ASSESSING THE ASSOCIATIONS BETWEEN TYPES OF GREEN SPACE, PHYSICAL ACTIVITY, AND HEALTH INDICATORS USING GIS AND PARTICIPATORY SURVEY

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ABSTRACT:

This study explores whether specific types of green spaces (i.e. urban green spaces, forests, agricultural lands, rangelands, and wetlands) are associated with physical activity, quality of life, and cardiovascular disease prevalence. A sample of 8,976 respondents from the Behavioral Risk Factor Surveillance System, conducted in 2006 in Washington State across 291 zip-codes, was analyzed. Measures included physical activity status, quality of life, and cardiovascular disease prevalence (i.e. heart attack, angina, and stroke). Percentage of green spaces was derived from the National Land Cover Dataset and measured with Geographical Information System. Multilevel regression analyses were conducted to analyze the data while controlling for age, sex, race, weight, marital status, occupation, income, education level, and zip-code population and socio-economic situation. Regression results reveal that no green space types were associated with physical activity, quality of life, and cardiovascular disease prevalence. On the other hand, the analysis shows that physical activity was associated with general health, quality of life, and cardiovascular disease prevalence. The findings suggest that other factors such as size, structure and distribution (sprawled or concentrated, large or small), quality, and characteristics of green space might be important in general health, quality of life, and cardiovascular disease prevalence rather than green space types. Therefore, further investigations are needed.

1. INTRODUCTION

Today, physical inactivity has become an important threat to human life. Therefore, the World Health Organization has identified physical inactivity as the fourth leading risk factor for global mortality (WHO, 2010). Studies indicate that serious health problems such as coronary heart disease, obesity, chronic diseases, type 2 diabetes, breast and colon cancers, psychological disorders, and shortens life expectancy are related to physical inactivity (Lee, et al., 2012; Sallis, et al., 2012; The Ministry of Health, 2014). As of 2012, 31.1% of adults worldwide are reported to be physically inactive (Hallal, et al., 2012) and for the USA 33.2% of women and 29.9% of men are physically inactive (Go, et al., 2013).

Considering the prevalence and negative effects of physical inactivity on human health, more attention is required to increase the level of people's physical activity (PA). In order to do that, it is important to know and understand the factors that are related to PA (Schipperijn, et al., 2013; Koohsari, et al., 2015). One of the important factors that affects PA is green space (Akpinar, 2016; Koohsari, et al., 2015; Bedimo-Rung, et al., 2005; Kaczynski & Henderson, 2007). Green spaces strongly affect nearby inhabitants' well-being, behavior, and health and address human needs (Niemelä, et al., 2011; Schipperijn, et al., 2010; Matsuoka & Kaplan, 2008) as well as physiological and psychological health (Morita, et al., 2007; Pretty, et al., 2007; Herzog & Strevey, 2008; Ward Thompson, 2011). Green spaces create important opportunities for people to connect with nature, to exercise through involvement in both passive and active recreation, and to be involved in many kinds of social, cultural and community activities (Dunnett, et al., 2002; Orr, et al., 2014). A growing body of research suggests that green spaces are related to people's level of PA (Akpinar, 2016; Schipperijn, et al., 2013; Amorim, et al., 2010; Kaczynski, et al., 2009; Cohen, et al., 2007). Research shows that nearest distance to green spaces is positively related to higher levels of PA (Cohen, et al., 2007; Kaczynski, et al., 2009; Toftager, et al., 2011; Akpinar, 2016) and frequency of green spaces use (Cohen, et al., 2007; Mowen, et al., 2007; Schipperijn, et al., 2010; Akpinar, 2014, 2016). Positive associations between higher level of PA and size of green spaces are also found (Kaczynski, et al., 2008; Sugiyama, et al., 2010; Paquet, et al., 2013; Akpinar, 2016).

PA contribution to human health is well documented. PA has been shown to improve general health (Akpinar, 2016; De Jong, et al., 2012; Bize, et al., 2007), well-being (Hansmann, et al., 2007), and mood (Rethorst, et al., 2009; Barton & Pretty, 2010). PA also has been found to reduce stress (Tsatsoulis & Fountoulakis, 2006; Hamer, et al., 2009; Barton & Pretty, 2010; Akpinar, 2016), mental health problems such as anxiety (Mackay & Neill, 2010; Fox, 1999) and depression (US Department of Health and Human Services, 1996; Rethorst, et al., 2009), overweight (Shaw, et al., 2006; Nocon, et al., 2008), and the risk of cardiovascular disease (Tamosiunas, et al., 2014; Sallis, et al., 2012; Warburton, et al., 2006).

Some studies argue that PA in green environment might produce greater health benefits than PA elsewhere (Coon, et al., 2011; Mitchell, 2013). For instance, walking, jogging, running etc. in the presence of nature/green space which is called as "green exercise" lessen the risk of cardiovascular diseases (Tamosiunas, et al., 2014; Sallis, et al., 2012) and provides mental and health benefits by improving self-esteem and well-being and reducing tension-anxiety, depression-dejection, confusion-bewilderment, and anger-hostality (Pretty, et al., 2007; Barton & Pretty, 2010; Mackay & Neill, 2010).

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Some of the studies, on the other hand, highlighted that it should not be presumed that all green space types are relevant across the whole spectrum of human benefits (Jorgensen & Gobster, 2010). Van den Berg, et al., (2007), for instance, emphasized that little is known about the relationship between types of green space and health benefits. Richardson, et al., (2012) and Akpinar, et al. (2016) also recommended that future studies should focus on trying to distinguish types of 'green' in terms of health outcomes. Similarly, in Lee & Maheswaran (2010)'s review, it is revealed that more research is required to establish and quantify the contribution of the different types of green spaces to health and PA. For that reason, some studies have begun investigating the relationship between different types of green space, PA, and health benefits and found that formal parks is significantly related to better PA and less overweight (Coombes, et al., 2010). Another study conducted by Picavet, et al. (2016) investigated the cross-sectional and longitudinal associations between types of green space and PA. The study did not find any significant association between aggregated green space (i.e. urban green space, agricultural green, forest, and natural areas) and health. Picavet, et al. (2016), on the other hand, found that more urban green space was associated with more PA (i.e. sports and bicycling), whereas more agriculture green was associated with less PA. Studies concluded that more research is needed to better understand what types and features of green space might encourage people's PA. And, impact of different types of green space on PA has yet to be clarified (Coon, et al., 2011; Picavet, et al., 2016).

In this respect, this study aimed to provide new evidence on the associations between types of green space and PA and health indicators (i.e., quality of life (QoL), general health (GH), and cardiovascular disease prevalence (CVD)) by combining information from the Behavioral Risk Factor Survey (BRFSS) and the National Land Cover Dataset (NLCD).

2. METHODS

2.1 The Survey

This study analyzed data from the BFRSS which is a telephone survey that is conducted by health departments of states with technical and methodological support of the Centers for Disease Control and Prevention (CDC) to assess the health practices and distribution of risk behaviors among non-institutionalized adults (CDC, 2006; Mokdad, 2009). The BRFSS includes information on residents' GH status, health related QoL, PA, CVD prevalence (i.e., heath attack, angina, and stroke), and demographics. The health data employed in this study from the BRFSS were:

1. *General health status* measured by the question "*Would you say that in general your health is 1= Excellent, 2= Very good, 3= Good, 4= Fair, 5= Poor*?"
2. *Quality of life* measured by the questions which could range from 0 to 30 days were;
   a) *Now thinking about your physical health, which includes physical illness and injury, for how many days during the past 30 days was your physical health not good?*
   b) *Now thinking about your mental health, which includes stress, depression, and problems with emotions, for how many days during the past 30 days was your mental health not good?*
   c) *During the past 30 days, for about how many days did poor physical or mental health keep you from doing your usual activities, such as self-care, work, or recreation?*
3. *Physical activity* measured by the question was "*During the past month, other than your regular job, did you participate in any physical activities or exercise such as running, calisthenics, golf, gardening, or walking for exercise?"*
4. *Cardiovascular disease prevalence* measured by the questions were:
   a) *Has a doctor, nurse, or other health professional EVER told you that you had a heart attack, also called a myocardial infarction?*
   b) *(Ever told) you had angina or coronary heart disease?*
   c) *(Ever told) you had a stroke?*

The BRFSS data contained responses coded to the US postal zip-code of the respondent's residence somewhere within the zip-code. The original dataset contained 23,760 responses in 668 zip-codes. The BRFSS data was processed to include only valid zip-codes for which there exist geographic (polygonal) boundaries. Thus, zip-codes that represented point locations such as Post Office Boxes and private companies where respondents clearly do not reside were excluded from the BRFSS dataset. The GIS zip-code dataset contained 532 zip-codes. Those zip-codes were matched to the BRFSS data. Non-matching zip-codes were also excluded, yielding 509 zip-codes. Cases coded as *Don`t know/not sure*, *Refused* or *Missing* for zip-codes as well as for the needed health and mental variables were also excluded (listwise deletion). This exclusion resulted in 9864 complete responses (41.52% of total responses), distributed in 500 zip-codes.

To maximize external validity, zip-codes with fewer than 10 responses were excluded. This last exclusion yielded 8,976 complete responses distributed across 291 zip-codes which vary in size (minimum = 0.46 sq. mi, maximum = 1,422.95 sq. mi, M = 160.32 sq. mi.), population (minimum = 275 people, maximum = 64,214 people, M = 22,018 people), population density (minimum = 2.55 people per sq. mi, maximum = 17,894.56 people per sq. mi, M = 1,556.56 people per sq. mi.), household income (minimum = $22,418, maximum = $177,455, medium = $41,891), unemployment (minimum = 1.41%, maximum = 45.71%, M = 7.01%), and education level (i.e. bachelor degree or above) (minimum = 1.12%, maximum = 95.83%, M = 20.14%). The exclusion of those zip-codes with fewer than 10 respondents did not alter the substantive results.

2.2 Green Space Data

The green space data was derived from the NLCD 2006 data, which contains the dominant type of land cover for each 30x30 m grid cell area in Washington State (USGS, 2012). Land cover classes in the NLCD 2006 were reclassified into five types of green space (i.e. urban green space, forest, rangeland, agricultural land, and wetland) (see Table 1). Among the NLCD 2006 Land Cover classes, only urban green space is not comprehensively identified; rather the NLCD 2006 identifies four classes of land use (i.e. developed-open space, developed-low intensity, developed-medium intensity, and developed-high intensity) in which built-on land is mixed with natural vegetation. These four classes are distinguished by the percentage of impervious land (i.e., pavement, asphalt, etc.) in the cell. For the urban green space category, the developed-open space and developed-low intensity classes where impervious surfaces account for less than 20% and 20% to 49% of total cover respectively were included. Based on the Forman`s (2008) definition of green space and similar work in the Netherlands (van Den Berg, et al., 2010) the developed-medium intensity and developed-high intensity classes where impervious surfaces account for 50% to 79% and 80% to 100% of total cover respectively were omitted due to

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large amount of impervious surfaces. Examples of the land uses included in the selected urban categories include large-lot single-family housing units, parks, golf courses, and vegetation planted in developed settings for recreation, erosion control, or aesthetic purposes (Fry, et al., 2011).

The NLCD Code	Reclassification
21: Developed Open Space 22: Developed Low Intensity	Urban Green Space
41: Deciduous Forest 42: Evergreen Forest 43: Mixed Forest	Forest
52: Shrub/Scrub 71: Grasslands/Herbaceous	Rangeland
81: Pasture/Hay 82: Cultivated Crops	Agricultural Land
90: Woody Wetland 95: Emergent Herbaceous Wetland	Wetland

Table 1. NLCD Green space variables.

Table 1 above lists the available land cover categories relevant to green space. To calculate the percentage of green space, the NLCD 2006 categories were reclassified as needed to obtain the green space categories given in Table 1, resulting in five green-space types for each zip-code area. The proportion (normalized amount) of each type of green space in each zip-code was also calculated using this reclassified data. These values represent the total proportion of a green space type within a zip-code area.

2.3 Socio-economic and Demographic Characteristics

Because health may differ according to people's background characteristics, gender, age (in years), race, level of education, occupation, and household income of each respondent. Income level was categorized from less than $10,000 to $75,000 or more. Level of education was categorized from never attended school or only attended kindergarten to college 4 years or more (College graduate.) The potential for zip-code level confounding variables that might affect the associations were also concerned. Therefore, data at the zip-code level describing population, size (sq. mi), population density, socio-economic status (SES) (i.e. median household income, occupation (unemployment rate), and education level (bachelor's degree or higher)) were obtained from U. S. Census 2000 data.

2.4 Analytic Strategy

Preliminary analyses examined the normality of the variables. The responses to the GH question were normally distributed. To help clarify the relationship between QoL and green space, three questions were reduced to one factor using maximum likelihood exploratory factor analysis. The factor analysis was used because these questions together were intended to measure the level of QoL. Each question asked a different indicator of QoL so that they should be considered together. Then, the normality of QoL, PA, and CVD prevalence were examined. Because the distributions of these variables were skewed, a log-transformation $y=\log_e(x+1)$ to these three outcomes on which all test statistics are based were applied. However, the untransformed results were similar to those of the transformed data, and therefore the untransformed results were reported.

First, the relationships between types of green space and PA were analyzed while controlling for individual respondent characteristics at the individual level, and zip-code characteristics at the zip-code level via multilevel linear regression analyses. Prior to performing multilevel linear regression analyses, presence of multicollinearity issues between independent variables were checked. In this analysis, multicollinearity issues between population density and green space was found. Hence, population density from the regression model was excluded due to the multicollinearity issue.

Lastly, relationships between the five types of green space, PA and (i) GH, (ii) QoL, and (iii) CVD prevalence were examined with multilevel linear regression analyses while controlling for the possible confounding factors. A *p*-value of .05 was used to indicate statistical significance. SPSS version 18 was used for all statistical analyses.

3. RESULTS

3.1 Sample Characteristics

34.47% of the BRFSS respondents were male and 65.53% were female while 55% of the respondents were married among the 8,976 participants. The average age of the participants was 50.55 years old. The highest participation age cohort in the BRFSS sample was ages 45 to 54 (23.2%) and the lowest was ages 18 to 24 (5.1%). The highest degree of education achieved by the respondents (college graduate or more) was 39.1%. Regarding occupation, 46.6% of the respondents were employed while 2.1% were students. In terms of the total annual household income, 21.6% of the BRFSS respondents were in the highest income level ($75,000 or more). Regarding race, the BRFSS sample was 90% White.

3.2 Health Responses and Green Space

The mean of the GH was 2.72 while median was 3; the minimum response was 0 while the maximum was 5. The mean of the QoL was 6.22 days and median was 2.67 day; the minimum response was 0 days while the maximum was 30. For the CVD prevalence, 5.5%, 6.3%, and 4% were diagnosed with hearth attack, heart disease, and stroke, respectively. In terms of PA, 78.8% of the respondents performed PA. Among all individuals, only 23.1% respondents rated their health in general as fair or poor. The descriptive statistics indicates that the data consists of self-reportedly healthy sample of individuals.

Regarding green space, the mean of percentage of urban green space in zip-codes was 24.93%; the minimum percentage was .33% while the maximum was 79.62%. The mean of percentage of forest was 28.50%; the minimum was 0% while the maximum was 93.20%. For the rangeland, the mean of percentage was 16.65%; the minimum was 0% while the maximum was 86.91%. The mean of percentage of agricultural land was 11.19%; the minimum percentage was 0% while the maximum was 87.83%. Lastly, the mean of percentage of wetlands was 3.15%; the minimum was 0% while the maximum was 39.61%.

3.3 The Associations between Types of Green Spaces and PA

After controlling for the covariates, the multilevel regression analysis revealed that no types of green space are associated with PA (Table 2). The regression results indicated that those in a higher income (β= .027, SE= .003, 95% CI .022 − .032) levels and those in higher education levels (β= .046, SE= .005, 95% CI .036 − .055) reported better PA whereas older adults (β= -.003, SE= .000, 95% CI -.004 − -.002), overweight people (β= -.001, SE= .000, 95% CI -.002 − .001), and those who are unable to work (β= -.148, SE= .016, 95% CI -.180 − -.116) reported less PA. No other significant results were found.

	Physical Activity	
	β	SE
Sex (Male)	.017	.009
Age	**-.003*****	**.000**
African American	-.060	.038
Asian	-.005	.034
Native Hawaiian or Other Pacific Islander	-.001	.079
American Indian, Alaska Native	.011	.033
Other races	-.027	.029
Multiracial	.010	.023
Weight	**-.001*****	**.000**
Divorced	-.022	.013
Widowed	-.006	.017
Separated	-.025	.029
Never Married	.025	.015
Unmarried Couple	.018	.021
Education	**.046*****	**.005**
Self-Employed	.028	.016
Out of Work (>1)	-.038	.028
Out of Work (1<)	.028	.035
Homemaker	-.002	.016
Student	.024	.030
Retired	-.003	.015
Unable to work	**-.148*****	**.016**
Income	**.027*****	**.003**
Urban Green Space	.000	.001
Forest	.000	.000
Rangeland	.000	.000
Agricultural Land	.000	.000
Wetland	-.001	.001
Zip-code Population	.001	.000
Zip-code Size	.001	.000
Zip-code Income	.001	.000
Zip-code Unemployment	.000	.001
Zip-code Education (College or more)	.001	.000
R^2	**.115*****	

Table 2. The associations between types of green space and PA. Note: ***p ≤ .001, **p ≤ .01, *p ≤ .05, Women, White, Married, and Employed are the reference groups.

3.4 The Associations between Green Spaces, PA, and Health Indicators

As seen in Table 3, the multilevel regression results showed that no types of green space were associated with GH whereas PA was significantly associated with GH (β= -.363, SE= .025, 95% CI -.413 − -.313), where more PA was correlated with better GH. In terms of covariates, the findings revealed that those in a higher income (β= -.098, SE= .007, 95% CI -.111 − .085) levels and those in higher education in both individual (β= -.114, SE= .011, 95% CI -.137 − -.032) and zip-code levels (β= -.003, SE= .001, 95% CI -.004 − -.001) reported better GH whereas older adults (β= .013, SE= .001, 95% CI .011 − .014) and overweight people (β= .004, SE= .000, 95% CI .003 − .005) reported poorer GH. Among races, those who identify as Native Hawaiian or other Pacific Islander, American Indian/Alaska Native, multiracial, and other races reported poorer GH compared to White participants. In addition, those who were self-employed reported better GH while those who were out of work, homemaker, student, retired, and unable to work reported poorer GH compared to employed people.

For the QoL, the multilevel linear regression model showed that no types of green space were associated with QoL, whereas PA was significantly associated with QoL (β= -2.895, SE= .164, 95% CI -3.215 − -2.574) where more PA was correlated with better QoL. In terms of covariates, the results revealed that those in a higher income (β= -.383, SE= .043, 95% CI -.467 − .299) levels and those in higher education levels (β= -.446, SE= .074, 95% CI -.591 − -.302) reported better QoL whereas older adults (β= .013, SE= .006, 95% CI .002 − .025) and overweight people (β= .006, SE= .002, 95% CI .003 − .009) reported poorer QoL. Among races, those who identify as multiracial races reported poorer QoL compared to White participants. Those who were out of work, homemaker, retired, and unable to work reported poorer QoL compared to employed people. In addition, divorced and separated adults reported poorer QoL compared to married people.

4. DISCUSSION

The purpose of this study was to investigate the associations between types of green space and PA and health indicators (i.e., quality of life (QoL), general health (GH), and cardiovascular disease prevalence (CVD)). The findings of this study that no type of green space was associated with PA and health indicators, which is unexpected considering the previous studies. On the other hand, the results revealed that PA was associated with health indicators. Several points are highlighted to explain the differences between this study and the previous studies.

First of all, the size of the study areas may be one of the reasons for the nonsignificant results. In previous studies, the relationship between green space and health was mostly examined either in a 1–3 km radius around participants' homes (de Vries et al., 2003; Maas et al., 2006; Van den Berg et al., 2010) or at the neighborhood level (Richardson et al., 2013; Beyer et al., 2014) while this study examined green space at the zip-code level which varies in size from 2.20 sq. mi to 1422.95 sq. mi. As previous studies indicated, distance, sometimes called proximity, is an important factor in the relationship between green space, PA, and health (Maas et al., 2009; Stigsdotter et al., 2010; Ward Thompson et al., 2012; Akpinar, 2016); hence, respondents may not have engaged with green space in large zip-codes when considered the size of zip-codes areas in this study. Therefore, possibly longer distances to green space may have also contributed to differences in results that the author did not find a significant association between types of green space, PA, and health indicators.

	General Health		Quality of Life		Cardiovascular Disease Prevalence					
					Hearth Attack		Angina		Stroke	
	β	SE	β	SE	β	SE	β	SE	β	SE
Sex (Male)	.001	.023	-.237	.146	**.044*****	**.005**	**.034*****	.006	**.014****	**.005**
Age	**.013*****	**.001**	**.013*****	**.006**	**.002*****	**.000**	**002*****	**.000**	**.001*****	**.000**
African American	.033	.091	-.360	.588	-.002	.021	-.001	.023	-.006	.019
Asian	.148	.082	-.845	.525	-.008	.019	-.005	.020	-.001	.017
Native Hawaiian or Pacific Islander	**.371***	**.190**	2.261	1.222	.065	.044	.061	.047	.029	.039

American Indian, Alaska Native	**.213****	**.080**	.820	.515	**.058****	**.019**	**.046***	**.020**	.009	.016
Other races	**.205****	**.070**	-.310	.453	-.001	.016	-.004	.018	-.008	.014
Multiracial	**.128***	**.055**	**1.938*****	**.351**	**.039*****	**.013**	**-.051*****	**.023**	.020	.011
Weight	**.004*****	**.000**	**006*****	**.002**	**.001***	**.000**	**.001*****	**.000**	-.001	.000
Divorced	.012	.030	**.521****	**.194**	-.011	.007	-.013	.008	.006	.006
Widowed	-.072	.041	.203	.262	.013	.010	-.001	.010	**.026****	**.008**
Separated	.034	.069	**1.264****	**.244**	-.009	.016	-.005	.017	.001	.014
Never Married	.045	.035	-.119	.015	-.014	.008	-.005	.009	-.001	.007
Unmarried Couple	.089	.050	.032	.324	-.006	.012	.002	.013	.001	.010
Education	**-.114****	**.011**	**-.446*****	**.074**	**-.009****	**.003**	-.005	.003	**-.005***	**.002**
Self-Employed	**-.116****	**.038**	.199	.243	-.011	.009	-.002	.009	.002	.008
Out of Work (>1)	**.439*****	**.066**	**5.181*****	**.428**	-.011	.016	.002	.017	**.034***	**.014**
Out of Work (1<)	**.142*****	**.061**	**2.166*****	**.392**	.012	.014	.007	.015	-.005	.012
Homemaker	**.120****	**.039**	**.705****	**.252**	.009	.009	.007	.010	.010	.008
Student	**.166***	**.072**	.556	.465	.020	.017	.033	.018	.011	.015
Retired	**.253*****	**.035**	**.872*****	**.015**	**.048*****	**.008**	**.067*****	**.009**	**.043*****	**.007**
Unable to work	**.995*****	**.040**	**.863*****	**.255**	**.056*****	**.009**	**.087*****	**.010**	**.064*****	**.008**
Income	**-.098****	**.007**	**-.383*****	**.043**	**-.007****	**.002**	**-.005****	**.002**	**-.003***	**.001**
Physical Activity	**-.363****	**.025**	**-2.895****	**.164**	**-.024****	**.006**	**-.018****	**.006**	**-.013***	**.005**
Urban Green Space	.000	.001	-.005	.008	.000	.000	.000	.000	.000	.000
Forest	-.001	.001	-.003	.005	.000	.000	-.001	.000	.000	.000
Rangeland	-.002	.001	-.009	.006	.000	.000	.001	.000	.000	.000
Agricultural Land	.001	.001	-.006	.006	-.001	.000	-.001	.000	.000	.000
Wetland	.000	.002	-.006	.016	.001	.001	.001	.001	.000	.000
Zip-code Population	.001	.000	-.001	.000	-.001	.001	.001	.000	.001	.000
Zip-code Size	.001	.000	.000	.000	.001	.000	.001	.000	.001	.000
Zip-code Income	-.001	.000	.001	.000	-.001	.000	-.001	.000	-.001	.000
Zip-code Unemployment	.002	.003	.011	.021	-.001	.001	-.001	.001	.001	.001
Zip-code Education (College or more)	**-.003**	**.001**	.005	.006	.001	.000	-.001	.000	-.001	.000
R^2	**.331*****		**.320*****		**.095*****		**.095*****		**.060*****	

Table 3. The associations between types of green space, PA, and health indicators.
Note: ***p ≤ .001, **p ≤ .01, *p ≤ .05, Women, White, Married, and Employed are the reference groups.

Distribution of green spaces (sprawled or concentrated, large or small) is another possible explanation of nonsignificant results. Previous studies showed that well-connected urban green spaces are associated with less mental health complaints, whereas people reported less mental health complaints and better general health with their environments when these environments consist of closed patches (Akpinar, 2015). Another study revealed that neighborhood satisfaction was high where the neighborhood environments were less fragmented, less isolated, and well connected (Lee, et al., 2008). The authors also found variety in the size and shape of tree patches also showed a positive relationship with neighborhood satisfaction. Therefore, distribution of types of green space may have affected the relationship with PA and health. In this respect, future studies need to investigate this possibility.

Another possibility is that as many studies emphasized, the quality rather than the quantity of green spaces may be important in the relationship between green space, PA, and health (Akpinar, 2016; Richardson et al., 2010; Richardson and Mitchell, 2010; Van den Berg et al., 2007; Maas et al., 2006; de Vries et al., 2003). Most of the previous studies suggested that those who live in relatively more abundant green space may have better mental and general health than those who live in less abundant green space conditions. However, this assumption is not supported by the findings of this study similarly to Picavet et al. (2016) and Richardson et al. (2012) studies. If “living in more abundant green” leads to better health, then the author should have found significant associations. However, no evidence were found in that direction. In this respect, quality over quantity of green space may be the reason for the nonsignificant results. Therefore, quality of green space should be investigated in the future studies.

Lastly, some studies found that some characteristics of green space are associated with PA (Akpinar & Cankurt, 2016). It is important to note that, each type of green has different characteristics and human perception of landscapes is found to be associated with health and stress reduction (Ulrich, 1984; Ulrich et al., 1991), increased neighborhood satisfaction (Kaplan, 2001),and better restoration (Van den Berg et al., 2014). Hence, characteristics of types of green space may have contributed to nonsignificant results the author found. In this respect, future studies should investigate the characteristic of green space.

Despite the contribution this study has some limitations. The primary limitation is that the BRFSS does not provide respondents’ exact locations within the zip-codes. Therefore, it was also not possible to know whether respondents engaged with green spaces or not. The cell size of the NLCD is another limitation in this study. The NLCD data is consist of 30 m cells, therefore the results did not include finer resolution details such as small-scale natural elements and areas like trees along streets, green road sides, or greenery were not explicitly represented in the study. Lastly, this research was a cross-sectional, therefore, causation cannot be implied.

5. CONCLUSIONS

This study investigated whether types of green space were associated with PA and health indicators. The findings showed no types of green space was associated with PA and health indicator. Based on the findings of this study and previous studies, four possibilities were emphasized: a) proximity to green space, b) structure and distribution of green spaces, c) quality of green space, and d) characteristics of green space. This study suggests that while there is not a significant relationship, these

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possibilities need to be investigated in the future studies. The author recommends that when investigating the relationship between types of green space, PA, and health, finer resolution of land cover data and exact location of participants would be desirable in order to have better and more accurate results in terms of green space calculation and health benefits of green space.

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