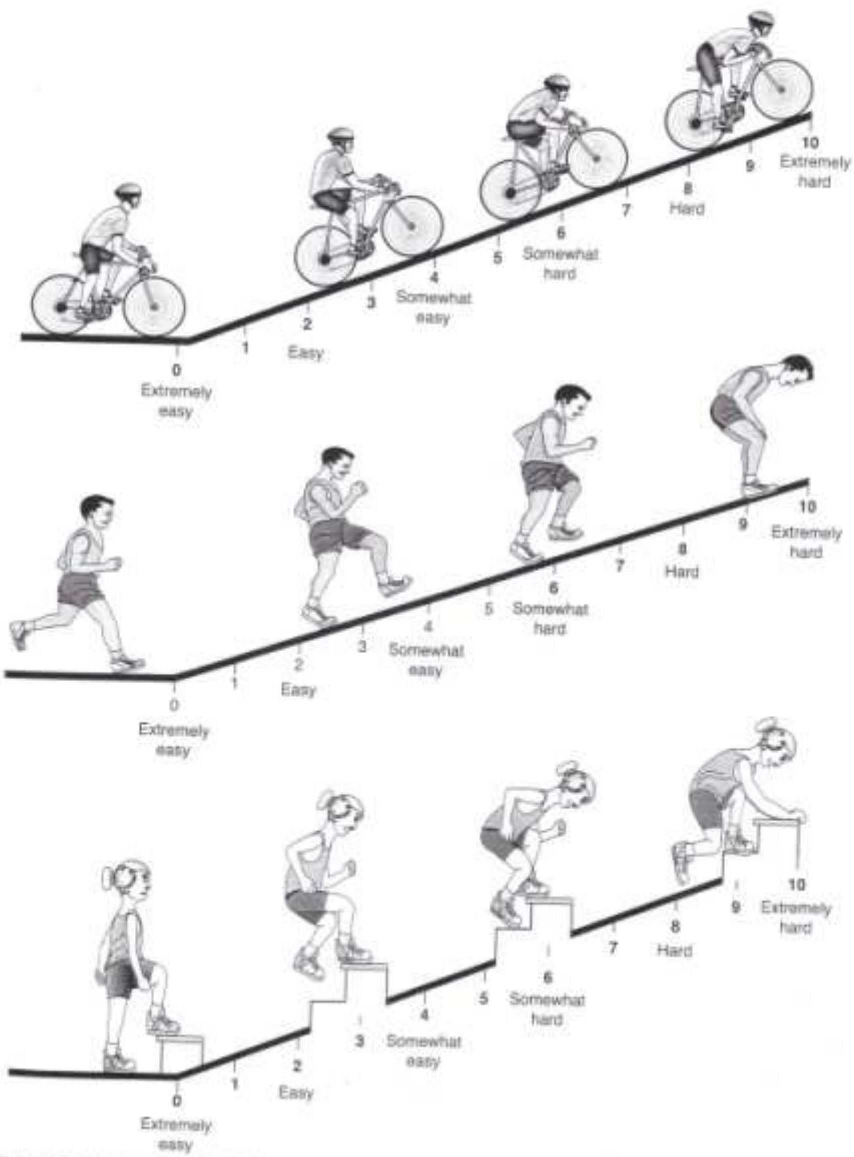
<tr><td></td><td colspan="5">Exercise performed:</td></tr>
</table>

Great Job! All Done ☺

Appendix E. Omni Scale for Rating of Perceived Exertion

OMNI RPE Scales



[illegible]

APPENDIX B.4

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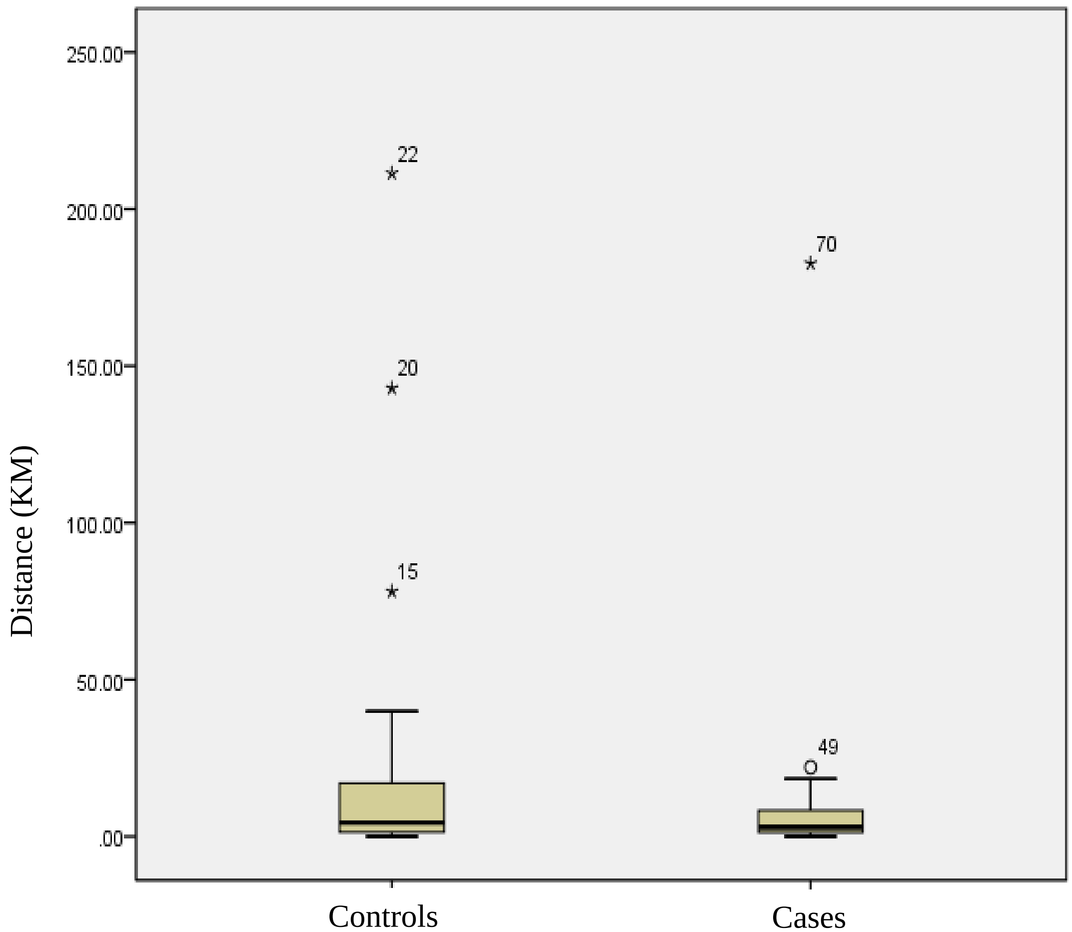
Appendix F. Types of Exercise Performed by Cases (n=41)

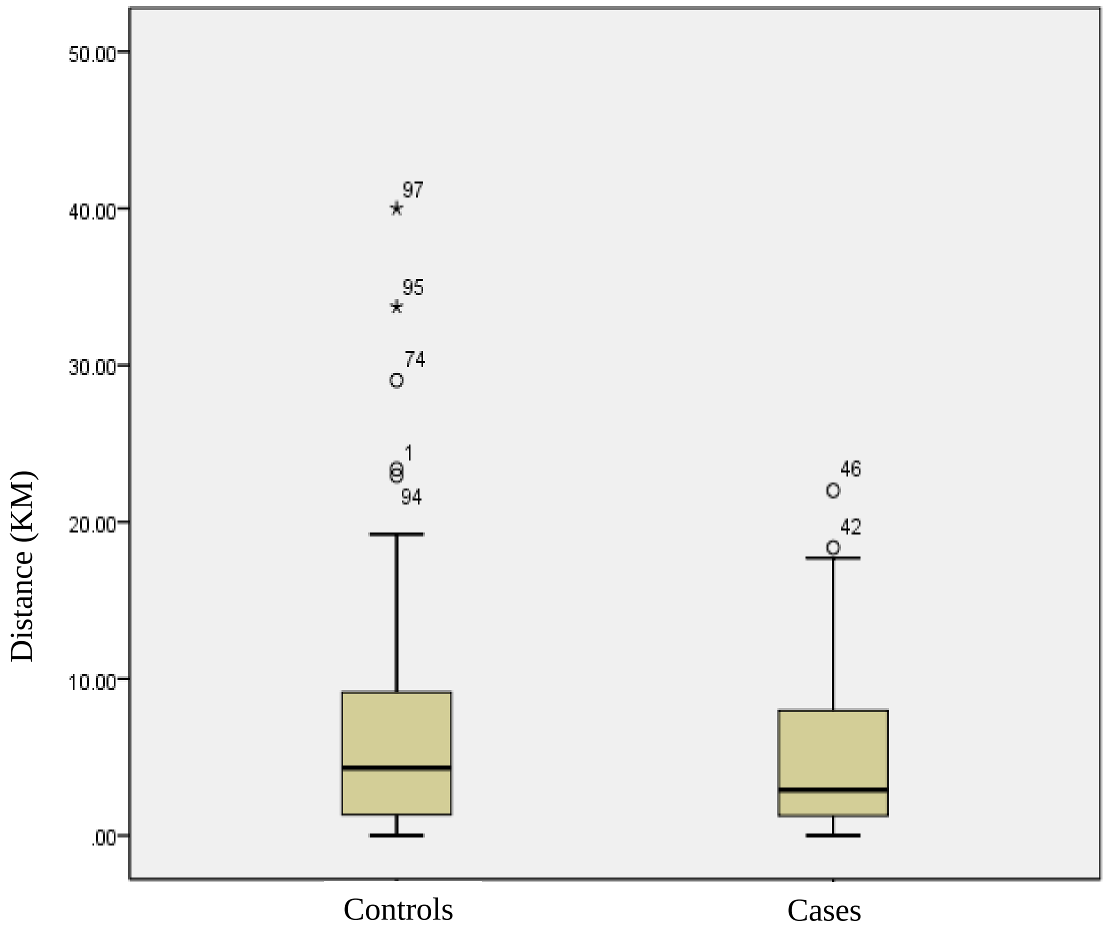
Exercise	**Number of Cases**
Walking	25
Running/Jogging	17
Weight Lifting	11
Elliptical	9
RPM/Spin Class	6
Tennis	5
Yoga	5
Circuits	5
Yard work	5
Treadmill	4
Zumba	4
Body Pump	4
Recumbent bike	3
Swim	3
Outdoor cycling	3
Body Combat	3
Boot Camp	2
Water Aerobics	2
Personal Training	2
Pilates	2
Stair Climbing	2
"Ripped" class	1
Rowing Machine	1
Step Aerobics	1
Hiking	1
Hula Hoop	1
Kettlebells	1
Kickball	1

Appendix G

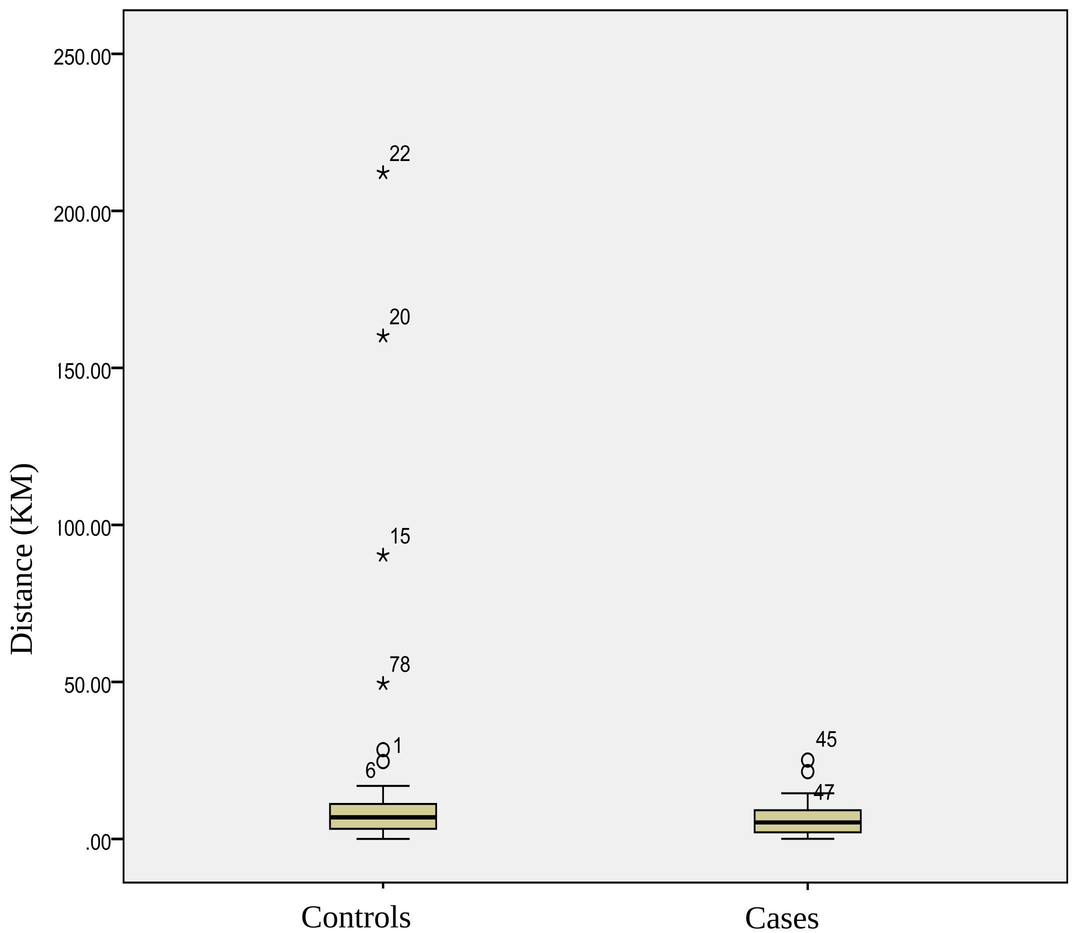
Boxplot of Average Distance between Home and MVPA locations for All Cases and Controls



Boxplot of Average Distance between Home and MVPA Locations with Outliers Removed



Boxplot of Average Distance between Work and MVPA Locations for All Cases and Controls



Boxplot of Average Distance between Work and MVPA locations with Outliers Removed