The Built Environment, Walking, and Physical Activity: A Comparison between Korean Immigrants and Caucasian Women in King County, WA

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Abstract

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The number of immigrants is continuously increasing in the U.S., and their rapid weight gain over time since entering this country has become a serious health concern. Immigrant and ethnic minority women have been shown to be a physically inactive group compared to non-immigrant and non-Hispanic white women. However, the findings were based on self-reported physical activity (PA) measures and did not consider all types of PA. Studies on park use have found that ethnic minorities were observed to be more sedentary at public parks than white park users, but these were not adjusted for important covariates such as socio-economic status. By comparing Korean immigrant women and Caucasian women, differences in PA and park use behaviors between the two ethnic women groups were investigated. In addition, previous studies on the effect of acculturation on PA by immigrants have shown mixed findings, and the effect of acculturation on PA is still unclear. To explore the association between acculturation and obesity-related behaviors, Korean immigrant women's behaviors were examined.

In this study, the intensity and the location of the activity were assessed by accelerometer for every 30-second epoch and with GPS devices at 30-second intervals during waking time for seven consecutive days. The participants were also asked to complete a seven-day travel diary and a questionnaire. A convenience sample of 60 Korean immigrant women and a matching sample of 69 Caucasian women in the Seattle metropolitan area showed that Caucasian women overall are more active than Korean women; they engage in more minutes of moderate-to-vigorous physical activity (MVPA) and of walking per day on average. Multivariate models demonstrate that there is an independent effect of race per se on physical activity among women. Regarding park behaviors, adjusted estimates indicate no racial effect on park visitation and on MVPA at parks. The differences in park-based MVPA were explained by other factors that had not been controlled in previous studies, such as perceived barriers to PA.

Acculturation is negatively associated with Korean immigrant women's walking, but has null association with MVPA at parks and driving time. Their travel behavior already seems to be assimilated to that of typical Americans, but their walking has not increased to the level of their Caucasian counterparts commensurate with their acculturation. Some immigrants who have lived in the U.S. for a long time might nevertheless interact infrequently with the mainstream culture, and they are therefore less likely to assimilate to the mainstream.

This study serves as a pilot to examine behavioral patterns of Korean immigrant and Caucasian women. MVPA, walking, park use, and driving behaviors can explain important aspects of their lifestyles. If expanded, its interdisciplinary framework between urban planning and public health could contribute to policy formation to promote active living and healthy communities for minorities, immigrants, and for all groups of the population. Further studies are needed in order to produce tailored approaches for minority and immigrant populations.

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Chapter 1 Introduction

Background

In the United States, the number of immigrants is continuously increasing, and the foreign-born population is now 13% of the total population (U.S. Census Bureau, 2010). The growth rate is even more noteworthy: a 28.4% growth rate in the immigrant population from 2000 to 2010, compared with a 9.9% growth rate in the U.S. population as a whole (calculated from U.S. Census Bureau 2000 Summary File 3 and 2010 American Community Survey). Among these immigrants, a trend in the rise of obesity is a public health concern. These immigrants initially came to the U.S. with normal weight and good health conditions, but as they stayed, they gained weight faster than their native counterparts. After 10-15 years, their Body Mass Index (BMI) converges to the BMI levels of their native counterparts. This is called "Unhealthy Assimilation" (Antecol & Bedard, 2006). Most literature shows that the length of residence in the U.S. is positively associated with an increase in BMI (Goel, McCarthy, Phillips, & Wee, 2004), and that those who arrived at an earlier age were more likely to become obese (Kaushal, 2009). In addition, foreign-born residents tend to be less obese than their U.S.-born counterparts (Park, Myers, Kao, & Min, 2009). This implies that some sort of health-related behavioral changes might have occurred over time among immigrants since they entered the U.S.

The possible behavioral factors of this unhealthy assimilation among immigrants could include changes in physical activity, travel behavior, diet, and other changes in lifestyles. Physical inactivity, a more automobile-oriented lifestyle, and a poor diet with more fat and

fewer vegetables and fruits are some behavioral features that are likely to be shared by a majority of Americans, as compared to residents in other countries (Popovic-Lipovac & Strasser, 2013; Gilbert & Khokhar, 2008; Pucher & Dijkstra, 2003; Guiliano & Dargay, 2006; Buehler, 2010.). Among these behaviors, changes in dietary habits among immigrants have been relatively well studied and, in particular, for European countries and Canada. In a study of Chinese immigrants, the degree to which they assimilated western eating habits was significantly associated with higher-fat dietary behavior and there was good agreement between the dietary acculturation level and standard acculturation indicators based on language use and preference (Satia et al. 2001).

However, the changes in physical activity (PA) behavior among immigrants have not been studied in any depth. New immigrant groups and ethnic minority groups have consistently been shown to engage in lower PA levels than non-immigrant or non-Hispanic white groups (He & Baker, 2005; Ransdell et al., 1998; Adabonyan et al., 2010; CDC, 2008; CDC, 2007; Simpson et al., 2003). According to national-level health survey results, PA prevalence varies by ethnicity/race in the U.S. In most of the studies, the most active group is non-Hispanic whites, while the least active groups are African-Americans and Hispanics. Asian-Americans usually fall in the middle (Adabonyan et al., 2010; CDC, 2008; CDC, 2007; Simpson et al., 2003). Table 1 shows that this disparity in PA across races has some relationship to health outcomes among women. The trend of the prevalence of obesity across race/ethnicity is opposite to that of PA prevalence by race/ethnicity. The overweight prevalence among African-American and Hispanic women is higher than that of non-Hispanic white and Asian women. Because physical inactivity is one of the important risk factors of obesity, enhancing

PA participation among ethnic groups at higher risk would help reduce disparities in obesity and chronic diseases, including diabetes, cardiovascular diseases, etc.

Table 1 The Prevalence of Obesity and PA by Race/Ethnicity among Women

Race/Ethnicity	White	African-American	Hispanic	Asian/Pacific Islander	American Indian/Alaska Native	Others
% Obesity*	23	38.4	28.9	7.8/24.3	31.9	27
% Physical Inactivity*	24	38.8	42.2	23.3/38.3	33.7	30.6
% Adequate Physical Activity**	16.9	9.4	9.5	10.3	14.9	16

*(Source: * Sundaram, Ayala, Greenlund, & Keenan (2005) using Behavioral Risk Factor Surveillance System, 2001. **Kaiser Family Foundation analysis of the Centers for Disease Control and Prevention's Behavioral Risk Factor Surveillance System Survey Data (BRFSS), 2011.)*

Based on previous findings from self-report measures, there are inter-racial differences in PA behavior and intra-racial differences among immigrants. National level surveys have consistently reported that a larger proportion of women were engaged in insufficient levels of PA than men and that their PA participation decreases with age (Schoenborn et al., 2004). Several studies have called for more attention to women's PA patterns, especially in women of color and women over age 40 (Ransdell et al., 1998; Feinleib, 1993; Henderson, 1993; Vuolle et al., 1986). In particular, immigrant women and minority women need special attention because their social environment is somewhat distinct from that of other groups. Their time engaged in family obligations is a barrier to physical activity (Johnson et al., 1990; Verhoef and Love, 1992). A study of African-American women found that women with greater social-role constraints (such as household chores and child care) possessed lower

levels of self-confidence for PA compared to those with fewer constraints (Fallon et al., 2005). Midlife minority and immigrant women have been shown to have a more discouraging social environment for PA participation compared to men (Vrazel et al., 2008). In addition, studies have found that there might be a differential impact of acculturation on overweight/obesity by gender because of women's desire for an idealized body shape (Wang et al., 2010). A separate investigation of women's PA and the role of cultural factors is needed. In order to reduce disparities in healthy behaviors across racial groups and between immigrant and non-immigrant groups and to promote physical activity at the population level, it is critical to understand the patterns and determinants of these behaviors.

Research Gaps

Based on the literature review of immigrants' and minorities' PA behaviors, three research gaps are identified and listed below, along with some research context and limitations of previous studies.

Total and specific types of PA: It is important to identify classification of types of physical activity in order to assess PA disparities and identify the source(s) of disparities in PA across races. However, many studies have focused only on leisure-time PA, and Florindo et al. (2009) suggest the possibility of overestimating the physical inactivity of women, and especially of minority women. This study of 1318 adults in Sao Paulo, Brazil, showed that women were less active in occupational, recreational, and transportation settings compared to men but more active overall and in household settings than men. Sternfeld, Ainsworth, &

Quesenberry (1999) consistently found that African-American, Asian, and Hispanic women engaged less in sports and exercise compared to white women, while Hispanics performed more household/caregiving activities than whites (OR=1.58(1.10-2.28)). According to Dogra et al. (2010), all ethnic groups and immigrants were less likely to engage in any kind of structured exercise for recreational purposes but more likely to perform active commuting than whites and non-immigrants. Berrigan et al. (2006) found that non-leisure-time walking and bicycling was highest among Latinos. Kruger et al. (2008), using the 2005 National Health Interview Survey (NHIS), provided consistent evidence that Asian/Native Hawaiian/Pacific Islander women (40.5%) were more likely to walk for transportation than other ethnic/racial groups.

The answer to the question of which group is more physically active would definitely depend on what types of physical activity were assessed. The types of PA in which middle-age minority and immigrant women tend to engage more than any other groups appear to be household PA and/or transportation-related PA, but these categories have only recently been added to the studies. Berrigan et al. (2006) has found that inclusion of transportation walking and bicycling reduces disparities in meeting the PA recommendations, although there are still significant gaps in overall PA across different racial/ethnic groups. In contrast, with adults from the ages of 51 to 61, He & Baker (2005) found that there were differences in occupational, household, and leisure-time PA by race but that the total physical activity was similar across racial/ethnic groups.

Another significant limitation of previous studies is reliance on self-reported PA measures, such as the International Physical Activity Questionnaire (IPAQ), which may induce

significant recall bias and social desirability bias. In most cases, the subjects were asked to fill out the survey at the end of the week or month by recalling the frequency and duration of their PA on average. This might have resulted in an inaccurate recall of past behaviors and an overestimation of their PA as a reflection of their desire to give positive responses and to comply with social norms (Adams et al, 2005).

The recent application of accelerometers with a global positioning system (GPS) allows us to objectively measure the intensity of physical activity and could provide better estimations of levels and types of physical activity than the self-reported data. When all types of physical activity—occupational, household, recreational, and transportation-related (Figure 1)—were objectively measured, we could empirically examine whether white women engaged in more recreational PA but less in transportation and household PA compared to ethnic/racial minority and immigrant women.

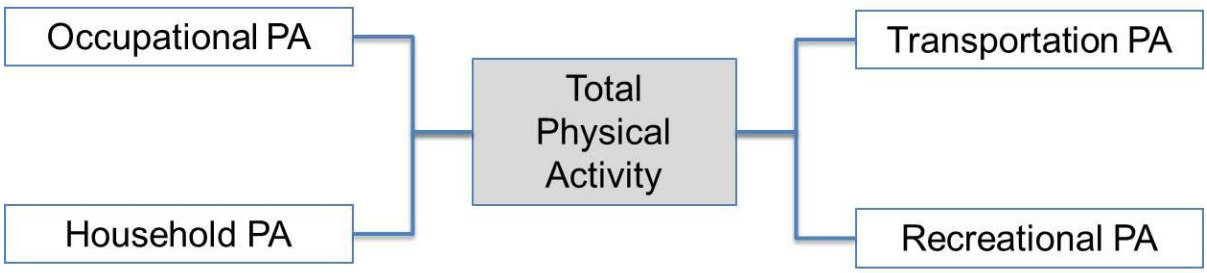


Figure 1 Four Types of Physical Activity

Park-based MVPA: Another line of research has shown that there are some important differences among ethnic groups in park use patterns. Gobster (2002) found that more Latinos and Asians were sedentary in parks than whites were; more Latinos and Asians picnic, socialize, or participate in organized activities, whereas more whites walk their dog,

jog, or bike. Whites tend to visit parks alone or with one other person and to engage in individual sports, but all minority groups are more likely to come as a group and to engage in passive and/or group activities. Two studies in Kansas City (Kaczynski et al., 2011; Kaczynski, Wilhelm Stanis, Besenyi, & Child, 2013) and a study in Chicago (Reed, Price, Grost, & Mantinan, 2012) confirmed a similar pattern. Female non-white users are less likely to be engaged in MVPA compared to other male and female white users and male non-white users. These findings imply that race/ethnicity with gender might be an important determinant of physical activity intensity in parks and open spaces.

However, there are some limitations in the previous studies showing racial differences in park-based physical activity. They relied on trained observers' direct observations and interviews of selected samples of park users. A widely used measuring method is called the System for Observing Play and Recreation in Communities (SOPARC), and trained observers also coded the intensity of physical activity as sedentary, walking, or vigorous. Even though the validity and reliability of the technique has been established (McKenzie, Cohen, Sehgal, Williamson, & Golinelli, 2006; McKenzie, 1991), objective measures of total park time and physical activity levels within parks could reduce the possibility of misclassification of the physical activity intensity category and better estimate the relationship between race and park-based physical activity. Another limitation of previous studies is that the reported relationship between race and physical activity levels at parks was not adjusted for other socio-economic factors among park users, such as age, income, and education. Without controlling for individual-level characteristics that are known to be correlated with physical activity, racial differences in park-based physical activity might be attributable to different socio-economic backgrounds across racial groups. Finally, races

other than white park users were lumped together into a non-white category or a single group, labeled "minority," which limits the distinction and investigation of diversities among subgroups. In physical activity behaviors, there are many variations across different ethnic groups. Hispanics, African-Americans, and Asians might prefer different styles of activity in parks partially due to their cultures and customs. Understanding diversity in park visitation and park use patterns among racial groups could inform park design and strategies for organized programs to promote physical activity among all groups.

Impact of acculturation on immigrants' obesity-related behaviors: Acculturation takes place when immigrants are exposed to and have interactions with "attitudes, values, customs, beliefs, and behaviors of" a foreign culture in new economic, social, and built environments (Abraido-Lanze, White, & Vasques, 2004). It is defined as the process of adapting to a host culture that often changes one's values and convictions (Liem, Lim, & Liem, 2000). Recently, a body of research has focused on the effects of acculturation on immigrants' health-related behaviors, but the findings are somewhat mixed (Perez-Escamilla & Putnik, 2007). Kandula and Lauderdale (2005) showed that among Asian-American women, the likelihood of meeting recommended leisure-time PA (LTPA) increased as years in the U.S. increased and that it was higher for those who spoke English at home. Similarly, Korean-Americans' acculturation was positively associated with light physical activity but not associated with vigorous PA (Lee, Sobal, & Frongillo, 2000). Another study on Korean descent has found a positive association between acculturation and vigorous exercise (Hofstetter et al., 2008). However, two studies, focusing on midlife Korean immigrant

women, found a null association between acculturation and leisure-time PA (Yang et al., 2007; Choi et al., 2008). The same inconsistency is also found in studies of Hispanics. Among Latinas, acculturation was positively associated with PA (Pichon et al., 2007; Jurkowski, Mosquera, & Ramos, 2010), while another study of Hispanic women found a null association between acculturation and physical activity (Banna, Kaiser, Drake, & Townsend, 2011). In addition, Afable-Munsu, Ponce, Rodriguez, & Perez-Stable (2010) found that the relationship between the immigrant generation and PA varies by ethnic group. The association between a later generation and LTPA was positive among Mexican adults but negative among Asian adults. This might suggest that the mechanisms explaining the effect of acculturation on PA could vary by ethnic group. Because the number of studies to date is limited, it is too early to make a firm conclusion about the relationship between acculturation and physical activity and its underlying mechanisms. The mixed findings were partially due to the use of inconsistent measures for physical activity and for acculturation and reliance on self-report and subjective measures. Further investigation is needed in order to examine immigrant women's physical activity patterns and their relationships to acculturation.

Whereas walking is an active form of transportation, driving is one of the sedentary behaviors that may influence obesity. Frank et al. (2004), in a study based in Atlanta, shows that each additional hour spent in a car per day is associated with a 6% increase in the likelihood of obesity, and that physical activity has negative associations with the likelihood of obesity. To examine the reasons for the increasing trend of BMI among immigrants, the effects of acculturation on driving as well as on physical activity should be researched. Blumenberg and Shiki (2007) argued that as the income of immigrants increases over time, the immigrants start to relocate to lower density suburban neighborhoods and, as a result,

their dependence on automobiles increases. The authors also compared relative transportation assimilation rates across four racial groups in California, and found that Asians are very quickly assimilated to auto use compared to Hispanics or African-Americans. This suggests that there could be cultural as well as economic factors influencing travel behaviors of immigrants.

In the present study, one sub-ethnic group, Korean immigrants, is selected from the Asian population in the U.S. The Asian population is the fastest growing race over the past 10 years, according to a 2010 Census Brief; the Asian population alone grew 43.3% compared to the total U.S. population, which grew 9.7% (U.S. Census Bureau, 2010). Within the Asian population of the U.S., ethnic Koreans make up 9.7%, which represents a 33.1% change between 2000 and 2010. Because patterns of physical activity between women and men have been different, this study focuses on women in particular. By comparing Korean immigrant women's behaviors to those of Caucasian women as a reference group and by using objective measurement tools, such as Geographic Positioning Systems (GPS) and accelerometers in conjunction with travel logs, this study aims to examine the effect of race/ethnicity on PA and park use behaviors of women in their daily routines while adjusting for other demographic, socio-economic, psychosocial, and built environmental factors. In addition, by closely looking at Korean immigrant women, this study explores the role of acculturation and built environment in shaping obesity-related behaviors of immigrant women.

Theoretical Framework

This study is based on social ecological models that emphasize multilevel interventions such as targeting individuals, as well as social and built environment and policy to promote PA at the population level (Sallis et al., 2006; Sallis & Owen, 2002). However, in looking at immigrant and ethnic minority women, one additional level of influences must be incorporated: cultural factors. This is because cultural factors such as norms and value systems that are independent of socio-economic factors are associated with preferences for and perceptions about physical activity and park use behaviors among minority and immigrant populations (Floyd, 1999). In the literature, certain factors, such as income and education, have been shown to be important determinants of physical activity participation among ethnic minority and immigrant women as well as mainstream women. Those with higher levels of educational attainment are likely to be categorized as highly active, according to the Behavioral Risk Factor Surveillance System (BRFSS) (Adabonyan et al., 2010; CDC, 2007). As for income and physical activity, women who had a household income of less than 200% of the poverty level were about 50% less likely to be classified as engaging in adequate PA than women with an income of 200% or more of the poverty level (Centers for Disease Control and Prevention, National Center for Health Statistics, National Health Interview Survey, 2007-2009; analysis conducted by the Maternal and Child Health Information Resource Center). Racial/ethnic minorities and individuals with lower socio-economic status (SES) engaged in less leisure time PA (CDC, 2001; Crespo et al., 2000; Winkleby et al., 1998, all from He & Baker, 2004; Sternfeld et al., 1999). The level of PA

among these women was influenced by age and education because younger immigrants tend to have high levels of education and have less difficulty in communication so they are likely to have higher affiliation with social groups, friendship and personal accomplishment needs for PA (Scharff et al., 1999). Education has been found to have different associations with leisure PA and with combined household/job-related PA. One study found a positive relationship between leisure PA and years of education but an inverse relationship between combined household/job-related PA and years of education. Education in general is also related to employment and to job-related PA especially among immigrant populations (He & Baker, 2004). In general, being younger, more educated, not married, and having fewer children were the factors influencing immigrant and minority women's PA participation (Hofstetter et al., 2008; Choi et al., 2008; Yang et al., 2007).

However, there are other explanations suggesting that the motivation for behaviors is influenced by cultural factors, which are independent of the socio-economic factors noted above. Vrazel et al. (2008) argued that more tangible support from a spouse/partner allows women to increase their PA significantly, and this support could vary by ethnicity and culture. For example, a demanding workload for ethnic minority women at home, such as caregiving and household chores, made them feel that they had already engaged in a sufficient level of PA, and, consequently, they did not think that special set-aside time for recreational PA was needed or even possible. Sternfeld, Ainsworth, & Quesenberry (1999) supports the finding of Vrazel et al. (2008) that African-American, Asian, and Hispanic women engaged less in sports and exercise compared to white women, while Hispanics performed more household/caregiving activities than whites (OR=1.58(1.10-2.28)). Lee & Im (2010) found that, for Asian-American women, the dual role of wage-earner and children's caregiver was

negatively associated with participation in exercise activities, whereas these factors were not significant for other ethnic groups. In general, minority/immigration status, cultural standards for women's participation in outdoor sports, and gender-role expectations at home have been identified as the dominant influences regarding PA for minority and immigrant women.

Assimilation theory specific to immigrants introduces measurable indicators of subcultures. This theory is based on the concept that greater assimilation among minorities results in patterns of behavior similar to that of the majority population. Recent studies using the measure of acculturation have utilized a bi-dimensional approach, meaning that acculturation is viewed as the processes of incorporating the customs from alternate and native societies independently. Using these measurable indicators, studies of immigrants and ethnic minorities over several generations can examine the effects of acculturation on specific health outcomes or health-related behaviors (Floyd, 1999).

In the present study, in addition to a consideration of cultural factors, other covariates are considered that might also account for the differences among ethnic women with respect to PA. Most of the public health studies published before 2005 on racial/ethnic differences in PA did not consider the potential effect of psychosocial factors and neighborhood built environment. Therefore, they concluded that racial and ethnic differences in leisure time physical activity were explained by low educational attainment and poorer health status. The potential differences in psychosocial factors and differential accessibility and proximity to opportunities and resources for PA by ethnic groups and by immigration status needs to be considered in studies on these populations.

Yang et al. (2007) found that Korean women who had more self-efficacy and perceived more benefits of, but fewer barriers to, PA were more likely to engage in leisure-time PA. However, a study of midlife women has shown that self-efficacy scores among Asian women were significantly lower compared to all other races—white, Hispanic, and African-American women—while there are only slight differences in barriers and attitude scores across racial groups (Im et al., 2012). A review paper on the social environmental influences of PA among women found that cultural appropriateness and acceptance of PA for women were perceived barriers to PA and discouraged them from being physically active (Vrazel et al., 2008). Depending on the subculture and acculturation of women and family members, these cultural barriers placed on minority and immigrant women might have different impacts on their PA participation. Because only few studies of immigrants and ethnic groups have considered these psychosocial factors in their empirical investigations, little has been known about confounding impacts of these psychosocial factors on PA. The potential differences in perceptions on and attitudes toward PA need to be investigated in order to examine the role of psychosocial factors in PA disparities across racial groups and between immigrants and non-immigrants.

Ecological models have introduced the physical environment as one of the influences on health-related behaviors. The role of the built environment on walking and physical activity has gained attention since 2000, and a great deal of interdisciplinary research has been conducted on the effect of neighborhood built environments on PA/walking by urban design and planning and public health professionals (Lee & Moudon, 2004). Environmental correlates of physical activity have been examined heavily in North America and Australia and tested in 11 countries. In addition to home and workplace environments for PA, the

combination of housing type, shops within walking distance, transit stops and sidewalks, recreation facilities, and safety of the neighborhood environment were studied and shown to be positively associated with meeting physical activity guidelines (Sallis et al., 2006; Spittaels et al., 2009)

In addition, recent studies have identified walking as a distinct type of PA and explored the association between walking and built environments (Lee & Moudon, 2006; Owen et al., 2004; Saelens et al., 2003; Saelens & Handy, 2008). Walking is the most popular type of PA and more prevalent among women and minority populations. It is also considered as a mode of transportation. Therefore, promoting walking is the most practical way to promote PA by incorporating it into people's daily routines. A literature review specific to walking by Owen et al. (2004) showed that environmental attributes found to be associated with utilitarian walking differed from those associated with recreational walking. For example, perceptions of the aesthetic nature of the environment have been found to be significantly associated with walking for exercise and with total walking, but were not associated with walking to get to and from places. Another review showed that distance to destinations, land use mix, and density are the environmental factors that are most frequently shown to be associated with transport-walking and that pedestrian infrastructure is the factor to be associated with recreational walking (Saelens & Handy, 2008). Lovasi et al. (2008) showed that none of the built environmental characteristics or their various combinations predicted exercise walking, which implies more influence of social and psychological factors on leisure physical activity.

This literature consistently finds that supportive neighborhood environments, such as high residential density, land use mix, street connectivity, and aesthetics, facilitate walking and

greater PA participation. However, most of the findings are from samples that are predominantly from non-Hispanic whites, which might ignore the difference in correlates of PA/walking across racial/ethnic groups due to their subcultures or potential confounders.

In this study, both walking and PA were identified and compared between Caucasian and Korean immigrant women and built environment attributes were taken into account.

Structure of Dissertation

Based on a review of the literature, three research questions were identified: a) are immigrant women (racial/ethnic minorities) more physically inactive than Caucasian women? b) are immigrants more inactive when they spend time at parks compared to Caucasian women? and c) among immigrant women, are long-term immigrants more sedentary than recent immigrants? In addition, this study also investigates the relationship between acculturation and physical activity/driving behavior. This dissertation presents three main hypotheses, with analysis of each.

Chapter 2 explains data collection methods used to compile the information about Korean immigrant women and matching strategies used to select data on Caucasian women from the Travel Assessment and Community (TRAC) study (U.S. National Institutes of Health, R01 HL091881). It also provides descriptive and group statistics regarding socio-demographic, psychosocial, and built environment factors common to three of the following chapters. Chapters 3, 4, and 5 each include an introduction, methods, results, and discussion section. Chapters 3 and 4 examine the effect of race per se on specific types of physical activity

(MVPA, walking) or on physical activity in a specific context (park-based). In Chapter 5, the analysis focuses on Korean immigrant women's physical activity (walking and park-based physical activity) and sedentary behaviors (driving time) and tests the relationships between acculturation and those behaviors. Chapter 6 summarizes and synthesizes three different analyses under the overarching theme of the built environment, physical activity/walking, and race, and seeks to draw comprehensive planning policy implications.

Chapter 2 Data

Korean Immigrant Women Data Collection

Using a convenience sampling method, 60 Korean immigrant women in King County, Washington, were recruited: 30 homemakers between July and October 2010 and 30 working women in the period between April and July 2011. They were recruited using personal networks and by posting flyers/posters in Korean groceries, churches, and on community websites. The focus of this study was women who are married, living with a partner, or widowed/divorced/separated, older than 20 years of age, and who identified themselves as having Korean ethnicity. The target was narrowed down to a specific ethnic group, Korean immigrant women, and the sample size with the target population was determined by the following constraints: 1) better access to Korean immigrants and understanding of nuances of their culture; 2) the limited costs for data collection ($80 compensation per subject after the completion of participation) and the number of devices available; and 3) time constraints due to the long assessment period required for each subject and weather conditions in the Seattle area. The period from April to October was selected because this is the most favorable time of the year for outdoor physical activities, given Seattle's rainy weather. The inclusion criteria for the study are listed below.

All participants should:

1) Be a (currently or previously) married female between the ages of 20 and 60 years old;
2) Have Korean ethnicity;

3) Have lived within one of the designated study neighborhoods for at least three months;

4) Be able to walk outside their home.

This study was approved by the Institutional Review Board at the Human Subjects Division of the University of Washington in June, 2010 (Application #38709, titled "Physical Activity and the Built Environment among Korean-Americans"). The approved posters that were used to recruit participants are presented in Figure 2.

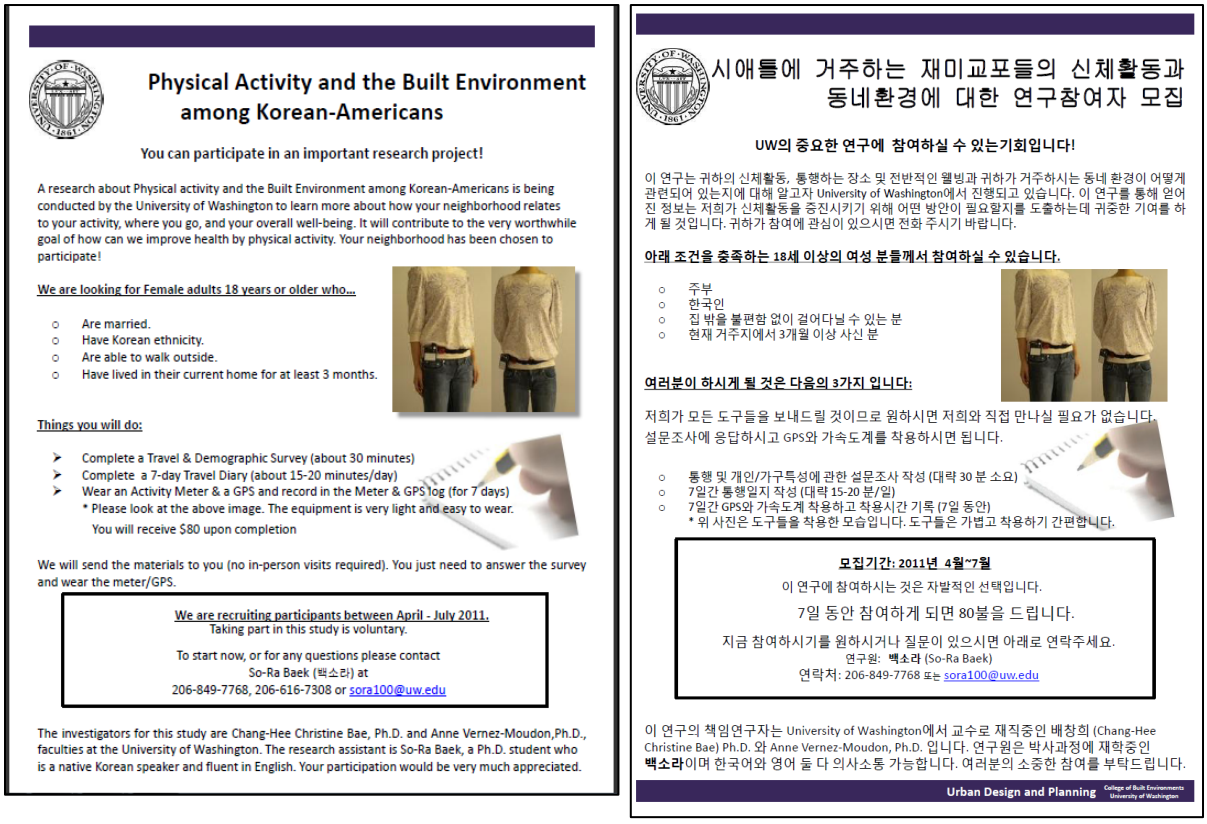


Figure 2 The Poster for Recruitment (left: English, right: Korean version)

Measurement Tools adapted from Travel Assessment and Community (TRAC)

The measurement tools for physical activity and location, demographics, attitudes about physical activity, travel and neighborhood, and perceived built environment were adapted from the Travel Assessment and Community (TRAC) project led by Dr. Brian Saelens (funded by the U.S. National Institutes of Health, R01 HL091881). The details on measurement tools synchronized with the TRAC are explained in the following list.

PA activity and location:

The intensity and the location of the activity were assessed by Accelerometry (GT3X, Actigraph LLC, Fort Walton Beach, Florida) for every 30-second epoch and GPS devices (GlobalSat DG-100 data logger, Taipei, Taiwan) at 30-second intervals during waking time for seven consecutive days. The accelerometer measures the vertical acceleration of the hip and provides an activity count that summarizes PA intensity for each 30-second epoch. The portable GPS receives x and y coordinates of the location from satellites and collects time-stamped location and speed information with no user input and with no output available to the user. During the periods when the subject wore the GPS and the accelerometer, we requested the completion of a travel diary for the same consecutive seven-day period in order to collect self-reported information on travel modes, departure and arrival times, destination name/address, and activity code (types of activities performed at destinations). Figure 3 shows snapshots of the three measurement tools.

Figure 3 Measurement Tools (left: GPS, middle: Accelerometer, right: seven-day travel diary)

Demographics:

Information about age, educational attainment, annual household income, employment status, number of vehicles owned by the household, number of children under 18, etc., was obtained through a questionnaire. Seven levels of educational attainment were later categorized as college graduates versus non-college graduates in order to make a dichotomous variable. Eleven levels of annual household income were also classified as two groups: a higher income (>$50k) versus a lower income group (<=$50k). Body mass index (BMI) was measured using self-reported height and weight and defined as weight in kilograms divided by squared height in meters. Overweight and obesity were defined as BMI greater than 25 and 30.

Attitudes about physical activity (psychosocial factors):

Self-reported measures of self-confidence (self-efficacy) for moderate PA, enjoyment of moderate PA, perceived benefits of regular PA, perceived barriers to regular PA, and social support were included in the questionnaire with 5-level Likert scale response options: from 1

(not at all) to 5 (almost always). Self-confidence for PA is the degree to which the person is confident with his/her ability to be physically active in any circumstances. Enjoyment of PA is the degree to which a person enjoys doing PA and the feeling he/she experiences while doing PA. Benefits of PA measures the degree to which a person recognizes some possible effects of regular PA. Barriers to PA is the degree to which circumstances prevent a person from getting PA, such as lack of interest, time, energy, company, equipment, good weather, skills, good health, etc. Social support is the degree to which family and friends themselves engaged in PA, offered to do PA with the person, or encouraged the person to do PA.

Perceived built environment:

The Neighborhood Environment Walkability Scale (NEWS) (Saelens, Sallis, Black, & Chen, 2003) was incorporated into the questionnaire to measure perceived residential density, land use mix (diversity in land use), access to facilities, street connectivity, infrastructure for walking, aesthetics, traffic hazards, and crime in the neighborhood. The 4- or 5-level Likert scales were used for response options. The scoring of each variable from the multiple questions was based on the report "Scoring procedures and preliminary psychometrics for the Neighborhood Environment Walkability Scale" (http://www.drjamessallis.sdsu.edu/measures.html).

Measurement Tools Adapted from the Existing Literature

Acculturation:

This part of the survey (with 15 questions) was added to the existing questionnaire originally developed for the TRAC project and applied to the Korean immigrant women sample for this particular study. The acculturation score was measured with the Acculturation Rating Scale for Mexican-Americans-II (ARSMA-II), which enables a measurement of the level of cultural orientation in the context of two cultures independently (Cuellar, Arnold, & Maldonado, 1995). The ARSMA-II was culturally adapted to use for Korean immigrants because it was originally developed for a different ethnic group. The level of Korean cultural orientation is called Korean Orientation Subscale (KOS) and the level of Anglo-American cultural orientation is called Anglo-American Orientation Subscale (AOS). Both scales range between 1 and 5 and the overall Acculturation Score is calculated by AOS minus KOS. Thus, the overall Acculturation Score ranges from -4 to 4, meaning that 0 is bicultural; -4 is the highest level of retention of Korean culture; and 4 is the highest level of assimilation to Anglo-American culture. To make the questionnaire as short and simple as possible, a short version of ARSMA-II was incorporated into the questionnaire (Figure 4, questions 1-12). Three additional measures related to the acculturation of Korean immigrants were also included in the questionnaire: the length of residence in the U.S., birthplace, and having a Korean husband as a dichotomous variable (see Figure 4, questions 13, 14, and 15).

Please check one answer for each item.	Not at all	Very little	Moderately	Very often	Almost always
1. I speak Korean.	☐	☐	☐	☐	☐
2. I speak English.	☐	☐	☐	☐	☐
3. I enjoy speaking Korean.	☐	☐	☐	☐	☐
4. I associate with Anglos.	☐	☐	☐	☐	☐
5. I enjoy listening to English language music.	☐	☐	☐	☐	☐
6. I enjoy Korean language TV.	☐	☐	☐	☐	☐
7. I enjoy Korean language movies.	☐	☐	☐	☐	☐
8. I enjoy reading books in Korean.	☐	☐	☐	☐	☐
9. I write letters in English.	☐	☐	☐	☐	☐
10. My thinking is done in the English language.	☐	☐	☐	☐	☐
11. My thinking is done in the Korean language.	☐	☐	☐	☐	☐
12. My friends are of Anglo origin.	☐	☐	☐	☐	☐

13. How long have you been in the United States? _____ year(s) _____ month(s)

14. Where were you born (your birth place)? Korea or within the US? Or other foreign countries? (including US territories) _____

15. What is your husband's race/ethnicity? (Please circle) Korea-born Korean / US-born Korean / others: please specify _____

Figure 4 12 Acculturation Rating Scale for Koreans adopted from ARSMA-II

Objective neighborhood built environment:

Geographic Information System (GIS) data were used to measure objective environmental attributes of the neighborhood. Specific neighborhood built environment variables identified and examined in previous studies were summarized and listed in Table 2.

Table 2 Attributes of Built Environment

Category	Variable	Definition (Unit)	Area of Consideration	Spatial Unit of Data	Data Source
Distance	Distance to the Closest Bus Stop	Airline distance from home to closest bus stop (ft)	NA	NA	King County GIS Data Portal

	Distance to the Closest Park	Airline distance from home to closest park (ft)	NA	NA	
	Distance to the Closest Trail	Airline distance from home to closest trail (ft)	NA	NA	
Connectivity	Street Density	Total Length of Street per Area (km/km2)	833 m circular buffer (10 minute-walking distance)	NA	
	Intersection Density	Number of 3- or 4-way Intersections per Area (count/km2)	1-km network-based buffer (from Frank et al., 2005)	NA	
Destinations	Land Use Mix	Evenness of distribution of parcel area of residential, commercial, and office use parcels	1-km network-based buffer (from Frank et al., 2005)	Parcel	
	Bus Stop Density	Number of Bus Stops per Area (count/km2)	833 m circular buffer	NA	
	Park Coverage	Percentage of 1 mile radius buffer from home covered by parks (%)	1 mile circular buffer	NA	
	Park Area	Total area of Parks within 1 mile radius from home (km2)	1 mile circular buffer	NA	
	Trail Length	Total Length of Trail within 1 mile radius from home (ft)	1 mile circular buffer	NA	
Density	Residential Density	Units per Acre (Area-weighted average density (from Frank et al. 2005)	1 mile circular buffer	Census Block Group	2010 Census Bureau
	Employment Density	Jobs per Acre (area-weighted average density)	1 mile circular buffer	Census Tract	Puget Sound Regional Council, Covered Employment Estimates Data

Translation of the Questionnaire and Travel Diary into Korean

Translation of all instruments, including questionnaires, travel diaries, and subject instructions, was needed. This study used the common "forward and backward" translation method to make sure the words in translation had meanings comparable to the original ones (Beaton, Bombardier, Guillemin, & Ferraz, 2000). The work flow is diagramed in Figure 5. A team of four translators was hired for four bilingual translations; two people whose first language is Korean did forward translations (from English to Korean). After creating one preliminary forward translation version, the two other people on the team, whose first language is English, did backward translations (from Korean to English). We then compared the completed backward translation with the original English version to finalize the forward translations. We were thus able to have a full set of materials and instruments that were ready for the Korean participants to use.

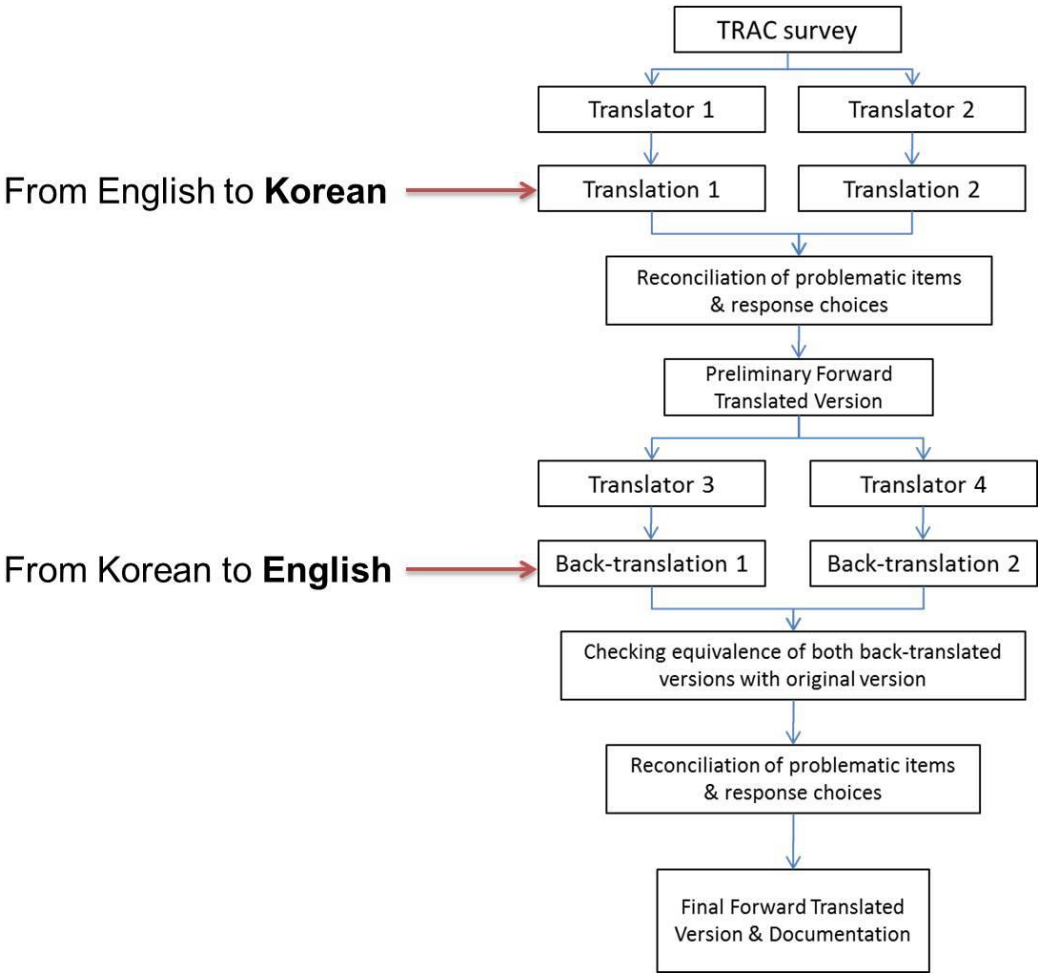
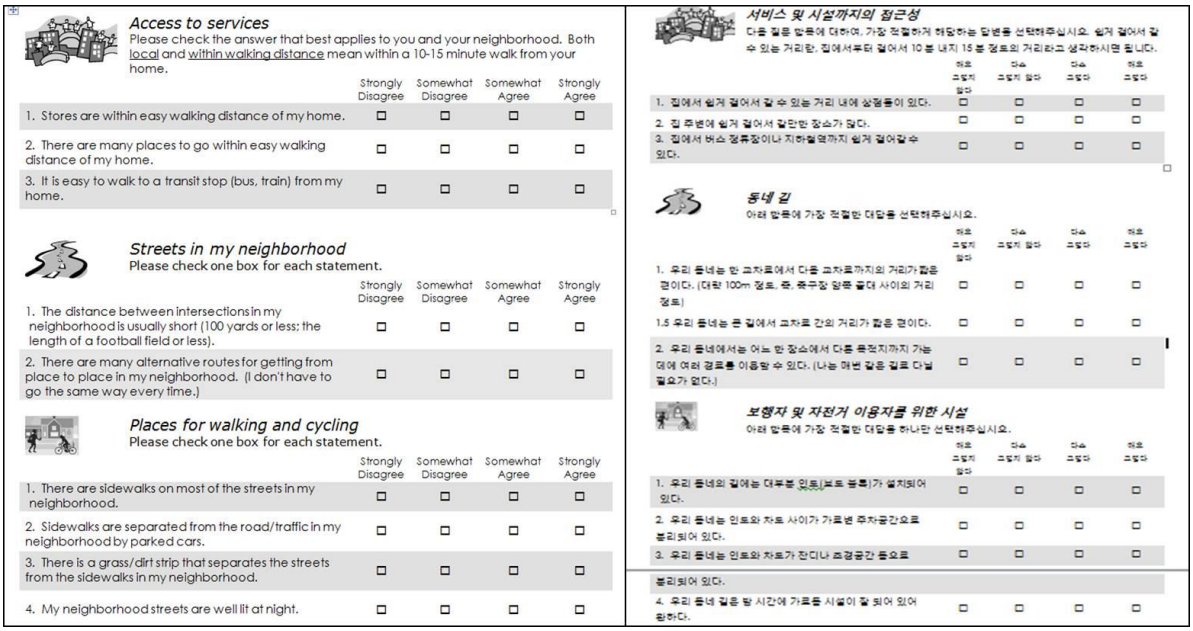


Figure 5 Forward-and-Backward Translation Method



Access to services
Please check 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.

	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree
1. Stores are within easy walking distance of my home.	☐	☐	☐	☐
2. There are many places to go within easy walking distance of my home.	☐	☐	☐	☐
3. It is easy to walk to a transit stop (bus, train) from my home.	☐	☐	☐	☐

Streets in my neighborhood
Please check one box for each statement.

	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree
1. The distance between intersections in my neighborhood is usually short (100 yards or less; the length of a football field or less).	☐	☐	☐	☐
2. 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 check one box for each statement.

	Strongly Disagree	Somewhat Disagree	Somewhat Agree	Strongly Agree
1. There are sidewalks on most of the streets in my neighborhood.	☐	☐	☐	☐
2. Sidewalks are separated from the road/traffic in my neighborhood by parked cars.	☐	☐	☐	☐
3. There is a grass/dirt strip that separates the streets from the sidewalks in my neighborhood.	☐	☐	☐	☐
4. My neighborhood streets are well lit at night.	☐	☐	☐	☐

서비스 및 시설까지의 접근성
다음 질문 항목에 대하여, 가장 적절하게 해당하는 답변을 선택해주십시오. 쉽게 걸어서 갈 수 있는 거리란, 집에서부터 걸어서 10 분 내지 15 분 정도의 거리라고 생각하시면 됩니다.

	아주 그렇지 않다	그렇지 않다	그렇다	아주 그렇다
1. 집에서 쉽게 걸어서 갈 수 있는 거리 내에 상점들이 있다.	☐	☐	☐	☐
2. 집 주변에 쉽게 걸어서 갈만한 장소가 많다.	☐	☐	☐	☐
3. 집에서 버스 정류장이나 지하철역까지 쉽게 걸어갈 수 있다.	☐	☐	☐	☐

동네 길
아래 항목에 가장 적절한 대답을 선택해주십시오.

	아주 그렇지 않다	그렇지 않다	그렇다	아주 그렇다
1. 우리 동네는 한 교차로에서 다음 교차로까지의 거리가 짧은 편이다. (대략 100m 정도, 즉, 축구장 양쪽 골대 사이의 거리 정도)	☐	☐	☐	☐
1.5 우리 동네는 한 집에서 교차로 간의 거리가 짧은 편이다.	☐	☐	☐	☐
2. 우리 동네에서는 어느 한 장소에서 다른 목적지까지 가는 데에 여러 경로를 이용할 수 있다. (나는 매번 같은 경로 다닐 필요가 없다.)	☐	☐	☐	☐

보행자 및 자전거 이용자를 위한 시설
아래 항목에 가장 적절한 대답을 하나만 선택해주십시오.

	아주 그렇지 않다	그렇지 않다	그렇다	아주 그렇다
1. 우리 동네의 길에는 대부분 인도(보도 등록)가 설치되어 있다.	☐	☐	☐	☐
2. 우리 동네는 인도와 차도 사이가 가로변 주차공간으로 분리되어 있다.	☐	☐	☐	☐
3. 우리 동네는 인도와 차도가 잔디나 화경공간 등으로 분리되어 있다.	☐	☐	☐	☐
4. 우리 동네 길은 밤 시간에 가로등 시설이 잘 되어 있어 환하다.	☐	☐	☐	☐

Figure 6 Translated Questionnaires (Left: English, Right: Korean)

Caucasian Matches

The 60 female Korean participants were between 25-58 years old, married, divorced, or widowed, and well-educated. About half of the participants were employed. The matching Caucasian women data were obtained from the TRAC project. Among 703 TRAC baseline samples, only females aged 25-60 and of Caucasian ethnicity were identified initially. Among this initial group, those who were single and had never been married were excluded; after this exclusion, 194 female Caucasians were identified.

However, the distributions of the census block group area-weighted average residential density for an 833-meter radius from home for the two groups were significantly different, as seen in Figure 7. A higher number of Caucasians lived in higher density neighborhoods (20-30 dwelling units per acre). In order to reduce heterogeneity between the two groups, 47

Caucasians living in ≥10 dwelling units per acre density neighborhoods were excluded, and the total number of the matching sample was reduced to 147. The excluded samples were mostly located in or near the downtown Seattle area.

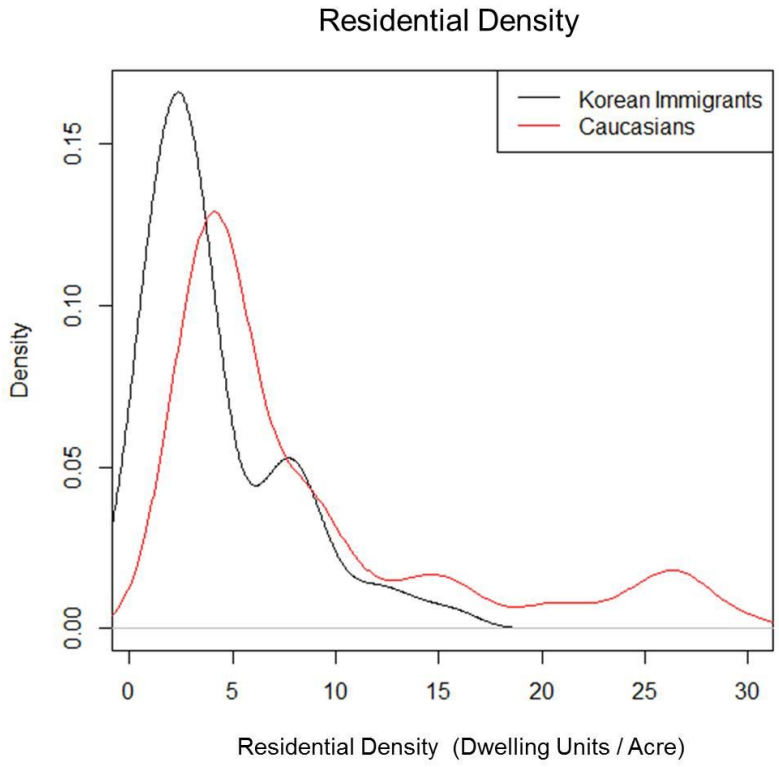


Figure 7 Residential Densities of the 60 Korean immigrant and 194 Caucasian women

With those 147 subjects, intersection density was plotted to check similarities in distribution between the two groups. The mean of housing and intersection density of the Caucasians is somewhat greater than that of the Koreans (Figure 8). Despite some differences, the two pairs of density curves between the two groups are in similar ranges.

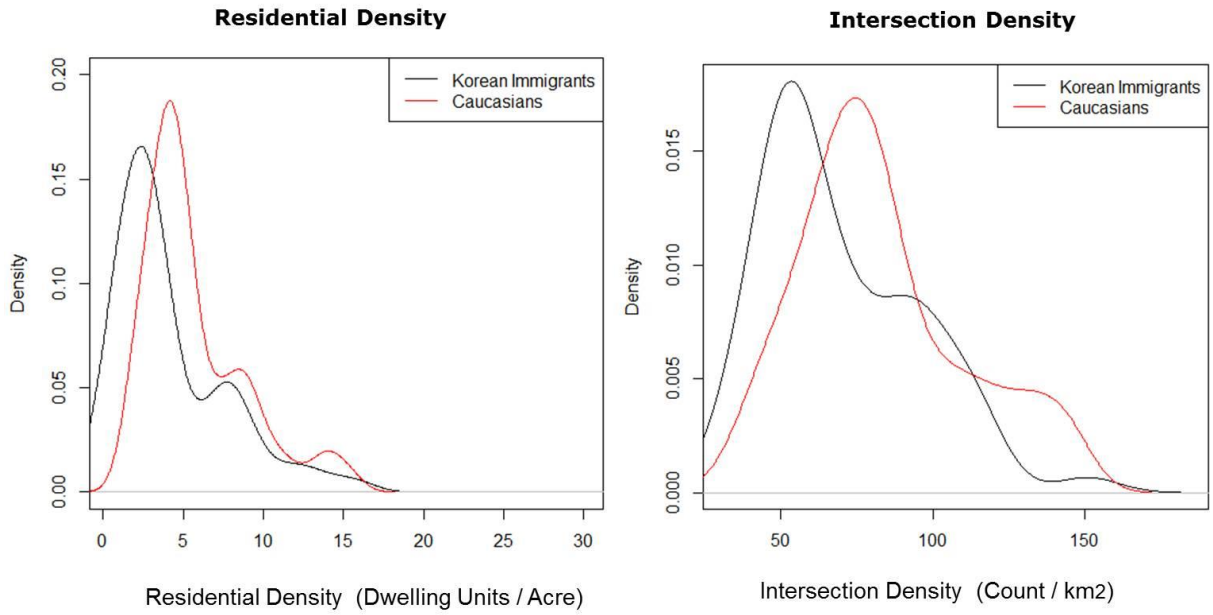


Figure 8 Residential and Intersection Density of 60 Koreans and 147 Caucasians

An additional selection criterion was considered to address the Caucasian samples' clustering in southeast Seattle and the high concentration in the west side of King County as compared to the Korean samples. The clustering of Caucasians can be accounted for in several ways: 1) the TRAC project where these Caucasian samples were from was originally intended to compare those living close to a light rail station (within a 1 mile radius; case) and those living far from a light rail station (control group), so there was a cluster in southeast Seattle where light rail stations are located (from the International District station to the Sea-Tac Airport station); 2) the southeastern part of King County near stations has relatively higher minority, low-income populations, higher residential density, and good access to retail services and transit. To find cases and controls that are similar in terms of their demographics and in their initial neighborhood built environment, many controls were sampled from the west side of King County, where more lower income people reside and where the net residential density, retail services, and bus ridership were relatively higher compared to the

east side of the county. In order to deal with the southeast Seattle or west side of King County cluster, 64 samples living within one mile of 10 light rail stations located in southeast Seattle were excluded.

The final criterion to be considered was the timeframe of the study. The assessment period was designed to reduce the potential effect of rainy and cold weather on PA; the data for the Korean immigrants was collected between April and October. Thus, 14 additional samples who participated during November and December 2008 and January 2009 were eliminated. The final Caucasian matches were 69 Caucasian females; the geographic distribution of household locations of the two groups is presented in Figure 9. The distributions of included and excluded Caucasian samples within King County are shown in Figure 10.

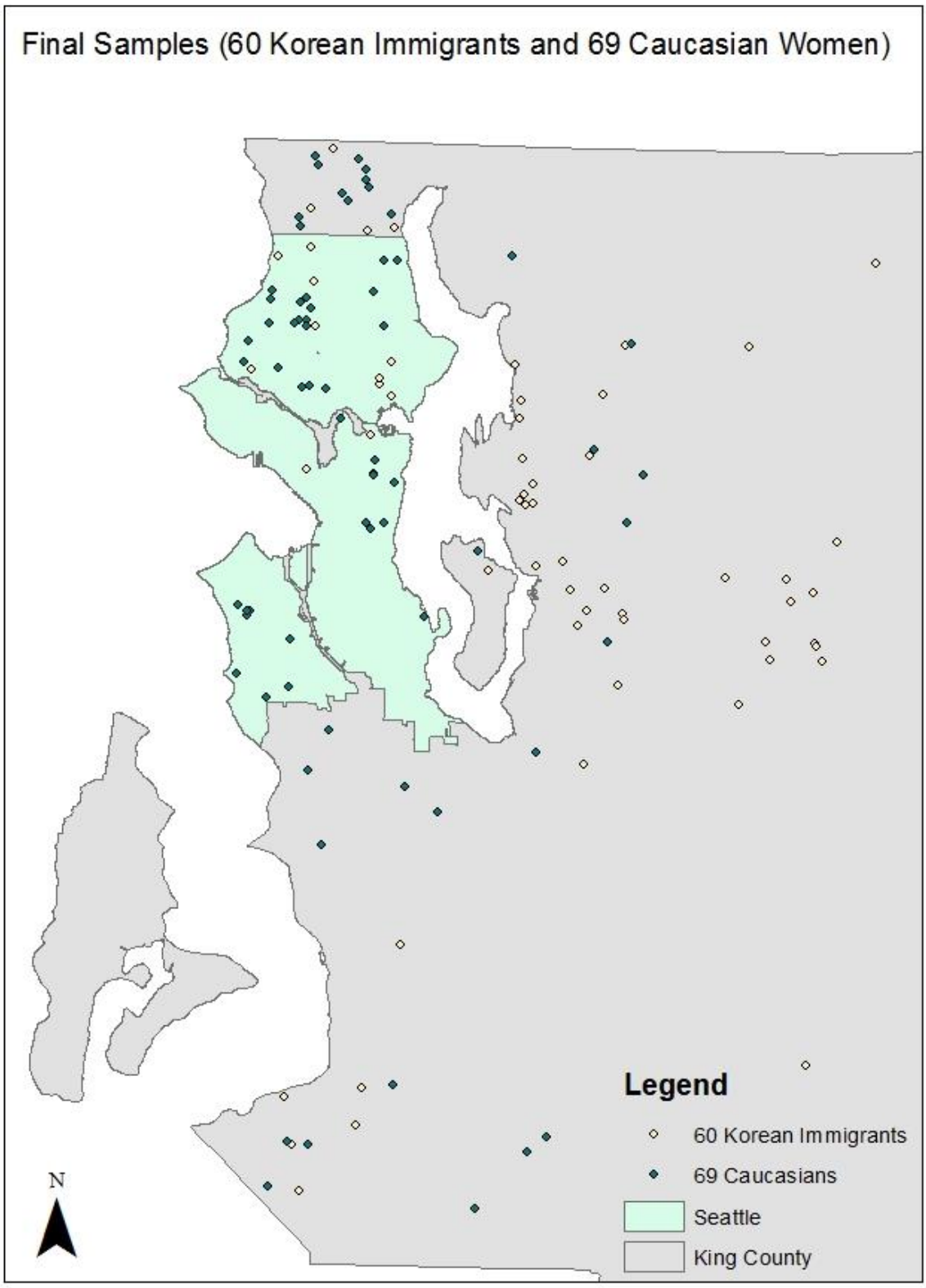


Figure 9 Final Selection

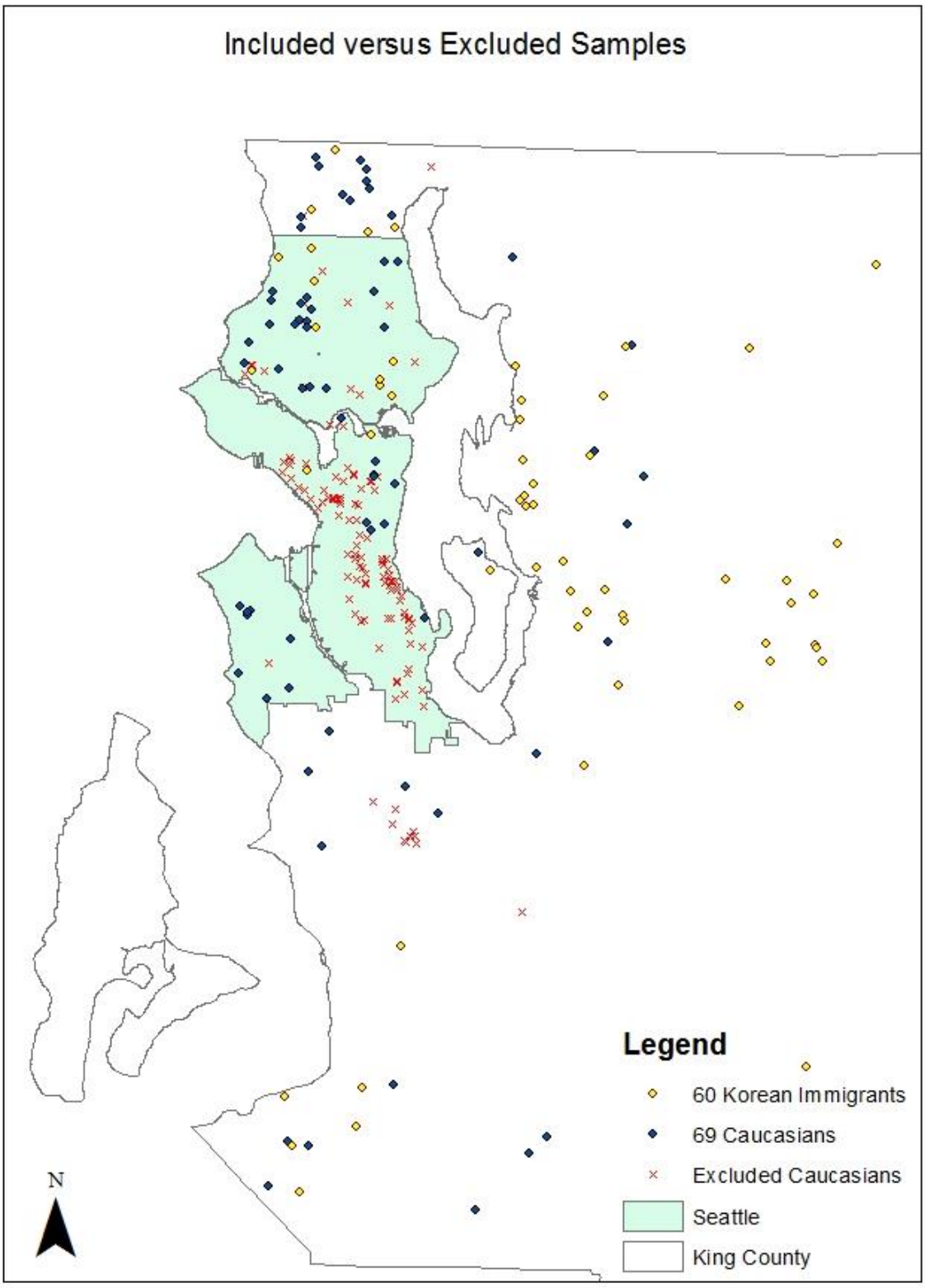


Figure 10 Included versus Excluded Samples

Descriptive Statistics

Descriptive Statistics of the Entire Sample

Descriptive statistics for all 129 subjects are presented in Table 3 for demographics, socio-economic status (SES), psychosocial factors, and objectively and subjectively measured built environment variables. Study participants are between 25 and 60 years old and the average age is 44 years. They are well educated, as about 81% of the participants completed some college or university. On average, these women have 0.87 children and 1.95 autos in their households. Of the women selected for the survey, 86% live with a spouse or partner and 69% were employed at the time of assessment. Three-quarters of the participants earned an annual household income of more than $50,000. Regarding the psychosocial factors, the participants perceive relatively higher levels of self-confidence for, enjoyment of, and benefits of regular physical activity, and report that they sometimes perceived barriers to physical activity and social support from family and friends.

Table 3 Characteristics of the Korean immigrants and the matched Caucasian Samples (n=129)

		Minimum	Maximum	Mean	Std. Deviation
Demographic /SES Factor	Age	25	60	43.6	9.02
	Body Mass Index	15.59	55.78	23.81	5.85
	Education (7 levels)	1	7	6.07	.94
	Education_dichotomous (>completed college/university=1)	0	1	.81	.40
	Number of Children	0	3	.87	.89
	Number of Vehicle owned	0	4	1.95	.71
	Living with spouse/partner	0	1	.86	.87
	Household Income	1	11	7.91	3.17
	Income (>50k=1, <=50k=0)	0	1	.75	.43
	Employed	0	1	.69	.46

Psychosocial Factor	Self Confidence (1=low, 5=high)	1	5	3.36	1.15
	Enjoyment (1=low, 5=high)	1	5	4.05	.88
	Benefits (1=low, 5=high)	1.44	5	4.26	.56
	Barriers (1=low, 5=high)	1.20	4	2.46	.63
	Social Support (1=low, 5=high)	1	5	2.60	.71
Objectively Measured Built Environment Variables	Distance to bus stop	53.14	8433.54	940.5	0.001
	Distance to closest parks	41.65	4507.86	1393.3	0.001
	Distance to closest trails	95.85	18648.63	3380.2	0.003
	Street Density	1.70	23.14	12.39	3.82
	Bus Stop Density	0	29	11.21	7.08
	Land use mix	0	1	.47	.25
	Intersection Density	30.82	150.90	70.99	26.28
	Area of park (km2)	.012	4.83	.63	.73
	Total trail length	0	20486.08	3176.7	0.004
	Residential density	.36	15.66	4.77	3.0
	Employment Density	.06	36.63	4.56	5.81
Subjectively Measured Built Environment Variables	Perceived Residential density	176	668	240.2	83.9
	Perceived Diversity	1	4.44	2.80	.79
	Perceived Access	1	4	3.06	.92
	Perceived Connectivity	1	4	2.94	.76
	Perceived Walking Facilities	1.17	4	2.91	.63
	Perceived Aesthetics	1	4	3.04	.71
	Perceived Traffic Hazards	1	4	2.16	.72
	Perceived Crime	1	3.33	1.47	.60

The statistics relating to neighborhood built environment characteristics show that their ranges are quite large. This indicates that there are enough variations in the neighborhood environment among the chosen subjects. For example, residential and employment density of the home neighborhoods are 0.4~16 dwelling units per acre and 0.06~37 jobs per acre, respectively; the average is 5 dwelling units/acre and 4.5 jobs/acre.

Group Statistics

We analyzed group statistics for the continuous and categorical variables to check for any significant difference in averages of any of the demographic, psychosocial, and perceived and objectively measured built environment characteristics between the Korean and Caucasian groups of women (see Table 4). T-tests for continuous variables and chi-square tests for dichotomous variables were conducted to examine the independence of the outcome variable with independent variables. Two important SES characteristics—educational attainment and annual household income—are similar between the two groups. Even though their geographic distributions are quite different (Caucasians live in relatively higher concentration in the Seattle-west King County area compared to the wide distribution of Koreans throughout King County), the socio-economic status was similar between the two. The Caucasians were, on average, eight years older than the Korean samples, and the average body mass index (BMI) was significantly higher among the Caucasian than the Korean women (25.8 vs. 21.5 kg/m^2). Most of the women in the Korean samples had one child under 18, while some Caucasian participants had no children: the average number of children is 1.17 (Korean) vs. 0.61 (Caucasian).

Regarding the psychosocial factors, the Caucasians perceived a higher level of self-confidence for, enjoyment of, and benefits of regular physical activity, whereas a lower level of barriers was perceived compared to the Koreans (3.97, 4.43, 4.39, 2.28 versus 2.66, 3.62, 4.11, and 2.66, respectively). Lower self-confidence for regular exercise among Korean immigrant women was consistent with a previous study conducted in the Midwest (Choi, Wilbur, Miller, Szalacha, & McAuley, 2008). This could mean that there is a racial difference in these attitude factors or that immigration status and cultural barriers might play

a role in influencing these personal attitudes toward physical activity. Consistent with previous findings from qualitative studies among immigrant women, there is significant difference in perceived social support between the two groups in this sample (2.75 (C) versus 2.47 (K) at p-value=0.028); lower social support among immigrant women compared to non-immigrants. Because these psychosocial factors had been strong predictors of PA participation in the general population, Caucasian women are expected to be more active than Korean immigrants if everything else is held constant.

The significant differences in some of the built environment features demonstrate that the greater concentration of Koreans in the east side of King County corresponds to relatively less supportive environmental features for utilitarian walking, such as lower street density, bus stop density, and residential density, and lower perceived access and connectivity, etc. However, Korean immigrant women on average lived in more favorable environments for recreational walking, with better accessibility to parks and trails and larger parkland area and longer trail lengths within the home neighborhood as compared to their Caucasian counterparts. Nevertheless, they shared some similarities in land use mix index and intersection density.

Table 4 Group Statistics

		race	N	Mean	Sig. (2-tailed)
Demographic/SES	Age	1 (Korean)	60	39.10	.000
		0 (Caucasian)	69	47.52	
	Body Mass Index (BMI)	1	60	21.49	.000
		0	67	25.88	
	Education (College Graduates)	1	60	.83	.471
		0	69	.78	
	Number of Children	1	60	1.17	.000
		0	69	.61	

	Number of Vehicle owned	1	60	1.98	.577
		0	69	1.91	
	Living with spouse/partner	1	60	.97	.001
		0	69	.77	
	Income (>50k=1, <=50k=0)	1	60	.72	.391
		0	69	.78	
	Employed	1	60	.52	.000
		0	69	.84	
Psychosocial Factors	Self Confidence (1=low, 5=high)	1	60	2.66	.000
		0	69	3.97	
	Enjoyment (1=low, 5=high)	1	60	3.62	.000
		0	69	4.43	
	Benefits (1=low, 5=high)	1	60	4.11	.005
		0	69	4.39	
	Barriers (1=low, 5=high)	1	60	2.66	.001
		0	69	2.28	
	Social Support (1=low, 5=high)	1	60	2.75	.028
		0	69	2.47	
Objectively Measured Built Environment	Distance to bus stop (feet)	1	60	1305.08	.004
		0	69	623.49	
	Distance to park	1	60	1174.26	.023
		0	69	1583.80	
	Distance to trail	1	60	1970.47	.000
		0	69	4606.04	
	Street Density	1	60	10.32	.000
		0	69	14.19	
	Bus Stop Density	1	60	9.70	.026
		0	69	12.53	
	Land use mix	1	60	.51	.155
		0	69	.44	
	Intersection Density	1	60	69.94	.671
		0	69	71.92	
	Area of park (km2)	1	60	.82	.007
		0	69	.46	
	Total trail length (feet)	1	60	4839.45	.000
		0	69	1730.82	
	Residential density	1	60	4.16	.031
		0	69	5.30	
	Employment Density	1	60	5.81	.031
		0	69	3.47	
Perceived Built Environment	Perceived Residential density	1	60	264.98	.003
		0	69	218.68	
	Perceived Diversity	1	60	2.80	.930
		0	69	2.79	

	Perceived Access	1	60	2.79	.002
		0	69	3.30	
	Perceived Connectivity	1	60	2.81	.065
		0	69	3.06	
	Perceived Walking Facilities	1	60	2.97	.287
		0	69	2.85	
	Perceived Aesthetics	1	60	2.95	.162
		0	69	3.12	
	Perceived Traffic Hazards	1	60	1.92	.000
		0	69	2.37	
	Perceived Crime	1	60	1.32	.004
		0	69	1.61	

In sum, the Korean and Caucasian women have some different individual characteristics that might affect their PA level, such as age, number of children, BMI, and employment status, and have different levels of attitudes about PA. Caucasians have more favorable attitudes about regular PA than Koreans do. Furthermore, built environment features present differences between the two groups, although they shared some characteristics in land use mix and intersection density. Generally speaking, Korean women subjects lived in relatively lower density, suburban neighborhoods than the Caucasian subjects. Due to a) time constraints, b) a lack of resources, and c) the use of convenient sampling, there are inevitable differences in some independent variables between the Korean immigrants and the Caucasians. Nonetheless, the two groups' income and education levels are not statistically different, and fitting multivariate models would help adjust for some important covariates.

Initial Data Processing

Raw data from three different tools—GPS, accelerometer (ACC), and travel diary entered in the mdb file format—were initially merged and processed using R scripts written by Philip M. Hurvitz and Bumjoon Kang from the University of Washington's Urban Form Laboratory. A "LifeLog" for each participant was created and uploaded onto a SQL server. The LifeLog includes information on activity counts (PA intensity), x and y coordinates (location information from GPS), speed, name and address of destinations, travel mode used to get to the destinations, and activity code (specific activity performed at the destination) at each 30-second interval for the assessment period of seven days (details can be found at Kang, Moudon, Hurvitz, Reichley, and Saelens, 2013). The following sections (Chapters 3, 4, and 5) used the processed Lifelog data for the analysis.

Chapter 3 Comparison of Physical Activity and Walking between Korean Immigrant and Caucasian Women

Introduction

Many U.S. national-level health surveys have shown that physical activity (PA) prevalence varies by ethnicity/race. In most of the studies, the most active group was non-Hispanic whites and the least active groups were African-Americans and Hispanics. Asian-Americans usually fell in the middle (CDC, 2008; CDC, 2007; Adabonyan et al., 2010; Simpson et al., 2003). While there is also diversity in PA participation among ethnic minority groups, the consistent finding is that, compared to any of the minority populations, non-Hispanic whites had the largest sufficiently active group, as defined by the PA recommendations. In addition to differential access to socio-economic resources across racial groups, which contributes to disparities in PA participation (Floyd, 1999), Vrazel et al. (2008) argues that different levels of social support by culture might contribute to differences in women's PA by ethnicity/race. According to Vrazel et al. (2008), the demanding work load ethnic women experience at home, such as caregiving and household chores, made them feel that they already engaged in a sufficient level of PA, and, consequently, they did not think that special set-aside time for recreational PA was needed or even possible. Lee & Im (2010) found that the dual role as a wage-earner and as a caregiver for children by Asian-American women was negatively associated with their exercise participation, whereas these factors were not significant for other ethnic groups. In general, minority/immigration status, cultural standards for women's

participation in outdoor sports, and gender-role expectations at home are identified as the dominant influences regarding PA for minority women. Because most of the findings about cultural factors on physical activity were drawn from focus group and interview results, there have been few empirical studies that examined contributors to disparities in PA across ethnic/racial groups.

Classification of types of physical activity is important to accurately assess PA disparities and identify the source(s) of disparities in PA across races. Florindo et al. (2009), with 1318 adults in Sao Paulo, Brazil, showed that women were less active in occupational, recreational, and transportation settings compared to men but more active overall and in household settings than men. This indicates that many studies investigating only leisure time PA might overestimate the physical inactivity of women, and especially of minority women, because the type of PA in which middle-age minority women tend to engage more than any other groups, household PA, has rarely been included. Sternfeld, Ainsworth, & Quesenberry (1999) consistently found that African-American, Asian, and Hispanic women engaged less in sports and exercise compared to white women, while Hispanics performed more household/caregiving activity than whites (OR=1.58(1.10-2.28)). Nonetheless, to date, a significant number of studies on physical activity have focused mainly on recreational/leisure-time PA participation.

Some surveys that include non-leisure time PA questions provide meaningful insights into the behavioral differences across races. A study based on the 2001 California Health Interview Survey (CHIS) found that non-leisure-time walking and bicycling (NLTWB) was highest among Latinos. Latinos are 58% more likely to meet PA guidelines based on

NLTWB compared to whites. African-Americans, Latinos, and Asians were less likely to meet PA recommendations based on leisure-time physical activity (LTPA) but more likely to meet the recommendations based on NLTWB (Berrigan et al., 2006). Kruger et al. (2008), using the 2005 National Health Interview Survey (NHIS), provided consistent evidence that Asian/Native Hawaiian/Pacific Islander women (40.5%) were more likely to walk for transportation than other ethnic/racial groups. With adults from the ages of 51 to 61, He & Baker (2005) found that total physical activity was similar across racial/ethnic groups, but that there were differences in occupational, household, and leisure-time PA by race. The multivariate models showed that black women were less active than white women in leisure time PA, but black and Spanish-speaking Hispanic women engaged more often in combined household/job-related PA. However, English-speaking Hispanic women's combined household/job-related PA was not significantly different from that of white women. This implies that minority women, particularly those who are less acculturated, engaged more in combined household/job-related PA than white and English-speaking Hispanics (He & Baker, 2004). The nonwhites were less active in leisure settings but more active in occupational settings than the whites. Depending on the types of PA included, the more active group varies (Florindo et al., 2009). Berrigan et al. (2006) found that inclusion of transportation walking and bicycling reduces disparities in meeting the PA recommendations, although there are still significant differences in overall PA across different racial/ethnic groups.

Another limitation of previous studies is reliance on self-reported PA measures, such as International Physical Activity Questionnaire (IPAQ), which may induce significant recall bias. The recent application of accelerometers with a global positioning system (GPS) allows us to objectively measure the intensity of physical activity during an epoch and record

locational information at every interval. These detailed and objective data could provide better estimations of levels and types of physical activity than the self-reported data. When all four types of physical activity were objectively measured, we could empirically examine whether non-Hispanic whites engaged in more recreational PA but less transportation and household PA compared to ethnic/racial minorities and immigrants.

Ecological models provide a framework that explains multi-level influences on health-related behaviors, such as physical activity and walking (Sallis & Owen, 2002; Sallis et al., 2006). The multilevel influences include intra- and inter-personal factors as well as social and built environment factors. However, ecological models are seldom studied with immigrant populations. Using this theoretical framework, this study aims to examine the effect of race (either Korean immigrant or U.S.-born Caucasian) on total physical activity, total walking, recreational walking, and utilitarian walking when demographic and socio-economic status (SES), psychosocial factors, and built environmental factors are adjusted. The hypotheses based on the previous findings were as follows: 1) Korean immigrant women would spend less time per day in moderate-to-vigorous physical activity (MVPA) and in walking than Caucasian women (assumed greater inactivity among immigrants compared to the U.S.-born mainstream); and 2) correlates of MVPA and walking between the two racial groups would be different (assumed ethnic-specific correlates influenced by subculture).

Methods

To examine whether race has an independent effect on physical activity when comparing Korean immigrant and Caucasian women when other demographic and built environment characteristics are adjusted, four outcome variables were derived. The outcomes were 1) objectively measured daily minutes of moderate-to-vigorous physical activity (MVPA); 2) total walking bout minutes per day; 3) utilitarian walking bout minutes per day; and 4) recreational walking bout minutes per day. The daily minutes were used to standardize for different numbers of valid days across subjects (4-8 days of valid days of data per subject). The valid days were defined as days which have accelerometer data longer than 8 hours per day after removing non-wearing time (consecutive zeros in activity count for at least 20 minutes) (Kang et al., 2013).

The MVPA is the sum of minutes with activity counts per epoch (30 sec) greater than 500 (points above the green dotted line in Figure 11). There has been no consensus in the literature regarding the intensity-threshold criteria for moderate intensity; Troiano et al. (2008) used 2020 activity counts for 1 minute, while Kang et al. (2013) used 500 activity counts for 30 seconds. For comparison purposes, both activity count thresholds of 500 and 1010 per 30 seconds are included in the results.

Kang et al. (2013) defined walking bout as "travel in space" with "sustained light or moderate intensity PA (activity count > 500 counts per 30 second epoch) for at least 7 min with a 2-min tolerance of lower PA intensity." To identify a walking versus non-walking bout and to classify types of walking, I used the classification algorithms and their definitions in Kang et al. (2013). The time period within the red arrow in Figure 11 was identified as a

PA bout (sustained light or moderate intensity PA). Based on whether or not they meet the criteria for "travel in space" according to their GPS records or travel diary information, the bout was classified as either a walking bout or non-walking bout. For walking bouts, they were classified into utilitarian versus recreational types. Utilitarian walking has a destination reported by the participant that is different from the origin of that trip, whereas recreational walking has no destination, meaning that the origin and the destination of the trip are the same. For example, if a person left home, walked around the neighborhood, and then came back home without stopping at any place during the trip, that walking trip is classified as recreational. The MVPA and all walking measures were derived only from valid days. More detailed information on the algorithms and definitions can be found at Kang et al. (2013).

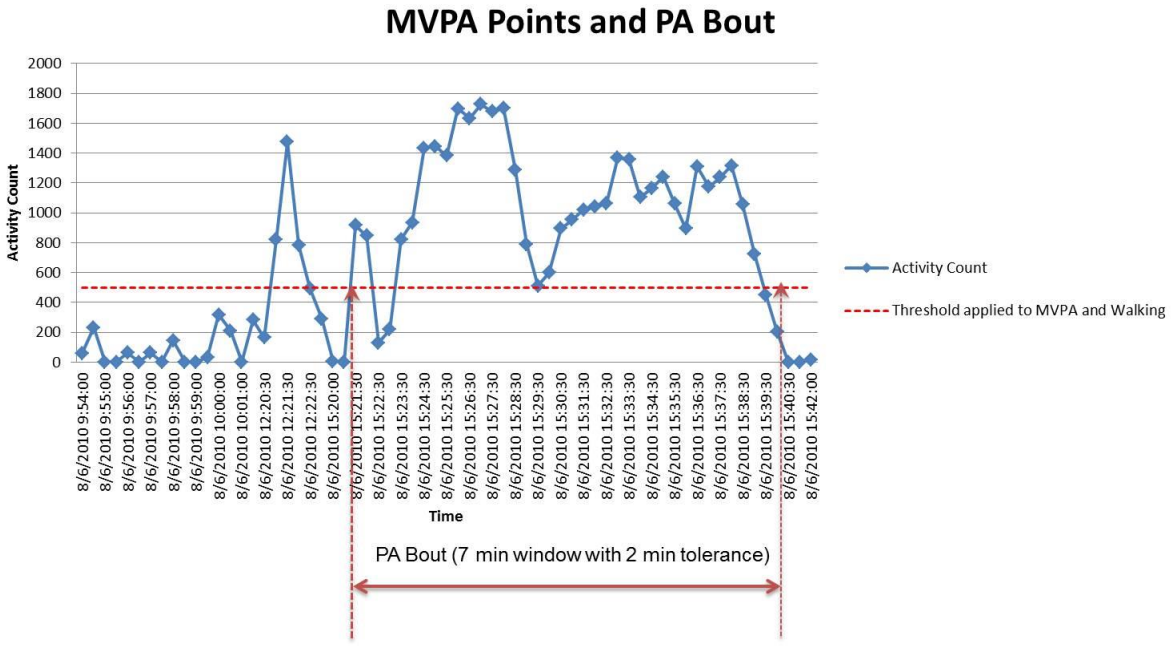


Figure 11 Graph showing thresholds applied to MVPA and PA Bout

Model Specification

T-tests were used for comparison of the mean of physical activity measures between the groups, and multivariate regression models were fitted to adjust for other covariates. For utilitarian and recreational walking bout minutes as outcome, negative-binomial models were employed to account for many zeros and skewed distribution of the outcomes. The negative binomial model is used for count variable (rounded number of minutes per day) and for over-dispersed outcome variables.

Independent variables were reviewed and pre-selected for a model based on 1) their correlation coefficients, and 2) the literature review to optimize the number of control variables and covariates given the small sample sizes (129 women).

The following section describes how the variables were selected.

1) Psychosocial variables: The biggest difference between Korean-American immigrants and the Caucasian women in the study is *Self-confidence*. The question is whether it is an outcome of or a driver for being active. With this small sample of the Likert-scale survey, it is difficult to test the direction of the relationship. In addition, among the five psychosocial variables, the three of the variables (*Self-confidence for PA, Enjoyment of PA*, and *Barriers to PA*) were highly correlated, showing correlation coefficients greater than 0.5 (see Figure 12). To reduce the number of control variables and avoid multicollinearity, two variables were selected, *Barriers to PA* and *Social support for PA*.

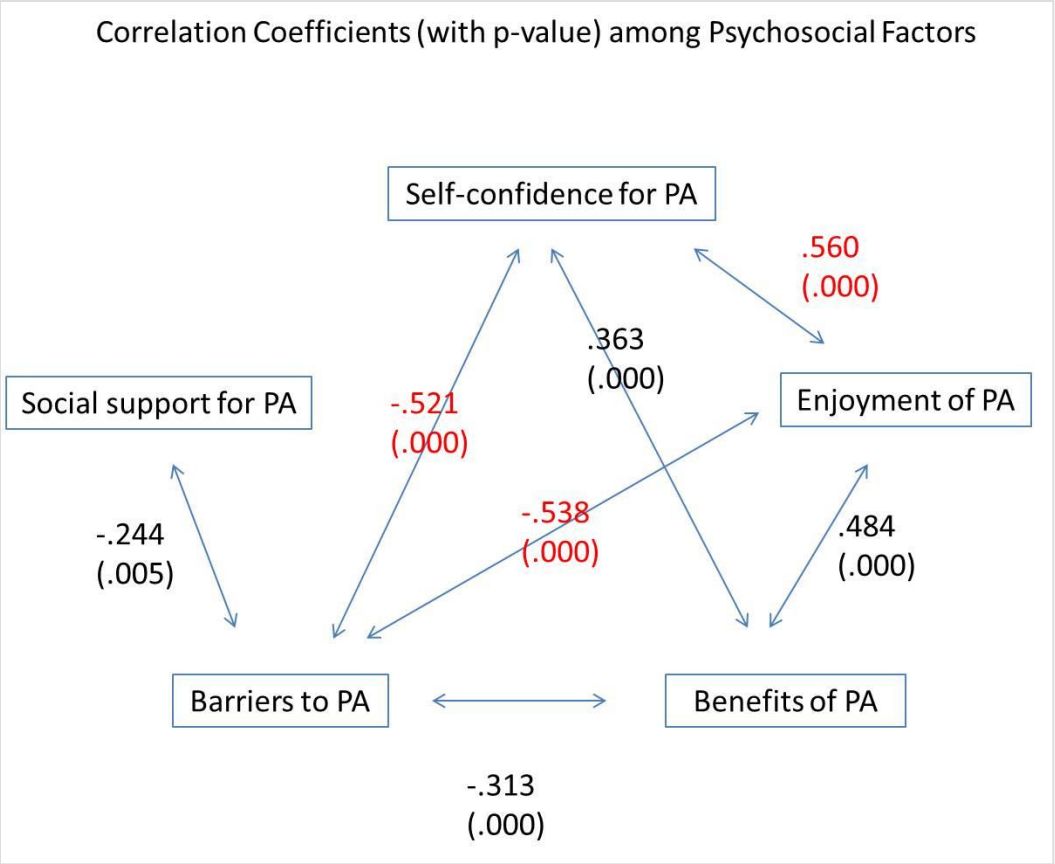


Figure 12 Correlations among Psychosocial Factors

2) Built environment variables: There are many objectively measured and perceived built environment variables that are related to PA and walking. The challenge is how to select the most important built environmental variables and to avoid multicollearity with a small sample size. Based on the literature review, we establish three criteria: (1) opportunities/resources for PA, (2) connectivity, and (3) density, and then select four variables, shown in Table 5.

Table 5 Criteria and Selected Built Environment Variables

Criteria	Variable
Opportunities/resources for PA	Area of Parks (km2)

	Distance to the Closest Trails (feet)
Connectivity	Intersection Density (counts/km2)
Density	Residential Density (du/acre)

3) Behavior-specific correlates based on the literature: Environmental attributes associated with utilitarian walking are different from those associated with recreational walking. Because utilitarian walking is a mode of transportation and can be substituted by driving trips, *Number of vehicles in the household* is included in models for utilitarian walking minutes. Psychosocial factors have shown strong associations with recreational walking or exercise but null association with utilitarian walking. They are therefore excluded in models for utilitarian walking minutes. Perceptions of the aesthetic nature of the environment have been found to be significantly associated with walking for exercise. *Perceived aesthetics* is included only in models for recreational walking minutes.

Results

The average wearing time of accelerometer per day during valid days was 792 minutes (13 hours and 12 minutes). This means that a significant amount of time or most of the waking hours per day were monitored so that the data successfully captured habitual physical activity patterns. The average number of valid days was 6.87 during the 7 days of total assessment. There were substantive variations in PA bout time/frequency and in daily walking minutes for any purpose among the 129 subjects. The participants spent 30 minutes in PA bouts and 15 minutes in walking per day. A third of the walking bout minutes were classified as recreational types of walking (4.7 min. out of 15.3 min. per day). These women in King County engaged more in utilitarian walking than in recreational walking.

Table 6 Descriptive Statistics of PA Outcomes

Variable	Minimum	Maximum	Mean	Std. Deviation
MVPA (min per day; with 500 activity count threshold)	17.0	186.0	74.4	34.57
MVPA (min per day; with 1010 activity count threshold)	2.58	132.79	30.8	22.7
PA Bout Minute (min per day)	0	141.29	29.97	26.86
Number of PA Bout (per day)	0	8.71	2.0	1.52
Wearing Time (min per day)	558.07	1133.71	792.4	93.5
Valid Day	4	7	6.87	.49
Recreational Walking Bout Minute (min per day)	0	58	4.72	9.02
Utilitarian Walking Bout Minute (min per day)	0	110	10.56	14.60
Total Walking Bout Minute (min per day)	0	110	15.29	18.20

The first histogram in Figure 13 shows a relatively normal distribution of daily MVPA among the 129 participants (60 Korean immigrant and 69 Caucasian samples). There are many participants who did not engage in any utilitarian or recreational walking bouts during the assessment week (high peak in zero in the two histograms at the bottom).

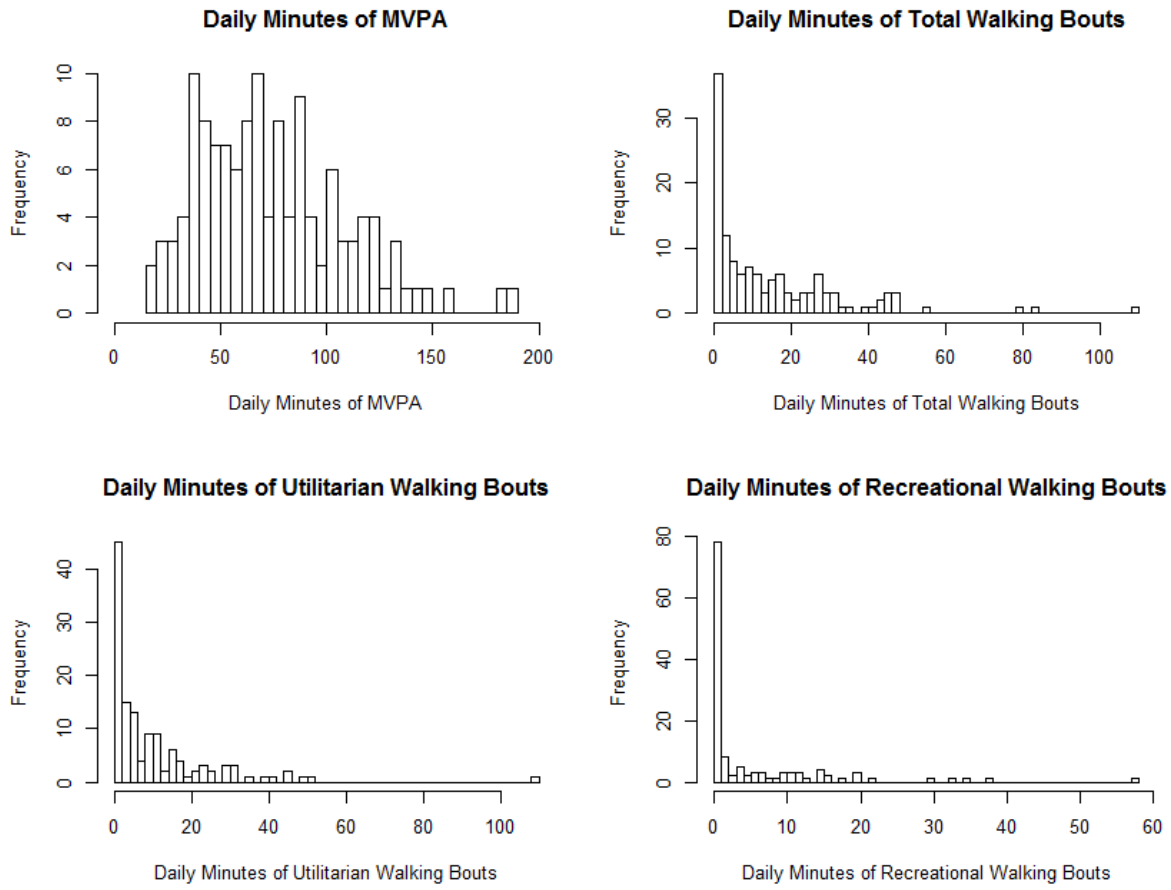


Figure 13 Histograms of the Four Outcomes

Group statistics are reported in Table 7 with the t-test results to examine statistically significant differences in PA and walking measures between the two groups. The independent samples t-tests showed that there was a significant difference in the two groups' physical activity patterns: Korean immigrants spent much less time in MVPA per day (58 min. vs. 89 min.) and engaged in 18 minutes of PA bout per day compared to 40 minutes by the Caucasians. The Caucasians' physical activity levels and durations (MVPA, PA bout time,

and frequency) were from one and one-half times to more than two times as high as that of the Korean immigrant women.

The Koreans spent 12 minutes less in total walking, four minutes less in recreational walking, and eight minutes less in utilitarian walking compared to the Caucasian women. While there is no statistical difference in wearing time per day between the two groups, all the physical activity measures, such as MVPA, PA bouts, and walking, demonstrate that the Caucasians engaged in a higher level of physical activities than the Korean women in this study.

Because these t-tests were not adjusted for other covariates, the multivariate linear and negative binomial regression models were specified.

Table 7 Group Statistics of Outcomes

	Race	N	Mean	Std. Deviation	Sig. (2-tailed)
MVPA (with 500 activity count threshold)	Korean=1	60	**57.8**	13.69	0.00***
	Caucasian=0	69	**88.9**	25.47	
MVPA (with 1010 activity count threshold)	Korean=1	60	**21**	13.7	0.00***
	Caucasian=0	69	**39.3**	25.5	
PA Bout Minute	1	60	**18.3**	16.12	0.00***
	0	69	**40.1**	30.14	
Number of PA Bout	1	60	**1.29**	.97	0.00***
	0	69	**2.63**	1.65	
Wearing Time	1	60	802.79	98.39	.241
	0	69	783.35	88.83	
Recreational Walking Bout Minute	1	60	**2.17**	5.63	0.002**
	0	69	**6.94**	10.72	
Utilitarian Walking Bout Minute	1	60	**6.30**	7.53	0.001**
	0	69	**14.26**	17.94	

					0.00***
Total Walking Bout Minute	1	60	**8.47**	9.66	
	0	69	**21.22**	21.59	

Daily Minutes of MVPA

The model explained 25.4% of variances in the data, and race is a significant and the strongest predictor explaining women's MVPA. When the MVPA threshold was 500, as shown in Table 8, the Caucasian women engaged in 30 more minutes of MVPA per day than the Korean immigrant women when other conditions were held constant. Higher education and income were positively associated with MVPA but the coefficients were not significant at 0.05 level. Perceived social support was significant at p-value of 0.05 level and the sign of the coefficient was consistent with previous studies: one unit increase in perceived social support was associated with a 9.7 minute increase of daily MVPA, respectively, among these women. None of the built environment variables were significantly associated with MVPA among these women. Table 8-1 shows an MVPA threshold of 1010. The relationship between race and MVPA is similar, whereas the coefficient is smaller than that of the previous model. The difference is that two additional variables are shown to be significant in Table 8-1; the higher intensity of MVPA with the 1010 threshold is positively associated with high income and social support and negatively associated with perceived barriers to PA.

Table 8 Linear Regression Model of Daily MVPA with 500 threshold

MVPA	Coef	Std. error	Sig.
(Constant)	72.47	32.95	.030

Being a Korean Immigrant	**-30.03**	**7.29**	**.000**
Age	-.07	.39	.864
High Education (Completed College/University)	5.16	7.33	.483
High Income (Annual Household Income > 50k)	8.08	6.76	.235
Number of Children	6.22	3.78	.103
Having a Spouse/Partner	-7.94	8.64	.360
Employed	4.51	6.46	.486
Barriers to PA (1-5 levels)	-7.84	4.88	.111
Social Support (1-5 levels)	**9.71**	**4.12**	**.020**
Area of Parks (km2)	-2.85	4.29	.508
Distance to the Closest Trails	.00	.00	.706
Intersection Density (count/km2)	-.04	.12	.767
Residential Density (Du/Acre)	1.37	1.17	.245

R square: 0.330, Adjusted R square: 0.254

Table 8-1 Linear Regression Model of Daily MVPA with 1010 threshold

MVPA	Coef	Std. error	Sig.
(Constant)	32.87	21.75	.133
Being a Korean Immigrant	**-14.70**	**4.82**	**.003**
Age	-.18	.26	.477
High Education (Completed College/University)	3.92	4.84	.419
High Income (Annual Household Income > 50k)	**9.41**	**4.46**	**.037**
Number of Children	1.73	2.49	.490
Having a Spouse/Partner	-7.99	5.70	.164
Employed	4.85	4.26	.257
Barriers to PA (1-5 levels)	**-6.25**	**3.22**	**.055**
Social Support (1-5 levels)	**5.75**	**2.72**	**.037**
Area of Parks (km2)	-1.18	2.83	.679
Distance to the Closest Trails	.00	.00	.928
Intersection Density (count/km2)	.08	.08	.933
Residential Density (Du/Acre)	.77	.14	.175

R square: 0.323, Adjusted R square: 0.246

Daily Minutes of Total Walking Bouts

Unlike the previous model, many individual-level factors were significant in the model with total walking. Being Korean was associated with an 8-minute decrease in total walking compared to being Caucasian (significant at 0.05 level). Women with high incomes spent 8.7 additional minutes in total walking than women with low incomes. Having a spouse or partner was associated with a decrease of 8.9 minutes in walking. None of the built environment variables were significantly associated with walking.

Table 9 Linear Regression Model of Total Walking

Total Walking	Coef	Std. error	Sig.
(Constant)	15.32	18.14	.400
Being a Korean Immigrant	**-8.22**	**4.02**	**.043**
Age	-.075	.22	.726
High Education (Completed College/University)	5.23	4.04	.197
High Income (Annual Household Income > 50k)	**8.71**	**3.73**	**.021**
Number of Children	.87	2.08	.676
Having a Spouse/Partner	**-8.85**	**4.76**	**.065**
Employed	2.54	3.56	.477
Barriers to PA (1-5 levels)	-4.27	2.69	.114
Social Support (1-5 levels)	1.17	2.27	.606
Area of Parks (km2)	-.03	2.36	.990
Distance to the Closest Trails	.00	.00	.842
Intersection Density (count/km2)	.06	.07	.382
Residential Density (Du/Acre)	.93	.64	.152

R square: 0.267, Adjusted R square: 0.184

Daily Minutes of Utilitarian Walking Bouts

When other covariates are held constant, being a Korean immigrant is associated with a 41% decrease in minutes of utilitarian walking bouts compared to being Caucasian. Women in the high income group engaged in 1.82 times more minutes of utilitarian walking compared to

women in the low income group. The utilitarian walking bout includes walking to get to places, such as work, school, stores, etc., and tend to be associated with built environment features that represent the walkability of the neighborhoods, although the magnitude of their independent effect is very minimal. A one unit increase in intersection density was associated with 1% more minutes of utilitarian walking. Residential density is positively associated with utilitarian walking minutes but the coefficient is not significant.

Table 10 Negative Binomial Model of Utilitarian Walking

Utilitarian Walking	Exp(B)	Lower 95% CI	Upper 95% CI
(Constant)	5.78	.85	39.55
Being a Korean Immigrant	**.59**	**.35**	**.98**
Age	.99	.96	1.01
High Education (Completed College/University)	1.56	.89	2.71
High Income (Annual Household Income > 50k)	**1.82**	**1.13**	**2.93**
Number of Children	.92	.69	1.21
Having a Spouse/Partner	.69	.36	1.32
Employed	1.45	.87	2.44
Number of Vehicles in household	.82	.60	1.10
Area of Parks (km2)	.99	.70	1.39
Distance to the Closest Trails	1.00	1.00	1.00
Intersection Density (count/km2)	**1.01**	**1.00**	**1.02**
Residential Density (Du/Acre)	1.07	.98	1.17

Log likelihood: -410, AIC: 847.5. BIC: 884.7

Daily Minutes of Recreational Walking Bouts

Table 11 shows that Korean immigrant women engaged in 57% less recreational walking minutes than Caucasian women after accounting for other covariates. While none of the psychosocial factors were associated with total and utilitarian walking, perceived barriers to PA was strongly and negatively associated with recreational walking minutes; a one unit increase in perceived barriers to PA decreases the expected number of recreational walking

minutes by 60%. A one unit increase in intersection density was associated with 2% fewer minutes of recreational walking. While intersection density is positively associated with utilitarian walking, it has a negative association with recreational walking. Intersection density represents connectivity of the street network as well as block size. A greater number of 3- or 4-way intersections and smaller block size may facilitate utilitarian walking but is less supportive for recreational walking because of the more frequent stops and encounters with cars during the trip. Having a spouse/partner is highly and positively associated with recreational walking minutes, whereas it was negatively associated with total walking. The results from Tables 10 and 11 confirm the previous findings that context-specific correlates should be considered when modeling for specific types of walking and physical activity.

Table 11 Negative Binomial Model of Recreational Walking

Utilitarian Walking	Exp(B)	Lower 95% CI	Upper 95% CI
(Constant)	42.69	2.56	712.00
Being a Korean Immigrant	**.43**	**.24**	**.75**
Age	.99	.97	1.03
High Education (Completed College/University)	1.15	.61	2.15
High Income (Annual Household Income > 50k)	**2.41**	**1.31**	**4.44**
Number of Children	.96	.72	1.28
Having a Spouse/Partner	**2.02**	**1.06**	**3.85**
Employed	1.08	.64	1.80
Barriers to PA (1-5 level)	**.40**	**.27**	**.61**
Social Support for PA (1-5 level)	.86	.60	1.24
Area of Parks (km2)	.97	.64	1.48
Distance to the Closest Trails	1.00	1.00	1.00
Intersection Density (count/km2)	**.98**	**.97**	**.99**
Residential Density (Du/Acre)	1.05	.95	1.17
Perceived Aesthetics (1-5 level)?	1.05	.73	1.52

Log likelihood: -298, AIC: 626.7. BIC: 669.6

Model Comparisons between Korean Immigrant and Caucasian Women

With the same set of covariates, group-specific models were fitted to examine whether the two racial groups have different sets of correlates for the same outcomes. The models, in general, explained Korean immigrant women's MVPA as compared to their Caucasian counterparts fairly well (9.4% (500 threshold) and 26% (1010 threshold) of variances of Korean immigrants is explained by the models vs. 2.7% and 7.7% of those of Caucasians.)

The common correlate of MVPA for these two groups was perceived social support for PA. This confirms the importance of social support for women's PA participation no matter to what race they belong. However, Korean women were strongly influenced by having a spouse/partner and by their household income, while those covariates were not significant predictors of Caucasians' MVPA. The model in Table 12-1 with MVPA using the 1010 threshold shows similar findings, except that residential density was marginally but positively associated with the MVPA of Caucasians. Objectively measured residential density was associated with Caucasians' MVPA only.

Table 12 MVPA Model Comparison between Korean and Caucasian Women with 500 threshold

	Korean			Caucasian		
MVPA	St. Coef	Sig.	R2	St.Coef	Sig.	R2
Age	.050	.757	0.279	-.017	.908	0.199
High Education (Completed College/University)	.195	.173	Adj.R2	.037	.799	Adj. R2
High Income (Annual Household Income > 50k)	**.240**	**.098**	0.094	.063	.691	0.027
Number of Children	.094	.575		.235	.125	
Having a Spouse/Partner	**-.306**	**.035**		-.014	.923	
Employed	.044	.792		.048	.706	
Barriers to PA	-.048	.728		-.060	.706	
Social Support for PA	**.223**	**.097**		**.272**	**.070**	
Area of Parks	-.165	.288		.064	.648	

Distance to the Closest Trails	-.063	.663	.012	.923	
Intersection Density	.135	.421	-.211	.205	
Residential Density	.087	.606	.251	.138	

Table 12-1 MVPA Model Comparison between Korean and Caucasian Women with 1010 threshold

	Korean			Caucasian		
MVPA	St. Coef	Sig.	R2	St.Coef	Sig.	R2
Age	.158	.278	0.413	-.141	.321	0.240
High Education (Completed College/University)	.197	.127	Adj.R2	.056	.694	Adj. R2
High Income (Annual Household Income > 50k)	**.225**	**.085**	0.263	.237	.126	0.077
Number of Children	-.178	.241		.164	.271	
Having a Spouse/Partner	**-.327**	**.013**		-.138	.321	
Employed	-.116	.442		.118	.336	
Barriers to PA	-.191	.130		-.041	.790	
Social Support for PA	**.213**	**.080**		**.251**	**.086**	
Area of Parks	-.106	.447		.067	.623	
Distance to the Closest Trails	-.059	.651		.051	.685	
Intersection Density	-.036	.813		-.143	.376	
Residential Density	.115	.453		**.280**	**.091**	

Table 13 is the model with total walking minutes for the two groups. The common correlate is having a spouse/partner. For both groups, women without a spouse or partner are likely to walk more. The number of children and the distance to the closest trail were negatively associated with Korean immigrant women's walking minutes. Among Caucasian women, household income and residential density are positively associated with walking minutes.

Table 13 Total Walking Model Comparison between Korean and Caucasian Women

	Korean			Caucasian		
Total Walking	St. Coef	Sig.	R^2	St.Coef	Sig.	R^2
Age	-.062	.684	0.347	-.059	.667	0.285
High Education	.042	.753	Adj.R^2	.096	.490	Adj. R^2
High Income	.189	.170	0.181	**.331**	**.029**	0.132

Number of Children	**-.422**	**.010**	.195	.177
Having a Spouse/Partner	**-.231**	**.091**	**-.266**	**.052**
Employed	-.080	.613	.025	.831
Barriers to PA	-.114	.388	-.049	.740
Social Support for PA	-.109	.388	.106	.450
Area of Parks	-.156	.290	.144	.279
Distance to the Closest Trails	**-.257**	**.066**	.074	.545
Intersection Density	-.213	.185	-.051	.742
Residential Density	.050	.757	**.334**	**.039**

Discussion

Both unadjusted and adjusted models support the finding that Caucasian women were significantly more active than Korean immigrant women. After the covariates were controlled, being Caucasian was still highly and positively associated with more minutes of all four types of PAs, i.e., MVPA, total walking, utilitarian, and recreational walking. This is consistent with the previous findings that non-Hispanic whites were a more active group than any minority groups in general and specifically for recreational purposes (CDC, 2008; CDC, 2007; Adabonyan et al., 2010; Simpson et al., 2003). However, it does not support the finding that non-leisure time walking and bicycling (which is generally considered as having a utilitarian purpose) was more frequently performed by minority groups (Berrigan et al., 2006; Kruger et al., 2008). This sample of Korean immigrant women was shown to engage in a lower level of utilitarian walking compared to their Caucasian counterparts. This might be partly because the neighborhood characteristics of Korean immigrants were less favorable for utilitarian walking, with a longer distance to the closest bus stop and lower street and residential density compared to that of the Caucasian women. However, the Korean sample lived in neighborhood environments that were more attractive for recreational walking, for

example, closer to parks and trails and with larger areas of parks in their neighborhood, even though these factors do not appear to have facilitated their recreational walking.

Walking is a popular form of physical activity because it does not require any skills, knowledge, or costs. Walking is an easy and affordable option that can be integrated into one's daily routine as a mode of transportation (Lee & Moudon, 2004). Meanwhile, MVPA includes all bodily movement that involves some significant level of energy expenditure. It encompasses all types of physical activity, such as heavy lifting in occupational settings, gardening in household settings, doing yoga or running on a treadmill in recreational settings, and walking to places (transportation-related PA). Because MVPA lumps all sources of physical activity together even though they have different features in terms of purpose, skills, settings, and costs, the associations between MVPA and specific correlates were weaker than the associations between walking and the correlates..

The results support the previous research findings that different types of walking, for example utilitarian versus recreational walking, were associated with different sets of environmental attributes (Owen, Humpel, Leslie, Bauman, & Sallis, 2004; Lovasi et al., 2008). Tables 10 and 11 showed greater influence from psychosocial factors on recreational walking, and opposite direction of influences of intersection density on utilitarian and recreational walking. This study confirms that in order to understand mechanisms on environment-behavior interactions, the use of "behavior-specific physical activity measures" is important. In order to promote recreational walking, it would help to decrease the perception of barriers to physical activity, and to increase utilitarian walking, modifications of intersection density would be useful. Objectively measured residential density (dwelling

units per acre) of the neighborhood was positively associated with MVPA and total walking only among Caucasian women. This supports the idea that higher density and a compact neighborhood may be associated with active living among Caucasian residents.

Comparison of correlates between the two groups suggests different sets of correlates for different cultural groups. This introduces the "culture-specific correlates" concept to studies on minorities' and immigrants' behavior, which is consistent with a previous study; Lee & Im (2010) found that for Asian-American women, being employed and the number of children were negative and strong correlates of exercise, whereas none of these factors were significant among white, African-American, and Hispanic women's exercise. We found a stronger influence of family members/family composition on Korean immigrant women's PA participation. On the other hand, there was a relatively stronger influence of objectively measured neighborhood built environment features among Caucasian women. Two previous studies shared the same findings, that is, having children under the age of 5 was negatively associated with leisure time physical activity among Korean immigrant women in the U.S. (Choi, Wilbur & Kim, 2011; Choi et al., 2008). Many studies of minority women, in particular Asian and Hispanic women, showed that their cultures, which emphasize the women's duty to address the needs of their family before their own need to exercise, was one reason for their inactivity (Im & Choe, 2001; Im & Choe, 2004; Afable-Munsuz et al., 2010; Hofstetter et al., 2008). Interventions on social support from family/friends, such as providing childcare during exercise and programs allowing both mothers and children to be active at the same time, might increase PA participation among Korean immigrant women (Lee & Im, 2010). Because classification of household and occupational PA was not conducted in this study, it was not clear whether immigrant women had more of the burden

of household physical activity than their Caucasian counterparts. Ten minutes per day of the Korean immigrant women's non-walking bouts and 18 minutes of the Caucasian women's non-walking bouts (the non-walking bout minutes is total PA bout minutes minus walking bout minutes) include occupational (for those who had jobs) and household PA, but we cannot distinguish them from unidentified PA bouts. In particular, those PA bouts performed at a home location could be one of any type, including household, recreational (walking on a treadmill or playing with children), or occupational (if the person telecommutes or works at home). Travel diary information includes the main activity performed at destinations associated with each trip but did not have specific details of all activities that took place indoors. For example, if two PA bouts were identified during a visit to a friend's house, the travel log had no additional information regarding the purpose or the characteristics of those bouts.

In sum, the group-mean comparison showed striking differences in the groups' PA: active Caucasian women vs. insufficiently active Korean immigrant women. Consistent with previous findings, the Korean immigrant women did not regularly walk and their daily routine was likely to be full of other types of physical activity, such as household and occupational PA (Choi, Wilbur, Miller, Szalacha, & McAuley, 2008). Disparities in PA participation between the two racial groups in King County existed and were independent of their socio-economic, psychosocial, and built environmental factors. According to the previous literature, the mean difference might be even larger if the study compared Caucasian versus other races, for example, African-Americans or Hispanics, because these were identified as the least active groups. Walking is a more complex activity, with a certain purpose and intention compared to MVPA. In order to understand important correlates and to

promote both PA and walking among ethnic minority and immigrant women, further studies with a large, random sample and multiple racial groups in diverse neighborhood environments using more detailed physical activity logs are needed. Despite some limitations, this study is the first to use objective measures of PA and walking and to compare and contrast them between one immigrant women's group (Korean) and a reference group (Caucasian).

Chapter 4 A Comparison of Park-based Physical Activity between Korean Immigrant and Caucasian Women

Introduction

Parks provide many ways to support physical activity for adults by providing facilities for activities such as tennis, soccer, and baseball; by having organized programs for physical activity such as yoga classes, tai-chi, etc.; and by functioning as a community space for social events (Han, Cohen, & McKenzie, 2013). However, some studies have found that many parks in the U.S. are underutilized (Cohen et al., 2010) and that a significant proportion of users were sedentary during the time they spent in parks: 66% in Los Angeles, 65% in Tampa and Chicago, and 34% in an eastern U.S. city (Cohen et al., 2007; Floyd et al., 2008; Shores & West, 2008). Many users visit and remain at a park for reasons other than physical activity. For example, passive park users may visit in order to view scenery, to watch games in which family members are participating, or to meet friends. Even though there are health benefits from being in parks apart from PA, including mental health benefits through relaxation and release of stress, parks can contribute to public health by providing opportunities for moderate-to-vigorous physical activity (MVPA). According to West, Shores, and Mudd (2012), the total parkland per acre of a given metropolitan area was significantly associated with increased odds of meeting PA guidelines and with reduced odds of being overweight/obese. It has been shown that parks contributed to a significant level of energy expenditure in two cities: 15,336 metabolic equivalence intensity (METs) in 10 parks in Tampa, FL and 7,305 METs in 19 parks in Chicago, IL were observed respectively during 14 hours of observation for each park (Suau, Floyd, Spengler, Maddock, and Gobster, 2012).

If more empirical evidence were accumulated on the ways in which they contribute to public health, parks could be positioned as an important element of the health care system.

Although there have been many studies on the association between the size and accessibility of neighborhood parks and park use behaviors among residents, studies focusing on the reasons some park users are sedentary and the characteristics of these passive park users are limited. A few studies have indicated that there are some important differences in park use patterns among racial and ethnic groups. Gobster (2002), using a mixed method approach (on-site surveys and interviews of park users) in Lincoln Park, one of the heavily used parks in Chicago, found that more Latinos and Asians were sedentary in parks than whites were; more Latinos and Asians picnic, socialize, or participate in organized activities, whereas more whites walk their dog, jog, or bike. Whites tend to visit parks alone or with one other person and to engage in individual sports, but all minority groups are more likely to come as a group and to engage in passive and/or group activities. Two studies in Kansas City indicated that overall, white park users were more active than non-white users (Kaczynski et al., 2011; Kaczynski, Wilhelm Stanis, Besenyi, & Child, 2013). Reed, Price, Grost, & Mantinan (2012) confirmed a similar pattern in 16 Michigan parks. Female non-white users are less likely to be engaged in MVPA compared to other male and female white users and male non-white users. These findings imply that race/ethnicity might be an important determinant of physical activity intensity in parks and open spaces.

Promoting park-based PA among minorities would require different approaches and culturally relevant efforts. If race moderates the relationship between park characteristics and park-based physical activity, the relationship between park characteristics and MVPA at

parks could be stronger for Caucasian women and less strong or nonexistent for Korean immigrant women. Previous studies in park provision and residents' physical activity have focused on differential access to and provisions of parks across racial groups, which were associated with racial disparities in physical activity and the use of parks (Cohen et al., 2007). If there is a distinctive pattern of park use and amount of time spent being active in parks among users across racial groups, there is something beyond simply park provision and accessibility that influences physical activity in this setting. Understanding diversity in park visitation and park use patterns among racial groups could inform park design and strategies for organized programs to promote physical activity among all groups.

There are some limitations in the previous studies showing racial differences in park-based physical activity. They relied on trained observers' direct observations and interviews of selected samples of park users. Their sampling was usually based on pre-sampled zones within parks at pre-selected periods during the day and during the week. This widely used measuring method is called the System for Observing Play and Recreation in Communities (SOPARC), and trained observers also coded the intensity of physical activity as sedentary, walking, or vigorous. Even though the validity and reliability of the technique has been established (McKenzie, Cohen, Sehgal, Williamson, & Golinelli, 2006; McKenzie, 1991), objective measures of total park time and physical activity levels within parks could reduce the possibility of misclassification of the physical activity intensity category and better estimate the relationship between race and park-based physical activity. Recent studies using portable GPS units and accelerometers provide stronger evidence of the link between objectively measured physical activity and locations in which it is performed. These tools could be better utilized in park user studies by providing locations within parks where the

majority of park-based MVPA was generated and where most of the sedentary park time occurred. The second limitation of previous studies is that the reported relationship between race and physical activity levels at parks was not adjusted for other socio-economic factors of park users, such as age, income, and education. Without controlling for individual-level characteristics that are known to be correlated with physical activity, racial differences in park-based physical activity might be attributable to different socio-economic backgrounds across racial groups. Finally, races other than white park users were lumped together into a non-white category or a minority group, which limits the distinction and investigation of diversities among subgroups. In physical activity behaviors, there are many variations across different ethnic groups. Hispanics, African-Americans, and Asians might prefer different styles of activity in parks partially due to their cultures and customs.

In this study, taking advantage of objective data on PA intensity and location, the association between PA intensity at parks and race is explored to see whether objective measures of total park time and MVPA at parks support previous findings that Caucasian women are more active at parks than Korean immigrant women. The purposes of this chapter are as follows: 1) to explore the unadjusted relationship between race and being a park user; 2) to estimate the racial effect on the likelihood of being a park user; 3) to examine differences in the proportion of active park time out of total park time between the two groups; and 4) to test the racial effect on the adjusted estimate of active park time. The hypotheses are that there are no racial differences in the likelihood of being a park user, and that Caucasian women spend more park time in being active than Korean immigrant women.

Methods

Behavioral data were obtained using GPS units, accelerometers, and travel logs for seven consecutive days. The merged GPS-accelerometer-travel log data by timestamps (called "LifeLog") can provide information about the subjects' park time in two different ways: 1) GPS points which are overlaid within King County park sites, and 2) the travel log record that has one of the King County park names in its "placename" field—the participants were asked to report their destination name (with its address) in the "placename" field during the assessment period.

The first method uses the objective data only, which assumes that locational information logged by GPS is the most accurate data to identify whether a person is actually at the park or not at the time of logging. If there are no significant satellite signal losses or battery problems during the observation period, GPS points within park sites would be a more precise representation of total park time because they provide objectively recorded arrival and departure times compared to the information provided by the self-report from a travel log. The King County park data were obtained from the Urban Form Laboratory, which collected park data directly from the King County GIS and other park jurisdictions within the county between April 30 and June 26, 2008 (Stewart, 2010). The park data are the best available and most comprehensive data on King County parks because they include only the park sites that are publicly owned and accessible to the public, and because they exclude any records of land that is not a park or an open space. Figure 14 shows an example of park time identified by GPS points with park site overlay—green dots on the Gilman Playground site are counted as park time whereas yellow dots were recorded during trips to and from the park.

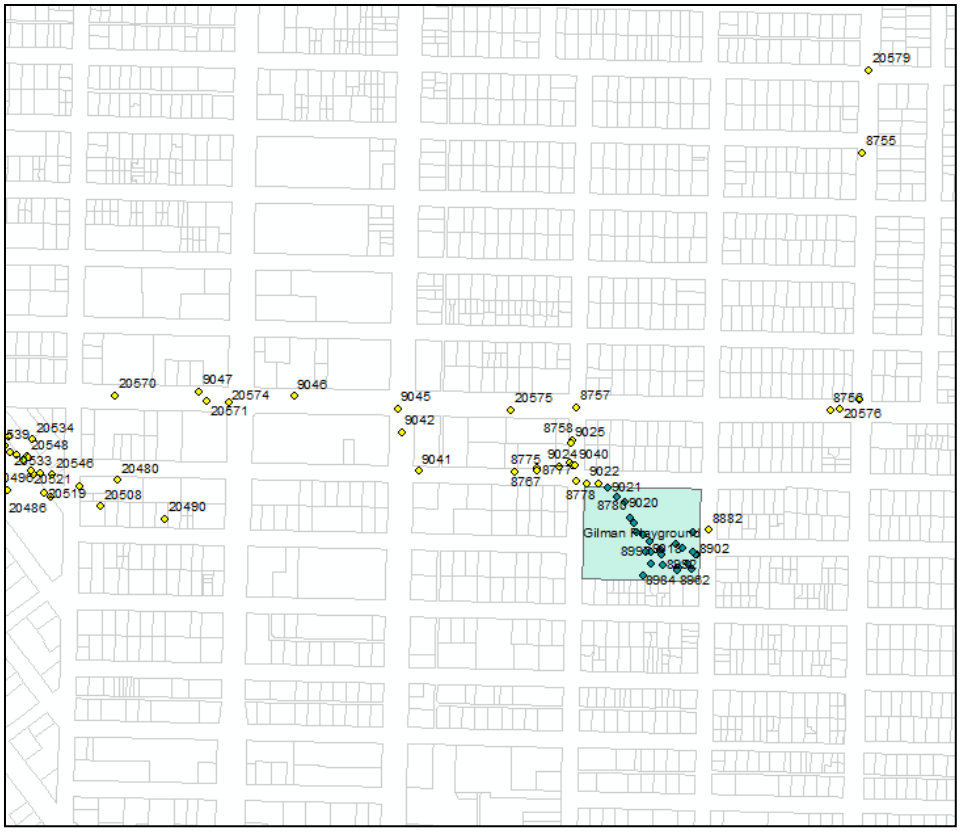


Figure 14 An Example of GPS Points identified as Park Time (Green Dots)

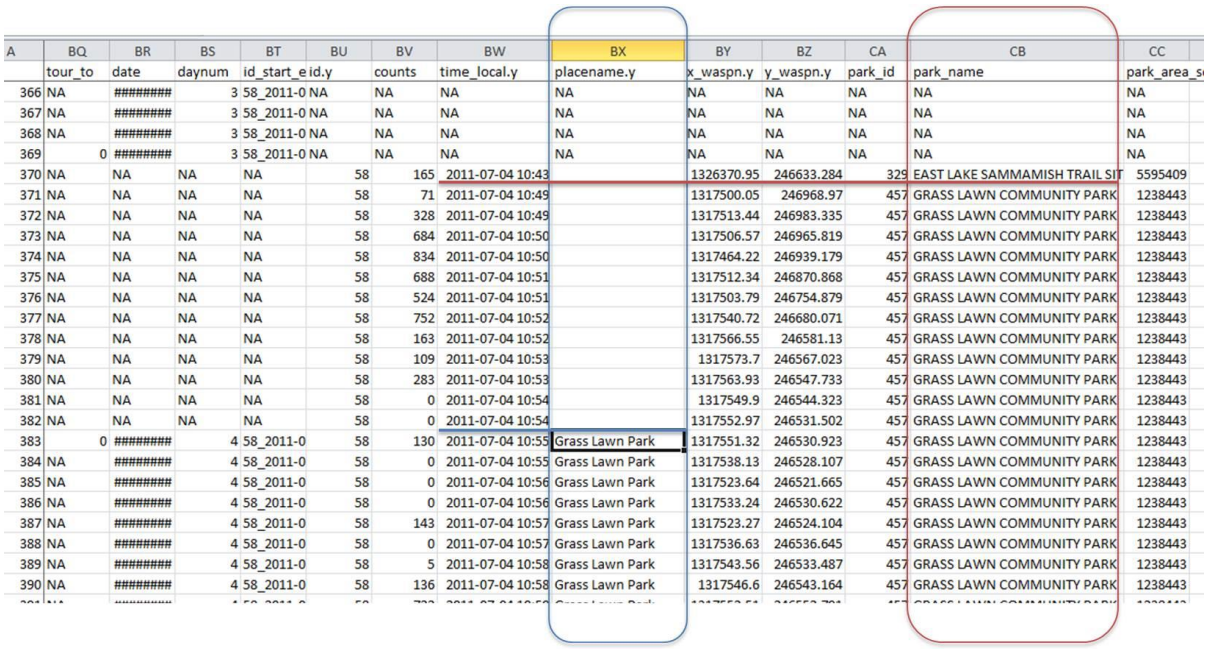
The second method relies on individual self-reports on the time at which the participants went to the park, how long they stayed, and which park they visited, which is subjective in nature and would inevitably induce recall bias because the participants filled out the log at the end of the day.

In this study, the two different sources of data—GPS and travel log—were combined and if at least one of the data sources identifies a record as park time, then it is classified as park time. Then any records of which "activity count" field is greater than or equal to 500 per epoch (meaning MVPA as in Chapter 3) were remarked as "park time that is active" or "active park time (MVPA at parks)." Although the 1010 threshold was also used in this chapter, the discussion will focus primarily on MVPA using the 500 threshold.

Figures 15 and 16 are snapshots of the dataset resulting from the first method, using travel log data only, and from the combined method. In Figure 15, the rows with "Grass Lawn Park" in the "placename.y" column is the park time and the very first row is the arrival time reported in the travel log. The following records indicated that the person stayed at the park for some time. The "park_name" column in Figure 16 contains the name of the park from the King County park data where each GPS point is overlaid. Based on the combined data method described above, this person's park time started at 10:49 am on July 4, 2011 (the row right below the red bar in Figure 16).

A	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ
	tour_to	date	daynum	id_start_e	id.y	counts	time_local.y	placename.y	x_waspn.y	y_waspn.y
366	NA	########	3	58_2011-0	NA	NA	NA	NA	NA	NA
367	NA	########	3	58_2011-0	NA	NA	NA	NA	NA	NA
368	NA	########	3	58_2011-0	NA	NA	NA	NA	NA	NA
369	0	########	3	58_2011-0	NA	NA	NA	NA	NA	NA
370	NA	NA	NA	NA	58	165	2011-07-04 10:43		1326370.95	246633.284
371	NA	NA	NA	NA	58	71	2011-07-04 10:49		1317500.05	246968.97
372	NA	NA	NA	NA	58	328	2011-07-04 10:49		1317513.44	246983.335
373	NA	NA	NA	NA	58	684	2011-07-04 10:50		1317506.57	246965.819
374	NA	NA	NA	NA	58	834	2011-07-04 10:50		1317464.22	246939.179
375	NA	NA	NA	NA	58	688	2011-07-04 10:51		1317512.34	246870.868
376	NA	NA	NA	NA	58	524	2011-07-04 10:51		1317503.79	246754.879
377	NA	NA	NA	NA	58	752	2011-07-04 10:52		1317540.72	246680.071
378	NA	NA	NA	NA	58	163	2011-07-04 10:52		1317566.55	246581.13
379	NA	NA	NA	NA	58	109	2011-07-04 10:53		1317573.7	246567.023
380	NA	NA	NA	NA	58	283	2011-07-04 10:53		1317563.93	246547.733
381	NA	NA	NA	NA	58	0	2011-07-04 10:54		1317549.9	246544.323
382	NA	NA	NA	NA	58	0	2011-07-04 10:54		1317552.97	246531.502
383	0	########	4	58_2011-0	58	130	2011-07-04 10:55	Grass Lawn Park	1317551.32	246530.923
384	NA	########	4	58_2011-0	58	0	2011-07-04 10:55	Grass Lawn Park	1317538.13	246528.107
385	NA	########	4	58_2011-0	58	0	2011-07-04 10:56	Grass Lawn Park	1317523.64	246521.665
386	NA	########	4	58_2011-0	58	0	2011-07-04 10:56	Grass Lawn Park	1317533.24	246530.622
387	NA	########	4	58_2011-0	58	143	2011-07-04 10:57	Grass Lawn Park	1317523.27	246524.104
388	NA	########	4	58_2011-0	58	0	2011-07-04 10:57	Grass Lawn Park	1317536.63	246536.645
389	NA	########	4	58_2011-0	58	5	2011-07-04 10:58	Grass Lawn Park	1317543.56	246533.487
390	NA	########	4	58_2011-0	58	136	2011-07-04 10:58	Grass Lawn Park	1317546.6	246543.164

Figure 25 Travel Log based Total Park Time



A	BQ	BR	BS	BT	BU	BV	BW	BX	BY	BZ	CA	CB	CC
	tour_to	date	daynum	id_start_e	id.y	counts	time_local.y	placename.y	x_waspn.y	y_waspn.y	park_id	park_name	park_area_s
366	NA	########	3	58_2011-0	NA	NA	NA	NA	NA	NA	NA	NA	NA
367	NA	########	3	58_2011-0	NA	NA	NA	NA	NA	NA	NA	NA	NA
368	NA	########	3	58_2011-0	NA	NA	NA	NA	NA	NA	NA	NA	NA
369	0	########	3	58_2011-0	NA	NA	NA	NA	NA	NA	NA	NA	NA
370	NA	NA	NA	NA	58	165	2011-07-04 10:43		1326370.95	246633.284	329	EAST LAKE SAMMAMISH TRAIL SIT	5595409
371	NA	NA	NA	NA	58	71	2011-07-04 10:49		1317500.05	246968.97	457	GRASS LAWN COMMUNITY PARK	1238443
372	NA	NA	NA	NA	58	328	2011-07-04 10:49		1317513.44	246983.335	457	GRASS LAWN COMMUNITY PARK	1238443
373	NA	NA	NA	NA	58	684	2011-07-04 10:50		1317506.57	246965.819	457	GRASS LAWN COMMUNITY PARK	1238443
374	NA	NA	NA	NA	58	834	2011-07-04 10:50		1317464.22	246939.179	457	GRASS LAWN COMMUNITY PARK	1238443
375	NA	NA	NA	NA	58	688	2011-07-04 10:51		1317512.34	246870.868	457	GRASS LAWN COMMUNITY PARK	1238443
376	NA	NA	NA	NA	58	524	2011-07-04 10:51		1317503.79	246754.879	457	GRASS LAWN COMMUNITY PARK	1238443
377	NA	NA	NA	NA	58	752	2011-07-04 10:52		1317540.72	246680.071	457	GRASS LAWN COMMUNITY PARK	1238443
378	NA	NA	NA	NA	58	163	2011-07-04 10:52		1317566.55	246581.13	457	GRASS LAWN COMMUNITY PARK	1238443
379	NA	NA	NA	NA	58	109	2011-07-04 10:53		1317573.7	246567.023	457	GRASS LAWN COMMUNITY PARK	1238443
380	NA	NA	NA	NA	58	283	2011-07-04 10:53		1317563.93	246547.733	457	GRASS LAWN COMMUNITY PARK	1238443
381	NA	NA	NA	NA	58	0	2011-07-04 10:54		1317549.9	246544.323	457	GRASS LAWN COMMUNITY PARK	1238443
382	NA	NA	NA	NA	58	0	2011-07-04 10:54		1317552.97	246531.502	457	GRASS LAWN COMMUNITY PARK	1238443
383	0	########	4	58_2011-0	58	130	2011-07-04 10:55	Grass Lawn Park	1317551.32	246530.923	457	GRASS LAWN COMMUNITY PARK	1238443
384	NA	########	4	58_2011-0	58	0	2011-07-04 10:55	Grass Lawn Park	1317538.13	246528.107	457	GRASS LAWN COMMUNITY PARK	1238443
385	NA	########	4	58_2011-0	58	0	2011-07-04 10:56	Grass Lawn Park	1317523.64	246521.665	457	GRASS LAWN COMMUNITY PARK	1238443
386	NA	########	4	58_2011-0	58	0	2011-07-04 10:56	Grass Lawn Park	1317533.24	246530.622	457	GRASS LAWN COMMUNITY PARK	1238443
387	NA	########	4	58_2011-0	58	143	2011-07-04 10:57	Grass Lawn Park	1317523.27	246524.104	457	GRASS LAWN COMMUNITY PARK	1238443
388	NA	########	4	58_2011-0	58	0	2011-07-04 10:57	Grass Lawn Park	1317536.63	246536.645	457	GRASS LAWN COMMUNITY PARK	1238443
389	NA	########	4	58_2011-0	58	5	2011-07-04 10:58	Grass Lawn Park	1317543.56	246533.487	457	GRASS LAWN COMMUNITY PARK	1238443
390	NA	########	4	58_2011-0	58	136	2011-07-04 10:58	Grass Lawn Park	1317546.6	246543.164	457	GRASS LAWN COMMUNITY PARK	1238443

Figure 36 Total Park Time based on the Combined Data

By comparing what was reported in the travel log's "placename.y" column to the actual park name according to the GPS points ("park_name"), discrepancies between the two resulting datasets were reviewed. There are two possible explanations with respect to a blank record in the placename field ("placename.y"). First, the participant may have reported that she was traveling to the park but, in fact, she was already there. If this is the case, it implies that the arrival and departure time as recorded in the travel log is not very accurate, as expected. Second, the blank in the placename field could occur if the subject was traveling on a road adjacent to the park site, but the GPS erroneously located a point within the park site. According to Rodriguez, Brown, & Troped (2005), although 81.1% of GPS data observations are within a 5-meter buffer from the exact location of the GPS unit, 16.7% of data observations are within a 5-10 meter buffer and 1.6% are within a 10-15 meter buffer from

the actual location of the unit. Because several meters off from the true location is possible because of GPS jitter and the specified location could range up to 20 meters or more away from the true location depending on the surrounding environment, e.g., tree canopy, high-density development, etc., another step was necessary. If the speed of the GPS point overlaid with park sites was greater than 6 km/h, the point and its nearby points were visually checked in order to determine whether it was a part of the driving traces and then excluded from the final result dataset.

Total park time and active park time were identified and summarized at the individual level. Participants were defined as park users if they had at least 5 minutes of park time (from the GPS and travel log combined data) during any day during the study week. Data collection procedures were approved by the institutional review board at the University of Washington.

Results

Table 14 presents the number of park users and non-users in the two groups. A Chi-square test shows that Korean immigrant women were more likely to be park users during the week than Caucasian women (significant at 0.05 level by Fisher's Exact test result in Table 15). While 65% of Korean immigrant women were park users, less than half (43.5%) of the Caucasian women were park users during the week.

Table 14 Crosstab of Race and Park user

	Korean immigrant	Caucasian	Total
Park user (1)	39	30	69

Nonuser (0)	21	39	60
Total	60	69	129

Table 15 Chi-Square Tests between Race and Park user

	Value	Df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5.975	1	.015		
Continuity Correction[b]	5.141	1	.023		
Likelihood Ratio	6.033	1	.014		
Fisher's Exact Test				**.021****	**.011****
Linear-by-Linear Association	5.929	1	.015		
N of Valid Cases	129				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 27.91.
b. Computed only for a 2x2 table

Table 16 shows two different models that predict the probability of being a park user. The first model includes socio-demographic characteristics and psychosocial factors and the second model was also adjusted for built environment characteristics. In both models, being a Korean immigrant or a Caucasian was not a significant predictor of being a park user; there was no racial difference in park visitation. Only social support for PA from family and friends explained the diversity in women's park visitation when everything else held constant. One unit increase in perceived social support for PA was associated with a two-fold increase in the probability of being a park user. However, after the four built environment variables were entered, none of the variables were statistically significant factors for being a park user.

We did not find a substantive impact of accessibility to the closest park or area of parks within the neighborhood on being a park user among these women.

Table 16 Logistic regression model with 5 more variables to estimate the probability of being a park user

	Model 1		Model 2	
	Exp(B)	95%CI	Exp(B)	95%CI
Being a Korean Immigrant	1.64	(.61, 4.37)	1.68	(.55, 5.08)
Age	.95	(.90, 1.01)	.96	(.90, 1.01)
High Education	2.06	(.72, 5.87)	2.36	(.79, 6.94)
High Income	.79	(.30, 2.07)	.84	(.31, 2.26)
Number of Children	1.33	(.81, 2.18)	1.40	(.81, 2.41)
Having a Spouse/Partner	.91	(.26, 3.19)	.87	(.24, 3.15)
Employed	1.23	(.47, 3.19)	1.28	(.47, 3.45)
Barriers to PA	.57	(.27, 1.17)	.59	(.28, 1.25)
Social Support for PA	**2.02**	**(1.05, 3.87)**	1.95	(.98, 3.86)
Area of Parks			.73	(.41, 1.31)
Distance to the Closest Trails			1.00	(1.00, 1.00)
Intersection Density			1.00	(.98, 1.02)
Residential Density			.99	(.99, 1.00)

In order to focus on the user's behavior at parks and examine differences in park-based PA between the two groups, the actual park users were identified and characterized for further analysis. There were a total of 69 park users. Among them, Caucasian park users spent a greater proportion of their park time in performing MVPA compared to Korean immigrant park users (significant at 0.05 level). This confirms the previous findings from direct observations that Caucasians tend to engage more in moderate-to-vigorous physical activity in parks while minorities are more likely to spend their park time in sedentary or passive behaviors.

Table 17 T-test on percentage of park time active by race

Race	N	Mean of Percentage of park time that's active	F	Sig.
Korean	39	26.4	2.976	**0.036***
Caucasian	30	40.5		

Figure 17 shows distributions of total and active park time by race. While the median of total park time was greater among Korean immigrant women, the median of active park time was much greater among Caucasian women. This illustrates park use patterns between the two groups; Korean women spent more time at parks in general but spent fewer minutes in MVPA at parks than Caucasian women. However, the differences in total and active park time between the two groups were not statistically significant.

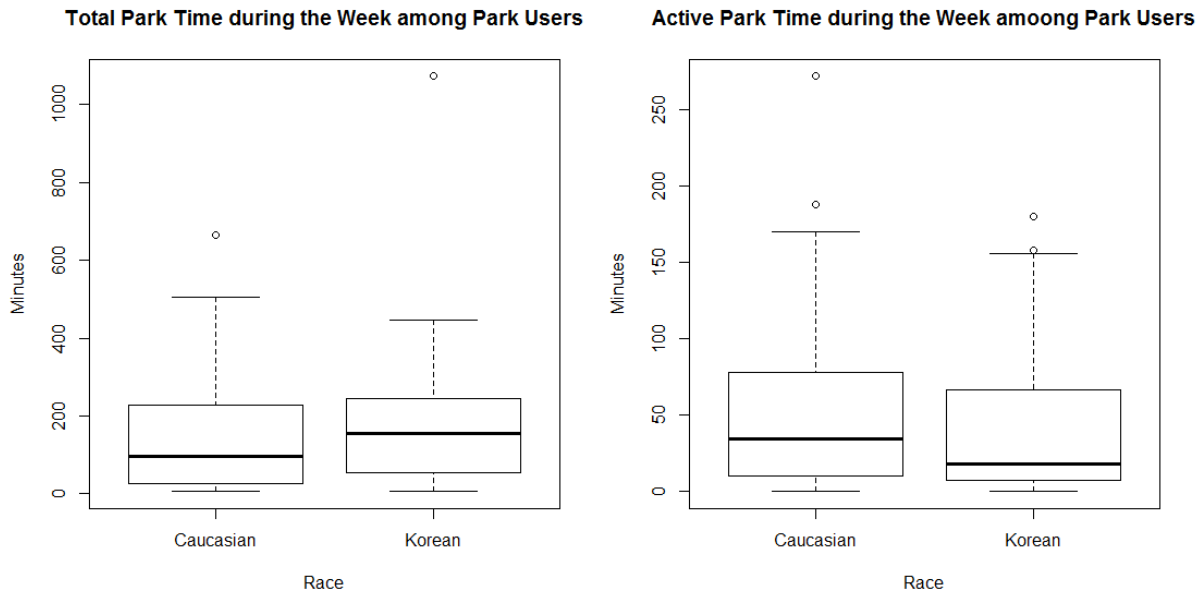


Figure 17 Total Park time and Active Park time

A negative-binomial regression model was fitted to examine the independent effect of race on park time that was active after adjusting for other individual-level covariates as well as total park time (see Table 18). After age, education, income, number of children, having a spouse/partner, employment status, and two psychosocial factors were adjusted, being a

Korean immigrant was not associated with active park time. Rather, barriers to PA were positively associated with active park time. Given that there was a significant difference in barriers to PA between the two racial groups (on average, 2.66 for Korean immigrants vs. 2.28 for Caucasians, p-value=0.001 [see Table 4]), Korean immigrant women's higher level of barriers to physical activity contributed to their being less active at a park compared to Caucasians. A one unit increase in barriers to PA was associated with a 38% decrease in the amount of active park time (from 500 threshold MVPA). When the 1010 MVPA threshold was applied, the barriers to PA impact are even stronger: a 48% decrease in active park time for Korean immigrant women compared to Caucasian women.

Table 18 Negative-binomial Regression Model for Active Park Time

MVPA at Parks	500 Threshold		1010 Threshold	
	Exp(B)	95%CI	Exp(B)	95%CI
Intercept	.57		.60	
Being a Korean Immigrant	.78	(.51, 1.20)	.74	(.41, 1.31)
Age	1.00	(.98, 1.03)	1.01	(.98, 1.05)
High Education	1.00	(.60, 1.68)	.96	(.53, 1.74)
High Income	.95	(.62, 1.45)	1.19	(.66, 2.15)
Number of Children	.87	(.69, 1.10)	.78	(.59, 1.02)
Having a Spouse/Partner	.87	(.45, 1.68)	.78	(.35, 1.75)
Employed	1.02	(.67, 1.56)	.86	(.47, 1.55)
Barriers to PA	**.62**	**(.44, .87)**	**.52**	**(.32, .82)**
Social Support for PA	1.26	(.97, 1.64)	1.15	(.84, 1.58)

Discussion

Based on the unadjusted statistics, Korean immigrant women were more likely to be park users and to spend more time at parks, even though their MVPA at parks was less than that of Caucasian women. This is consistent with a previous finding that minorities are more likely to be park users. Reed, Price, Grost, & Mantinan (2012) showed that a greater proportion of minorities are park users than whites when the number of park users was compared to the number of residents by race in a city or region. However, Koreans lived closer to parks and trails and had a larger area of parkland within a one-mile radius from their home compared to Caucasian women. Based on the t-tests in Chapter 2, these differences by race were statistically significant. There were substantial differences in the neighborhood built environments between the two groups based on the unadjusted probability of being park users that may contribute to the higher proportion of park users among Korean immigrant women (data not shown). Only perceived social support for PA stands out as a predictor of being a park user and there is no racial effect. A one unit increase in perceived social support from family and friends among women is associated with a two-fold increase in the likelihood of being a park user. As seen in Chapter 3, social support is an overriding factor for women's PA participation and for park visitation. However, after adjusting for built environment factors for park visitation, including parkland area, distance to the closest trail, and intersection and residential density of the neighborhood, the effect of social support diminished. Although a greater proportion of Korean immigrant women were park users compared to Caucasian women, their proportion of active park time was significantly lower than that of Caucasians. Koreans spent 26% of their park time being active while Caucasians spent 40% of their park time engaging in MVPA. This supports the previous findings that

whites tend to engage in more intense activities in parks, such as individualized sports, walking, or jogging, whereas non-white park users engaged in less intense activities. A significant correlate of active park time when total park time is controlled was the barriers to physical activity. If women perceived a lack of interest or enjoyment in exercise, self-discipline, time, energy, company, equipment, skills, facilities, knowledge, good health, and good weather, etc., she is less likely to engage in MVPA at parks. From qualitative studies, minority and immigrant women reported that they already engaged in a sufficient level of PA through household settings, so that they did not recognize the necessity of additional time for PA, had no time for PA because of their priority on their family's needs, and had no relatives or family support because of immigration status. The t-test in Chapter 2 already confirmed a higher level of perceived barriers to PA among Korean immigrant compared to Caucasians.

No built environment factors were considered in the last model of active park time because the model aimed at examining whether being a Korean immigrant or a Caucasian woman made any difference in active park time when both women were already in the park for the same amount of time. In this case, surrounding neighborhood built environment features do not influence women's park-based MVPA. Rather, the most influential environmental factors would be park characteristics, for example, park size, amenities in parks, programs, safety, etc.

It is a limitation of this study that data on park characteristics were not available. Whether women are active within a park may be influenced by characteristics of the park itself, such as maintenance, having trails or tennis courts, and so forth (Kaczynski, Potwarka, & Saelens, 2008). Park size, water features, and more organized activities were associated with a greater

number of park users (Cohen et al., 2010). A more recent study underscored the importance of programmed activities at a park, showing that simply improving and investing in park facilities does not necessarily increase the number of park users (Cohen et al., 2013). Physical improvements of the park should be accompanied by programing efforts for at least some events at parks.

Another limitation of this study is that Koreans' behaviors were assessed between April and October while the Caucasians' data were gathered from February to October. The weather effect might play a role in the differences in park visitation between the two groups, especially in the Seattle metropolitan area, where there are many rainy days during the winter. The relatively small sample size with the convenient sampling method is a significant limitation of this study. Further studies with large size and random samples are necessary to generalize the findings of this study.

Despite the limitations, this study objectively measured total and active park time among 129 Korean immigrant and Caucasian women in King County, WA, and examined the independent effect of race on park visitation and active park time when socio-economic and psychosocial factors were adjusted. It underscored the contribution of immigrant women's higher level of barriers to PA to their lower level of park-based PA compared to Caucasian women.

Chapter 5 The Effects of acculturation on Korean immigrant women's physical activity/inactivity

Introduction

In the United States, the number of immigrants is continuously increasing; the foreign-born population currently makes up 13% of the total population. The Western states have the highest concentration of foreign-born population in the U.S. (U.S. Census Bureau, 2010). Among these immigrants, an obesity trend is a concern in public health. These immigrants initially came to the U.S. with normal weight and in good health, but as they stayed, they gained weight faster than their native counterparts. After a period of 10-15 years, their Body Mass Index (BMI) converges to that of their native counterparts. This is called "Unhealthy Assimilation" (Antecol & Bedard, 2006).

Research shows that length of residence is positively associated with an increase in BMI (Goel, McCarthy, Phillips, & Wee, 2004), and that those who arrived at earlier ages are more likely to become obese (Kaushal, 2009).Although the foreign-born tend to be less obese than their U.S.-born counterparts (Park, Myers, Kao, & Min, 2009), among Asian-Americans, being a native-born citizen or a long immigrant resident of the U.S. is associated with a higher risk of being overweight (Lauderdale and Rathouz, 2000). This implies that some sort of health-related behavioral changes among Asian-Americans might have occurred among immigrants over time since they entered the U.S. After the immigrants' relocation to the U.S., some unhealthy behaviors could be adopted as a part of the acculturation process. Acculturation takes place when immigrants are exposed to and have interactions with

"attitudes, values, customs, beliefs, and behaviors" of a foreign culture in new economic, social, and built environments (Abraido-Lanze, White, & Vasques, 2004). It is defined as the process of adapting to a host culture that often changes one's values and convictions (Liem, Lim, & Liem, 2000). Recently, a body of research has focused on the effects of acculturation on immigrants' health-related behaviors, including physical activity.

However, the findings are somewhat mixed (Perez-Escamilla & Putnik, 2007). Kandula and Lauderdale (2005) showed that among Asian-American women, the likelihood of meeting recommended LTPA increased as years in the U.S. increased and that it was higher for those who spoke English at home. Similarly, Korean-Americans' acculturation was positively associated with light physical activity but not associated with vigorous PA (Lee, Sobal, & Frongillo, 2000). Another study found a positive association between acculturation and vigorous exercise (Hofstetter et al., 2008). However, two studies, focusing on midlife Korean immigrant women, found a null association between acculturation and leisure-time PA (Yang et al., 2007; Choi et al., 2008). The same inconsistency is also found in studies of Hispanics. Among Latinas, acculturation was positively associated with PA (Pichon et al., 2007; Jurkowski, Mosquera, & Ramos, 2010), while another study of Hispanic women found a null association between acculturation and physical activity (Banna, Kaiser, Drake, & Townsend, 2011). In addition, Afable-Munsu, Ponce, Rodriguez, & Perez-Stable (2010) found that the relationship between the immigrant generation and PA varies by ethnic group. The association between a later—second or third—immigrant generation and LTPA was positive among Mexican adults but negative among Asian adults. This suggested that the mechanisms explaining the effect of acculturation on PA could vary by ethnic group. Because the number of studies to date is limited, it is too early to make a firm conclusion

about the relationship between acculturation and physical activity and its underlying mechanisms. The mixed findings relied partially on the use of inconsistent measures for physical activity and for acculturation and on self-report and subjective measures. The main findings of previous studies are summarized in Table 19. Further investigation is needed in order to examine immigrants' physical activity patterns and their relationship to acculturation.

Table 19 Previous Findings regarding acculturation and PA

	Subject	Association
Jurkowski et al., 2010	289 Latino women in northeastern New York	Acculturation scale based on the Marin Short Acculturation Scale is positively associated with likelihood of engaging in leisure-time PA.
Pichon et al., 2007	526 Latino women in the southwest region of San Diego County	Acculturation Rating Scale for Mexican Americans (ARSMA-II) is positively associated with vigorous and moderate PA but not associated with walking.
Banna et al., 2011	1298 Hispanic women from 2005 California Women's Health Survey	Null association between language acculturation/length of residence in the U.S. and moderate/vigorous PA.
Kandula and Lauderdale, 2005	1865 Asian-American women from 2001 California Health Interview Survey	The likelihood of meeting recommended level of leisure-time PA increases with length of stay in the U.S.
Lee, Sobal, & Frongillo, 2000	141 Korean-American women in the continental U.S.	Acculturation level measured using the two-culture matrix model is positively associated with light PA but not significantly associated with vigorous PA.
Yang et al., 2007	152 Korean-American women in central Texas	The Suinn-Lew Asian Self-Identity Acculturation Scale is not significantly associated with leisure-time PA.

Whereas walking is an active form of transportation, driving is one of the sedentary behaviors that may influence obesity. Frank et al. (2004), in a study based in Atlanta, shows that each additional hour spent in a car per day is associated with a 6% increase in the likelihood of obesity, and it has negative associations with the likelihood of obesity.

Reducing auto use by one mile per driver per day for six years is associated with a 0.21 kg/m^2 reduction in average annual BMI (Behzad, King, & Jacobson, 2013). Six years is the time lag between the start of the behavioral change and the observation of the expected health outcome. In other words, in order to achieve a reduction of 0.5 in the average annual BMI, each licensed driver in the U.S. has to travel 863 miles less per year (average 16.55 miles/week) in the six years prior. In addition, McCormack (2012) demonstrates an inverse relationship between PA and driving, indicating that the likelihood of achieving sufficient PA was negatively associated with each hour per week of driving. To examine the reasons for the increasing trend of BMI among immigrants, the effects of acculturation on driving as well as on physical activity need to be researched.

Blumenberg and Shiki (2007) argued that as the income of immigrants increases over time, the immigrants start to relocate to lower density suburban neighborhoods and, as a result, their dependence on automobiles increases. The authors also compared relative transportation mode assimilation rates across four racial groups in California, and found that Asians are very quickly assimilated to auto use compared to Hispanics or African-Americans. This suggests that there could be cultural as well as economic factors influencing travel behaviors of immigrants. Immigrant parents' travel mode also affects their children's transportation. In San Diego, walking to school was negatively associated with acculturation; having parents who were foreign-born and having resided only for a short time in the U.S. made it more likely that the children walked to school (Martinez et al., 2008). However, for girls, walking to school was positively associated with their language preference for English. The findings of the relationship between acculturation and walking to school are sensitive to the kind of

acculturation measure being used. Other than these studies, there is no research on the relationships between travel behaviors and acculturation.

In the field of transportation planning, driving and walking are explained by demographics and socio-economic status, neighborhood design, travel attitudes, and residential preferences. It has been found consistently that the characteristics of a neighborhood's built environment have a separate influence on travel behavior after controlling for self-selection of residential location (Cao et al., 2009; Frank et al., 2007; Cao et al., 2007). Studies on the links between urban form and travel behavior support the idea that creating walkable environments may result in higher levels of physical activity and less driving. Based on the behaviors of immigrants and the possible cultural effects on physical activity and driving derived from the literature, this chapter examines the independent effects of acculturation on walking, park-based physical activity, and driving among Korean immigrant women. Based on the aforementioned findings and observations, we hypothesized initially that acculturation had negative effects on walking and on park-related physical activity, but a positive effect on driving.

Methods

Walking and park-based physical activity were measured in the previous chapters. Driving time per day was obtained from GPS data processing using the Physical Activity and Location Measurement System (PALMS) and from travel log data when the GPS data were not available.

Driving Trip Detection Method using GPS data

The Physical Activity and Location Measurement System (PALMS) was used to identify driving trips based on data from the GPS. The PALMS is a secure web application of PA and location data developed by the University of California at San Diego. It merges GPS-accelerometer data, identifies trips using built-in algorithms, and detects the travel mode based on speed distributions within a trip. After several GPS and accelerometer data explorations with the self-reported trip information from the travel log, we selected appropriate parameters for the sample and processed the data through the PALMS to detect auto trips. The steps built into the PALMS are described below: they are preprocessing of GPS data, trip detection, and trip mode estimation.

1) Filter invalid GPS values:
    - Maximum speed over 150 km/h, maximum change in elevation over 1 km, and maximum change in distance between fixes over 5 km
    - Remove fix if change in distance between fix 1 and fix 3 is less than 10 meters, which indicates a forward and backward movement that typically is caused by GPS jitter.
2) Trip detection: with the following criteria, the PALMS detect trips by classifying each point into stationary, moving, and paused states. The initial state of all points is stationary, and to change from a stationary state to a moving state, the specific criteria explained below should be met. Figure 18 shows the work flow of this state-based model.

- Minimum distance traveled over one minute (meters): 34 m, the minimum distance that must be traveled over one minute to indicate the start of a trip (1 km/hour = 17 meters/minute)
- Minimum trip length (meters): 100 m, the minimum length of a trip to be considered valid
- Minimum trip duration (seconds): 3 minutes
- Minimum pause time (seconds): when the duration at a given point exceeds 3 minutes, the point is marked as a pause point
- Maximum pause time (seconds): when the duration of a pause exceeds 5 minutes, the point is marked as an end point
- Loss of signal: after 5 minutes of no GPS fixes, loss of signal (LOS) is declared.

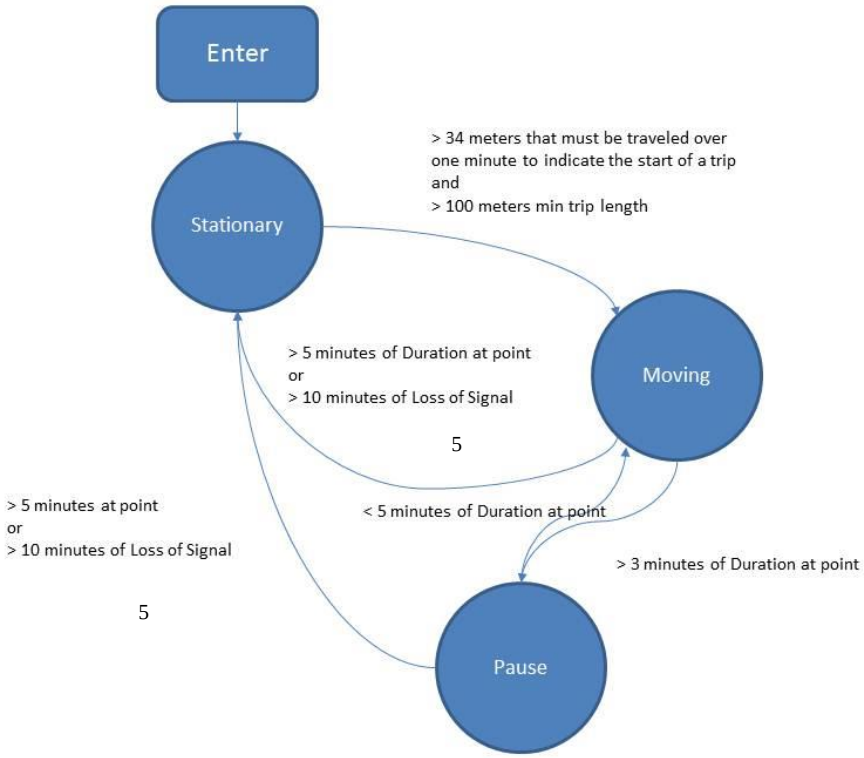


Figure 18 Flow of Trip Detection Algorithm by the PALMS

3) Trip mode estimation based on speed

- The speed at the 50th percentile of the points within each trip (the median speed) was used to classify the mode of transportation. Choosing the median speed could prevent misclassifications based on erroneous speeds caused by GPS jitter.
- Vehicle speed cutoff: 6km/hour
- Walk speed cutoff: 2 km/hour

The results were reviewed with travel diary information to exclude self-reported public transit trips so that only private automobile trips were included.

Self-Reported Driving Trips without GPS Data

Self-reported trips that occurred entirely during the loss of signal from the GPS were identified based on matching GPS-derived trips and self-reported trips. For these trips, the departure and arrival time from the travel log were used to calculate driving time. All driving times were summarized at an individual level and per day.

Acculturation Measures

The adapted version of ARSMA-II for Korean immigrants was used and explained in Chapter 2. Based on the answers from the 12 items, we obtained the Korean Orientation Subscale (KOS), the Anglo-American Orientation Subscale (AOS), and the Acculturation

Score (= AOS minus KOS). These measures were based on a bi-dimensional approach, looking at the processes of incorporating the customs from alternate and native societies independently. In addition to these factors, the length of residence in the U.S. and having a Korean husband (as a dummy variable) were also measured as proxies for acculturation level.

Statistical Model

This chapter explores intra-racial diversity and examines the relationship between acculturation and Korean immigrant women's obesity-related behaviors. The behaviors of interest here are walking bout minutes per day, minutes of active park time, and driving time per day.

The set of independent variables were already selected in Chapters 3 and 4 based on their correlation coefficients and the literature review in order to optimize the number of control variables and covariates given the small sample sizes. However, Korean immigrant specific analyses in this chapter (n=60) require a smaller number of independent variables in the model than the models for the entire sample (n=129). Among many demographic variables, age, household income, educational attainment, and employment status were adjusted. For the built environment, only residential density was adjusted. As in the previous chapters, barriers to PA and social support for PA were examined in the models for PA (walking minutes and park-based MVPA models). In order to create a model of driving time, variables for the number of vehicles in the household and the self-reported preference for driving were included. None of the psychosocial factors for PA were included in the model for driving time. The preference for driving variable was obtained from the questionnaire and represents

the degree to which one prefers driving and feels safer when driving as opposed to other types of transportation modes, and also the degree to which one needs a car in her daily routine. The answer options are based on 5-Likert scale, from 1 (strongly disagree) to 5 (strongly agree).

Linear regression and negative binomial regression models were used respectively for walking minutes and MVPA at park measures. The Generalized Estimating Equation (GEE) model was used to fit driving time in order to take correlated data into account. The robust method of GEE that does not assume any distributional assumptions would help fit data with a small sample size and deal with multicollinearity. The analyses were conducted using R program with the package "gee."

Results

The 60 Korean immigrant women participants had lived for an average of 11 years (ranging from 8 months to 39 years) in the U.S., which represents a very diverse first generation of Korean immigrant women in the U.S. Many Korean immigrant women in the data tend to have a relatively high KOS and a low-mid AOS so that their Acculturation Scores are mostly below zero, as seen in the first plot of Figure 19. The mean of KOS, AOS, and Acculturation Score of these 60 Korean immigrants were, respectively, 3.87, 2.63, and -1.25. The participants were identified more with Korean culture than Anglo-American culture. Of the Korean immigrant women, 85% had a husband of Korean ethnicity.

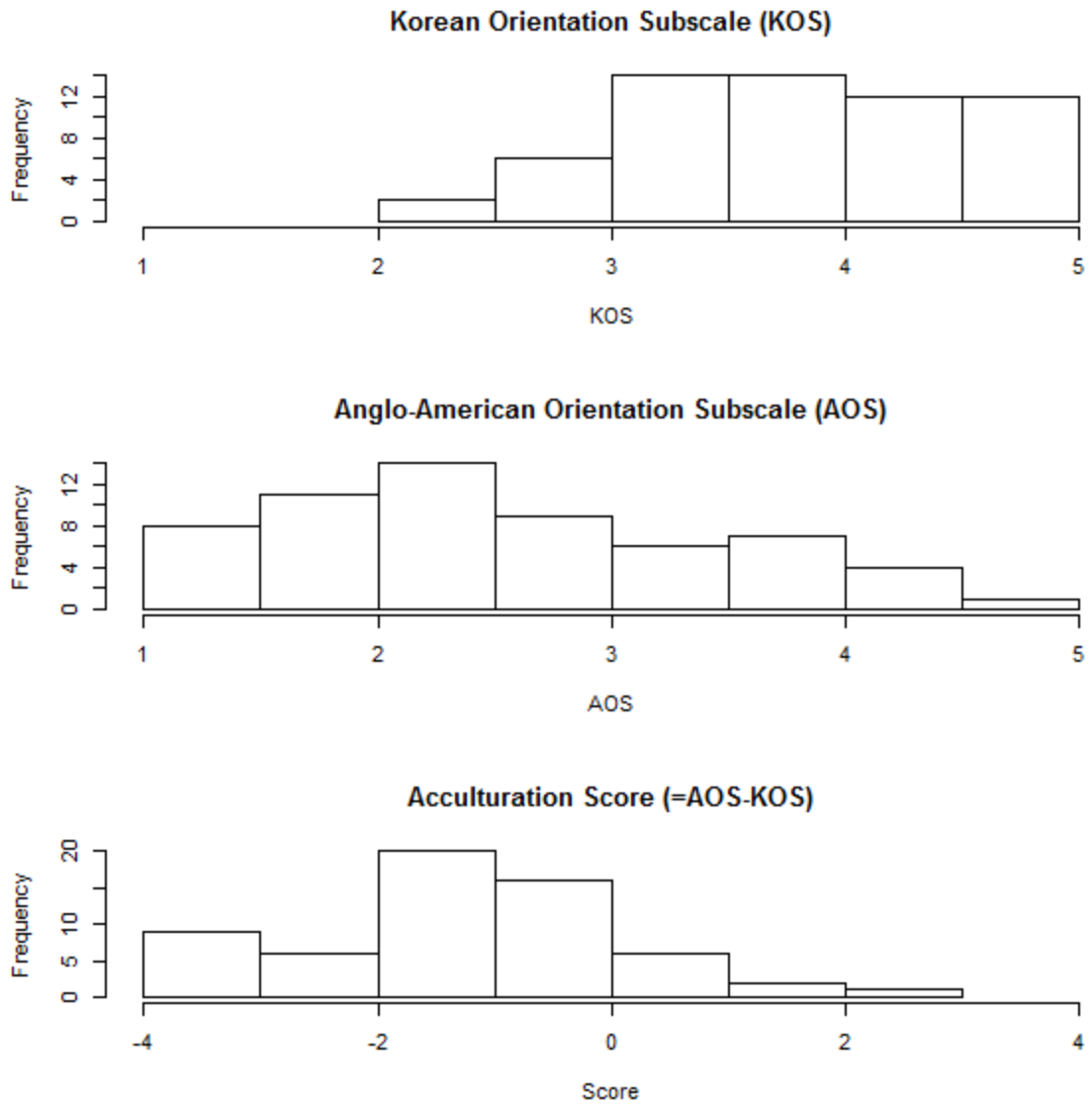


Figure 19 Distributions of the Three Acculturation Measures

Correlations between the acculturation measures and independent variables were examined to verify multicollinearity. AOS was positively correlated with income and education (coefficients were 0.319 and 0.361, significant at 0.05, 0.01 level). Length of residency in the U.S. was highly correlated with number of vehicles in the household (coefficient =0.540 significant at 0.001 level), significantly correlated with household income (coefficient =0.297

at 0.05 level) but not correlated with education level. Length of residence was negatively associated with street density, bus stop density, residential density, employment density, perceived access to facilities, and perceived crime. Based on the correlation tests, years since immigration seemed to be related to an increase in the household income and in auto ownership, and to a lower density residential neighborhood among the immigrants. However, none of the psychosocial factors were correlated with any of the acculturation measures. The adjusted model of walking minutes is presented in Table 20. It indicates that the Acculturation Score was negatively associated with walking bout minutes per day. A one unit increase in Acculturation Score is associated with a 2.2-minute decrease in walking per day and this is significant at 0.05 level. More acculturated Korean immigrant woman engaged in fewer minutes of walking than less acculturated woman, which is contrary to previous findings. Also, the Barriers to PA were negatively correlated to walking, even more than the Acculturation Score; 4.7-minute less walking per day at a significance level of 0.05. This implies that for Korean immigrant women who have some level of perceived barriers to PA and are more acculturated, their daily walking could be almost 7 minutes less than those who have one unit lower on the Acculturation Score and one unit lower in their perceived barriers to PA. Their weekly walking difference could be as much as 35 minutes.

Table 20 Linear Regression Model of Walking with Acculturation Score

Total Walking	Coef	Std. error	Sig.
(Constant)	17.95	13.32	.184
Age	.02	.19	.915
High Education (Completed College/University)	2.13	3.59	.556
High Income (Annual Household Income > 50k)	2.20	2.86	.446
Employed	3.57	2.84	.214
Barriers to PA (1-5 levels)	**-4.73**	**2.28**	**.043**

Social Support (1-5 levels)	-.79	1.92	.681
Acculturation Score	**-2.20**	**1.02**	**.036**
Having a Korean Husband	-5.54	3.81	.152
Residential Density (Du/Acre)	.30	.39	.448

R square: 0.229, Adjusted R Square: 0.127

Among 39 Korean immigrant women park users, active park time was fitted with the Acculturation Score. The coefficients of the Acculturation Score with active park time, measured using either the 500 or 1010 activity count threshold, was not statistically significant. In both models in Table 21 and 21-1, both of the psychosocial factors (Social Support for PA and the Barriers to PA) were significantly associated with MVPA at parks. Consistently, Korean women perceiving a lower level of barriers to PA and a higher level of social support are likely to engage in more minutes of MVPA at parks.

Table 21 Negative-binomial Model for Active Park Time among Korean Immigrant Women (500)

Active Park Time	Coef	Lower 95%CI	Upper 95%CI
(Intercept)	.09	.01	.77
Age	1.00	.95	1.05
High Education (Completed College/University)	1.51	.43	5.32
High Income (Annual Household Income > 50k)	1.14	.59	2.23
Employed	1.16	.63	2.16
Barriers for PA	**.57**	**.36**	**.91**
Social Support for PA	**1.70**	**1.21**	**2.39**
Acculturation Score	.95	.78	1.15
Having a Korean Husband	1.04	.41	2.59

Table 21-1 Negative-binomial Model for Active Park Time among Korean Immigrant Women (1010)

Active Park Time	Coef	Lower 95%CI	Upper 95%CI
(Intercept)	.07	.00	2.06
Age	.99	.93	1.07
High Education (Completed College/University)	1.67	.21	13.25
High Income (Annual Household Income > 50k)	1.38	.44	4.26
Employed	1.47	.57	3.79
Barriers for PA	**.35**	**.16**	**.75**

Social Support for PA	**2.05**	**1.23**	**3.40**
Acculturation Score	.82	.60	1.11
Having a Korean Husband	.93	.22	4.02

Table 22 shows the GEE model results with driving time per day as outcome. Estimated increase in driving time per day based on a one unit increase in Acculturation Score was 3.14 minutes, with a robust 95% confidence interval (-3.27, 9.56). Because the confidence interval includes zero, the coefficient was not statistically significant. However, the number of vehicles owned by a household was positively associated with driving time: a 15.4-minute increase in driving time per day among these Korean immigrant women for every additional auto owned by the household. The association between residential density and driving time was insignificant.

Table 22 Generalized Estimating Equation Model of Driving Time per Day

Driving Time	Coef	Lower 95%CI	Upper 95%CI
(Intercept)	-10.8	-131.2	109.7
Age	.74	-.78	2.27
High Education (Completed College/University)	17.1	-4.04	38.24
High Income (Annual Household Income > 50k)	4.42	-14.51	23.25
Employed	-.44	-16.51	15.62
Number of Vehicle in Household	**15.36**	**1.91**	**28.81**
Preference for Driving	4.84	-10.54	20.21
Acculturation Score	3.14	-3.27	9.56
Having a Korean Husband	5.99	-16.85	28.84
Residential Density (Du/Acre)	-1.00	-4.76	2.76

Discussion

This study found more daily walking among the less acculturated compared to that of the more acculturated. This is inconsistent with the previous findings that acculturation is either positively associated or has null association with physical activity. Also, it is contradictory to what we can expect from Chapter 3, which found that behavioral patterns of the more acculturated might be similar to those of Caucasians (a higher level of MVPA and walking compared to less acculturated Korean immigrant women). Even though the coefficient of the Acculturation Score is relatively small, 2.2 minutes per day, it could mean that a two unit increase in Acculturation Score is associated with 31 minutes less walking during a week. This study adds to the evidence of mixed findings in studies of acculturation and PA.

The amount of MVPA at parks and time spent driving were not significantly associated with acculturation. Even in Chapter 4, MVPA at parks had no association with race/ethnicity, and in this chapter, we have shown null association with acculturation measures. MVPA at parks may not be directly influenced by cultural factors. Rather, park-based PA is associated with individual perceptions of and attitudes toward PA.

The negative relationship between acculturation and walking and the positive relationship between the number of vehicles in the household and driving time per day among Korean immigrant women could partially explain unhealthy assimilation, that is, why BMI is higher among long-term immigrants as compared to recent immigrants. The more acculturated women engage in fewer minutes of walking per day compared to the less acculturated. Over time, as immigrants' auto ownership increases, their time spent in driving is likely to increase.

Each increase in the number of autos owned by a household is associated with additional 1 hour and 48 minutes of driving per week. This is another evidence of unhealthy assimilation, if this increased driving time occurs at the expense of their PA time. The literature recommends 150 minutes of PA per week for healthy lifestyle.

Because the number of vehicles and length of residence in the U.S. were strongly correlated (coefficient=0.597 and significant at 0.001 level), the relationship between the length of residency in the U.S. and increasing driving time over time might be mediated by the number of vehicles. Auto ownership is considered as a function of socio-economic status of the household, residential location, and transportation system (Guiliano & Dargay, 2006). Over time, the immigrants' level of earnings usually increases and their auto ownership increases as well, which may contribute to their dependency on automobiles and less active living over time.

On average, Korean immigrant women drove 80 minutes per day. According to the 2005-2009 American Community Survey for King County, WA, the mean travel time to work among workers is 26.6 minutes per day (about 53.2 minutes for a round trip). Given that about a half of the women in the sample were housewives, 80 minutes per day is relatively large. All of the Korean immigrant women have a driver's license, and only 11 out of 60 women own one car for the household. The rest (82%) owned at least two automobiles for the household (data not shown here). This high auto ownership rate might be a good indicator of significant levels of automobile travel assimilation among these immigrants.

The differences in prevalence of walking and in social and physical environments between the host country and the country of origin might determine the time, level of stress, and

health implication (impact) associated with the acculturation process. Usually, for Asians and Latinos, their country of origin was not as automobile dependent as the U.S. They walked more and used public transit more often in their country of origin, but after they moved to U.S. cities, they had to adapt their walking and travel behaviors to the new environment, where active forms of transportation are less favorable and friendly (Sussner, Lindsay, Greaney, & Peterson, 2008). However, after they settled into their new location and purchased an auto, their driving increased because the environment for driving is more favorable in the U.S. compared to their country of origin. Due to the cheaper gasoline, lower taxes, and no tolls or parking fees, all driving-related costs are less in the U.S. (Pucher, 2007), and the immigrants eventually adapt to this environment, and may, and sometimes have to, change their behaviors. This may be the underlying mechanism explaining the negative relationship between acculturation and walking and the positive relationship between the number of vehicles and driving time among these Korean immigrant women.

The impact of immigrants' behavioral changes will become greater over time as immigrants form an increasingly larger portion, especially in the West coast, of the total U.S. population in the future. Public health and planning professionals need to pay special attention to immigrants' behavioral changes over time and with increasing acculturation to reduce undesirable consequences.

Chapter 6 Conclusions

A convenience sample of 60 Korean immigrant women and a matching 69 Caucasian women in the Seattle metropolitan area showed that Caucasian women overall are more active than Korean women; they engage in more minutes of MVPA and of walking per day on average. Objective measures of physical activity from the samples support previous findings showing that immigrants are less active than the mainstream population. Multivariate models demonstrate that there is an independent effect of race per se on physical activity among women. In addition, differences in walking minutes per day among these women were also explained by other factors, such as income level, marital status, perceived barriers to PA, social support, and intersection density. Separate models for each ethnic group showed that specific variables are significant correlates for one group's behavior but not for the other, for example, a negative association of number of children with Korean immigrant women's MVPA and positive association of residential density with Caucasian women's MVPA and walking. Even though the presence of ethnic-specific correlates and the significance of number of children among Asian-American women are consistent with previous studies, further investigations with more comparable and systematically sampled data are needed to understand cultural influences on mechanisms of PA and walking differences across ethnic groups.

If we consider the park use of these groups of women, we see that there is a difference in park-related physical activity between the two groups. Unadjusted estimates showed significant racial differences in park visitation and proportion of active park time; there is a higher proportion of park users among Korean immigrant women but a higher percentage of

MVPA during park time among Caucasian women. However, adjusted estimates indicate no racial effect on park visitation or on MVPA at parks. The previous finding that Caucasian park users were observed to be more active than the minority park users was not statistically supported by this study. The ethnic differences in park-based MVPA were rather explained by other factors that had not been controlled in the previous studies, such as perceived barriers to PA. Parks play an important role in supporting physical activity. There are many possibilities to increase park-based PA participation among both Korean immigrant and Caucasian women through culturally relevant PA programs and resources for childcare that could potentially change their perceptions of PA.

Acculturation is negatively associated with Korean immigrant women's walking, but has null association with driving. Their travel behavior seems to be already assimilated to that of native-born Americans, but their walking has not increased to the level of their Caucasian counterparts commensurate with their acculturation. Similar findings appeared in a study of Japanese-American men in Hawaii; those who were born in Japan engaged in more PA than those born in Hawaii, and those who retained a more Japanese-style diet were more physically active than those who had a more western diet (Huang et al., 1996). However, the study was not adjusted for other covariates, which limits the significance of these findings.

One possible explanation for the opposite finding in this study is that the acculturation measures used here largely focused on language spoken and used in the participants' thought processes and their exposure to the host country's media (and also language). These acculturation measures might not reflect immigrants' values and behavioral changes regarding PA, which may be different from language and identity issues. Also, fluency in and

preference for a language spoken in a host county does not necessarily mean the adoption of values and customs of the host country (Banna et al., 2011). Some immigrants who have lived in the U.S. for a long time might nevertheless not have much interaction with the mainstream culture. During conversations with the study participants, a few of them asked the same question about the acculturation measures: why did the acculturation measures only ask about acquaintance with Anglo-American (white) culture but not the cultures of other ethnic minorities? If one has more interaction with his/her own ethnic group or with other minority groups than with mainstream, then the likelihood of one's adopting and assimilating the mainstream culture is less relevant to changes in values, customs, and behavior similar to those of Caucasians. Along the same lines, behavioral changes with increasing acculturation may result from adoption of behaviors of minorities or the lower middle class.

Another explanation for the divergent findings of this study is complex mechanisms explaining women's behavior: a slim body as a desirable norm is also an important factor for PA and diet among women. In the literature, desire for a slim body figure among mainstream women in the U.S. might be a greater motivation to engage in PA among more acculturated Hispanic women (Pichon et al., 2007). However, for Korean immigrants, the direction of the change in motivation could be the opposite: women's desire for a slim body figure is even more prevalent and stronger among Korean women in Korea, so the higher BMI among mainstream women in the U.S. than the average BMI of their country of origin may counteract and discourage immigrant women's motivation for PA. If this is the case, the more acculturated women may be more comfortable with an increase in BMI and feel less motivated to engage in PA to lose weight compared to those who are less acculturated.

A partial reason for these mixed findings is the use of different measures for PA. While this study assessed total walking minutes, other studies have focused on MVPA, light PA, vigorous PA, or leisure-time PA. Depending on what is being measured, the direction of the association between PA and acculturation may be sensitive. Because a relatively consistent finding is the positive association between acculturation and leisure-time PA, if we measured total leisure-time PA that includes PA, for example, during yoga class at gym or at home, the association could be a null or positive association among these Korean immigrant women. A model was fitted with recreational walking minutes as outcome but it did not show any significance (data not shown here).

No significant association was found between driving time and acculturation. Rather, the number of vehicles is highly associated with driving time per day. Because immigrants own more autos as their income goes up over time and length of residence in the U.S. is correlated with number of vehicles, this may partially support auto assimilation among immigrants toward more auto-dependency.

In sum, among these Korean immigrant women in King County, acculturation does not necessarily mean that they are adopting the mainstream (or Caucasian) PA behavioral patterns. Rather, the behavior of more acculturated women resembles that of unhealthy parts of the nation, including other minority groups. Further studies are needed to draw conclusions about the effect of acculturation on walking and driving in order to produce tailored approaches for minority and immigrant populations.

This study serves as a pilot to examine behavioral patterns of Korean immigrant and Caucasian women. MVPA, walking, park use, and driving behaviors can explain important

aspects of their lifestyles. If expanded, its interdisciplinary framework between urban planning and public health could contribute to policy formation to promote active living and healthy communities for minorities and immigrants and for all groups of the population.

However, there are limitations to this study: cross-sectional design, small sample size, convenient sampling, and inevitable difference in some covariates between the Caucasian and Korean immigrant women. First, the cross-sectional study design allowed comparing and contrasting physical activity behaviors between two ethnic groups that were assessed during a certain week per each participant. However, this assessment week, which varies by subject, might not fully represent an average week for the participants or summarize her habitual behavior because it represents only one period of time within a year. There could be potential influences of weather, special events such as holidays, family occasions, the academic year, or vacations on their physical activity behaviors. In addition, in order to fully examine the impact of acculturation on immigrants' walking, park-based MVPA, and driving behaviors, tracking recent immigrants' behavior and their interaction with their changing demographic, psychosocial, and built environment characteristics over time would be an ideal. However, to date, all acculturation studies including this one looked at diverse immigrants in a cross-sectional frame and classified them by generation (first generation versus second generation and beyond), by length of stay in the U.S. (less than 5 years, 5-10 years, and 15 years or more) or by a continuum of standardized acculturation scores.

Second, the small sample size both for Korean immigrant and Caucasian women might result in statistical insignificance of some potential covariates, built environment, and acculturation score variables. Future studies with large sample and inclusion of immigrants over the full

spectrum of acculturation—from highly acculturated, bicultural, and less acculturated immigrants—would provide stronger evidence for the relationship between acculturation and health-related behaviors.

Third, both the Korean immigrant and Caucasian women samples were not randomly selected from the populations. Convenient sampling methods were used to recruit Korean immigrant women for the sake of time and budget constraints. The Caucasians in this study were initially selected based on the TRAC study, which focused on the inclusion of minority and low income populations and from walkable neighborhoods based on their access to transit and retail services. Therefore, the findings of this study might not be generalizable to larger populations or to any other region. However, efficient random digit dial sampling of immigrants or ethnic minorities would be very difficult given a relatively small proportion of the population and uneven geographic distributions of immigrants in the cities or the region (Hofstetter et al., 2008). An additional difficulty in the sampling in this study was that the geographical extent was limited to King County, WA, while many Korean immigrant enclaves are located outside King County, such as in Edmonds and Lynnwood in Snohomish County and in Tacoma, Pierce County. Many of the samples ended up being recruited from the eastern side of King County, which is relatively different from western King County in terms of built environment characteristics. Another limitation is in the differences in geographic locations of the participants' homes. The characteristics of neighborhood built environments between the two groups are quite different, which means that the two groups experienced different levels of nearby opportunities and facilitators of, and barriers to, their physical activity, walking, and park use.

Fourth, even though various ideas and strategies were attempted in order to find good matches from the TRAC study's Caucasian female pool, there were inevitable difference in some covariates between the Caucasian and Korean immigrant women. Age, number of children, and employment status of the women are all important factors that may be related to their lifestyle and their demand for certain types of activities at home and/or at work, and with available resources for PA. Fortunately, the average household income and educational attainment, which were found to be strong confounders of the relationship between PA and race/ethnicity, are not statistically different between the two groups. Using multivariate models, much of these group differences were adjusted in the analyses, but given the number of observations, only a limited number of independent variables could be included in the models. Uncontrolled or unconsidered variables that are significantly different between the two groups might explain some of the variations in the data and some differences in PA between the groups. Ideally, if the matching samples are collected among those who live in the same neighborhood, the behavioral comparison of the different races could be more illuminating.

Regarding the study instruments, each device and tool has its own limitations and disadvantages. GPS signal dropouts under tree canopy and between high-rise buildings may affect the results of driving time estimation using the PALMS and walking and park time identification which relies on GPS data. The accelerometer does not capture an accurate level of energy expenditure when one is walking up a hill and/or carrying and lifting heavy things because activity counts are a summarization of the vertical acceleration of the upper hip. Recall bias and social desirability bias with the travel log could result in some misclassification of walking versus non-walking bouts. Also, depending on how the

participants reported their destinations and tours, classification of recreational versus utilitarian walking bouts might be sensitive. If there is significant recall bias in arrival and departure time at parks in the travel log, identification of park time using the combined data might not be the best strategy.

The acculturation measure is not designed for assessing health-related, including physical activity and dietary behavioral, aspects of acculturation and changes in behaviors. Acculturation is a very complex process and it is multidimensional. High acculturation in language use and personal identity might not reflect immigrants' adoption of social norms and resulting behavioral changes. There is a need to include behavior-specific acculturation measures when studying a particular facet of acculturation related to diet and physical activity (Satia et al., 2001).

For future comparative studies, more systematic sampling design is necessary to reduce possible heterogeneity between ethnic groups' SES, demographics, and the built environment. Given the fact that many ethnic groups live in certain areas of the city or the region, especially in the eastern and western coastal states in the U.S., selecting a large geographic area that includes those enclaves as a sampling frame would be a feasible starting point. As researchers recruit greater numbers of minority participants and collect their SES and demographic characteristics, recruitment of corresponding Caucasian samples within the same sampling frame can be an efficient comparative research approach. This strategy would be useful and effective for several reasons: 1) recruiting ethnic minorities may take longer than recruiting Caucasians; and 2) once researchers start with populations that share a similar range of built environments, they can then screen out some potential Caucasian participants

in advance based on their SES and demographic profiles. If there are not enough Caucasians within the sampling frame that match with existing minority samples, then a geographic area for sampling can be extended to adjacent neighborhoods that share similar built environment features.

An effective study design that aims to investigate the relationship between acculturation and PA among immigrant men and women would be a longitudinal study that observes the same cohorts of immigrants and their behaviors over time. This enables the examination of unhealthy assimilation, whether their health-related behaviors have changed over time, and whether that may lead to a faster weight gain compared to that of their country of origin.

Because of the small sample size, it was not possible to apply more advanced statistical methods in this research. However, given the complex relationships among independent variables and between covariates and outcome, more sophisticated statistical methods are necessary in the future. A structural equation modeling or a mediation analysis may enable researchers to examine direct and indirect effects of individual, acculturation, and neighborhood built environment factors on PA.

Despite these limitations, this study shed light on racial differences in and correlates of physical activity, walking, and park use. This is the first study examining PA and walking differences across racial groups using objective measures. Investigation of MVPA at parks identified by the combination of GPS and travel logs and the effect of race on MVPA at parks provided new insight on park use behaviors by race. Immigrant-specific analyses on acculturation influences on walking, park use, and driving behaviors partly suggest a potential underlying mechanism of unhealthy assimilation among immigrants. This study

provides new avenues for tailored approaches for minority and immigrant women to increase their PA participation and discourage weight gain. The future expanded research can shed more light on how to design healthy and active living intervention programs for immigrants and diverse racial groups to reverse the obesity trend in the U.S.

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