THE ROLE OF LANDSCAPE SPATIAL PATTERNS

ON CHILDHOOD OBESITY AND QUALITY OF LIFE:

A STUDY OF HISPANIC CHILDREN IN INNER-CITY NEIGHBORHOODS

A Dissertation

by

JUN HYUN KIM

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

May 2010

Major Subject: Urban and Regional Science

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Approved by:

Co-Chairs of Committee,	Chanam Lee
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ABSTRACT

The Role of Landscape Spatial Patterns on Childhood Obesity and Quality of Life:

A Study of Hispanic Children in Inner-City Neighborhoods. (May 2010)

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This research examines the associations between landscape spatial patterns of urban forests, health-related quality of life (HRQOL), and obesity (captured by body mass index, BMI) among Hispanic children living in Houston's inner city neighborhoods.

One hundred 4th and 5th grade children and their mothers were recruited from five elementary schools. Children's BMI values were calculated from objectively measured height and weight. Children were surveyed about their environmental perceptions, physical activity, and socio-demographic factors. In addition, both the children and their mothers completed the PedsQL survey to measure the children's HRQOL. Using high-resolution Digital Orthophoto Quarter Quadrangle (DOQQ) aerial photo imagery, landscape spatial patterns of urban forests were measured by Geographic Information Systems (GIS) and remote sensing. FRAGSTATS was used to compute various landscape indices for areas within a half-mile and a quarter-mile from each child's home, using both airline and network distances.

Multiple regression models were used to predict the children's BMI and HRQOL. Four groups of independent variables were examined: landscape indices, socio-demographic variables, physical activity, and environmental perceptions and satisfaction (factor variables). Separate models were estimated using the GIS variables captured at different spatial extents including a half-mile and quarter-mile airline buffer, and a half-mile and quarter-mile network buffer.

This research showed that several landscape indices were significantly correlated with the children's BMI and HRQOL. Well-connected landscape spatial patterns and more tree patches (disaggregated landscape patterns) in a half-mile airline buffer from the subjects' homes were negatively associated with the children's BMI. Less fragmented landscape spatial conditions and larger areas of urban forests and tree patches showed positive associations with the children's HRQOL.

This research adds to the current multi-disciplinary area of research on environment-health relationships, by investigating the roles of urban greeneries and linking their spatial structure to children's obesity and quality of life.

DEDICATION

This dissertation is dedicated …

to my family, Yang Mi Kim and Aiden Minjun Kim,

to my parents, Seungwoo Kim and Sunghee Ko,

and to my parents-in-law, Deokgon Kim and Deokja Jang,

who made all of this possible,

for their endless encouragement and patience.

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My co-chair, Dr. Christopher Ellis, has been always there to listen and give advice, regardless of a long physical distance between Texas and Michigan. I am deeply grateful to him for shaping a large body of my knowledge in terms of the role of landscape ecology on landscape architecture research. His mentorship was paramount and studying with him has been a great pleasure.

I was also fortunate to have an advisory committee covering every aspect of my dissertation. Dr. Robert Coulson gave me valuable comments about landscape ecology theory, and Dr. Douglas Wunneburger provided crucial knowledge about GIS as a spatial analytical tool for my research.

I would like to express my appreciation to Dr. James Varni. Generously, he has agreed using the Pediatric Quality of Life Inventory (PedsQL) 4.0 generic core scale for my research. My special thanks to Dr. Norma Olvera and Dr. Dennis Smith at the University of Houston. They have allowed permission to add the PedsQL survey on the Urban Hispanic Perceptions and Environment and Physical Activity among Kids (UH-PEAK) research project. Parts of data sets of this study were supported by the UH-PEAK project.

Most importantly, I would like to express deepest appreciation to my family, Yangmi and Minjun. Their support, encouragement, patience, sacrifice and firm love have been the best foundation that has made my achievement. I'm indebted to the love of my parents. Their endless love and sacrifice have been vital to making my dreams come true. My success was also sincerely rooted in the love from my parents-in-law. Their support and encouragement deserve my gratitude. Last but not least, my brother, Jaehyun, and my sister-in-law, SeungEun have also been my best sources of strength and support.

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CHAPTER I

INTRODUCTION

1.1. Background of the Study

Despite the increasing interest in the relationship among neighborhood environments, physical activity, and health conditions, few studies have examined the effects of landscape spatial patterns on physical activity and quality of life. Incorporating both scientific and empirical evidence, a number of studies have reported positive correlations between landscape patterns and various human behaviors. As one of the most significant elements for shaping landscape spatial patterns, urban trees and forests[1] must be considered as parts of the built environment. Urban trees and forests can help deal with some of the problems associated with sedentary lifestyles by creating attractive places that encourage people to spend time and participate in physical activity outdoors (Coley et al., 1997; Nowak and Dwyer, 2007). In addition, urban or neighborhood forests improve the quality of life by increasing the sense of place, purifying physical and mental health by reducing stress and promoting relaxation, and creating beautiful places in which to live. Since those settings are strongly associated with built environments,

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This dissertation follows the style of Journal of Landscape and Urban Planning.

[1] The concept of urban forests is most often defined as “the cultivation and management of trees and their present and potential contribution to the physiological, sociological, and economic well-being of the urban society” (Rydberg and Falck, 2000. p.2) (Johnston, 1996; Jorgensen, 1986; Rydberg and Falck, 2000). In general, an urban forest is considered to be the total tree population within an entire urban area, including urban parks, public squares, monuments, cemeteries, boulevard medians, street trees, parking lots, and riparian areas (Grey 1996; Miller, 1998; Rydberg and Falck, 2000).

their findings could help promote diverse physical activities in individuals (Hartig et al., 1991; King et al., 2002).

At the same time, there has been some effort to examine the relationship between the aesthetic qualities of trees or forests in communities, and physical activity. However, measurement techniques in these studies have been limited, and the concept of aesthetics has not been well defined (Ball et al., 2001; Humpel et al., 2004a; King et al., 2000). Nonetheless, aesthetic qualities were found to be related to natural features and forests within neighborhoods or park areas. These researchers reported positive relationships between the aesthetic quality of the environment and physical activity (Ball et al., 2001; Brownson et al., 2000; Humpel et al., 2002; King et al., 2000). There have been a few attempts to capture the associations between public health and the amount of green space in neighborhoods (Maas et al., 2006; Mitchell and Popham, 2007; Nielsen and Hansen, 2007). However, these studies used only the total area of green space calculated from land use data. Thus, they were not able to account for the real structure of landscape and the types of green spaces. More empirical studies are needed to better understand the relationship between landscape patterns and health conditions.

In spite of many proven benefits from physical activity, according to the 2005 state summary data from the Centers for Disease Control (CDC), less than 50 percent of American adults meet the recommended level of physical activity (at least 5 days a week for 30 minutes a day of moderate intensity activity or at least 3 days a week for 20 minutes a day of vigorous intensity activity), and even 25 percent are not active at all.

The nature of the environment–physical activity relationship varies depending upon the type of physical activity and on the characteristics of the population (Humpel et al., 2004a; Lee and Moudon, 2006; Taylor et al., 1998). Recent studies suggest that a better understanding of different population groups would provide an important next step in physical activity research (Kohl III and Hobbs, 1998; Lee, 2007), because numerous studies have shown that sedentary lifestyles are strongly associated with differences in gender, ethnicity, income and age (Gordon-Larsen et al., 2002; Sallis et al., 1993; Sallis et al., 2000; Trost et al., 2003). Along these lines, research on the predictors of physical activity in children and adolescents has received growing attraction because they are vulnerable populations due to their inability to make healthy choices on their own (Boarnet et al., 2005; Braza et al., 2004; Hill et al., 2003). The level of physical activity decreases during the transition from childhood to adolescence. According to the CDC (2003), only 39 percent of children aged 9~13 years participated in regular physical activity. Moreover, Hispanics of all ages show lower levels of physical activity than Caucasians and this difference arises in early childhood (McKenzie et al., 1992; McKenzie et al., 1997). Hispanic parents are vulnerable to adverse health conditions, due to their statistically lower socioeconomic status (SES) and physical inactivity. These conditions work together to affect their children's participation in physical activities. Low levels of physical activity among Hispanic children and adolescents contribute not only to influence the increasing prevalence of obesity (Ogden et al., 2006; Ogden et al., 2002) and related comorbidities, but also to lowering their health-related quality of life.

1.2. Research Aims

Despite the increasing evidence supporting the significant roles of the environment on physical activity and health conditions, few studies have investigated landscape spatial patterns as part of the environment. The benefits of urban nature are well documented, especially regarding in production of psychological health benefits (Hartig et al., 2003; Kaplan and Kaplan, 1989; Kaplan, 1995; Ulrich et al., 1991). However, to what extent some exposure to urban nature and activity–friendly environments can help promote physical activity, physical health conditions, and quality of life had not yet been clearly understood.

Since the environment–behavior relationship is highly dependent upon the characteristics of the population, empirical research should explicitly consider the specific study population's socioeconomic background and behavior patterns.

Landscape patterns are generated by ecological processes resulting from complex interactions between abiotic / biotic factors and human systems, occurring at multiple spatial scales (Urban et al., 1987). Landscape patterns are considered crucial determinants in shaping human-dominated environments (i.e. settlements).

Aim 1: To assess the association between landscape spatial patterns and children's obese conditions. In addition to measuring environmental perceptions and satisfaction with the neighborhood built environment through a survey, children's obese conditions could be captured by their body mass index (BMI), calculated from an objectively measured height and weight. To measure the landscape spatial patterns of urban forests, objective measurements would be taken using aerial photos, Geographic Information System (GIS), remote sensing, and FRAGSTATS, developed by McGarigal and Marks (1995).

Aim 2: To examine the association between landscape spatial patterns and the health-related quality of life among children. Little research has attempted to assess the health-related quality of life (HRQOL) of Hispanic children. This aim tests the hypothesis that Hispanic children's health-related quality of life would be associated with the quality of environment, and landscape patterns would be a significant factor in determining the quality of environment. To measure children's health-related quality of life, this research proposes to use the Pediatric Quality of Life Inventory (PedsQL 4.0) developed by James Varni (Varni et al., 2001; Varni et al., 1999). The quality of environment would be examined by applying the concept of landscape ecology. The measurement methods used in the landscape ecology literature offer useful tools for assessing landscape patterns (Gustafson, 1998; Haines-Young and Chopping, 1996; Turner, 1990).

Aim 3*:* To examine the relationship between childhood obesity and children's health-related quality of life. Previous studies reported that obese persons showed lower HRQOL than healthy people (Fontaine and Bartlett, 1998; Fontaine and Bartlett, 2000; Kolotkin et al., 1995). Although only few studies attempted to examine the association between childhood obesity and HRQOL, they showed the same results as other studies with regards to adult population groups. Obese children showed significantly lower values of HRQOL, as compared to healthy children, as well as to cancer patients (Schwimmer et al., 2003).

Aim 4*:* To understand the physical activity patterns of Hispanic children and to examine gender differences in the environmental correlates of childhood obesity and HRQOL. A few studies related to children's physical activity indicated that ethnic differences played an important role in patterns of physical activity (McKenzie et al., 1992; McKenzie et al., 1997). In addition, several previous studies indicated that gender differences were also important to levels of physical activity (McKenzie et al., 1997; Sallis et al., 1993; Sherar et al., 2007; Trost et al., 1996). The various types of survey instruments would be used to address issues raised by this aim.

Aim 5: To identify what landscape indices are most powerful in capturing the landscape structural attributes relevant to children's obesity and quality of life.

1.3. Significance

The activities of daily life are formed in response to locations, and landscape architecture is suited to understanding this variation over space. Research on landscape ecology has improved the understanding of the interaction between ecology and behavior in both natural and human-dominated landscapes (Turner, 2005). This body of research offers a useful conceptual framework for this study. Applying ecological thinking to the design and planning disciplines is important because there are many complicated and seemingly unrelated decisions that must be made simultaneously, when engaging in the processes of landscape or urban planning. In addition, since human activity is a complicated concept, it is difficult to analyze people’s behaviors including motivators of and barriers to specific behaviors through a single disciplinary approach. Landscape architecture is a discipline that can build collaborations between environmental and behavioral issues, and its theoretical foundations provide the basis for bringing ecological thinking within a multi-disciplinary framework.

At the same time, the challenges are to understand the interactions between the built environment and public health conditions from the perspectives of the diverse academic fields including urban and transportation planning, and public health research. However, there are few empirical studies which attempt to interpret physical activities (e.g., play, walking, biking, and exercising) and quality of life from a landscape ecological perspective. The condition of landscape spatial patterns in communities or neighborhoods may be one of the most important attributes for promoting physical activity, as well as for improving quality of life, because a better environmental quality generated by appropriate landscape spatial patterns could increase people’s willingness to spend more time outside and engage in physical activity in outdoor areas.

The quantitative approach to measuring landscape spatial patterns can effectively and objectively examine the potential significance of landscape patterns as important correlates of physical activity. Further objective and subjective measures of environmental attributes are correlated, yet different. The use of both types of measurements is well suited to understanding the influence of the built environment on physical activity and health conditions.

The study population of this present research is Hispanic children. This group is one of the fastest growing populations, as well as one of the highest risk groups for many health problems in the U.S. Better understanding of their activity patterns and quality of life is in urgently needed in order to provide tailored and effective interventions. Moreover, Hispanic children and adolescents have a high prevalence of physical inactivity, overweight/obese conditions, diabetes mellitus, asthma, limited access to health care, and impaired quality of care (Flores et al., 2002; Schwimmer et al., 2003).

A number of studies, although none that included Hispanic children, report significant parental influences on the health behaviors of youth, including physical activity (Trost et al., 2001; Trost et al., 2003). The vulnerable health condition of Hispanic parents due to a lower SES and lack of participation in physical activity could affect their children's health conditions and quality of life.

1.4. Organization of the Dissertation

This dissertation consists of five chapters. Chapter I introduces the background of the study and research aims. Chapter II reviews the interlocking theories and models as well as the literature relevant to this research. In the subchapter discussing the interlocking theories and models within Chapter II, concepts of landscape ecology, landscape spatial patterns, the models and guidelines of for the optimum land use arrangement, the theory of behavior settings, and restorative environment theory are reviewed. In addition, the literature includes the benefits of landscape spatial patterns of urban forests, relationships among urban environments, physical activity, and public health, the health-related quality of life of children and adolescents, and the relationships among the natural environment, children's physical activity, and health conditions. Chapter III includes the conceptual framework, research hypotheses, and research flow and design. Chapter III also specifies the research setting and population, data sources, and the methodology used for testing the hypothesis. Chapter IV reports the results of the analysis including the socio-demographic characteristics of respondents, physical activity patterns, environmental perceptions, landscape spatial patterns of urban forests and trees, children's body mass index (BMI) and HRQOL. Finally, Chapter V states the significant findings of the study, discussion and conclusions based on the findings, recommendations for future research, and study limitations.

CHAPTER II

THEORIES AND LITERATURE REVIEW

2.1. Introduction

This chapter reviews interlocking theories, models and literature related to this research. This chapter consists of two subchapters. The first subchapter focuses on the interlocking theories, including concepts of landscape ecology, landscape spatial patterns and quantifying methods, the models and guidelines for the optimum land use arrangement as well as for measuring landscape spatial patterns, the theory of behavior settings, and restorative environment theory. The second subchapter organizes the literature review into: 1) the benefits of landscape spatial patterns of urban forests and trees on human wellbeing, 2) relationships among urban environments, physical activity, public health, and the health-related quality of life (HRQOL) of children and adolescents, and 3) relationships among natural environments, children’s physical activity, and health conditions.

2.2. Interlocking Theories

2.2.1. Landscape Ecology

The concept of landscape ecology is adapted in this research to quantitatively measure the quality of landscape spatial patterns within neighborhoods. Various definitions of landscape ecology exist (Forman, 1995a; Forman and Godron, 1986; Pickett and

Cadenasso, 1995). The most common definition is based on the understanding of the reciprocal interactions between spatial patterns and ecological processes (Turner, 2005). As an aspect of landscape planning, landscape ecology can be described as the application of spatial analyses focusing on problems of habitat planning and management within diverse landscapes (Marsh, 2005). Landscape structures, functions, and changes are major characteristics highlighted by the study of landscape ecology, as shown in Figure 1 (Forman and Godron, 1986; McGarigal and Marks, 1995).

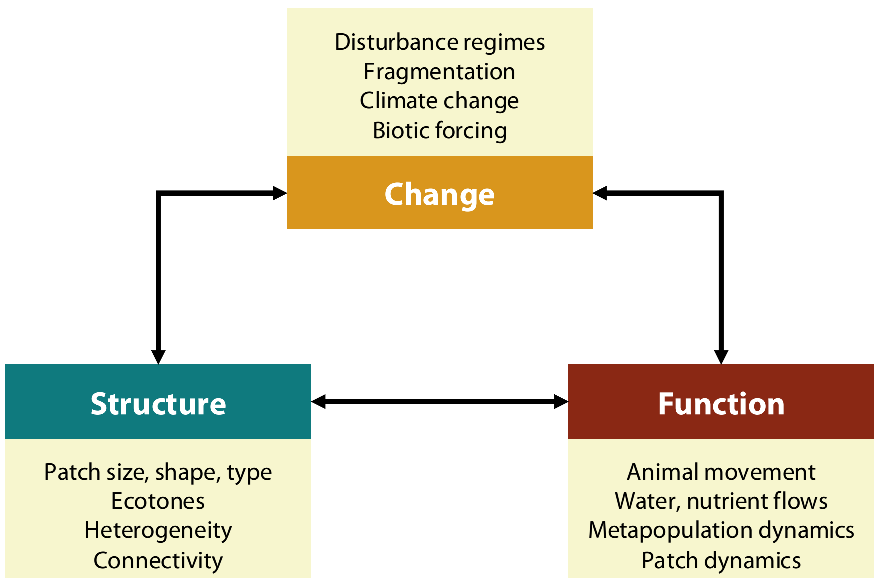


Figure 1. Three Main Characteristics of the Landscape.
(Adapted from Hobbs, 1997. p.4)

Landscape structure refers to the spatial relationships among discrete elements, especially patches. Most landscape structure can be categorized into two groups: composition and spatial configuration (pattern), as shown in Table 1 (Gustafson, 1998; Li and Reynolds, 1995; McGarigal and Marks, 1995; Turner, 2005; Turner et al., 2001).

Landscape composition refers to features related to the variety and plenteousness of patch types within the landscape. To put it another way, composition is simply defined as the types of different landscape elements, such as size and shape (Forman and Godron, 1986; McGarigal and Marks, 1995). However, composition does not consider the spatial character, placement, or location of patches within a mosaic. Since composition needs integration over all patch types, only the landscape level is available for composition metrics. Spatial configuration (pattern) refers to the spatial character and arrangement within a class or landscape. It can be determined by the arrangement and distribution of components within a given area. Quantifying configuration is much more difficult. Some aspects of configuration include patch isolation or patch contagion, the measure of the placement of patches or patch types, their relationship to other patches or patch types, and other features of interest (Gustafson, 1998; McGarigal and Marks, 1995).

More specific descriptions of landscape structure are introduced later under the 'Patch-Corridor-Matrix model' on page 19.

Table 1. Landscape Indices Categorized by Composition and Configuration
(Adapted from Gustafson, 1998, p.145; Lee, 2002, p.36)

Component	Quantification	Measure
Non-spatial (Composition)	▪ Number of categories	The number of classes in the map
	▪ Proportions	The proportion of each class relative to the entire map
	▪ Diversity	A composite measure of richness and evenness
	- Richness	The number of different patch types
	- Evenness	The relative abundance of different patch types
Spatial (Configuration)	▪ Patch-based metrics	
	- Size	The simple patch size which represents a fundamental attributes of the spatial character of a patch
	- Density	The number of patches within a unit area
	- Shape complexity	The geometry of patches-whether simple, compact, irregular or convoluted
	- Core area	The interior areas of patches after a user-specified edge buffer is eliminated
	- Isolation / Proximity	The tendency for patches to be relatively isolated in shape from other patches
	- Contrast	The relative differences among patch types
	- Subdivision	The degree to which a patch type is broken up (i.e., subdivided) into separate patches (i.e., fragments)
	- Connectivity	The functional connections among patches
	- Fractal dimension	The contrast over a range of measurement scales
	▪ Pixel-based metrics	
	- Contagion	The tendency of patch types to be spatially aggregated
	- Dispersion	The tendency for patches to be regularly distributed or clumped with respect to each other
	- Lacunarity	A scale-dependent measure of the texture or “gappiness” of a landscape or map.

Landscape change is the alteration in the structure and function of the ecological mosaic, over time, by factors such as disturbances, geomorphology, plant and animal invasion, and the activities of humans (Forman and Godron, 1986; McGarigal and Marks, 1995).

Landscapes are continuously changing under the effects of various different forces. Landscape changes create landscape spatial patterns. Natural forces such as climate and geological processes generate certain landscape patterns. In addition, human activities such as agriculture, forestry management, and settlements are strongly related to landscape changes which then produce landscape patterns. Since human activities that change landscapes tend to provide both rapid and strong factors, understanding those patches and corridors created by human interaction could be a key to understanding and anticipating landscape ecological patterns (Johnson et al., 2002).

Landscape function is the interaction among the spatial elements, including quantities of the various flows of energy, materials, and species within and among the component ecosystems (Forman and Godron, 1986; McGarigal and Marks, 1995).

In general, corridors can play a role as conduits or filters for the movements of various species, nutrients, materials, and water across a landscape. Matrix and network characteristics influence such movements in contrasting ways that depend upon whether the objects cross corridors or use those corridors as conduits (Forman and Godron, 1986).

Connectivity and width are crucial concepts in the flow and movement of objects. Connectivity plays a significant role related to corridors and networks, as well as in describing how patches are connected or disconnected to the landscape. In addition, connectivity identifies the function of the landscape. Corridor width is a useful measure for calculating averages and variances. In general, wider corridors may improve all of the five main functions of a corridor including habitat, conduit, filter, sources, and sink (Forman, 1995a; Forman and Godron, 1986).

The principle of landscape ecology is the exploration of the interaction between landscape form and function in order to design landscapes that create a better quality of environment for different species. The goals of landscape ecology include reducing the fragmentation and bonding of fractured landscapes back together in order to build more functional patterns which, in turn, have greater ecological resilience and sustainability (Marsh, 2005).

The application of landscape ecological approaches has influenced diverse planning areas such as natural resource management and land use planning. In addition, since the main focus of landscape ecology is research associated with large areas and long-term changes, it can provide a foundation for designing and planning, with a more sustainable future in mind (Forman, 1995a).

Landscape ecology research has improved the understanding of the interactions between the causes and ecological effects of spatial patterns in natural and human-dominated landscapes (McGarigal and Marks, 1995; Turner, 2005; Turner et al., 2001). Although landscape ecology stresses the sustained movements of energy, materials, and species through the landscape, contemporary landscape or urban planning practices tend to be geared toward meeting human interests first, thus generating more fragmented and less heterogeneous environments. Fragmentation and homogeneity not only disrupt the movement and flow of nutrients and materials, but also reduce ecological values and cause declines in biological diversity.

2.2.1.1. Landscape Spatial Patterns

A landscape has its own structure, as well as multiple parts that share consistent relationships among them. In a holistic approach, describing this pattern is important because it must be realized by observing the whole array of parts, rater than any single one part (Naveh, 2000; Naveh and Lieberman, 1994). One way to examine landscape spatial patterns is through the quantification of these patterns.

There are numerous forces, such as physical, biological, and social forces, which create spatial patterns in landscapes. Almost all landscapes have been affected by human activities, and as such the resulting landscape mosaic occurs through a complicated mixture of natural and human-dominated patches characterized by various sizes, shapes, and arrangements (Turner, 1989). Interests in measuring landscape patterns have been linked to the premise that ecological processes are connected to, and can be estimated by, various broad-scale spatial patterns (Gustafson, 1998).

Since landscape ecology has focused on the reciprocal interrelationships between spatial patterns and processes (Forman and Godron, 1986; Gustafson, 1998; Turner, 1989), studying landscape patterns is an important consideration in landscape and urban design and planning. In addition, landscape spatial patterns have been used to characterize both landscape structures and composition (Gustafson, 1998).

The question of quantifying and analyzing landscape patterns and their effects is one of the most significant issues in landscape ecology research (Bogaert et al., 2000; Davidson, 1998; Gustafson, 1998; Haines-Young and Chopping, 1996; Li and Reynolds, 1994; Li and Reynolds, 1995; Li and Wu, 2004; McGarigal and Marks, 1995; O'Neill et al., 1988; Riitters et al., 1995; Schumaker, 1996; Turner, 2005; Turner et al., 2001; Turner et al., 1989). To understand the diverse interactions between landscape patterns and processes, landscape structures must be defined and quantified in meaningful ways.

2.2.1.2. Quantification of Landscape Spatial Patterns

One challenge of research related to urban nature, including urban forests, is how such research can be analyzed and interpreted effectively. An urban area is highly heterogeneous. There are various and complicated interrelationships among numerous elements of abiotic and biotic factors. In addition, human intervention in the process of land conversion in urban areas has caused fragmented landscape patterns to be manipulated to satisfy human needs (Collinge, 1996).

Although it still may not be sufficient to cover the full range of complex factors in urban areas, considering landscape patterns with the understanding of landscape ecology would be useful for quantitatively analyzing the quality of urban nature.

Since the quantification of landscape patterns has been highlighted as an area of broad practical interest (Turner et al., 2001), developing methods to quantify landscape patterns has been emphasized in many previous research efforts (Bogaert et al., 2000; Gustafson, 1998; Haines-Young and Chopping, 1996; McGarigal and Marks, 1995; O'Neill et al., 1988; Turner, 1989; Turner, 2005; Turner et al., 2001). Quantifying landscape patterns is necessary for considering the importance of variability over time, comparing different landscapes, identifying the degree of similarity or discreteness, and linking landscape patterns to ecological functions (Turner et al., 2001).

There are two major bodies of quantitative methods in landscape ecology (Lee, 2002; Turner et al., 2001). The first is spatial statistics, and the other is landscape indices. Spatial statistics are typically used to detect the spatial scales of autocorrelation within an analysis of landscape patterns or to interpolate point data to extrapolate the spatial distributions of a variable of interest (Turner et al., 2001). According to Fortin (1999, p.255), spatial statistical methods could be classified into four groups, according to their objectives. The first group includes Ripley's K, Ripley's K_{12}, Moran's I, Variogram, Spatial Clustering, and Edge Detection. These methods have the purpose of describing the spatial structure of a landscape. Trend and Surface Analysis, Kriging and Spline are included in the second group, which serves the mapping or interpolation objective. The third group, including Ripley's K, Ripley's K_{12}, Moran's I, and Mentel's Test, is used to test for the presence of spatial autocorrelation. The final group examines the spatially autocorrelated data with Clifford et al.'s correlation, Partial Mentel's Test, and Partial CCA (Fortin, 1999).

Landscape indices are algorithms used to quantify the specific spatial characteristics of a landscape at three different levels: patch, class, and the entire landscape level (McGarigal and Marks, 1995). Since the study of landscape patterns, processes, and changes is the most common interest of landscape ecology research, it is useful to apply landscape indices to the landscape ecology field in order to evaluate landscape patterns through quantitative approaches (Gustafson, 1998; Turner, 1989; Turner, 2005). The main purpose of landscape indices is to acquire sets of quantitative data, in order to compare different landscapes for their grouping or differentiation (Antrop, 2000; McGarigal and Marks, 1995). In the landscape ecology field, landscape spatial patterns can be derived from various statistics and indices which recognize proportion, diversity, density, complexity, richness, and proximity.

2.2.1.3. The Models and Guidelines for the Optimum Land Use Arrangement

To assess landscape patterns, one of the most important questions is what determines the optimum arrangement of land use in a landscape (Dramstad et al., 1996; Forman, 1995a). Although there are only a few theoretical and empirical efforts geared toward understanding and comparing the optimum arrangement of landscape patterns, there exist some useful principles which offer guidelines for determining the ideal conditions.

2.2.1.3.1. Patch-Corridor-Matrix Model (P-M model)

The Patch-Corridor-Matrix model (P-M model) could be useful to evaluate and interpret landscape spatial patterns. According to Forman (1995a), there are three major types of spatial elements, and the extent and configuration of these determinants describe the landscape pattern. All points in a landscape are included within these three elements, and they hold in any landscape area, from the rural to the urban.

This model of analysis of landscape patterns characterizes patches, corridors, and the matrix as the spatial components of any pattern in a landscape. A patch refers to a relatively discrete nonlinear area of homogeneous environmental conditions differing in appearance from its surroundings (Forman, 1995a; McGarigal and Marks, 1995). With spatial units at the landscape scale, patches play a significant role in determining the shape, size, and arrangement of landscape patterns. Corridors are narrow strips that differ from their surroundings on either side. In general, corridors are considered to be linear landscape elements based on structural aspects. A matrix is the most extensive and connected landscape element type present, and therefore it plays the dominant role in landscape function by influencing the flows of energy, materials, and species. Connectivity, dominance, and function are useful variables when determining the matrix in a given landscape (Forman and Godron, 1986).

The P-M model highlights the heterogeneity of landscape elements, and each component provides a specific ecological function. In the P-M model, a pattern (structure) is identified by the landscape process (function). Since landscape mosaics are constituted by the three components of patches, corridors, and the background matrix, landscape structures in the mosaics (i.e., shapes and spatial patterns) are directly or indirectly affected by the interrelationships among the patches, corridors, and matrices. Landscape structural patterns or arrangements are determined by the functional flow and movements of nutrition, energy, animals, and materials through the landscape elements, over time. In addition, the pattern and process of the landscape is generated by simultaneous factors such as patch size and shape, the characteristics of corridors, connectivity, and edges (Forman, 1995a; Forman, 1995b; Turner, 1990).

2.2.1.3.2. Landscape Spatial Guidelines for the Optimum Land Use Arrangement

Since every species needs different suitable landscape conditions to survive, a problem arises when attempting to define optimal landscape patterns. One way to develop the optimum arrangement of land use is to use principles and models (Dramstad et al., 1996; Forman, 1995a; Forman, 1995b). These models can be useful when simplifying a complex system, and they offer important insights into design and planning practices.

The theory of island biogeography was originated by MacArthur and Wilson (1967). The main concept supporting this theory is that patterns of immigration and extinction are strongly related to the size of a given island. In addition, the theory posits that isolation on the island relates solely to the resources available and the habitats present on the island (McArthur and Wilson, 1967; Ndubisi, 2002). This principle can be applied to design or the planning of projects in terms of reservation or other habitat fragments, since islands can correspond to other habitats or different land use types. This theory affects the generalization of spatial principles for designing nature reserves (Ndubisi, 2002). Thus, Diamond (1975) described his spatial principles based on island biogeography (see Figure 2).

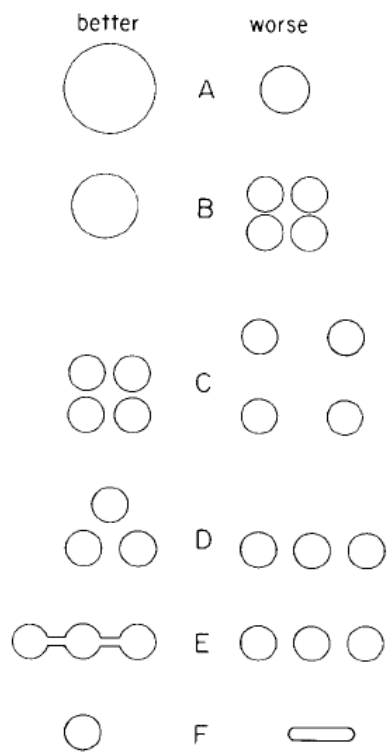


Figure 2. Suggested Geometric Principles.
In each of the six cases labeled A to F, species extinction rates will be lower for the reserve design on the left than for the reserve design on the right. *(Source: Diamond, 1975. p.143)*

In 1994, Shafer suggested graphical guidelines for spatial patterns in order to compare and explore the relationships between better and worse landscapes, as illustrated in Figure 3.

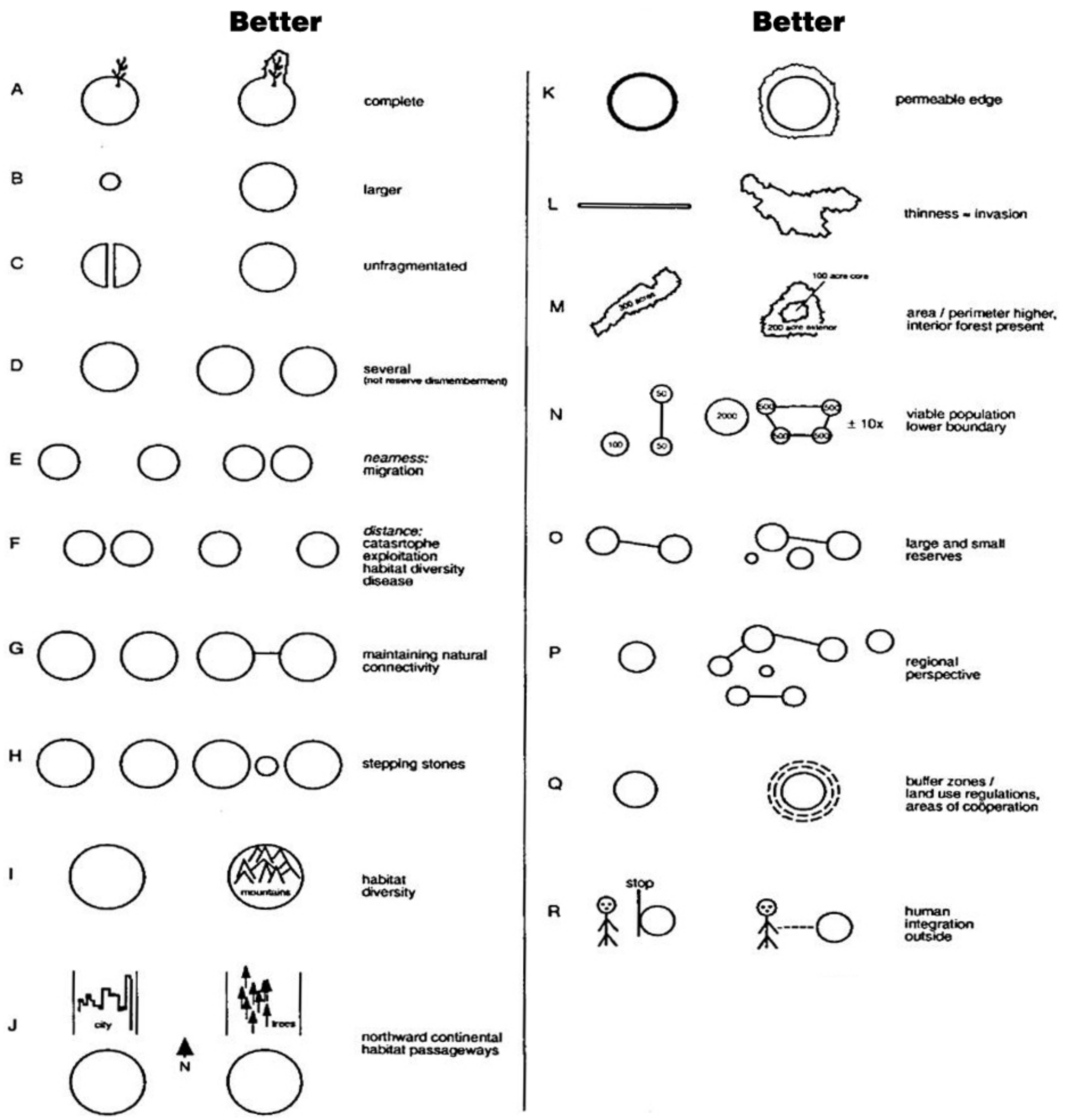


Figure 3. Shafer's Spatial Guidelines for Better Landscapes.
The option on the right is proposed as better than the one on the left
(Source: Shafer, 1994. p.217)

This guideline, affected by the theory of island biogeography, provides comprehensive approaches for designers or planners with diverse scales. In addition, this principle of using graphical language is useful when understanding the relationships between various landscapes and humans. In these guidelines, larger patches and unfragmented patches are more suitable than small patches. In addition, it is recommended that patches and corridors be connected in order to utilize the flow of movements and energy. At the same time, keeping small stepping stones within a landscape, permeable boundaries, thicker patch shapes, and variances in patch size are suggested as criteria for creating sustainable landscape conditions (Shafer, 1994).

Unfortunately, many elements within these concepts have not been proved by empirical studies. Although the theory of island biogeography could be a milestone in the development of landscape ecology, there are crucial limitations when applying these guidelines as a primary model for landscape research. In landscape ecology, because of their simplified assumptions and different principles, the use of island biogeography theory in order to research patches in the landscape is often criticized. For example, whereas isolation and size of species richness are major features of island biogeography theory, they are relatively minor variables on land (Forman, 1995a; Ndubisi, 2002).

However, this theory is still significant in ecology. Historically it has provided a useful heuristic tool for designing nature reserves (Ndubisi, 2002). Both Diamond's (1975) and Shafer's guidelines (1994) are somewhat simpler than Forman's aggregate-with-outlier principle (Forman, 1995a; Forman, 1995b) as an aspect of comparing quantitative methods, yet all these principles share some of the same fundamental concepts. In addition, this theory has emerged as a type of stepping stone that refers to *"suitable intervening habitats can mitigate the effect of isolation (p.56)"* (Forman, 1995a).

2.2.1.3.3. The Aggregate-With-Outliers Principle

Forman's aggregate-with-outliers principle (Forman, 1995a; 1995b) is one of the more useful models that stresses spatial guidelines for generating multifunctional optimal landscapes. According to Forman (1995a; 1995b), this principle states that *"one should aggregate land use, yet maintain corridors and small patches of nature throughout developed areas, as well as outliers of human activity spatially arranged along major boundaries (p.437)"* (Forman, 1995a). This principle incorporates seven main landscape-ecological attributes: large patches of natural vegetation, grain size, risk spreading, genetic variation, boundary zones, small patches of natural vegetation, and corridors (Forman, 1995a; Forman, 1995b) (See Figure 4).

The strength of this principle is in its format and its flexibility for creative problem solving (Forman, 1995a). Even though Forman warned that this principle has not been applied across spatial scales, he and his colleagues explained how landscape patterns can be used in design and planning projects with over fifty guidelines and principles illustrated by examples (Dramstad et al., 1996). In their book, fifty-five landscape ecology principles in landscape architecture and land-use planning – some of which are strongly related to the aggregate-with-outliers principle – were proposed, with grouping into patches, edges and boundaries, corridors and connectivity, and mosaics. In addition, the authors offered some principles and patterns, such as a few large patches of natural vegetation or vegetated corridors along major streams, are indispensable spatial patterns, defined as top-priority patterns for protection and with no feasible alternative or substitute for providing their ecological benefits is known (Dramstad et al., 1996; Forman, 1995a; 1995b).

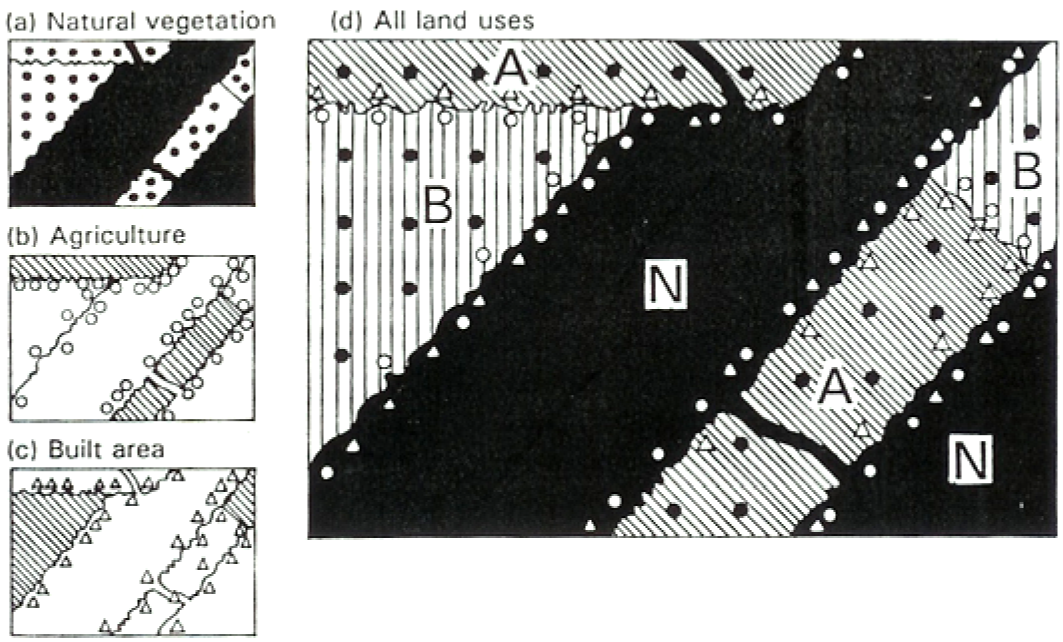


Figure 4. Arrangement of Land Uses Based on Aggregate-With-Outliers Principle. *N = natural vegetation; A = agriculture; B = Built area. Outliers of natural vegetation, agriculture, and built area are represented by small black dots in (a), circles in (b), and triangles in (c), respectively. (Source: Forman, 1995a, p.437)*

2.2.2. Theory of Behavior Settings

"What are the structural and dynamic properties of the environments to which people must adapt? (p.7)" (Baker, 1968). This is the main question asked in the field of ecological psychology. Ecological psychology focuses on the interdependent relationships between the purpose-directed actions of peoples and the behavior settings

where these actions happen (Wicker, 1979). People and their environments are crucial sources in this discipline.

The theory of behavior setting is a helpful concept for understanding the influence of environment on behavior (Sallis and Owen, 2002). This theory was developed by Roger Baker, a social scientist, in the late 1940s. He argued that an ecological approach to the research of human behavior would improve both practical and scientific benefits (Wicker, 1979).

The theory of behavior setting focuses on the significance of dynamic and interactive real-life settings in which people's behaviors take place (Baker, 1968; Lee and Moudon, 2004; Wicker, 1979). According to Wicker (1979), a behavior setting is defined as *"a bounded, self-regulated and ordered system composed of replaceable human and nonhuman components that interact in a synchronized fashion to carry out an ordered sequence of events called the setting program (p.12)"* (Wicker, 1979). Behavior settings emerge in particular physical locations and are described by a prime behavioral program or organized set of activities (King et al., 2002).

The theory of behavior setting can be applied to an understanding of physical activity in a number of respects (King et al., 2002). First, communities that have a larger number of recreational facilities or settings could offer more opportunities for residents to regularly engage in physical activities. This potential benefit could be expanded to the influences of landscape spatial patterns on physical activity, since landscape structure is considered an important factor which promotes recreation and social activities within neighborhoods. Second, behavior settings can be thought of as social capital, so neighborhoods that present a variety of well-organized behavior settings are more conducive of social trust and civic engagement. Supportive behavioral settings can encourage residents' active use of public open spaces and transportation systems for recreational, social, and transportation purposes (King et al., 2002).

2.2.3. Restorative Environment Theory

The stress-reducing and stress-buffering qualities of environments have been evaluated in a number of environment-behavior and environmental psychology studies (Hartig et al., 1991; Kaplan and Kaplan, 1989; Kaplan, 1995; Ulrich et al., 1991). The environment can play a role as an enabler of health behavior, as well as a provider of health resources (Stokols, 1996). The theory of restorative environments (Kaplan, 1995) could be useful for identifying a set of environmental circumstances related to stress reduction (King et al., 2002). Stress relief could also result from participation in physical activities. Natural features such as water, foliage, wide open space, and other aesthetic elements have strong influences on the restorative guidance of the environment. Exposure to restorative environments has shown to reduce subjective and psysiologic levels of stress (Hartig et al., 2003; Hartig et al., 1991; Kaplan and Kaplan, 1989; Kaplan, 1995; Korpela et al., 2001; Ulrich et al., 1991). Residential and community environments can be designed and managed to reduce stress and promote relaxation and good health. Since residential and community settings are strongly associated with build environments that affect physical activities, this theory could be applied to promote the diverse recreational physical activities of individuals.

2.3. Literature Review

2.3.1. Benefits of Landscape Spatial Patterns of Urban Forests and Trees

Landscape spatial patterns created by urban natural environments shaped by trees and forests in neighborhoods must be considered as important parts of the built environment. Trees and forests are among the most significant units that form landscape spatial patterns. The presence of trees and forests could establish more pleasant neighborhood environments. Since urban trees and forests could improve the quality of the neighborhood environment, they could also increase the number of opportunities to spend more time walking and biking (Miller, 1988; Nowak and Dwyer, 2007), and possibly reduce automobile use.

Strong evidence suggests that trees and forests impact human well-being. A large number of studies have indicated that trees and forests can bring *mental health benefits* such as promoting recovery from surgery (Ulrich, 1984) and from stress (Hartig et al., 2003; Hartig et al., 1991; Kaplan and Kaplan, 1989; Kaplan, 1995; Ulrich et al., 1991). In one of the more famous studies, Ulrich (1984) found that patients with window views of trees reported shorter postoperative hospital stays, when compared with patients who had views of a brick wall. In addition, he found that patients with a tree view had fewer negative notes from nurses and took fewer moderate to strong doses of analgesics. Hartig and collogues (2003) found that college students in a natural environment reported an increasing positive effect and a decreasing level of anger/aggression, whereas the opposite patterns of change showed up in the urban environment settings. Further, urban forests contribute to healthier lives for people by improving air quality, decreasing stress levels, and reducing interpersonal conflicts (Nowak and Dwyer, 2007).

Urban trees and forests can *enhance the ecological quality of neighborhoods* by controlling microclimates by reducing wind, moderating temperature and humidity, and by providing cooling shade (Miller, 1988; Rydberg and Falck, 2000), as well as improving air quality (Nowak and Dwyer, 2007). In addition, urban forests improve the aesthetic quality of street and park environments (Schroeder, 1989).

As one of the representative elements of landscape spatial patterns, the presence of trees in neighborhoods has encouraged *social benefits* such as promoting social interaction, improving a sense of safety, and enhancing a sense of place (Kweon et al., 2006). Several researchers have found that trees and forests decreased levels of crime and violence (Kuo and Sullivan, 2001; Miles et al., 1998). To investigate the relationship between urban trees or forests and neighborhood satisfaction, Jorgensen et al. (2002) examined the interaction between the structure of vegetation and spatial configurations in urban parks. The result was that spatial arrangements were the most significant aspect associated with a sense of safety. In addition, urban nature, including trees and shrubs, provides a positive influence on neighborhood satisfaction. Ellis and colleagues (2006) found that trees and shrubs could moderate the negative relationship between neighborhood satisfaction and retail land use. Urban forests provide significant emotional and spiritual experiences which generate a strong sense of place (Chenoweth and Gobster, 1990; Dwyer et al., 1991). To examine the aesthetic experience of landscape in ordinary life, one research recruited 25 college students and asked them to fill out diaries in terms of their aesthetic experiences during the entire semester. These researchers found that 77 percent of respondents answered that their feelings were much better after having aesthetic experiences in the landscape (Chenoweth and Gobster, 1990).

Several researchers have focused on the relationship between urban trees or forests and *economic values* (Bolitzer and Netusil, 2000; Geoghegan, 2002; Tyrväinen, 1997; Tyrväinen, 2001; Tyrväinen and Väänänen, 1998). Anderson and Cordell (1988) found that having more than five trees in the front yard of each house was associated with a 3.5 ~ 4.5 percent increase in housing price. Luttik (2000) reported that houses having a garden facing a lake showed the largest increase in housing values. In addition, if the house had a view to water or open space, the housing price was considerably increased. This research found that housing prices were considerably affected by landscape type. In addition, other research found that a larger proportion of total forested area affected a positive influence on the residential sales prices of houses (Irwin, 2002; Tyrväinen, 1997; Tyrväinen, 2001; Tyrväinen and Väänänen, 1998). Lutzenhiser and Netusil (2001) found that natural parks, as well as other types of open spaces including urban parks, golf courses, and specialty parks/facilities, were positively associated with sale prices. Geoghegan (2002) also pointed out that both permanent and developable open space showed positive relationships on sale price, and respondents were willing to pay more to live near permanent open space.

Few studies have attempted to examine the role of landscape patterns on housing prices by using landscape indices. Geoghegan et al.[2] (1997) used six landscape indices as landscape pattern characteristics, applying a hedonic price model. As the results from the double log model, the diversity index had a positive effect in the 1.0 km buffer, but was not significant with regards to the 0.1 km buffer. However, the fragmentation index was insignificant in both types of buffers.

Since these previous studies attempted to identify the benefits, perceptions, and/or behaviors related to natural settings, including urban and neighborhood forests, they also furthered the environment-behavior research associated with urban and landscape planning. In addition, some researchers suggested potential positive correlations that better neighborhood environments could promote physical activity; as one of the important benefits associated with urban trees and forests, such landscape could offer a solution to the common concerns with sedentary lifestyles by encouraging exercise and promoting outdoor activities (Coley et al., 1997; Nowak and Dwyer, 2007).

2.3.2. Relationships between Urban Environment, Physical Activity, and Public Health

2.3.2.1. Built Environment and Physical Activity

Increasing participation in physical activity has long been a public health priority (Hoehner et al., 2005; Owen et al., 2004) Physical inactivity has been recognized as one

[2] According to Geoghegan et al. (1997), the diversity index is used for measuring the degree of dominance by a proportion of the landscape with different cover types such as forest, agriculture, urban open area, residential area, and so fourth. In addition, their fragmentation index is represented by an edge-to-interior ratio in order to measure potential changes of function of land use by the variable sizes of interior areas.

of the issues to blame in the recent and continued growth in chronic diseases. In spite of the proven benefits of physical activity, less than 50 percent of American adults meet the recommended amount, and 25 percent are not active at all (CDC, 2005).

A growing body of empirical studies from multiple disciplines has investigated the influence of the built environment on physical activity and public health (Hoehner et al., 2005; Moudon et al., 2006). Some recent research has focused on some of the regional or neighborhood environmental attributes associated with physical activity such as access to facilities or places to engage in physical activity (Giles-Corti and Donovan, 2002a; Kirtland et al., 2003; Lee and Moudon, 2006), enhancing neighborhood walkability (Giles-Corti and Donovan, 2003; Saelens et al., 2003a; Saelens et al., 2003b), land use mix (Handy, 1996), aesthetic features (Ball et al., 2001; Giles-Corti and Donovan, 2002b; Humpel et al., 2004a; King et al., 2000) and infrastructure design (Lee and Moudon, 2006; Moudon et al., 2006).

In recent years, a few studies associated with physical activity have emphasized the importance of multidisciplinary approaches for measuring the built environment in order to get more precise and relevant results. This is because the majority of research has not reached the point where it can provide simultaneous results from subjectively and objectively measured environmental factors (Hoehner et al., 2005; Lee and Moudon, 2004; Lee et al., 2006; Moudon et al., 2006). As mentioned above, despite previous research sharing in the overall interest in the built environmental determinants of physical activity, few empirical studies have assessed the influences of the landscape spatial patterns formed by urban trees or forests.

2.3.2.2. Landscape Spatial Patterns and Physical Activity

Landscape pattern is one of the most important components defining the built environment as an objective factor. Landscape patterns have been used to characterize and quantify both landscape structure and composition (Gustafson, 1998). In addition, landscape spatial patterns have received attention as an important consideration in designing and planning neighborhoods to improve quality of life through spatial analysis tools such as GIS or remote sensing programs (Alberti, 2005; McDonnell et al., 1997). It is important to support the understanding of the influences of landscape spatial patterns on physical activity because the successful integration of humans and their activities into built environments can help alleviate social and health problems.

Previous studies have attempted to identify the heath benefits and positive human behaviors related to natural settings, and in so doing, they have contributed to the environment-behavior research associated with urban and landscape planning. However, few studies have looked at landscape structure or the pattern of urban forests and their relationship to physical activity and quality of life.

Recent studies have suggested that neighborhood environments could be designed to *promote physical activity*. In addition, an urban natural environment can help create attractive settings for people to engage in exercise and outdoor activity (Bedimo-Rung et al., 2005; Coley et al., 1997; Nowak and Dwyer, 2007). Coley et al. (1997) reported that natural landscaping promoted more use of outdoor areas by residents, and that landscape elements promote social interaction. Several studies have focused on parks as major public recreational facilities. They found that using parks, as well as perceived the existence of parks within neighborhoods, were both associated with increased physical activity (Brownson et al., 2001; Hoehner et al., 2005; Lee and Moudon, 2004; Powell et al., 2003; Sallis et al., 1998; Sallis et al., 1997). Studies have also reported positive relationships between physical activity and accessibility to parks, as shown in Table 2 on p.39 (Booth et al., 2000; Hoehner et al., 2005; Lee, 2007; Tilt et al., 2007). Further, other natural environments have been shown to correlate with physical activity, including public open spaces, trails, rivers and water features, beaches, and trees (Giles-Corti and Donovan, 2002a; Giles-Corti and Donovan, 2002b; Humpel et al., 2004b). The size of parks and green spaces for recreation areas was positively correlated with walking among adults (Li et al., 2005; Roemmich et al., 2006). In addition, shade from tree canopies and scenery both could increase walking (Sallis et al., 1997).

There have been efforts to examine the aesthetic factors of trees or forests in urban settings, although the measurement methods used in these studies are limited. The most common objective measure used in these studies was simply counting the number of trees along various streets within the research area. These studies reported positive relationships between the aesthetic quality of the natural environment and physical activity (Ball et al., 2001; Giles-Corti and Donovan, 2002a; Handy et al., 2003; Hoehner et al., 2005; Humpel et al., 2004a; King et al., 2000). In these studies the concept of the aesthetic quality of natural environments has not been well defined. They used the mere presence or counting of the number of trees along street segments as objective measures to capture the natural elements. Subjective measures including environmental perceptions regarding the overall aesthetic quality were used to assess scenery in research settings such as participants' neighborhoods or parks. Despite these limitations, the aesthetic quality of natural elements was always closely related to urban natural features within park areas or along the streets in neighborhoods. However, more attention is required to link the quality of urban nature with physical activity in a quantitative manner.

2.3.2.3. Urban Natural Environments, Landscape Patterns and Public Health

There have been a few attempts to capture the associations between *public health* and the amount of green space in neighborhoods (Maas et al., 2006; Mitchell and Popham, 2007; Nielsen and Hansen, 2007; Pretty, 2004), and such research has shown that people who live in a greener environment have more positive perceptions about their health. In addition, Takano et al. (2002) reported that the elderly who live a walkable distance to green spaces showed longer life spans than those who did not (see Table 2).

This positive association appeared with both natural and agricultural green spaces in neighborhoods, and this greener environment showed a significant beneficial effect among people from all education levels and age groups (Masse et al., 2002). From a study that assessed associations between socioeconomic inequalities, overall health, and exposure to green space, using 40,813,236 U.K. adults as research subjects, it was shown that health inequalities were related to income deprivation and mortality from all causes. Circulatory diseases were lower in those populations who enjoyed greater exposure to green space than in those people who had less exposure to green space. This research also suggested that if people in lower socioeconomic areas have the highest exposure to green space, 1,328 lives per year could be saved, as compared to the same income deprived population having less exposure to green space (Mitchell and Popham, 2008).

Sugiyama et al. (2008) examined the associations between perceived neighborhood greenness and perceived physical and mental health, with a research population of 1,895 Australian adults. They found that people who perceived more green areas in neighborhoods reported better physical and mental health conditions. In addition, this research showed that mental health was more strongly associated with perceived neighborhood greenness than physical health.

Although the focus of these studies was on the influences of green areas on public health, using a simple, total area of green space calculated from land use data, this body of literature offers insights into the roles of landscape patterns on physical activity and health.

A small number of studies assessed the interrelationships between urban natural environment and health conditions, using both objective and subjective measures. Tilt et al. (2007) examined the influence of the amount of vegetation on health conditions. As only one of a few studies which used the Normalized Difference Vegetation Index (NDVI) to capture the associations between neighborhood greenness and an obese condition, their study showed that there was a significantly negative relationship between the Body Mass Index (BMI) and the NDVI in a given neighborhood. Although there was no significant association between objective greenness and walking trips, BMI was lower in neighborhoods which had a more objective accessibility and more objective greenness, as compared to neighborhoods with a high level of accessibility and low greenness. Those results were supported by the results from other previous studies, that adolescents who live in a higher population density area with more greenness measured by the NDVI have a lower BMI value (Liu et al., 2007). Also, children living in greener neighborhoods retain a lower BMI over two years (Bell et al., 2008).

Distance to green areas appears important for health conditions. Nielsen and Hansen (2007) examined the influence of accessibility and the formal visit to green areas on both stress level and BMI. The results showed that the distance to green areas was a more important predictor of stress levels than the actual use of green areas. Moreover, access to a private garden or a short distance to green areas reduced stress levels and was associated with a lower likelihood of obesity. While they attempted to examine the influences of green spaces on health conditions, this study depended on subjective measures (self-reported survey) only.

Several studies have emphasized the need for more research in terms of the interaction between objective and subjective measures, especially green spaces and satisfaction with those spaces. They have suggested that those measures could improve physical activity and health research, and help to understand the influence of urban natural settings on various physical activities, including walking (Hoehner et al., 2005; Lee and Moudon, 2004; Lee et al., 2006; Tilt et al., 2007).

A few previous studies have attempted to examine the influence of green areas on BMI or general health conditions as strongly related to physical activity. However, they used the total area of vegetation by calculating aggregated land use data, and conducted self-reporting measures for analyzing BMI and health conditions. To date, no study has considered capturing the real landscape pattern or structure generated by trees or forests to examine the associations between landscape spatial patterns and physical activity.

Table 2. The Relationships among Natural Environments, Physical Activity, and Health

Citation	Variables	Physical Activity Outcome	Physical Health Outcome	Mental Health Outcome	Measure for Environment	Setting	Population
(Booth et al., 2000)	Accessibility (subjective) - Park	Physical activity[a] (+)			Self-reported survey	Not identi-fied	Adults in Australia (449)
(Giles-Corti and Donovan, 2002a)	Usage of facilities (subjective) - Public open space (28.8% preference) - Beach (22.7% preference)	Physical activity[a] (+)			Self-reported survey & GIS		Adults in Australia (1,803)
	Accessibility (objective) - To beach - Attractive open spaces - To river	Using facilities[a] (+)					
(Giles-Corti and Donovan, 2002b)	Accessibility (objective) - Open space - Beach	Walking[a] (+) Walking[a] (+) / Vigorous exercising[a] (+)			Self-reported survey & GIS	Urban	Adults in Australia (1,803)
(Powell et al., 2003)	Usage of facilities (subjective) - Public park	Physical activity[a] (+)			Telephone survey	Urban	Adults in the U.S. (4,532)

(Table 2. Cont'd)

Citation	Variables	Physical Activity Outcome	Physical Health Outcome	Mental Health Outcome	Measure for Environment	Setting	Population
(Hoehner et al., 2005)	Proximity (both objective and subjective) - Park / - Trail *Perceived facilities (subjective)* *- Park / - Trail* Trees along streets (objective)	Usage [a] (+) Physical activity[a] (+) Physical activity[a] (+) Physical activity[a] (+)			Telephone survey & audits	Urban	Adults in the U.S. (1,073)
(Li et al., 2005)	Neighborhood level (objective) - Area of green and open space for recreation	Walking[a] (+)			Self-reported survey & GIS	Urban	Adults in the U.S. (577)
(Roemmich et al., 2006)	- Percentage of park and recreation area	Physical activity[a] (+)			Accelerometer / GIS	Urban	Adolescents (4~7 years) in the U.S. (59)
(Maas et al., 2006)	The percentage of green spaces (1km radius: objective) The percentage of green spaces (3km radius: objective)		Perceived health condition [a] (+: in all education groups and all age groups / stronger for people with a lower SES)		The National Land Cover Classification database (LGN4: based on land use of each 25X25 meter grid cell)	Non identi-fied	Adults in the Netherlands (250,782)

(Table 2. Cont'd)

Citation	Variables	Physical Activity Outcome	Physical Health Outcome	Mental Health Outcome	Measure for Environment	Setting	Population
(Mitchell and Popham, 2007)	The percentage of green spaces (objective)		Perceived health condition [a] (+: depends on the degree of urbanity and level of income deprivation in as area)		The Generalized Land Use data base 2001	Commu-nities (min. 1,000 pop.)	Adults in U.K. (32,482)
(Nielsen and Hansen, 2007)	Proximity (subjective) 1. Small urban park / 2. large urban park, forest / 3. urban square with old trees / 4. residential area with green space / 5. historic monument with green space / 6. location suitable for bading in lake / 7. ocean-view / 8. green sports facility / 9. green area		BMI [a] (-)	Stress [a] (-)	Self-reported survey	Urban	Adults in Denmark (500)
(Lee, 2007)	Proximity (objective) - Park	Walking[a] (+) Physical activity[a] (+)			Telephone survey & GIS	Urban	Adults in the U.S. (438)
	-Trail	Physical activity[a] (+)	BMI [a] (-)				
	More street trees (objective)	Walking[a] (+)					

(Table 2. Cont'd)

Citation	Variables	Physical Activity Outcome	Physical Health Outcome	Mental Health Outcome	Measure for Environment	Setting	Population
(Tilt et al., 2007)	Accessibility (both objective and subjective) 1. Parks / 2. beaches	Walking[a] (+)			Self-reported survey & GIS (0.4 mile network distance)	Urban	Adults in the U.S. (529)
	Greenness (subjective) 1. Birds and other small wildlife / 2. larger wildlife / 3. large trees / 4. lakes or streams / 5. street trees / 6. view of nature from home / 7. natural vegetation in yards / 8. scenic vistas or views	Walking[a] (+)			Self-reported survey		
	Greenness (objective)		BMI [a] (-)	Satisfaction[a] (+)	NDVI[b] with Landsat 5		
(Liu et al., 2007)	Greenness (objective: 2km circular buffer)		BMI [a] (-: in higher population density area)		NDVI[b] with Landsat ETM+	County	Adolescents (3~18 years) in the U.S. (7,334)

(Table 2. Cont'd)

Citation	Variables	Physical Activity Outcome	Physical Health Outcome	Mental Health Outcome	Measure for Environment	Setting	Population
(Bell et al., 2008)	Greenness (objective: 1km airline and network buffers)		BMI (-) over 2 years		NDVI[b] with satellite imagery	County	Adolescents (3~16 years) in the U.S. (3,831)
(Mitchell and Popham, 2008)	Greenness (objective)		Less mortality rates from all-causes and circulatory disease		The Generalized Land Use data base 2001	Commu-nities (min. 1,000 pop.)	Adults in U.K. (40,813,236)
(Sugiyama et al., 2008)	Greenness (subjective)		Perceived physical health condition [a] (+)	Perceived mental health condition [a] (+)	The Neighborhood Environmental Walkability Scale (NEWS)	32 neighbor -hoods	Adults in Australia (1,895)

[a] Self-reported survey. [b] NDVI: Normalized Difference Vegetation Index. *Italic*: Insignificant variables

2.3.2.4. The Potential Relationship between Built Environment, Behavior, and Benefits

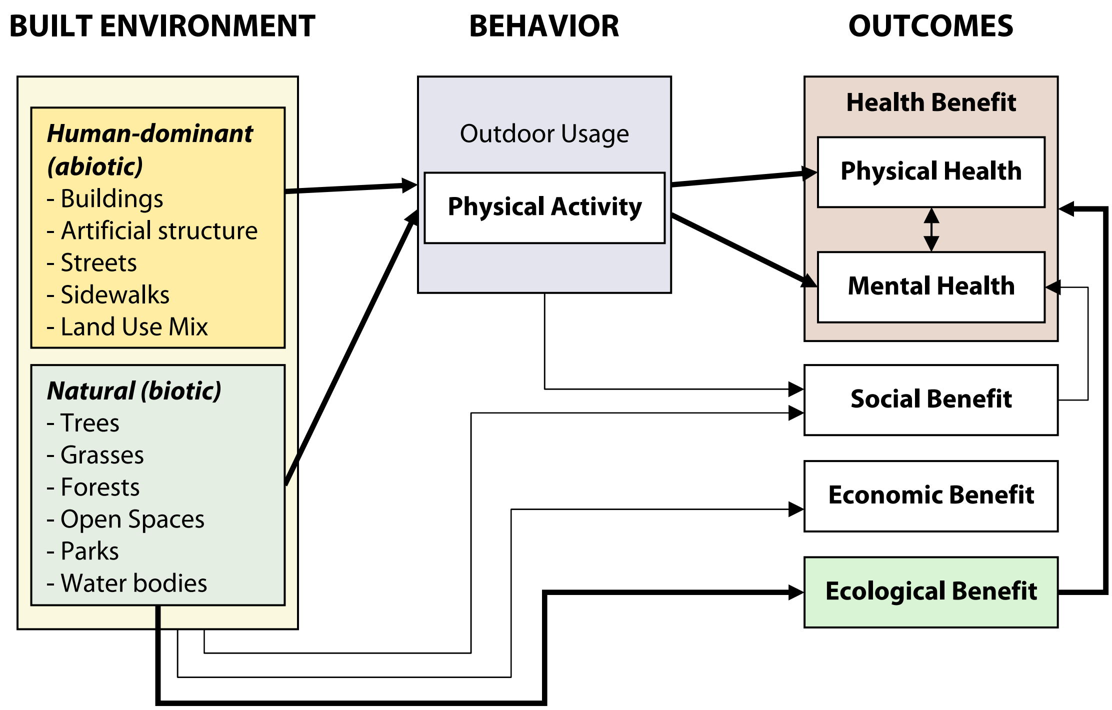


Figure 5. The Potential Relationship between Built Environment, Behavior, and Health.
(Bold arrows describe the focus relationships of this research)

Based on the literature review, this research proposes a framework for conceptualizing the potential relationship between built environments and the benefits for human wellbeing (Figure 5). This model can provide a framework for assessing the linkage between the built environment conditions, people's physical activity and health.

2.3.3. Physical Activity of Children and Adolescents

A growing volume of literature has paid attention to the influence of the environment on the physical activity of children and adolescents (Bell et al., 2008; Boarnet et al., 2005;

Braza et al., 2004; Davison and Lawson, 2006; Jago et al., 2006; Liu et al., 2007; Nelson et al., 2006). However, most studies have focused on understanding the influence of the natural or built environment on physical activity among adults (Lee and Moudon, 2004; Owen et al., 2004; Saelens and Handy, 2008; Sallis et al., 1997; Sallis and Owen, 2002). In addition, less attention has been paid to specific socio-demographic groups.

There have been efforts to examine associations between the built environment and the physical activities of children and adolescents. One study, which tested changes in the physical activity levels of two comparison groups of children (determining whether or not to pass the Safe Routes to School (SRTS) project), found that environmental changes could increase children's likelihood of walking or biking to school (Boarnet et al., 2005). Another body of research, which attempted to assess associations among the physical activity levels of 210 boys aged 10 to 14 years and their built environment, using observed, self-reported, and GIS measurements, reported that only sidewalk characteristics were related to children's sedentary lifestyle, as well as light intensity physical activity (Jago et al., 2006). In addition, especially among girls, perceived limitations to access to public transportation and parks / sports grounds were negatively associated with children's walking and biking (Timperio et al., 2004).

Timperio et al. (2006) examined personal, family, social and environmental correlates of children's active commuting to school, with two age groups: 235 children aged 5 to 6 years and 677 children aged 10 to 12 years. This study reported that a long route to school, crossing busy streets, and lack of lighting and crosswalks were negatively associated with children's walking and biking to school. Another interesting finding of this research is that children in both age groups were more likely to commute to school if the possible shortest distance to school was less than 800 meters.

In addition to neighborhood environments of children and adolescents, school environments were also related to children's physical activity. Sallis and his colleagues (2001) examined the association between school environmental characteristics and students' physical activity. After examining 24 public middle schools, this research found that under high levels of supervised activities from adults, girls and boys were more likely to be physically active.

Because of measurement difficulties, there are salient limitations to assessing the psychological, cognitive, and emotional factors in youth, especially in the 3~12 age group (Taylor and Sallis, 1997; Trost et al., 2000). However, it is very important to understand the physical activity patterns in children and adolescents in order to prevent the serious condition of obesity and related comorbidities, since physical activity plays an important role in the expenditure aspect of energy balance by using more daily calories (Kohl III and Hobbs, 1998). In addition, higher levels of habitual physical activity in children could provide greater levels of physical fitness, thereby reducing the risk of developing cardiovascular diseases (CVD), as well as many other chronic diseases (McKenzie et al., 1992).

Many studies examining the levels of physical activity in children and adolescents have indicated that boys are usually more active than girls (Baranowski et al., 1993; McKenzie et al., 1997; Sallis et al., 1993; Trost et al., 1996), that children's activity level tends to be higher outside than inside (Baranowski et al., 1993), and children tend to become less active as they get older (McKenzie et al., 1997; Sallis et al., 1993). In addition, children and adolescents who have parents with higher levels of physical activity are generally more physically active than children and adolescents who are less physically active (Kohl III and Hobbs, 1998; Sallis et al., 2000). Some studies reported that there was no relationship between the amount of television watching and physical activity, although boys usually spend more time watching television than girls (McKenzie et al., 1992; Taylor and Sallis, 1997). However, other researchers have found that there is a significant association between an increased BMI value and the amount of time spent watching television (Gordon-Larsen et al., 2000).

Although little has been revealed about the differences in physical activity among specific populations groups, there have been significant findings in terms of the ethnic and national differences that determine physical activity in children and adolescents. McKenzie et al. (1992) examined the physical activity patterns of a large group of bi-ethnic preschool children, in both their homes and at school, during two observation periods. Hispanic children showed 24% less Moderate to Vigorous Physical Activity (MVPA) at home, as well as 10% less MVPA at recess, than Caucasian children. At home, Hispanic children engaged in significantly more time lying down, being indoors, and being in the company of adults, whereas Caucasian children spent significantly more time walking, being active, and had a higher MVPA. Hispanic children spent more time watching TV than Caucasian children. One of the significant findings of this study is that differences in physical activity levels from ethnic and gender differences arose as early as age four.

The results of different physical activity patterns by different ethnic populations were supported by other studies. McKenzie et al. (1997) observed young bi-ethnic children during two outdoor recess periods, over approximately 2.2 years. From this study they also found similar patterns, in that Hispanic children showed less MVPA than Caucasian children, and boys were more active than girls. As they got older, the children tended to be less active. In addition, Gordon-Larsen et al. (2000) supported the findings of the above studies by showing that non-Hispanic black and Hispanic adolescents showed lower MVPA and higher inactivity levels.

2.3.4. Health-related Quality of Life (HRQOL) of Children and Adolescents

Although numerous psychological, biological, social, and environmental factors lead an individual to become obese, physical activity still holds an important role in preventing obesity. Since inactive patterns in physical activity contribute to increased weight gain, it is easy to understand the prevalence of obesity in children and adolescents with low levels of physical activity MVPA (Gordon-Larsen et al., 2002).

Obesity caused by sedentary life styles has strong associations with a poor quality of life and a low level of well-being. The majority of studies of quality of life among children and adolescents have focused on groups with chronic health conditions or comorbid conditions. A few studies have attempted to measure the HRQOL of obese children or adolescents (Schwimmer et al., 2003). Because evidence suggests that childhood obesity could be related to psychological and social factors (Banis et al., 1988), the multidimensional and comprehensive structure of HRQOL makes it a useful tool for assessing and enhancing their health conditions (Schwimmer et al., 2003; Varni et al., 2001).

To examine the health-related quality of life (HRQOL) of obese children and adolescents, Schwimmer and colleagues (2003) recruited three groups comprised of children and adolescents: an obese group, a healthy group, and a group of youth diagnosed with cancer. The results of the study were such that obese children and adolescents showed significantly lower values of the HRQOL as compared to healthy children and adolescents. Obesity in a child or adolescent increased the likelihood of an impaired HRQOL by 5.5, as compared to a healthy child or adolescent, and 1.3 times compared to a cancer patient. This significant piece of research recruited a relatively large number of Hispanic children and adolescents, as compared to previous work related to childhood obesity, and the authors insisted that this research would be important for Hispanic children due to the high prevalence of obesity in this demographic group.

Studies involving obese adults showed that they have a lower HRQOL compared to non-obese adults (Fontaine and Bartlett, 1998; Kolotkin et al., 1995), but there is little information in terms of HRQOL with regards to obese children (Schwimmer et al., 2003). Since children are one of the most vulnerable population groups as they may not be ready to make informed health-related choices by themselves, more studies are required to understand the influence of obese conditions on their quality of life. This information will be useful in reducing the prevalence of obese Hispanic children and for improving their overall health condition through promoting physical activity, in turn expending more calories. Preventing weight gain could be accomplished by small changes such as 15 minutes per day of walking (Hill et al., 2003). Moreover, to prevent obesity and improve the quality of life among children, it is necessary to understand different physical activity patterns among diverse ethnic groups, as well as among those with different health conditions. Further, a better understanding of the specific built environment conditions is needed to create better tailored plans and designs which promote physical activity.

2.3.5. Relationships between Natural Environment, Children's Physical Activity and Health Conditions

As mentioned above, a number of previous studies for multiple disciplines have reported that exposure to a natural environment provides a positive influence on diverse psychological and physiological processes (Hartig et al., 2003; Kaplan, 1984; Kaplan and Kaplan, 1989; Liu et al., 2007; Ulrich et al., 1991; Wells and Evans, 2003). However, although a substantial body of literature has provided the effects of natural environments on the well-being of an adult population, the influence of natural environments on the health outcomes of children or adolescents has not been fully investigated (Liu et al., 2007; Wells and Evans, 2003).

Natural environments offer children and adolescents more opportunities for engaging in outdoor activities and improving social interactions. In inner-city neighborhoods, in particular, both youth and adults spend more time in public outdoor spaces with more trees and vegetation than in treeless outdoor spaces (Coley et al., 1997).

The green spaces have shown to be more supportive of children's play. More green inner-city areas could promote more abundant opportunities for social interaction and the monitoring of outdoor areas (Coley et al., 1997; Faber Taylor et al., 1998).

A few bodies of research have focused on the relationships between natural environments and children's mental health. Wells and Evans (2003) examined the role of nearby natural environments in rural residential areas on children's psychological wellbeing. With 337 rural children from 3rd through 5th grade, they found that nearby nature could offer moderating effects on the impact of stressful life events in children, and also improve cognitive functioning. In addition, children living in greener residential environments showed lower levels of the impact of life stress, while children living in environments with little nearby nature reported higher levels of stress. Kuo and Faber Taylor (2004) examined the influence of natural environments on Attention Deficit Hyperactivity Disorder (ADHD) in children. They found that ADHD symptoms were significantly reduced during green outdoor activities than in activities conducted in both built outdoor and indoor settings. In addition, this result appeared consistently across a wide range of characteristics including individual demographic factors, residential settings, and ADHD case severity.

Recently, a few previous studies attempted to examine the effects of natural environments on children's physical activity and obese conditions. One body of research assessed the relationships between physical activity levels in children and factors of the built environments. This research tested 20 built environment factors correlated with children's physical activity, and among them the proportion of green space was significantly positively associated with children’s physical activity, while the frequency of paved playgrounds in their neighborhoods was negatively associated with their physical activity (de Vries et al., 2007).

A few studies demonstrated that more green spaces in neighborhoods reduce the risk of children being overweight (Bell et al., 2008; Liu et al., 2007). Liu and his colleagues (2007), using the NDVI, examined associations between the obese conditions of 7,334 children and youth aged 3 to 18 years, living in Marion County, IN, and the amount of vegetation surrounding each subject’s home. From 2km circular buffer assessments, they found that greener environments in the higher population density areas were associated with a decreased risk of childhood obesity.

Another study by Bell and her colleagues (2008) supports these results. They examined the association between greenness and 2-year changes in the BMI of 3,842 children aged 3 to 16 years, in Marion County, IN. Using the NDVI and both 1km airline and network buffers to measure neighborhood greenness, they found that there was a significant inverse relationship between neighborhood greenness and BMI values in children. In the logistic regression model, they found that more greenery was associated with lower BMI z-scores (OR=0.87). Moreover, children and youth living in greener areas were less likely to become obese over 2 years, as compared to children and youth living in less-green neighborhoods. This research further reported that there was less relevance in residential density and children’s BMI levels, unless greenness was controlled. This research provides the potential notion that natural environments in neighborhoods could play an important role in preventing childhood obesity.

Those articles described in this section suggest that not only do green spaces provide positive benefits for children, but also that a disconnection from natural environments can harm children's health.

2.4. Summary

In this chapter, the interlocking theories and models, as well as the literature related to the research aims were reviewed. The interlocking theories provided a fundamental understanding of landscape ecology and terminology. In addition, this subchapter introduced models and guidelines for the optimum land use arrangement in order to measure landscape patterns, and also discussed an approach to quantify landscape spatial patterns by applying landscape indices. Furthermore, this subchapter presented the basic understanding of the theory of behavior settings and restorative environment theory.

The literature showed that well-designed built environments supporting walking, bicycling and other healthy physical activities can help improve HRQOL, as well as reduce childhood obesity and its co-morbidities. Such health factors have become a major public health challenge in the U.S. Supportive environments for physical activity include connected sidewalks, safety, access to playgrounds, parks and other utilitarian destinations, and visual quality (Humpel et al., 2002; Lee and Moudon, 2004; Sallis et al., 2000). While the roles of land uses and transportation infrastructure have been studied frequently, landscape spatial patterns shaped by urban forests, trees and grasses have not been examined sufficiently. Urban greeneries can contribute to public health not only by promoting outdoor activities, but also by helping to relieve daily stresses (Hartig et al., 2003; Nowak and Dwyer, 2007; Ulrich et al., 1991).

CHAPTER III

RESEARCH METHODS AND DATA

3.1. Introduction

This chapter discusses the research methods and data used in this research including the conceptual framework, hypotheses, research flow and design with variables, research settings, sampling, and measurement methods. This chapter also specifies methods for understanding the associations between children's obese conditions and HRQOL, and landscape spatial patterns.

This research utilizes the data collected as part of a previously funded project by the Robert Wood Johnson Foundation's Active Living Research (ALR) program called the Urban Hispanic Perceptions of Environment and Physical Activity among Kids (UH-PEAK). The specific aim of the UH-PEAK research is to assess the willingness and perceptions of 4^{th} and 5^{th} grade Hispanic children and their maternal guardians to be physically active in their home, school, and park environments. These environmental settings were assessed for accessibility, comfort and convenience, attractiveness, and safety. This project collected objective and perceptual data from children and their mothers using surveys, accelerometers, Global Positioning System (GPS) and GIS, environmental audits, and Ecological Momentary Assessments (EMA).

Building onto this larger project, this research aims to make three additional contributions to the existing literature discussed in the previous chapter: 1) an assessment of landscape spatial patterns, 2) an examination of HRQOL, 3) and an assessment of gender differences related to childhood obesity and physical activity levels. Additional data required for this dissertation research were built into the UH-PEAK project or performed separately by myself. The UH-PEAK team has approved the inclusion of a 1-page inventory for assessing HRQOL among the participants. Most environmental data collection and measurements were performed independently for this dissertation.

3.2. Conceptual Framework and Hypotheses

3.2.1. Conceptual Framework

The conceptual framework for this research is shown in Figure 6. The fundamental idea of this research is based on the fact that people's physical activity levels and health conditions can be linked with their built environment conditions. In order to develop the conceptual framework, this research focused on four potential factors gleaned from a literature review of previous studies. The factors include landscape spatial patterns of urban forests and trees, environmental perceptions and satisfaction, physical activity patterns, and socioeconomic and demographic factors.

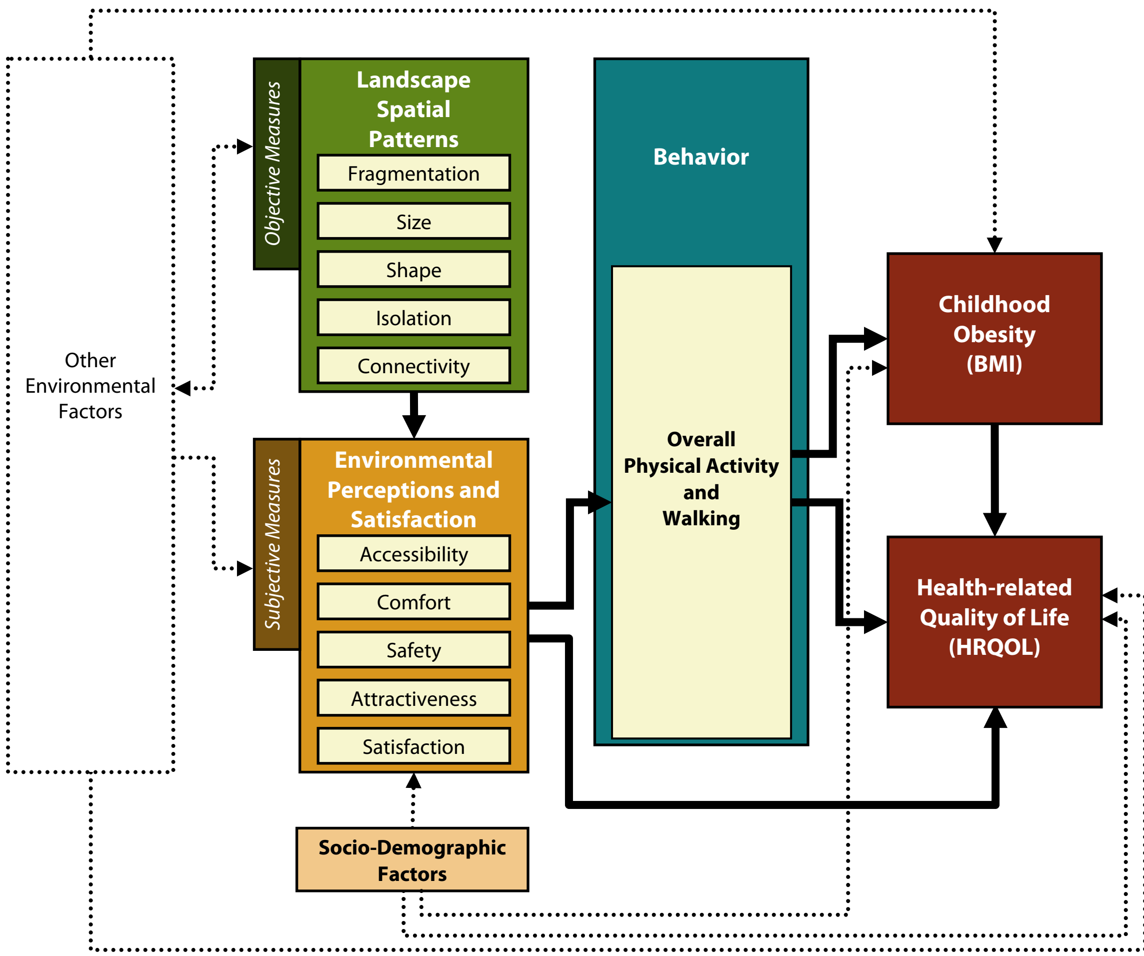


Figure 6. Conceptual Framework.
(Bold arrows indicate the main associations examined in this research)

3.2.2. Research Hypotheses

Based on the above research background and conceptual framework, hypotheses used in this research have been developed as below:

Hypothesis 1: *A child who lives in a neighborhood with a higher quality of landscape spatial patterns will have a lower BMI value than a child who lives in a neighborhood with a lower quality of landscape spatial patterns.*

The main research question is whether or not landscape spatial patterns shaped by urban forests can influence children's physical health conditions. To address this question, it is hypothesized that a higher quality of landscape spatial patterns in urban forests such as conditions where there are a larger variety of sizes, or where conditions are less fragmented and well-connected, are related to lower BMI values. A few previous studies have reported that there is a negative relationship between children's BMI values and neighborhood greenness (Bell et al., 2008; Liu et al., 2007). Therefore, this research hypothesizes that the negative association between children's BMI values and high quality landscape spatial patterns exists among Hispanic children.

Hypothesis 2: *A child who lives in a neighborhood with a higher quality of landscape spatial patterns will have a higher HRQOL value than a child who lives in a neighborhood with a lower quality of landscape spatial patterns.*

This research considers both physical and mental health condition. Since it is widely known that natural environments in neighborhoods provide positive effects on improving the mental health of adults (Hartig et al., 2003; Kaplan, 1995; Sugiyama et al., 2008; Ulrich et al., 1991) as well as children (Kuo and Faber Taylor, 2004; Wells and Evans, 2003), it is hypothesized that children's HRQOL is positively associated with the quality of environment and landscape spatial patterns.

Hypothesis 3: *A child with a higher BMI value will have a lower HRQOL value.*

One's mental health condition is significantly associated with their physical health condition (Fox, 1999). A few previous studies have reported that obese children have a lower HRQOL in all domains than healthy children, and are also lower than cancer patients (Schwimmer et al., 2003).

Hypothesis 4: *Correlates of childhood obesity and HRQOL will differ between boys and girls.*

It is thought that there could be different patterns of childhood obesity and HRQOL in children, across the gender differences. Previous studies have also reported that gender differences have some effect on physical activity levels and patterns among children (Baranowski et al., 1993; McKenzie et al., 1997; Sallis et al., 1993; Sherar et al., 2007; Trost et al., 1996).

3.3. Research Process and Design

3.3.1. Research Design and Variables

This is a cross-sectional study which examines the relationship between the landscape spatial patterns of urban forests, and childhood obesity and HRQOL levels among 4^{th} and 5^{th} grade Hispanic children living in an inner-city neighborhood in Houston, TX. The study considers variables on socio-demographic factors, physical activity patterns, and environmental perceptions and satisfaction, as potential correlates of childhood obesity and quality of life (See Table 3). These variables were collected by surveys obtained from the children and their mothers. Aerial photo imagery was used to capture landscape spatial patterns.

Table 3. Research Construct and Variables

Construct		Variables	Measurement	Data Source
Dependent Variables				
Obese Condition*		- BMI value	Continuous	Height & weight
Health-related Quality of Life (HRQOL)**		- Total score of the PedsQL survey	Ordinal	PedsQL 4.0 Survey
Independent Variables				
Children's Physical Activity (PA) Patterns*	PA Location	- Home or apartment street, front or back yard / - PE class / - Church / - Park / - Health Club / - YMCA / - Playground / - Other places	Ordinal	Survey
	Walking Patterns	- Walk to/from school - Walk to/from a park - Walk to/from a friend's house - Walk to/from a store/shop - Take the school bus - Take the public bus	Ordinal	Survey
	PE classes Activity	- PA levels in PE class	Ordinal	Survey
	PA Patterns at Recess and lunch time	- Physical activity patterns at recess time - Physical activity patterns at lunch time	Nominal	Survey
	PA after school	- PA levels after school	Ordinal	Survey
	PA on weekend	- PA levels on last Saturday - PA levels on last Sunday	Ordinal	Survey
	Sedentary Activity Patterns	- Watching TV time (week days / weekend days) - Playing video/computer games (week days / weekend days)	Ordinal	Survey
Environmental Perceptions and Satisfaction*	Accessibility (Only children were asked)	- Perceived accessibility to destinations including parks, playgrounds, open fields, stores, restaurants, school, friend's house, etc.	Ordinal (Likert scale)	Survey
	Comfort and Convenience	- Sidewalk existence / conditions - Bike lane existence / conditions - Street amenities - Amount of trees along street - Walking barriers from no sidewalks / bad sidewalks / no shade along sidewalks / parked cars along streets or sidewalks	Ordinal (Likert scale)	Survey
	Safety	- Safe to walk or bike during the day / at night - Amount of exhausted fumes - Amount of noise - Concern about being injured - Safety concern from traffic, speed, walking facilities, stray dogs, gangs, strangers	Ordinal (Likert scale)	Survey

(Table 3. Cont'd)

Independent Variables						
Environmental Perceptions and Satisfaction*	Attractiveness	- Existence of attractive buildings or gardens - Existence of natural things - Amount of litter / graffiti - Amount of parks - Chance to see natural elements (birds, squirrels, or rabbits) - Chance to hear nature sounds			Ordinal (Likert scale)	Survey
	Satisfaction	- Overall satisfaction on walking and biking - Satisfaction for quality of shade - Satisfaction for commuting time to school - Satisfaction for quality of parks and playgrounds - Satisfaction for number of friends - Sense of place			Ordinal (Likert scale)	Survey
Landscape Spatial Patterns***	Fragmentation	- Number of Patches (NP), Patch Density (PD), Mean Patch Size (MPS) - Fragmentation Measurement Index (FMI)				FRAGSTATS / Fragmentation Measurement Index
	Size	- Total Area (TA), Percentage of Landscape (PLAND), Total Edge (TE)				
	Shape	- Landscape Shape Index (LSI), Mean Shape Index (MSI)				
	Isolation	- Mean Nearest Neighborhood Distance (MNN)				
	Connectivity	- Patch Cohesion Index (COHESION)				
Confounding Variables						
Socio-Demographic Factors*	Children's Individual Factors	- School - Gender - Age - Grade	- Ethnicity - Birth place - Guardians - Family members	- # of TVs, VCRs/DVDs, Computers, Videogames, Phones, and Music Players		Survey
	Mother's Individual Factors	- Age - Birth place - Marital status - Education - Employment status	- Health status - Household Size - # of cars - # of dogs - Physical activity intention	- Household income - Health insurance ownership		Survey

* Data from the UH-PEAK research
**More detailed information on Appendix 1
***More detailed information in Table 6

3.3.2. Research Process

The research process consists of four main streams: 1) measuring landscape spatial patterns by remote sensing techniques with aerial photo imagery; 2) measuring the built environment using GIS; 3) assessing environmental perceptions and HRQOL by using person-to-person surveys administrated by a research staff, as well as self-reported survey data; and 4) assessing physical activity and amount of walking by utilizing self-reported surveys (See Figure 7).

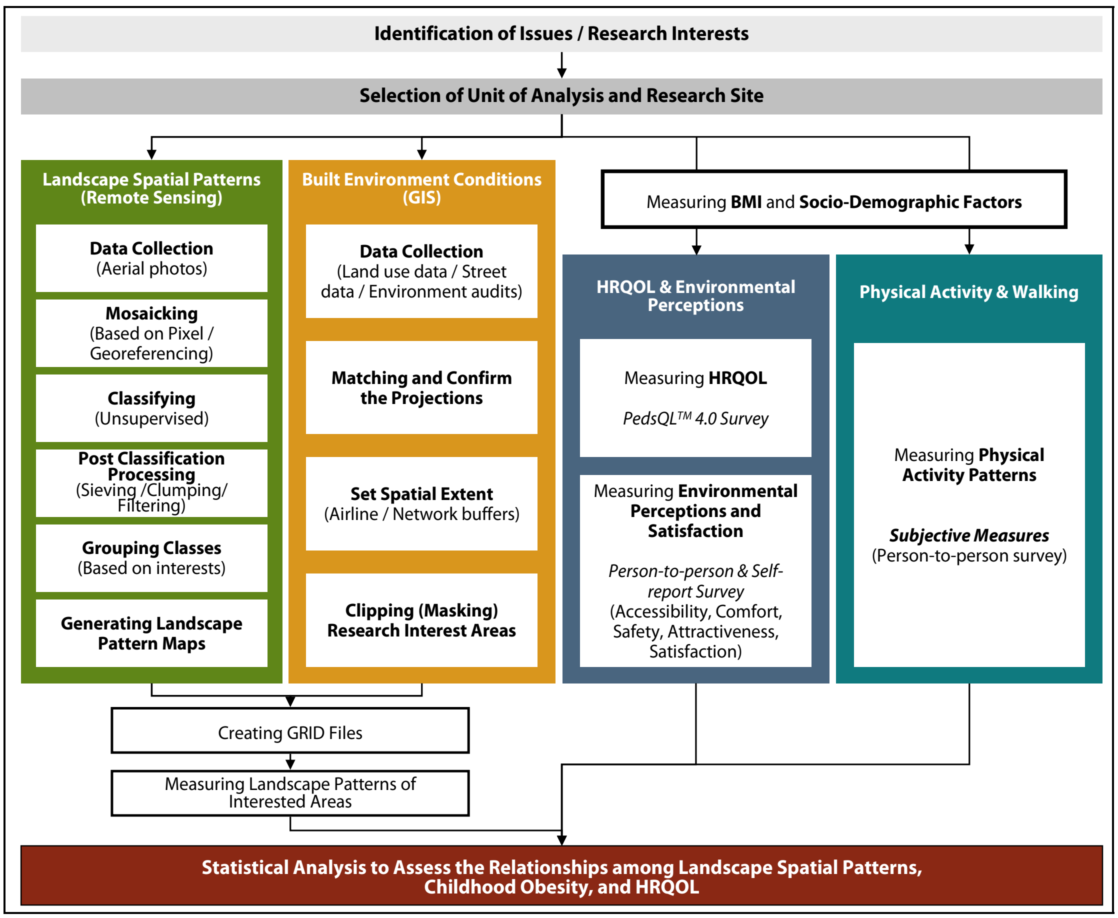


Figure 7. Research Flow.

3.3.3. Research Setting and Population

The trend of declining physical activity among children and adolescents also pervades in Harris County, TX. According to 2004~2005 school and nutrition physical activity

(SPAN) data, only 18 percent of 4th grade children engaged at least 30 minutes of moderate physical activity on five or more days per week and 64 percent of them reported at least 20 minutes of vigorous physical activity on three or more days per week. Among 4th graders, 28 percent of the children were overweight and 20 percent of them were considered at risk for becoming overweight. In addition, according to the Behavioral Risk Factor Surveillance System (BRFSS), 60.5 percent of the surveyed Hispanic population were overweight or obese, compared to 58.7 percent of the white respondents (HCPHES, 2005). Hoelscher et al. (2004) reported that a much higher percentage (31.1%) of Hispanic 4th graders in Texas were overweight, compared to African Americans (21.6%) and Whites (17.7%).

3.3.3.1. Location

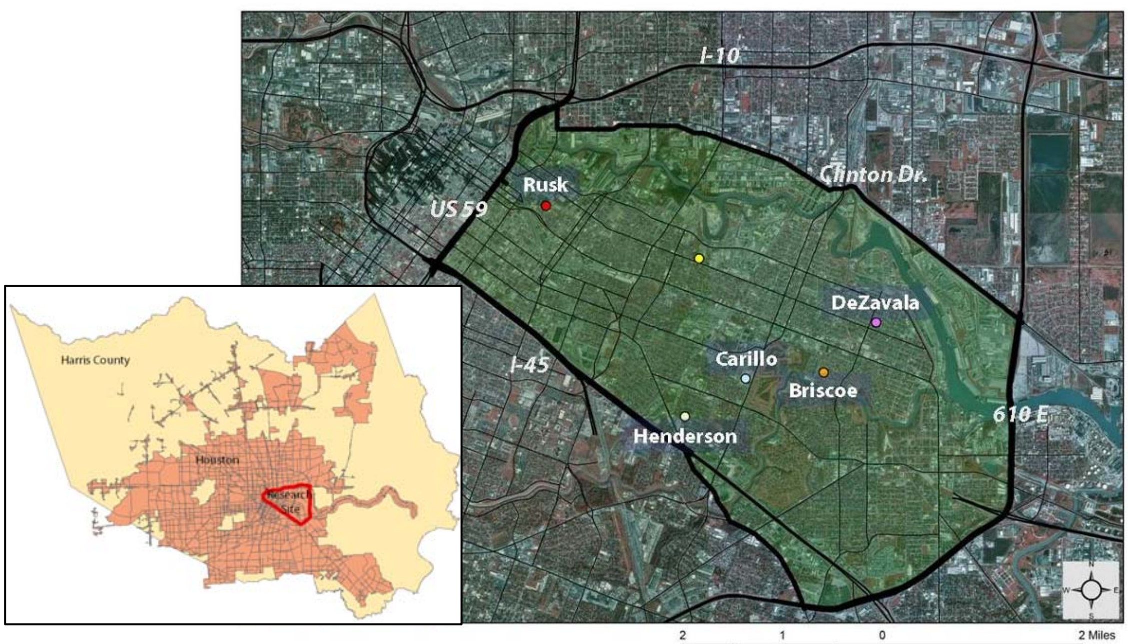


Figure 8. Research Location Showing 5 Selected Elementary Schools.

This research is conducted in the East End district in Houston, TX. The East End district is located southwest of the Houston downtown area. This area is bounded by Clinton Drive on the north, State Highway 59 on the west, Loop 610 and the Port of Houston on the east, and Interstate Highway 45 on the south (See Figure 8).

The rationale in choosing the neighborhoods in the East End district for this research is as follows. First, according to 2000 Census data, this area has a largely Hispanic population (92%) with 35 percent of children younger than 18 years of age. Second, 36 percent of the East End households reported earning less than $15,000 in 2000. In addition, 54 percent of residents who are 25 years old and older have no high school diploma, and only 4 percent have a college degree or higher. Low income and education levels are among the most significant factors causing increases in the risk of obesity. Finally, the East End district has diverse physical environmental settings including different types of parks, land use, and housing types (See Figure 9).

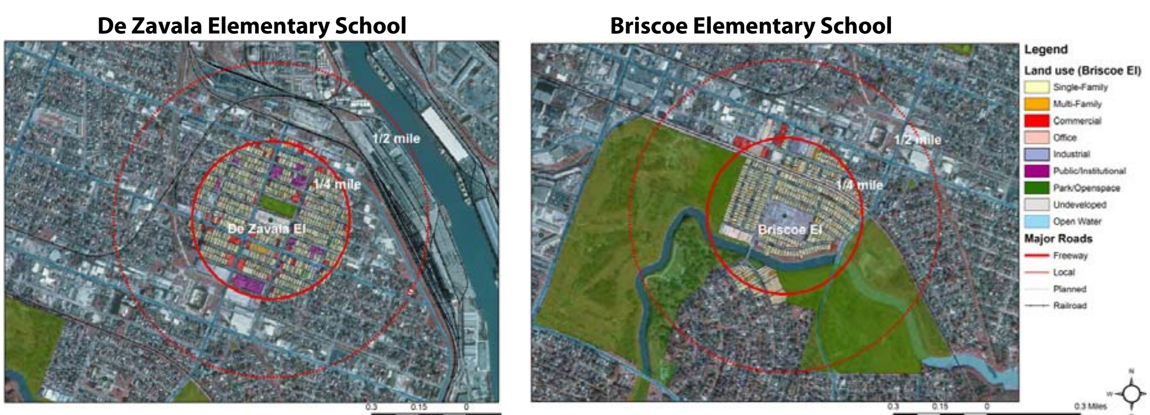


Figure 9. Examples of Neighborhood Environmental Characteristics around Selected Schools.
(See Appendix 2 for all 5 selected schools)

3.3.3.2. Schools

Five elementary schools located in the East End district were selected for this study (See Table 4). The rationale of selecting these schools is the large enrollment of Hispanic children (over 97%) and low socioeconomic status, as indicated by the percentage of children who receive free or reduced lunch (over 92%). These selected schools have diverse environmental settings such as different distances to parks, types of parks, land use mix, and housing types near each school. In addition, some of the selected schools are participating in SPARK, the School Park Program of Houston. The SPARK School Park Program, developed in 1983, is promoting a sense of ownership in the park among children and the community.

Table 4. Characteristics of 5 Selected Schools

	Briscoe	Carrillo	De Zavala	Henderson	Rusk
Enrollment 2005~2006 (students)	513	749	681	740	285
Hispanic students	98 %	97 %	99 %	98 %	98 %
Students receiving free or reduced price lunch	92 %	93 %	94 %	100 %	94 %
Distance to the closest park (and size)	0.17 miles (161 acres)	0.08 miles (161 acres)	0.03 miles (2.8 acres)	0.55 miles (8.2 acres)	0.03 miles (4.6 acres)
SPARKS	Yes	Yes	Yes	Yes	No

3.3.3.3. Study Population and Sampling

By the University of Houston research team led by Dr. Norma Olvera in the department of Health and Human Performance, 100 hundred Hispanic 4^{th} and 5^{th} graders and 100 mothers were recruited to participate in this research. The children's ages ranged from 9 to 12 years old. The rationale for selecting this range is that these age groups are reported to be at risk for a decline in physical activity level during the transitional year from elementary to middle school (CDC, 2006). Furthermore, more reliable self-reported data can be obtained from children 10 years of age and older (Welk et al., 2000). In order to place more focus on group differences among Hispanic children, this study did not include a comparison group of non-Hispanic children. In addition, children with a physical disability, children who are not living with a maternal guardian in the same household, children who have a maternal guardian unable to read or write in English or Spanish, and children who do not attend the targeted schools were excluded from this study.

The study population was 737 4^{th} and 5^{th} graders from five elementary schools and their maternal guardians from the East End District in Houston, TX. The overall response rate was 12.75 percent, which generated a sample of 96 children. In addition to recruiting Hispanic children, this research collected 66 mothers among 96 youth participants. Both children and maternal groups went through the same data collection process, including measuring their height and weight, in order to calculate BMI and body fat percentage, physical activity level, environmental perceptions and satisfaction, and socio-demographic factors, through person-to-person surveys administrated by the research staffs of the UH-PEAK project.

3.4. Measuring Landscape Spatial Patterns and Built Environments

3.4.1. Data and Maps

To collect data for the built environment, GIS data were obtained by various sources including the city of Houston geographic information system (COHGIS) and the Houston-Galveston Area Council (HGAC). Houston has affluent parcel-level GIS data sets including 250 categories of detailed land use data. Available GIS data from COHGIS and HGAC were acquired, including transportation (STAR*Map), land use, buildings, addresses, and demographic data.

To analyze landscape spatial patterns in the research area, 1m high-resolution Digital Ortho Quadrangles (DOQs) imagery, taken in 2004, was collected from the Texas Natural Resources Information System (TNRIS) and the Harris County Public Infrastructure Department. DOQ is a scanned-generated image of an aerial photograph via a geo-referencing process. In the U.S., aerial photograph images are available as Digital Orthophoto Quarter Quadrangles (DOQQs) that have already been orthorectified. Thus, geometric distortion resulting from the terrain topography and the camera lens has been eliminated on DOQQs images. A typical DOQ image covers one quarter of a 1:24,000 scale USGS topographic map, with some slight overlap.

In addition, to capture the characteristics of the physical environment and to assess the magnitude of the built environment on physical activity, this study incorporated some crucial items of existing environmental audits. As parts of the UH-PEAK project, two different types of audit tools were developed in this research. One is the school environmental audit developed as a ten-page checklist consisting of the items that were unavailable from secondary sources, including the street characteristics of adjacent frontage segments along the school boundary, sidewalk existence and conditions, shading conditions, speed limits for both general and school zone segments, buffers, amenities, the visual quality of streets, perceptions, facilities along each segment and inside of schools, drop off and pick up location conditions, amenities for frontage streets and school sites, and so on. Another audit tool is the neighborhood street audit tool for assessing both the frontage streets of each participant's home and the streets along the shortest routes from home to the child's school. The neighborhood street audit tool was developed as a double-sided page checklist including sidewalk existence and conditions, shade conditions, buffers, amenities and facilities along the streets, street characteristics, obstacles on streets to walk or bike, pavement conditions, visual quality of streets, perceptions, visible people on the street, and so on.

3.4.2. Classification of Land Cover

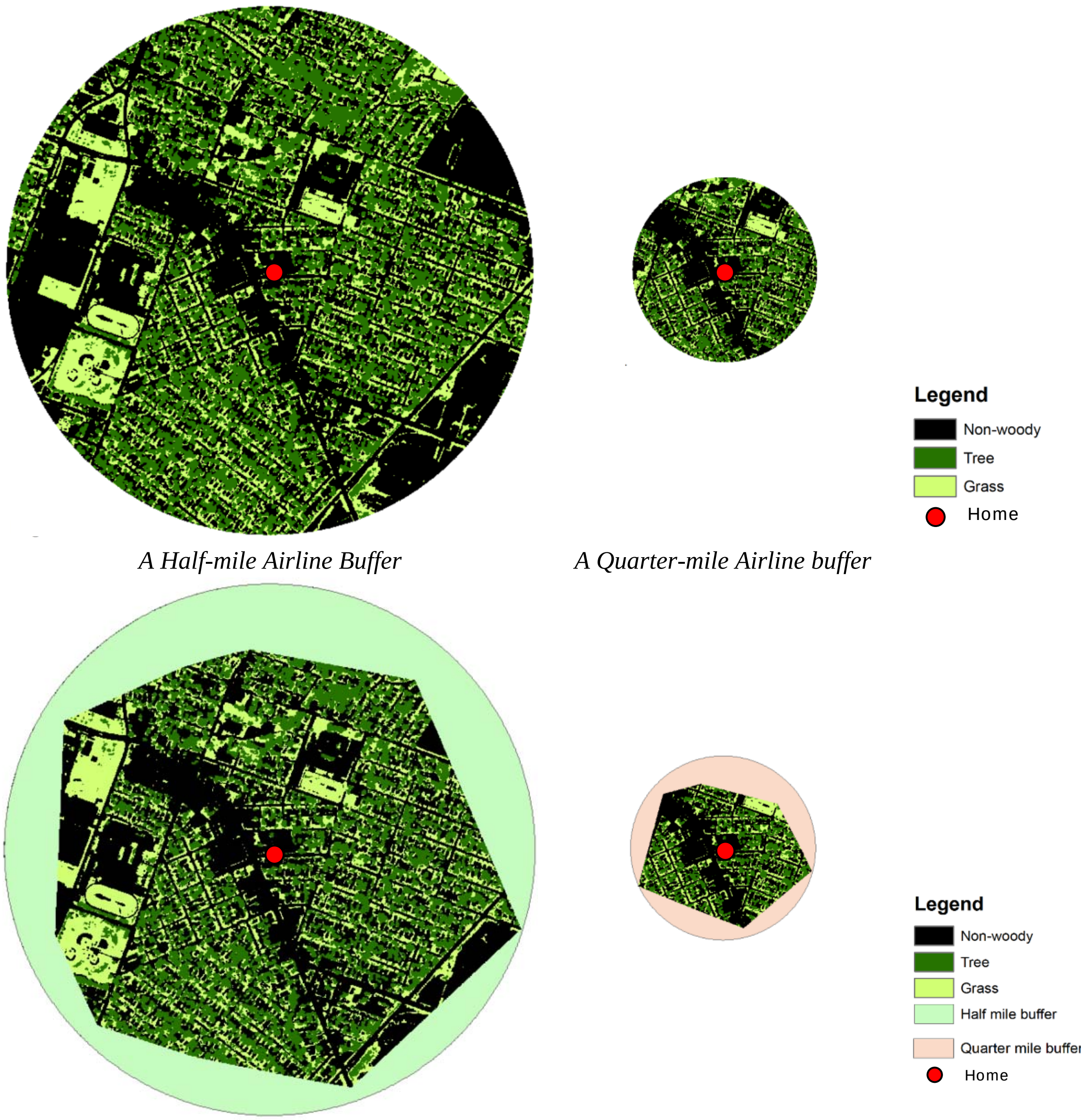
GIS and remote sensing techniques were used to measure different types of landscape cover. For measuring landscape spatial pattern using aerial photo images, this research used the ArcGIS Version 9.2 (ESRI, Redlands, California) and ENVI Version 4.3 (geospatial image analyzing software; ITT Visual Information Solutions, White Plains, New York) software. To capture landscape spatial patterns, the imagery was classified by using the unsupervised classification process, into 40 classes based on spectral similarity. These 40 classes created by each landscape were grouped into two main land cover types: woody and non-woody areas. In addition, the woody areas were classified into two sub-land cover types: trees/forests and grass areas. To group each land cover type, a visual interpretation of aerial photo images and other field photos was conducted. In addition, the size, shape, shadow, color, texture, patterns, brightness, height, depth and context of the features of the aerial photos were considered for photo interpretation.

After grouping the classes, post classification processes were conducted by applying sieving, clumping, and filtering processes. Since this research used high resolution imagery with 1m resolution and the tree canopy size is generally more than 1 m^2, single isolated pixels could affect the output of an analysis of landscape patterns. Thus, post classification processes should be considered to eliminate the single isolated cells.

Next, land cover classification imagery was converted to GRID in order to create a separated GRID corresponding to landscape spatial patterns within different environment settings. The created GRIDs were clipped and stored for each participant's environment settings (airline and network buffers), respectively.

Finally, each GRID, clipped with different settings, was analyzed in FRAGSTATS 3.3, a spatial pattern analysis program developed by McGarigal and Marks (1995). GRIDs were used to calculate landscape indices by applying the class level, in order to examine the overall relationship among landscape spatial patterns, childhood obesity, and health-related quality of life, rather than certain patch-specific relationships.

3.4.3. Measuring Spatial Settings



A Half-mile Airline Buffer *A Quarter-mile Airline buffer*

A Half-mile Network Buffer *A Quarter-mile Network buffer*

Figure 10. Examples of Different Spatial Settings to Measure Landscape Spatial Patterns.

To capture the existing landscape spatial patterns of urban forests and built environment attributes, two different settings were analyzed. To examine home neighborhood environments, a quarter-mile radius airline buffer and a half-mile radius buffer around the centroid of each property were generated to capture landscape spatial patterns and the nearby built environment conditions. At the same time, network buffers with both quarter and half-mile radius buffer were used to compare the differences between the airline and network buffers (See Figure 10). The buffer distance of a half-mile, approximately 800m, around homes was selected as a reported distance that both adults and children would be likely willing to walk, based on previous research (Ewing, 1995; Lee and Moudon, 2006; Lee et al., 2006; Timperio et al., 2004). A quarter-mile buffer was added to assess more proximate home neighborhood environment conditions around each child’s home.

3.4.4. Selection Criteria of Landscape Indices for Analyzing Landscape Spatial Patterns

There exist numerous landscape indices that have been developed and tested. There are several criteria for a set of indices to be considered useful for quantifying landscape patterns. For example, the selected indices should have a particular purpose to their analysis, and the indices should be independent of each other. In addition, the behavior of the indices should be discrete and the measured value should cover the full range of potential values (Haines-Young and Chopping, 1996; Turner et al., 2001). There are still some inherent limitations such as uniqueness, sensitivity, redundancy, and scale issues (Gustafson, 1998; O'Neill et al., 1988; Riitters et al., 1995). However, these indices are useful for estimating the interrelationships between human activities and the ecosystem, as well as for deriving more accurate statistical evidence through quantitative approaches (Bogaert et al., 2000; Gustafson, 1998).

3.4.4.1. The Principles for Assessing Landscape Spatial Patterns from Ecological Perspectives

In the previous chapter, this research introduced some significant models and guidelines with regards to what determines the optimum arrangement of land use in a landscape with ecological perspectives (Section 2.3. The models and guidelines for the optimum land use arrangement in Chapter II). In the section introducing the P-M model, this research reviewed landscape spatial guidelines from McArthur and Wilson (1967) and Shafer (1994), as well as the Aggregate-With-Outliers principle provided by Forman (1995a; 1995b).

Those guidelines, as mentioned in the previous section, are useful for this research in summarizing landscape spatial patterns by arrangement. Several criteria have been extracted to guide the selection of appropriate landscape indices in this research, in order to access the quality of landscape structure (Dramstad et al., 1996; Forman, 1995a; Forman, 1995b; Haines-Young and Chopping, 1996; Lee, 2002; Shafer, 1994). The criteria used to examine the ecological quality of landscape structures generated by urban trees and forests are as follows:

1. Unfragmented landscape structure;
2. Closer distance between single patches;
3. Irregular shaped boundaries of patches;
4. Larger patch size;
5. Patch connectivity.

3.4.4.2. The Principles for Assessing Landscape Patterns from Human Health Perspectives

A few studies have directly investigated the relationships between landscape patterns and human health. In usual, they focus on people's preferences about aesthetic qualities or their perceptions of landscape structural patterns. (Chenoweth and Gobster, 1990; Coley et al., 1997; Hartig et al., 2003; Jorgensen et al., 2002; Kweon et al., 2006; Ulrich, 1984; Ulrich et al., 1991). Although there are a few efforts associated with public health and green spaces, these researchers relied on aggregated land use data and overlooked any detailed information about the quality of landscape patterns (Maas et al., 2006; Mitchell and Popham, 2007). However, previous studies from various fields have proposed useful principles for examining the influence of landscape patterns on human health. These principles are as follows:

1. Existence of landscape structure;
2. Size of landscape structure;
3. Formal or artistic attribute (line, form, color, and texture) of landscape structure;
4. Connectivity of landscape structure (along linear elements like streets, and foreground edges of natural elements such as urban forests or parks).

3.4.4.3. Criteria of Quantifying Landscape Patterns for Physical Activity Research

Drawing from the principles mentioned above, this research uses and tests a set of landscape indices including Total Area (TA), Percentage of Landscape (PLAND), Number of Patches (NP), Patch Density (PD), Total Edge (TE), Landscape Shape Index (LSI), Mean Patch Size (MPS), Mean Shape Index (MSI), Mean Nearest Neighborhood Distance (MNN), Patch Cohesion Index (COHESION), and Fragmentation Measurement Index (FMI) (see Tables 5 and 6). FRAGSTATS 3.3 was used to calculate landscape indices applying the four-cell neighborhood rule.

Table 5. Proposed Criteria of Assessing Landscape Patterns for Physical Activity Research

	Ecological Criteria	**Health Criteria**	**Proposed Landscape Indices * (acronym)**
Fragmentation	Unfragmented landscape structure	Existence of landscape structure	Number of Patches (NP), Patch Density (PD), Mean Patch Size (MPS), Fragmentation Measurement Index (FMI)
Size	Larger patch size	Size of landscape structure	Total Area (TA), Percentage of Landscape (PLAND), Total Edge (TE)
Shape	Irregular shaped boundaries of patches	Formal or artistic attribute of landscape structure	Landscape Shape Index (LSI), Mean Shape Index (MSI)
Isolation	Closer distance between single patches	-	Mean Nearest Neighbor Distance (MNN)
Connectivity	Connectivity	Connectivity of landscape structure	Patch Cohesion Index (COHESION)

* *See Table 6 for more details*

Table 6. Selected Landscape Indices
(Adapted and revised from McGarigal and Mark (1995); and Bogaert et al. (2000))

Landscape Indices	Formula *	Unit & Range	Description
Fragmentation			
Number of Patches (NP)	$NP = n_i$	- None	NP is a simple measure of the fragmentation of the patch type. Although it has no information about area, distribution, or density of patches, it is still a significant index in ecological meanings.
Patch Density (PD)	$PD = \frac{n_i}{A}(10{,}000)(100)$	- Number per 100 hectares - PD>0, constrain-ed by cell size	PD is constrained by the cell size of the raster image, since the maximum PD is calculated when every pixel is a separate patch. Although PD has limited information, it has a fundamental, aspect of landscape pattern. PD had the same simple utility as NP as an index, thus if total landscape area is held constant, PD and NP deliver the same information.
Mean Patch Size (MPS)	$MPS = \frac{\sum_{j=1}^{n} a_{ij}}{n_i}\left(\frac{1}{10{,}000}\right)$	- Hectares - MPS>0, without limit	MPS is one of the most important and useful index of information in terms of a habitat fragmentation contained in a landscape. The smaller MPS in a landscape could be considered the more fragmented condition. MPS is limited by the grain and extent of the image as well as minimum patch size.
Fragmentation Measurement Index (FMI) +	$FMI\,(\lvert\phi_f\rvert) = \sqrt{\alpha_f^2 + \beta_f^2 + \nu_f^2 + \delta_f^2}$ $\alpha = (a_{obs} - a_{\min})/(a_{\max} - a_{\min}) \times 100$ $\beta = (p_{\max} - p_{obs})/(p_{\max} - p_{\min}) \times 100$ $\nu = (n_{\max} - n_{obs})/(n_{\max} - n_{\min}) \times 100$ $\delta = (d_{\max} - d_{obs})/(d_{\max} - d_{\min}) \times 100$	- None - 0 ≤ FMI ≤ 200	FMI was developed by Bogaert et al (2000) to measure fragmented landscape pattern. Higher values (200) of FMI represent less fragmented patterns, while lower values (0) indicate more fragmented conditions.

(Table 6. Cont'd)

Landscape Indices	Formula **	Unit & Range	Description
Size			
Total Area (TA)	$TA = \sum_{j=1}^{a} a_{ij}\left(\frac{1}{10,000}\right)$	- Hectares	TA is the sum of areas belonging to a given landscape.
Percentage of Landscape (PLAND)	$PLAND = P_i = \frac{\sum_{j=1}^{n} a_{ij}}{A}(100)$	- Percent - 0 < PLAND ≤ 100	If PLAND values attain lower values (0), it means that the corresponding patch type is increasingly rare in the landscape. On the other hand, if PLAND values become the maximum value as 100, the entire landscape is comprised of a single patch type.
Total Edge (TE)	$TE = \sum_{k=1}^{m} e_{ik}$	- Meters - TE ≥ 0, without limit	TE is the sum of the total perimeters (m) involving the corresponding patch type. TE is an absolute measure of total perimeter and could compare landscapes of varying size.
Shape			
Landscape Shape Index (LSI)	$LSI = \frac{e_i}{\min e_i}$	- None - LSI ≥ 0, without limit	LSI represents a simple measure of class aggregation. Higher values of LSI indicate more disaggregated landscape patterns.
Mean Shape Index (MSI)	$MSI = \frac{\sum_{j=1}^{n}\left(\frac{0.25 p_{ij}}{\sqrt{a_{ij}}}\right)}{n_i}$	- None - MSI ≥ 0, without limit	MSI is for measuring how much irregular shape the corresponding patch type has. Higher values of MSI mean more irregular shape.

(Table 6. Cont'd)

Landscape Indices	Formula **	Unit & Range	Description
Isolation			
Mean Nearest Neighbor Distance (MNN)	$MNN = \frac{\sum_{j=1}^{n} h_{ij}}{n_i}$	- Meters - MNN ≥ 0, without limit	MNN is the distance to the nearest neighboring patch of a similar type based on the way of edge to edge.
Connectivity			
Patch Cohesion Index (COHESION)	$COHESION = \left[1 - \frac{\sum_{j=1}^{n} p_{ij}}{\sum_{j=1}^{n} p_{ij}\sqrt{a_{ij}}}\right]\left[1 - \frac{1}{\sqrt{A}}\right]^{-1}.(100)$	- None - 0 ≤ COHESION < 100	COHESION measures the physical connectedness of the equivalent patch type. COHESION values increase when the patch attains more clumped or aggregated in the landscape, and it means more physically connected.

n_i= number of patches in the landscape of patch type I; A = total landscape area (m^2); e_i = total length of perimeter of class i in terms of number of cell surfaces; min e_i = minimum total length of perimeter of class i in terms of number of cell surfaces ; e_{ik} = total length (m) of edge in l andscape involving patch type; a_{ij} = area (m^2) of patch ij; P_i = proportion of the landscape oc cupied by patch type; p_{ij} = perimeter of patch ij; h_{ij} = distance (m) from patch ij to nearest neighboring patch of the same type, based on edge-to-edge distance

+ a_{obs} : total habitat area, p_{obs} : total habitat perimeter, n_{obs} : number of patches, d_{obs} : patch isolation.

* See McGarigal and Marks (1995); http://www.umass.edu/landeco/research/fragstats/documents/Metrics/Metrics%20TOC.htm; and Bogaert et al. (2000) for more details

In application, the interpretation of each landscape index is as follows. Higher values of NP, PD, and MPS indicate more fragmented landscape patterns. The FMI developed by Bogaert et al. (2000) was used to measure the overall fragmented conditions of landscape spatial patterns. High values (e.g., 200) represent less fragmented patterns, while low values (e.g., 0) indicate more fragmented conditions.

TA, PLAND, and TE are directly affected by the corresponding patch size. Higher values of TA and PLAND indicate larger patch sizes, while a high TE implies that the landscape patterns is comprised of small or convoluted patches at the class level.

When the LSI value becomes 1, it means that the landscape is comprised of a single square or a maximally compact patch. Higher LSI values indicate that the patch has a more disaggregated condition. In addition, when the MSI approaches 1, the patch shape has a more regular shape (i.e., a square).

Higher MNN values describe more isolated landscape patterns. In addition, a lower percentage of COHESION (e.g., 0%) represents a less physically connected landscape pattern, whereas a higher percentage of COHESION (e.g., 100%) means a more physically connected landscape pattern.

3.5. Measuring Obesity, Physical Activity, and Environmental Perceptions and Satisfaction

3.5.1. Measuring Body Mass Index (BMI)

To collect children’s and mothers’ body mass index (BMI) data, this study objectively collected students’ and their mothers’ height and weight. The average of two assessments of body height and weight was used. Body height and weight was measured on the subjects utilizing a standard physician’s scale and stadiometer, rounded to the nearest 0.5 kg and 0.5 cm, respectively (Detecto, Cardinal Scale Mfg, Co., Webb City, MO). Participants were asked to take off their shoes and to place the back of their head touching the stadiometer stand. They were also asked to remove their shoes and socks before stepping on the scale.

Each child and mother's height and weight was used to calculate their BMI by using Quetelet's index (weight in kilograms/m^2). According to the regulations provided by the CDC (2009b), the BMI values of each child were identified by their age and gender-specific percentile. At or above the 85^{th} percentile of BMI values were classified as overweight, and at or above the 95^{th} percentile of BMI values were classified as obese. At or above the 5^{th} percentile to less than the 85^{th} percentile of BMI values were classified as normal weight. In addition, underweight conditions were classified as less than the 5th percentile in BMI values.

According to the CDC (2009a), adults' BMI values were categorized four different ranges. BMI values below 18.5 were classified as underweight, and values at or over 18.5 to 24.9 were classified as normal. BMI values at or over 25.0 to 29.9 were categorized as overweight, and values at or over 30.0 were categorized as obese.

3.5.2. Measuring Environmental Perceptions and Satisfaction

This research used three different pairs of survey instruments to examine Hispanic children and mothers' environmental perceptions and satisfaction about built environments, their physical activity levels in their neighborhoods, as well as any socio-demographic factors pertinent for each individual. The surveys were administrated on the same day of measuring their body height and body weight. Since this study focuses on the landscape spatial patterns of urban forests and trees within neighborhoods, potential correlates and variables were collected in terms of perceived accessibility, comfort and convenience, safety concerns, attractiveness, and perceived satisfaction with home neighborhood environments. Survey variables are as shown in Table 3. SPSS 15.0 (SPSS Inc., Il) was used to analyze the survey data set.

3.6. Measuring Health-related Quality of Life for Children

To evaluate HRQOL, this research used the Pediatric Quality of Life Inventory (PedsQL) 4.0 generic core scale developed by James Varni (Chan et al., 2005; Varni et al., 2003; Varni et al., 2002; Varni et al., 2001; Varni et al., 1999).

According to Varni (2001), the PedsQL is a modular instrument used to assess HRQOL among children and adolescents ages 2 to 18. The PedsQL consists of parallel child self-reports and parent proxy reports using essentially identical forms. Separate reports from parents and children are used since the child's self-repots are designed to assess their perceptions of internal states, while parents' reports reflect the child's observable behaviors. This instrument has been tested extensively and used for various HRQOL measurements. Most questions regarding perceptions related to health conditions use a 5-point Likert scale (0=never a problem, 1=almost never a problem, 2=sometimes a problem, 3=often a problem, and 4=almost always a problem). The 23-item PedsQL 4.0 generic core scale was classified into 4 main factors, such as physical functioning (8 items), emotional functioning (5 items), social functioning (5 items), and school functioning (5 items). To describe children's HRQOL easily (higher scores show better HRQOL), after collecting all of the questionnaires, each item was reverse-scored and linearly transformed on a zero to 100 scale (0=100, 1=75, 2=50, 3=25, 4=0). Then, a total scale score calculated by the mean of all 23 items indicates a summary of the child's HRQOL. Across the ages, the total scale score of self-reporting and proxy-reporting was shown to approach a high score Cronbach alpha reliability coefficient of 0.90. Previous research has shown that the PedsQL could detect HRQOL differences between healthy children and ill children (Schwimmer et al., 2003; Varni et al., 2001; Varni et al., 1999). The PedsQL was selected for this research due to its high reliability and ease of use both by the participant and by the researcher.

3.7. Data Analysis

The data analysis focuses on detecting the significance of different landscape spatial patterns when explaining childhood obesity and children's HRQOL. The research involved four major steps of data analysis. First, descriptive statistics were performed to understand the respondents' socio-demographic characteristics, overall physical activity patterns, BMI and BIA, HRQRL, and landscape spatial patterns computed by landscape indices. Furthermore, this step evaluated the participants' environmental perceptions and satisfaction with regards to their neighborhood. Then the standard diagnostic testing was performed to identify key variables and outliers. In addition, this study tested for the multicollinearity among the independent variables, especially for the various landscape indices.

Second, bivatiate analyses were conducted to understand any associations between each independent variable and dependent variable. The correlations among children's BMI, HRQOL, and physical activity patterns were evaluated. In addition, the relationships between landscape spatial patterns and the children's BMI and HRQOL were assessed.

Third, to reduce the number of environmental perception and satisfaction variables given the small sample size, a Principal Component Analysis (PCA) was conducted. Due to the different ways that the questions were asked in the survey regarding environmental perception and satisfaction variables, this research performed two separated PCA analyses. For the PCA, this research used the Varimax of the orthogonal rotation method. The appropriate and feasible numbers of factors were extracted after examining the Eigenvalues and the scree plot. This research selected results only above the .5 value on the Kaiser-Myer-Olkin (KMO) and Bartlett's test of spericity (Hutcheson and Sofroniou, 1999; Kaiser, 1974). In addition, PCA results showing above 60 percent of the cumulative percentage of variance explained were considered. This research applied a minimum factor loading of .4 to determine the latent factors (Field, 2005; Stevens, 1992).

Finally, a series of multiple regression models was estimated to predict outcome variables using the landscape structure variables captured by different indices. Before entering selected variables for developing the final regression models, this research conducted the imputing process for some demographic variables, showing the small number of cases based on descriptive statistics. The regression model hypothesized that the variance in children's BMI and HRQOL would be affected by landscape spatial patterns of urban forests, socio-demographics, physical activity patterns, and environmental perceptions and satisfaction. Based on the four different spatial settings adopted in this research, such as a half and a quarter-mile airline buffer, and a half and a quarter-mile network buffer, and different dependent variables such as children's BMI and HRQOL, ten separate multiple regression models were estimated. This research used the backward stepwise model fitting process to develop efficient models, while considering a large number of potential correlates.

3.8. Summary

This chapter provided the research methods based on the literature review and research aims. In addition, the conceptual model and research design were developed to test the research hypotheses.

This research focuses on Hispanic elementary school children from inner-city neighborhoods who represent a high-risk group for childhood obesity. One hundred students in 4^{th} and 5^{th} grade and their mothers were recruited from five elementary schools in Houston, TX. Children's BMI values were calculated from objectively measured heights and weights, and subjects were asked to answer surveys in order to measure environmental perceptions and satisfaction, as well as physical activity patterns with their socio-demographic factors. In addition, both children and their mothers were asked to answer the PedsQL survey to measure the children's HRQOL.

Using high-resolution (1m x 1m) DOQQ aerial photo imagery, landscape spatial patterns of urban forests and trees were measured by GIS and remote sensing.

FRAGSTATS was used to compute various landscape indices for airline and network buffers of a half-mile and a quarter-mile around each child's home.

The data analysis focused on detecting the correlates between landscape spatial patterns of urban forests, and childhood obesity and HRQOL. Once descriptive analyses were completed with the selected variables, bivatiate analyses were conducted to examine relationships between each independent variable and dependent variable. To reduce the number of environmental perceptions and satisfaction variables, a PCA was conducted. Finally, statistical models were estimated by using a series of multiple regression analyses to predict outcome variables, using landscape indices with other confounding variables.

CHAPTER IV

RESULTS

4.1. Introduction

This chapter presents the analysis and results from testing the research aims and hypotheses presented in Chapter III. First of all, the first three subchapters describe the results of descriptive analyses of the survey data. Each subchapter describes the participants' socio-demographic characteristics of both the children and the mothers, and the children's physical activity patterns. Additionally, each subchapter includes the respondents' body fat status using a BMI and BMI percentile, and assesses gender and age differences depending on their BMI. Then subchapter 4 tests how children's weight status is affected by their mothers' weight condition. Subchapter 5 reports the children's HRQOL measured by the PedsQL survey, and tests gender and age differences in their HRQOL using the PedsQL surveys reported by children and their mothers. The correlation results between their BMI, HRQOL, and physical activity patterns are also reported. Second, from subchapter 7, characteristics of landscape spatial patterns with the four different spatial settings are described. This subchapter goes on to characterize how the associations between landscape spatial patterns and the children's BMI and HRQOL are different, corresponding to their different spatial settings. Third, the subchapter evaluates the respondents' environmental perceptions with regards to their respective neighborhoods. Fourth, it presents the factor analysis results that can be used to group and reduce environmental perception variables. Finally, the last subsection presents the multiple regression analysis results, explaining the correlations between children's BMI and HRQOL and landscape spatial patterns, while considering environmental perceptions and socio-demographic factors.

There are differences between the numbers of samples in this research. While 96 children were recruited, only 66 mothers were completed and returned surveys assessing their environmental perceptions, physical activity levels, and socio-demographic characteristics. A total of 61 out of 66 mothers agreed to report their addresses. Thus, this research analyzed children's physical activity patterns, HRQOL, environmental perceptions, and socio-demographic characteristics from a full sample of 96 children, but could use only 61 of subjects to analyze all informative variables with landscape spatial patterns measured by landscape indices. From here, this research refers to the entire sample of 96 children or 66 mothers as the 'full sample,' and the 61 subjects as the 'sub sample.' In Chapter IV, all tables showing the results from descriptive and bivatiate analyses report for both the full sample and the sub sample.

4.2. Characteristics of Respondents

4.2.1. Characteristics of Children

The socio-demographic characteristics of the child respondents are shown in Table 7. The children participated from five elementary schools, and only a few of those (5 from the full sample and 3 from the sub sample) were recruited from Rusk Elementary school.

In addition, many children who enrolled at Henderson Elementary school did not report their addresses, which caused a loss of 12 participants in the sub sample.

In both the full and the sub samples, children's socio-demographic factors showed very similar characteristics. The proportion of children's genders were about 40 percent boys and 60 percent girls (40.6% of boys and 59.4% of girls from the full sample and 39.3% of boys and 60.7% of girls from the sub sample). Their ages were distributed between 9 to 12 years old and the majority were enrolled in 5th grade (61.5% in the full sample and 54.1% in the sub sample), followed by 4th grade (35.5% and 44.3% of the samples, respectively). In terms of ethnicity, the Hispanic group was dominant with over 80 percent (84.4% and 82.0% from the samples, respectively) and the rest of the respondents answered 'don't know' to queries regarding their ethnicity. From both samples, it is clear that most of the children were born in the U.S. (77.1% and 75.4%, respectively) and were living with both parents (70.8% and 75.4%, respectively). Over seventy-five percent of the children had siblings, but the majority were living with no grandparents (85.4% and 85.2% of the full and sub samples, respectively).

From both samples, it was gathered that all children had at least one television in their home, and over eighty-five percent of them had at least one television in one of the home's bedrooms. More than 45 percent of the children had two VCRs or DVD players, and more than 85 percent of the children had a computer at home. Over 85 percent had at least one game console in their household. While about 25 percent did not have a home phone, more than 90 percent of the children's households had more than one cell phone.

Table 7. Socio-demographic Characteristics of Child Respondents

Variables	Full Sample (N=96) Freq. (%)	Sub Sample (N=61) Freq. (%)	Variables	Full Sample (N=96) Freq. (%)	Sub Sample (N=61) Freq. (%)
School			**# of TVs at Home**		
Rusk	5 (5.2%)	3 (4.9%)	0	0 (0.0%)	0 (0.0%)
Briscoe	27 (28.1%)	17 (27.9%)	1	7 (7.3%)	4 (6.6%)
Henderson	17 (17.8%)	5 (8.2%)	2	26 (27.1%)	15 (24.6%)
Carrillo	27 (28.1%)	19 (31.1%)	3 +	63 (65.6%)	42 (68.9%)
De Zavala	20 (20.8%)	17 (27.9%)			
			# of TVs at Bedrooms		
Gender			0	12 (12.5%)	9 (14.8%)
Boy	39 (40.6%)	24 (39.3%)	1	48 (50.0%)	30 (49.2%)
Girl	57 (59.4%)	37 (60.7%)	2	23 (24.0%)	12 (19.7%)
			3 +	13 (13.5%)	10 (16.4%)
Age					
9	11 (11.5%)	10 (16.4%)	**# of VCRs/DVDs at Home**		
10	49 (51.0%)	32 (52.5%)	0	7 (7.3%)	6 (9.8%)
11	32 (33.3%)	18 (29.5%)	1	33 (34.4%)	23 (37.7%)
12	4 (4.2%)	1 (1.6%)	2	44 (45.8%)	26 (42.6%)
			3 +	12 (12.5%)	6 (9.8%)
Grade					
3rd	2 (2.0%)	1 (1.6%)	**# of Computers at Home**		
4th	35 (35.5%)	27 (44.3%)	0	14 (14.6%)	9 (14.8%)
5th	59 (61.5%)	33 (54.1%)	1	60 (62.5%)	36 (59.0%)
			2	18 (18.8%)	12 (19.7%)
Ethnicity			3 +	4 (4.2%)	4 (6.6%)
Hispanic	81 (84.4%)	50 (82.0%)			
Don't know	15 (15.6%)	11 (18.0%)	**# of Video Game Consoles at Home**		
			0	14 (14.6%)	9 (14.8%)
Country Born			1	21 (21.9%)	13 (21.3%)
US	74 (77.1%)	46 (75.4%)	2	32 (33.3%)	18 (29.5%)
Mexico	18 (18.8%)	12 (19.7%)	3 +	29 (30.2%)	21 (34.4%)
Central America	3 (3.1%)	3 (4.9%)			
Missing	1 (1.0%)		**# of Telephones at Home**		
			0	25 (26.0%)	15 (24.6%)
Guardians			1	28 (29.2%)	17 (27.9%)
Mom only	16 (16.7%)	10 (16.4%)	2	30 (31.3%)	20 (32.8%)
Dad only	1 (1.0%)	0 (0.0%)	3 +	13 (13.5%)	9 (14.8%)
Mom and Dad	68 (70.8%)	46 (75.4%)			
Parent and Step-parent	9 (9.4%)	5 (8.2%)	**# of Cell Phones at Home**		
Missing	2 (2.1%)	-	0	9 (9.4%)	6 (9.8%)
			1	14 (14.6%)	6 (9.8%)
Living with Siblings			2	34 (35.4%)	25 (41.0%)
Yes	72 (75.0%)	48 (78.7%)	3 +	39 (40.6%)	24 (39.3%)
No	24 (25.0%)	13 (21.3%)			
			# of Music Players at Home		
Living with Grandparents			0	13 (13.5%)	10 (16.4%)
Yes	14 (14.6%)	9 (14.8%)	1	31 (32.3%)	18 (29.5%)
No	82 (85.4%)	52 (85.2%)	2	24 (25.0%)	16 (26.2%)
			3+	28 (29.2%)	17 (27.9%)

4.2.2. Characteristics of Mothers

Sixty-six percent of the one hundred maternal samples queried, completed and returned their surveys. The socio-demographic characteristics of the maternal participants are summarized in Table 8.

As was the case with the results of the children's socio-demographic characteristics, both the full and sub maternal samples presented similar characteristics. The average age of the maternal respondents in the full sample was 35.6 years old, and the average age of the mothers from the sub sample was 35.7 years old. The youngest respondents were 25 (full sample) and 27 (sub sample) years old, whereas the oldest mother from both the full and sub samples was 54 years old. From both samples, the most common age group was the 30s (63.6% in the full sample, and 60.7% in the sub sample) followed by the 40s (22.7% and 19.7%, respectively). About 60 percent of those were born outside of the U.S., and the majority of the subjects were born in Mexico (60.6% of the full sample and 59.0% of the sub sample). The marital status of the majority of mothers were married (68.2% and 62.3%, respectively) followed by single and never married (15.2% of the full sample and 13.1% of the sub sample). About 9~10 percent were either divorced, a widow, or separated (9.1% and 9.8%, respectively). In terms of their highest education, over 53 percent of the mothers in the full sample and over 75 percent of those in the sub sample were below college degree level. From both samples, over forty-five percent of maternal respondents were employed for wages, and among them the largest occupation group was in administrative support (19.0% and 19.7%, respectively). Most stated that their general health condition was good (50.8% of the full sample and 45.9% of the sub sample), or average (33.8% of the full sample and 34.4% of the sub sample).

From both samples, the average household size was about five persons (4.88 and 4.85, respectively). The majority had at least one car per household (95.5% and 95.1%, respectively), and over 50 percent (51.5% and 55.7%, respectively) of those were living with at least one dog in their house.

While less than 45 percent of maternal respondents (44.6% and 42.6%, respectively) had health insurance to cover themselves, over 65 percent had insurance for their children (72.7% and 65.6%, respectively). In terms of mother's physical activity intentions, about 45 percent of those who answered said that they would likely (34.9% and 31.1%, respectively) or very likely (19.0% and 14.8%, respectively) be involved in physical activities in the next week. From both samples, the distribution of total household income was relatively low ranges such as less than $10,000 showed levels of 18.2% and 13.1%, between $10,000 to $20,000 showed 16.7% and 18.0%, between $20,001 to $30,000 showed 16.7% and 18.0%, and between $30,001 to $40,000 showed 10.6% and 9.8% of each sample, respectively.

Table 8. Socio-demographic Characteristics of Maternal Respondents

Variables	Full Sample (N=66) Freq. (%)	Sub Sample (N=61) Freq. (%)	Variables	Full Sample (N=66) Freq. (%)	Sub Sample (N=61) Freq. (%)
Mean Age	35.6	35.7	**Household Size**		
Country Born			2	2 (3.0%)	2 (3.3%)
US	19 (28.8%)	18 (29.5%)	3	7 (10.6%)	6 (9.8%)
Mexico	40 (60.6%)	36 (59.0%)	4	17 (25.8%)	15 (24.6%)
Central America	6 (9.1%)	3 (4.9%)	5	22 (33.3%)	18 (29.5%)
Other	1 (1.5%)	-	6	9 (13.6%)	9 (14.8%)
Missing	-	4 (6.6%)	7	7 (10.6%)	6 (9.8%)
			8	2 (3.0%)	1 (1.6%)
Marital Status			Missing	-	4 (6.6%)
Single, never married	10 (15.2%)	8 (13.1%)			
Married	45 (68.2%)	38 (62.3%)	**# of Cars**		
Living w/ partner	5 (7.6%)	5 (8.2%)	0	3 (4.5%)	3 (4.9%)
Divorced, widow, separated	6 (9.1%)	6 (9.8%)	1	23 (34.8%)	18 (29.5%)
Missing	-	4 (6.6%)	2	30 (45.5%)	26 (42.6%)
			3	9 (13.6%)	9 (14.8%)
Education			4+	1 (1.5%)	1 (1.6%)
Elementary – 6	8 (8.1%)	7 (11.5%)	Missing	-	4 (6.6%)
7 – 8	11 (11.1%)	10 (16.4%)			
9 – 12	34 (34.4%)	29 (47.5%)	**# of Dogs**		
1 – 2 years of college	2 (2.0%)	2 (3.3%)	0	32 (48.5%)	27 (44.3%)
3 – 4 years of college	1 (1.0%)	1 (1.6%)	1	19 (28.8%)	18 (29.5%)
College graduate or higher	5 (5.1%)	4 (6.6%)	2	9 (13.6%)	7 (11.5%)
Vocational / Technical	4 (4.0%)	4 (6.6%)	3 +	6 (9.1%)	5 (8.2%)
Missing	1 (1.0%)	4 (6.6%)	Missing	-	4 (6.6%)
Employment			**Health Insurance Ownership**		
Employed for wages	31 (47.0%)	28 (45.9%)	Yes	29 (44.6%)	26 (42.6%)
Self-Employed	3 (4.5%)	2 (3.3%)	No	36 (55.4%)	30 (49.2%)
Out of work for more than 1 year	2 (3.0%)	2 (3.3%)	Missing	-	4 (6.6%)
Out of work for less than 1 year	3 (4.5%)	3 (4.9%)			
Homemaker	27 (40.9%)	22 (36.1%)	**Children's Health Insurance Ownership**		
Missing	-	4 (6.6%)	Yes	48 (72.7%)	40 (65.6%)
			No	18 (27.3%)	17 (27.9%)
Current Occupation			Missing	-	4 (6.6%)
Managerial / professional	4 (6.3%)	2 (3.3%)			
Technician / sales	2 (3.2%)	2 (3.3%)	**Physical Activity Intention in the Next Week**		
Administrative support	12 (19.0%)	12 (19.7%)	Very likely	12 (19.0%)	9 (14.8%)
Service / skilled worker	6 (9.5%)	5 (8.2%)	Likely	22 (34.9%)	19 (31.1%)
Manual labor	3 (4.8%)	2 (3.3%)	Somewhat likely	20 (31.7%)	17 (27.9%)
Retired	3 (4.8%)	3 (4.9%)	Unlikely	7 (11.1%)	7 (11.5%)
Housewife	25 (39.7%)	20 (32.8%)	Very unlikely	2 (3.2%)	2 (3.3%)
Unemployed	3 (4.8%)	3 (4.9%)	Missing	-	7 (10.4%)
Missing	8 (7.9%)	12 (19.7%)	**Household Income**		
			< $10,000	12 (18.2%)	8 (13.1%)
General Health Status			$10,000~$20,000	11 (16.7%)	11 (18.0%)
Very good	7 (10.8%)	5 (8.2%)	$20,001~$30,000	11 (16.7%)	11 (18.0%)
Good	33 (50.8%)	28 (45.9%)	$30,001~$40,000	7 (10.6%)	6 (9.8%)
Average	22 (33.8%)	21 (34.4%)	$40,001~$50,000	3 (4.5%)	3 (4.9%)
Poor	2 (3.1%)	2 (3.3%)	>$50,000	6 (9.1%)	5 (8.2%)
Very Poor	1 (1.5%)	0 (0.0%)	Not sure or refused	15 (22.7%)	12 (19.7%)
Missing	-	5 (8.2%)	Missing	1 (1.5%)	5 (8.2%)

4.3. Children's Physical Activity Patterns

4.3.1. Children's Preferred Places to Be Active

Children's preferred places to be involved in physical activity are shown in Table 9. Their preferred places to be active showed a similar distribution in both of the full and sub samples.

Table 9. Frequencies of Locations Used for Physical Activity among Children

Variables	Sample*	N	Never	Sometimes	Often	Always
How often are you typically active in …?						
Your home/apartment, street, front/back yard	F	96	1 (1.0%)	33 (34.4%)	31 (31.3%)	31 (31.3%)
	S	61	0 (0.0%)	19 (31.1%)	22 (36.1%)	20 (32.8%)
Your school PE class	F	96	1(1.0%)	37 (38.5%)	24 (25.0%)	34 (35.4%)
	S	61	1 (1.6%)	23 (37.7%)	15 (24.6%)	22 (36.1%)
Your church facility	F	96	31 (32.3%)	39 (40.6%)	17 (17.7%)	9 (9.4%)
	S	61	22 (36.1%)	25 (41.0%)	9 (14.8%)	5 (8.2%)
A park	F	96	2 (2.1%)	41 (42.7%)	26 (27.1%)	27 (28.1%)
	S	61	2 (3.3%)	25 (41.0%)	17 (27.9%)	17 (27.9%)
A health club	F	96	76 (79.2%)	11 (11.5%)	5 (5.2%)	4 (4.2%)
	S	61	47 (77.0%)	8 (13.1%)	3 (4.9%)	3 (4.9%)
A YMCA	F	96	79 (82.3%)	10 (10.4%)	4 (4.2%)	3 (3.1%)
	S	61	50 (82.0%)	7 (11.5%)	2 (3.3%)	2 (3.3%)
A playground or green space in an apartment complex	F	96	38 (39.6%)	24 (25.0%)	17 (17.7%)	17 (17.7%)
	S	61	20 (32.8%)	19 (31.1%)	12 (19.7%)	10 (16.4%)
Other places	F	45	13 (28.9%)	9 (20.0%)	12 (26.7%)	11 (24.4%)
	S	28	6 (21.4%)	4 (14.3%)	9 (32.1%)	9 (32.1%)

** F: Full sample / S: Sub sample*

Children were typically active near their home or apartment. More than 60 percent of children were often or always active in their home/apartment, street, and front/back yard, typically. During the school physical education (PE) class, they were always (35.4% of the full sample and 36.1% of the sub sample) or sometimes (38.5%

and 37.7%, respectively) active. However, parks and playgrounds, or green spaces in an apartment complex were relatively less preferred as compared to places near their home and their school PE class. The majority answered they were never active at a health club (79.2%, and 77.0% of each sample, respectively), or at a YMCA (82.3% and 82.0%, respectively).

Children in the sub sample reported that they were more frequently active in other places beyond those mentioned in the full sample. The open-ended question asking the subjects to name other places where they were physically active showed that friends or relatives' houses, sports facilities including basketball courts, soccer fields and swimming pools, or the after school program were also used for physical activity among children.

4.3.2. Children's Walking Patterns

Many children did not walk to or from school during a regular week (See Table 10). From both samples, more than 60 percent (65.2% and 60.7%, respectively) did not walk to or from school once per week. Frequencies of walking patterns to or from other places including a park, a friend's house, and a store or shop were higher than walking to or from their school, but still a majority of them did not walk to or from any of these places. Friends' houses appeared to be important walking destinations. About 15 percent of children from both of the samples walked to or from their friend's house 7 or more times per regular week. They did not take the school bus or a public bus during the week.

Table 10. Children's Walking Patterns

Variables	Sample *	N	No, 0 time	1-2 times	3-4 times	5-6 times	7 times or more
In the past 7 days, have you walked to/from … ?							
School	F	90	60 (65.2%)	7 (7.1%)	7 (7.1%)	7 (7.1%)	11 (12.0%)
	S	61	37 (60.7%)	4 (6.6%)	4 (6.6%)	6 (9.8%)	10 (16.4%)
A park	F	92	40 (43.5%)	34 (37.0%)	7 (7.6%)	5 (5.4%)	6 (6.5%)
	S	61	26 (42.6%)	24 (29.3%)	3 (4.9%)	5 (8.2%)	3 (4.9%)
A friend's house	F	92	37 (40.2%)	23 (25.0%)	13 (14.1%)	5 (5.4%)	14 (15.2%)
	S	61	28 (45.9%)	12 (19.7%)	7 (11.5%)	5 (8.2%)	9 (14.8%)
A store/shop	F	92	45 (48.9%)	25 (27.2%)	13 (14.1%)	4 (4.3%)	5 (5.4%)
	S	61	30 (49.2%)	18 (29.5%)	7 (11.5%)	2 (3.3%)	4 (6.6%)
In the past 7 days, have you taken the school bus to/from school?	F	92	69 (75.0%)	4 (4.3%)	1 (1.1%)	7 (7.6%)	11 (12.0%)
	S	61	47 (77.0%)	2 (3.3%)	1 (1.6%)	4 (6.6%)	7 (11.5%)
In the past 7 days, have you taken a public bus or light trail?	F	91	78 (85.7%)	9 (9.9%)	2 (2.2%)	1 (1.1%)	1 (1.1%)
	S	61	53 (86.9%)	6 (9.8%)	1 (1.6%)	0 (0.0%)	1 (1.6%)

** F: Full sample / S: Sub sample*

4.3.3. Children's Physical Activity during the PE Classes

As shown in Table 11, the majority of children were sometimes active (42.4%, and 44.3% of each sample, respectively) during their PE class during a regular week.

Table 11. Children's Physical Activity during PE classes

Variables	Sample *	N	Hardly ever	Sometimes	Quite often	Always
In the last 7days, during your PE classes, how often were you very active?	F	92	10 (10.9%)	39 (42.4%)	22 (23.9%)	21 (22.8%)
	S	61	7 (11.5%)	27 (44.3%)	12 (19.7%)	15 (24.6%)

** F: Full sample / S: Sub sample*

4.3.4. Children's Physical Activity Patterns at Recess and Lunch Time

As shown in Table 12, children answered that they ran and played hard most of the time during the recess time, whereas lunch time was sedentary (they sat down to talk, read, or do homework).

Table 12. Children's Physical Activity Patterns at Recess and Lunch Time

In the 7 days, what did you usually do most of the time at …	**Recess (N=89)**	**Recess (N=60)**
Sat down (talking, reading, doing school work)	1 (1.1%)	1 (1.7%)
Stood around or walked around	9 (10.1%)	6 (10.0%)
Ran or played a little bit	17 (19.0%)	13 (21.7%)
Ran around and played quite a bit	21 (23.6%)	12 (20.0%)
Ran and played hard most of the time	41 (46.1%)	28 (46.7%)
In the 7 days, what did you usually do most of the time at …	**Lunch (N=92)**	**Lunch (N=61)**
Sat down (talking, reading, doing school work)	85 (92.4%)	58 (95.1%)
Stood around or walked around	4 (4.3%)	2 (3.3%)
Ran or played a little bit	1 (1.1%)	0 (0.0%)
Ran around and played quite a bit	1 (1.1%)	1 (1.6%)
Ran and played hard most of the time	1 (1.1%)	0 (0.0%)

4.3.5. Children's Physical Activity after School

As described in Table 13, many children were involved in physical activities after school. After school, about 25 percent of those were engaged in playing sports, dancing or doing physical activities at least 2 or 3 days (27.2%, and 24.6% from each sample, respectively), or 5 days (25.0%, and 26.2%, respectively) per regular week.

Table 13. Children's Physical Activity after School

Variables	Sample *	N	None	1 day last week	2 or 3 days last week	4 days last week	5 days last week
In the last 7 days, on how many days after school (before dinner) did you play sports, dance, or do physical activities in which you were very active?	F	92	15 (16.3%)	13 (14.1%)	25 (27.2%)	16 (17.4%)	23 (25.0%)
	S	61	9 (14.8%)	10 (16.4%)	15 (24.6%)	11 (18.0%)	16 (26.2%)

** F: Full sample / S: Sub sample*

4.3.6. Children's Physical Activity on Weekend

About 30 percent of children were engaged in physical activities 2 or 3 times per weekend day. However, more than 30 percent of those surveyed did not participate in any physical activities during the weekend (See Table 14).

Table 14. Children's Physical Activity on Weekend

Variables	Sample *	N	None	1 time	2-3 times	4-5 times	6 or more times
How many times did you play sports, dance, or do physical activities in which you were very active?							
Last Saturday	F	92	14 (15.2%)	13 (14.1%)	35 (38.0%)	16 (17.4%)	14 (15.2%)
	S	61	10 (16.4%)	10 (16.4%)	18 (29.5%)	11 (18.0%)	12 (19.7%)
Last Sunday	F	92	11 (12.0%)	19 (20.7%)	32 (34.8%)	19 (20.7%)	11 (12.0%)
	S	61	9 (14.8%)	10 (16.4%)	21 (34.4%)	12 (19.7%)	9 (14.8%)

** F: Full sample / S: Sub sample*

4.3.7. Children's Sedentary Activity Patterns

As summarized in Table 15, children watched TV for a longer period of time during the weekend (29.3% of the full sample, and 31.1% of the sub sample watched TV 5 or more hours per weekend day) as compared to weekdays.

Table 15. Children's Sedentary Activity Patterns

	Sample *	N	Do not watch or do not play	Less than 1 hour	1 hour per day	2 hours per day	3 hours per day	4 hours per day	5 or more hours per day
How many hours do you watch TV …?									
At home on an average school day	F	92	3 (3.3%)	11 (12.0%)	16 (17.4%)	23 (25.0%)	20 (21.7%)	6 (6.5%)	13 (14.1%)
	S	61	0 (0.0%)	7 (11.5%)	12 (19.7%)	12 (19.7%)	15 (24.6%)	6 (9.8%)	9 (14.8%)
In your bedroom on an average school day	F	92	15 (16.3%)	16 (17.4%)	23 (25.0%)	18 (19.6%)	11 (12.0%)	4 (4.3%)	5 (5.4%)
	S	61	9 (14.8%)	10 (16.4%)	19 (31.1%)	10 (16.4%)	6 (9.8%)	4 (6.6%)	3 (4.9%)
During the weekend	F	92	6 (6.5%)	9 (9.8%)	8 (8.7%)	11 (12.0%)	15 (16.3%)	16 (17.4%)	27 (29.3%)
	S	61	4 (6.6%)	6 (9.8%)	5 (8.2%)	6 (9.8%)	8 (13.1%)	13 (21.3%)	19 (31.1%)
How many hours do you play video/computer games or use a computer for something that is not schoolwork?									
On an average school day	F	92	16 (17.4%)	15 (16.3%)	24 (26.1%)	21 (22.8%)	6 (6.5%)	3 (3.3%)	7 (7.6%)
	S	61	11 (18.0%)	10 (16.4%)	15 (24.6%)	15 (24.6%)	6 (9.8%)	1 (1.6%)	3 (4.9%)
On the weekend	F	92	18 (19.6%)	16 (17.4%)	12 (13.0%)	21 (22.8%)	8 (8.7%)	10 (10.9%)	7 (7.6%)
	S	61	13 (21.3%)	9 (14.8%)	6 (9.8%)	14 (23.0%)	7 (11.5%)	8 (13.1%)	4 (6.6%)

** F: Full sample / S: Sub sample*

4.4. BMI and BMI Percentile of Respondents

4.4.1. Children's BMI and BMI Percentile

The respondents' BMI and BMI percentile were summarized with both their mean values and standard deviations, as seen in Table 16. This research applied the standard rating system using children's BMI percentile to group them into three different categories: obese, overweight, and normal or underweight. As shown in Table 17, among child respondents from both samples, over 50 percent were categorized as obese

(30.2% of the full sample and 34.4% of the sub sample) or overweight (19.8% and 23.0%, respectively).

Table 16. Children's BMI and BMI Percentile

	BMI		BMI Percentile	
	Full Sample	**Sub Sample**	**Full Sample**	**Sub Sample**
N	96	61	96	61
Mean	21.48	21.71	72.17	73.84
Std. Deviation	5.23	5.20	29.88	30.23

Table 17. Children's Body Fatness Categorized by Three Categories Based on Their BMI Percentile

	Full Sample (N=96) Frequency (%)	**Sub Sample (N=61) Frequency (%)**
Obese	29 (30.2%)	21 (34.4%)
Overweight	19 (19.8%)	14 (23.0%)
Normal or underweight	48 (50.0%)	26 (42.6%)

4.4.2. Children's BMI and BMI Percentile by Gender

Table 18 describes the differences in children's BMI and BMI percentile by gender. As shown in the previous studies, boys had larger values in both indicators of weight conditions.

As shown in Table 19, More boys were categorized as obese (43.6% of boys and 21.1% of girls), or overweight (25.6% of boys and 15.8% of girls).

Table 18. Children's BMI and BMI Percentile by Gender

	BMI				BMI Percentile			
	Full Sample		**Sub Sample**		**Full Sample**		**Sub Sample**	
	Boy	Girl	Boy	Girl	Boy	Girl	Boy	Girl
N	39	57	24	37	39	57	24	37
Mean	23.35	20.20	23.03	20.86	82.16	65.34	82.92	86.60
Std. Deviation	5.76	4.44	5.56	4.83	23.91	31.78	25.68	32.10

Table 19. Children's Body Fatness Categorized by Three Categories Based on Their BMI Percentile by Gender

	Full Sample (N=96) Frequency (%)		Sub Sample (N=61) Frequency (%)	
	Boy (N=39)	Girl (N=57)	Boy(N=24)	Girl (N=37)
Obese	17 (43.6%)	12 (21.1%)	11 (45.8%)	10 (27.0%)
Overweight	10 (25.6%)	9 (15.8%)	7 (29.2%)	7 (18.9%)
Normal or underweight	12 (30.8%)	36 (63.1%)	6 (25.0%)	20 (54.1%)

In the full sample, children's gender played a significant role in their BMI and BMI percentile (See Table 20). From the sub sample, however, this gender difference was statistically significant only for the BMI percentile at the 0.1 level.

Table 20. Results of the ANOVA Analysis of Children's BMI and BMI Percentile by Gender (Full Sample)

		Sum of Squares	df	Mean Square	F	Sig.
BMI	Between Groups	229.581	1	229.581	9.119	.003***
	Within Groups	2366.657	94	25.177		
	Total	2596.238	95			
BMI Percentile	Between Groups	6553.482	1	6553.482	7.870	.006***
	Within Groups	78279.827	94	832.764		
	Total	84833.310	95			

**: p-value < .10 **: p-value < .05 ***: p-value < .01*

4.4.3. Children's BMI and BMI Percentile by Age

In both the full and sub samples, the results of children's BMI and BMI percentile presented in ways different from the researcher's original expectation. Considering that children's bodies would gradually grow larger as they got older, this research expected the same pattern of outputs by the children's ages. However, the results reported relatively lower values of BMI and BMI percentile in 10 year old children, in both the full and the sub samples, as represented in Table 21 and Table 22.

Table 21. Children's BMI and BMI Percentile by Age (Full Sample)

		All children (N=96)			Boy (N=39)			Girl (N=57)		
	Age	N	Mean	Std. Deviation	N	Mean	Std. Deviation	N	Mean	Std. Deviation
BMI	9	11	22.13	8.13	6	23.77	4.23	5	20.16	3.61
	10	49	20.62	12.34	20	23.04	6.10	29	18.95	4.18
	11	32	22.33	10.78	12	24.07	6.26	20	21.29	4.55
	12	4	23.40	12.04	1	18.40	-	3	25.07	3.85
BMI Percentile	9	11	81.69	26.53	6	87.27	25.69	5	75.00	28.85
	10	49	67.56	31.44	20	81.51	25.35	29	57.94	32.00
	11	32	74.88	29.14	12	83.35	21.34	20	69.81	32.39
	12	4	80.80	21.89	1	50.40	-	3	90.93	10.13

Table 22. Children's BMI and BMI Percentile by Age (Sub Sample)

		All children (N=61)			Boy (N=24)			Girl (N=37)		
	Age	N	Mean	Std. Deviation	N	Mean	Std. Deviation	N	Mean	Std. Deviation
BMI	9	10	21.80	4.28	5	23.42	4.64	5	20.16	3.61
	10	32	20.03	4.60	12	20.74	4.59	20	19.61	4.67
	11	18	24.28	5.67	7	26.69	6.29	11	22.75	4.94
	12	1	28.50	-	-	-	-	1	28.50	-
BMI Percentile	9	10	80.07	27.39	5	85.14	28.13	5	75.00	28.85
	10	32	65.86	31.22	12	73.47	29.94	20	61.30	31.82
	11	18	83.25	27.95	7	94.11	5.53	11	76.33	34.27
	12	1	97.80	-	-	-	-	1	97.80	-

In addition, the group of 12 years old boy's BMI percentile showed the lowest value in the full sample. However, since only one 12 year old boy was recruited, sample bias should be considered.

In the full sample, only girls' BMI values were significantly correlated with their age at the 0.1 level (p=.064), while only boys' BMI values were significantly correlated with their age at the 0.1 level (p=.073) from the sub sample (See Appendix 3).

Table 23 indicates the children's level of obese conditions after applying the standard rating system using the children's BMI percentile. As expected from the previous results, many of 10 year-old children (61.3% of the full sample and 59.3% of the sub sample) showed a normal or underweight status.

Table 23. Children's Body Fatness Categorized by Three Categories Based on Their BMI Percentile by Age

	Full Sample (N=96) Frequency (%)				Sub Sample (N=61) Frequency (%)			
	9	**10**	**11**	**12**	**9**	**10**	**11**	**12**
Obese	6 (54.5%)	11 (22.4%)	10 (31.3%)	2 (50.0%)	5 (50.0%)	7 (21.9%)	8 (44.4%)	1 (100.0%)
Overweight	2 (18.2%)	8 (16.3%)	9 (28.1%)	-	2 (20.0%)	6 (18.8%)	6 (33.3%)	-
Normal or underweight	3 (27.3%)	30 (61.3%)	13 (40.6%)	2 (50.0%)	3 (30.0%)	19 (59.3%)	4 (22.2%)	-

4.4.4. Mothers' BMI

Maternal respondents showed a greater number of obese conditions than the child respondents. The mothers had larger mean values of BMI, higher percentages of obesity (45.5% of the full sample, and 45.6% of the sub sample), and overweight conditions (33.2% and 29.8%, respectively) as compared to children (See Tables 24 and 25).

Table 24. Mothers' BMI

	BMI	
	Full Sample	**Sub Sample**
N	66	57
Mean	30.61	30.41
Std. Deviation	7.01	7.24

Table 25. Mothers' Body Fatness Categorized by Three Categories Based on Their BMI

	Full Sample (N=66) Frequency (%)	Sub Sample (N=57) Frequency (%)
Obese	30 (45.5%)	26 (45.6%)
Overweight	22 (33.3%)	17 (29.8%)
Normal or underweight	14 (21.2%)	14 (24.6%)

4.4.5. Correlation between Children's and Mothers' BMI

Children's BMI values were significantly affected by their mothers' conditions. In both of the full and the sub sample, mothers' BMI values played a significant role in their children's BMI values at the 0.01 level (See Table 26).

Table 26. Correlation between Children's and Their Mothers' BMI (Full and Sub Sample)

		Unstandardized Coefficients		Standardized Coefficients		
Independent Variables	R^2	**B**	**Std. Error**	**Beta**	**t**	**Sig.**
Mother's BMI (Full sample; N=66)	.459	.341	.083	.459	4.133	.000***
Mothers' BMI (Sub sample; N=57)	.422	.301	.087	.422	3.423	.001***

***Dependent Variable**: Children's BMI*
**: p-value < .10   **: p-value < .05   ***: p-value < .01*

4.5. HRQOL from the PedsQL Surveys

4.5.1. The PedsQL Scores Reported by Children and Mothers

The measured children's HRQOL by PedsQL surveys were summarized with mean values and standard deviations, as seen in Table 27. Since the total PedsQL score was composed of two main health summary scores, such as the physical and the psychosocial health summary scores, this research tested those sub-scores separately. Three of the PedsQL scores including mean, total, and the physical health summary scores showed higher values from the survey measured by children than the one assessed by their mothers. Mothers reported higher scores for the psychosocial health summary score than children did.

Table 27. Children's HRQOL Assessed by the PedsQL Surveys

		Mean PedsQL Score	Total PedsQL Score	Physical Health Summary Score	Psychosocial Health Summary Score
Child self-report report (Full sample; N=95)	Mean	76.82	1766.84	640.26	1126.58
	Std. Deviation	14.07	323.57	124.27	224.85
Mother proxy report (Full sample; N=66)	Mean	74.74	1718.94	587.50	1131.44
	Std. Deviation	16.47	378.89	185.03	239.92
Child self-report report (Sub sample; N=61)	Mean	75.87	1745.08	635.66	1109.43
	Std. Deviation	15.09	347.01	132.32	240.41
Mother proxy report (Sub sample; N=57)	Mean	74.26	1707.89	592.98	1114.91
	Std. Deviation	16.94	389.72	182.60	246.35

Total of mean PedsQL score = 100, Total of the total PedsQL score = 2300, Total of the physical health summary score = 800, Total of the psychosocial health summary score = 1500

4.5.2. The PedsQL Scores by Gender

There were differences in the PedsQL scores between the child self-report scores and the mother proxy report scores. In both the full and the sub samples, boys reported higher mean and total PedsQL scores than girls, except for the physical health summary score, in the full sample. However, girls had higher mean and total PedsQL scores in the mother proxy reports.

Table 28. The PedsQL Scores by Children's Gender

		Mean PedsQL Score		Total PedsQL Score		Physical Health Summary Score		Psychosocial Health Summary Score	
		Boy	Girl	Boy	Girl	Boy	Girl	Boy	Girl
Child self-report report (Full sample; N=95)	N	38	57	38	57	38	57	38	57
	Mean	80.26	74.52	1846.05	1714.04	606.53	626.75	1185.53	1087.28
	Std. Deviation	14.47	13.43	332.86	308.95	128.75	120.44	224.18	218.46
Mother proxy report (Full sample; N=66)	N	23	43	23	43	23	43	23	43
	Mean	70.09	77.22	1611.96	1776.16	510.87	628.49	1101.09	1147.67
	Std. Deviation	15.65	16.54	359.84	380.44	179.46	176.57	232.51	244.94
Child self-report report (Sub sample; N=61)	N	24	37	24	37	24	37	24	37
	Mean	78.80	73.97	1812.50	1701.35	642.71	631.08	1169.79	1070.27
	Std. Deviation	14.45	15.38	332.32	353.75	123.68	139.12	232.19	240.57
Mother proxy report (Sub sample; N=57)	N	20	37	20	37	20	37	20	37
	Mean	70.92	76.06	1095.00	1749.32	536.25	623.65	1095.00	1125.68
	Std. Deviation	16.45	17.16	248.76	394.60	174.24	181.90	248.76	247.80

Total of mean PedsQL score = 100, Total of the total PedsQL score = 2300, Total of the physical health summary score = 800, Total of the psychosocial health summary score = 1500

In addition, there were differences between the full and the sub samples in terms of the physical and the psychosocial health summary scores. In the PedsQL result of the child self-report scores from the full sample, girls reported higher values on the physical health summary score, while boys showed higher on the psychosocial health summary score. In the case of the mother proxy report results from the full sample, girls showed higher values on both the physical and the psychosocial health scores. However, these results were different in the sub sample. From the result reported by children in the sub sample, boys described higher values on all domains of the PedsQL scores, while girls showed larger values on all domains of the PedsQL scores from the mother proxy report (See Table 28).

With the full sample, children's gender played a significant role in the children's self-reporting total PedsQL scores at the 0.1 level (p=.051), while it was significantly different for children's psychosocial health summary score reported by children at the 0.05 level (p=.036). In terms of the PedsQL score reported by mothers from the full sample, the total PedsQL score (p=.094) and the physical health summary score (p=.013) were significantly associated with the children's gender. However, from the sub sample, only the physical health summary score (p=.085) reported by mothers was significantly correlated with gender (See Appendix 4).

4.5.3. The PedsQL Scores by Age

The PedsQL scores by age were summarized in Table 29. In both the full and sub samples, younger children showed higher self-report PedsQL scores. However, the mother proxy PedsQL scores showed the highest scores in the 10-year-old children group, in both the full and the sub samples.

From the full sample, the children's ages were significantly related to their total PedsQL scores and psychosocial health summary scores reported by the children (p=.080 and .087, respectively). From the sub sample, the children's ages were significant on the mother proxy physical health summary scores only (p=.084) (See Appendix 5).

Table 29. The PedsQL Scores by Children's Age

		Full Sample			Sub Sample		
	Age	N	Mean	Std. Deviation	N	Mean	Std. Deviation
Child self-report score							
Mean PedsQL score	9	11	82.12	12.03	10	80.33	11.03
	10	48	75.59	14.46	32	76.46	16.31
	11	32	76.60	14.45	18	73.01	14.98
	12	4	78.80	12.44	1	64.13	-
Total PedsQL socre	9	11	1888.64	276.67	10	1847.50	253.71
	10	48	1738.54	332.54	32	1758.59	375.22
	11	32	1761.72	332.27	18	1679.17	344.63
	12	4	1812.50	286.14	1	1475.00	-
Physical health summary score	9	11	681.82	95.58	10	670.00	91.90
	10	48	620.31	136.51	32	634.38	147.25
	11	32	649.22	116.65	18	618.06	129.42
	12	4	693.75	59.07	1	650.00	-
Psychosocial health summary score	9	11	1206.82	214.21	10	1177.50	201.19
	10	48	1118.23	219.09	32	1124.22	247.85
	11	32	1112.50	240.30	18	1061.11	245.28
	12	4	1118.75	235.74	1	825.00	-
Mother proxy score							
Mean PedsQL score	9	8	66.17	14.165	8	66.17	14.165
	10	38	77.80	17.18	32	77.82	17.628
	11	19	73.74	13.96	16	72.96	14.754
	12	1	45.65	-	1	45.65	-
Total PedsQL socre	9	8	1521.88	325.81	8	1521.88	325.81
	10	38	1789.47	395.10	32	1789.84	405.45
	11	19	1696.05	321.05	16	1678.13	339.35
	12	1	1050.00	-	1	1050.00	-
Physical health summary score	9	8	559.38	181.73	8	559.38	181.73
	10	38	612.50	188.14	32	623.47	177.34
	11	19	571.05	163.14	16	575.00	171.76
	12	1	175.00	-	1	175.00	.
Psychosocial health summary score	9	8	962.50	172.17	8	962.50	172.17
	10	38	1176.97	252.18	32	1166.41	268.63
	11	19	1125.00	211.80	16	1103.13	203.89
	12	1	875.00	-	1	875.00	-

Total of mean PedsQL score = 100, Total of total PedsQL score = 2300, Total of physical health summary score = 800, Total of psychosocial health summary score = 1500

4.6. Correlations between BMI, HRQOL, and Physical Activity Patterns

4.6.1. Bivariate Analyses: Correlations between Children's BMI and HRQOL

According to unadjusted bivatiate analysis results using simple regression analyses, there was no significant relationship between children's BMI values and the PedsQL scores reported by children themselves, from both the full and sub samples (See Table 30). On the other hand, there were statistically significant correlations between the children's BMI and the mothers' proxy PedsQL scores in both samples (See Table 31). These significant patterns were shown in the total PedsQL scores as well as in the sub summary scores, including the physical health summary scores and the psychosocial health summary scores.

Table 30. Correlations between Children's BMI and the Child Self-report PedsQL Scores

Independent Variables in Simple Reg. Models	R^2	Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
Full Sample (N=95)						
Total Score	.000	.000	.002	-.014	-.135	.893
Physical Health Summary Score	.000	.000	.004	.002	.023	.982
Psychosocial Health Summary Score	.000	.000	.002	-.021	-.207	.836
Sub Sample (N=61)						
Total Score	.002	-.001	.002	-.044	-.337	.737
Physical Health Summary Score	.001	-.001	.005	-.031	-.240	.811
Psychosocial Health Summary Score	.002	-.001	.003	-.046	-.355	.724

***Dependent Variable**: Children's BMI*
**: p-value < .10 **: p-value < .05 ***: p-value < .01*

Table 31. Correlations between Children's BMI and the Mother Proxy PedsQL Scores

Independent Variables in Simple Reg. Models	R^2	Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
Full Sample (N=66)						
Total Score	.063	-.004	.002	-.279	-2.234	**.023****
Physical Health Summary Score	.075	-.008	.003	-.273	-2.273	**.026****
Psychosocial Health Summary Score	.053	-.005	.003	-.230	-1.889	**.063***
Sub Sample (N=57)						
Total Score	.063	-.003	.002	-.251	-1.926	**.059***
Physical Health Summary Score	.051	-.006	.004	-.227	-.1728	**.090***
Psychosocial Health Summary Score	.053	-.005	.003	-.230	-1.749	**.086***

Dependent Variabl*e: Children's BMI*
**: p-value < .10 **: p-value < .05 ***: p-value < .01*

4.6.2. Bivariate Analyses: Correlations between Children's BMI, and Physical Activity and Socio-Demographic Conditions

Table 32 describes unadjusted bivatiate analysis results applying simple regression analyses in order to assess correlations between children's BMI and their physical activity patterns. Not many variables in children's physical activity patterns showed significance when predicting their BMI. From both samples, children's ages were positively significant in their BMI. In addition, there were negatively significant relationships between the mothers' education levels and the children's BMI in both samples. This means that the higher the level of education their mothers achieved, the lower the BMI values the children reported. Interestingly, from the full sample, children who reported that they walked to school more frequently showed a significantly positive

Table 32. Correlations between Children's BMI, and Physical Activity and Socio-Demographic Conditions

Independent Variables	Full Sample (N=96)			Sub Sample (N=61)		
	B	β	Sig.	B	β	Sig.
Utilitarian Walking†						
Walking to school‡	2.066	.195	**.062***	1.428	.135	.299
Walking to a park‡	.394	.039	.714	.432	.041	.751
Walking to a friend's house‡	.870	.085	.423	1.536	.148	.254
Walking to a store / shop‡	.435	.043	.684	.492	.048	.715
Taking school bus‡	-.949	-.081	.440	-1.055	-.086	.510
Taking public bus‡	1.969	.136	.196	1.855	.121	.351
Physical Activity related to School†						
PE class activity	-.057	-.011	.919	.252	.048	.713
After school activity	.384	.105	.317	.611	.164	.206
Weekend Physical Activity						
Saturday	.058	.014	.892	.464	.120	.357
Sunday	.262	.061	.565	1.119	.269	**.036****
Sedentary Activity Patterns†						
Watching TV hours on weekdays	.100	.032	.760	.263	.079	.545
Watching TV hours in your bedroom on weekdays	.132	.043	.684	.465	.145	.264
Watching TV hours on weekend days	-.152	-.058	.583	.103	.039	.764
Playing hours of video/computer games or using computer on weekdays	-.334	-.111	.294	-.651	-.197	.129
Playing hours of video/computer games or using computer on weekend days	-.083	-.031	.771	-.407	-.150	.248
Socio-Demographic Conditions						
Age	3.149	.297	**.003*****	1.946	.266	**.038****
Gender‡	.707	.098	.341	2.117	.206	.111
Mother's marital status‡	-1.160	-.094	.440	-.715	-.449	.655
Mother's education	-1.445	-.240	**.050***	-1.437	-.243	**.060***
Mother's employment status‡	.723	.573	.569	.688	.066	.612
Car ownership	-1.152	-.171	.158	-1.028	-.159	.222
Dog ownership	.337	.032	.790	1.233	.119	.362
Sibling‡	1.961	.163	.112	1.884	.150	.250

***Dependent Variable**: Children's BMI*

† In the past 7 days / ‡ Dummy Variables

**: p-value < .10 **: p-value < .05 ***: p-value < .01*

association with their BMI. In addition, from the sub sample there was a positively significant relationship between the children's BMI and physical activity hours on Sunday.

4.6.3. Bivariate Analyses: Correlations between Children's HRQOL, and Physical Activity and Socio-Demographic Conditions

4.6.3.1. Results from the Full Sample

In the full sample, there was no significant correlation between the child-reported PedsQL scores and their utilitarian walking patterns (See Table 33). However, their physical activity during PE class and in after school programs increased their PedsQL scores significantly. In addition, the children's weekend physical activities played a significant role in improving their HRQOL. However, their sedentary lifestyle affected the PedsQL scores negatively. Specifically, more TV watching hours decreased their psychosocial health summary scores significantly.

Table 33. Correlations between the Child Self-report PedsQL Scores, and Physical Activity and Socio-demographic Conditions

Independent Variables	Total Score			Physical Health Summary Score			Psychosocial Health Summary Score		
	B	β	Sig.	B	β	Sig.	B	β	Sig.
Utilitarian Walking†									
Walking to school‡	111.042	.164	.118	37.083	.144	.172	73.958	.157	.136
Walking to a park‡	6.779	.010	.921	24.663	.099	.346	-17.885	-.039	.709
Walking to a friend's house‡	52.211	.079	.452	30.467	.121	.249	21.744	.047	.654
Walking to a store / shop‡	92.459	.143	.173	27.423	.111	.290	65.035	.145	.169
Taking school bus‡	-32.609	-.044	.679	- 18.841	-.066	.530	-13.764	-.027	.802
Taking public bus‡	2.872	.003	.977	-2.629	-.007	.944	5.501	.009	.936
Physical Activity related to School†									
PE class activity	3.935	.269	**.010*** **	24.832	.193	**.065***	65.665	.279	**.007*** **
After school activity	1.899	.188	**.073***	9.054	.102	.333	34.630	.214	**.041** **
Weekend Physical Activity									
Saturday	3.603	.318	**.002*** **	30.633	.308	**.003*** **	52.237	.287	**.005*** **
Sunday	2.657	.222	**.034** **	28.175	.268	**.010*** **	32.937	.171	**.102**
Sedentary Activity Patterns†									
Watching TV hours on weekdays	-2.012	-.233	**.026** **	-10.629	-.140	.183	-35.647	-.257	**.013** **
Watching TV hours in your bedroom on weekdays	-1.253	-.146	.164	-.542	-.007	.946	-28.288	-.206	**.049** **
Watching TV hours on weekend days	-2.052	-.283	**.006*** **	-11.851	-.186	**.076***	-35.350	-.304	**.003** **
Playing hours of video/computer games or using computer on weekdays	-.627	-.075	.478	-3.596	-.049	.644	-10.836	-.081	.445
Playing hours of video/computer games or using computer on weekend days	-.774	-.103	.326	-3.457	-.053	.618	-14.355	-.120	.256
Socio-Demographic Conditions									
Age	132.018	.201	**.051***	33.772	.134	.196	98.246	.215	**.036** **
Gender‡	-22.702	-.051	.622	5.132	.030	.772	-27.834	-.090	.384
Mother's marital status‡	128.040	.156	.229	18.465	.059	.651	109.574	.193	.136
Mother's education	-25.117	-.064	.626	-.5115	-.034	.795	-20.062	-.073	.575
Mother's employment status‡	-35.403	-.051	.696	-19.090	-.072	.580	-16.313	-.261	.795
Car ownership	-5.464	-.013	.918	7.920	.048	.695	-13.383	-.045	.714
Dog ownership	-62.623	-.093	.443	-23.520	-.092	.451	-39.104	-.084	.488
Sibling‡	-93.148	-.126	.225	-7.453	-.026	.801	-85.695	-.166	.107

***Dependent Variable**: Child Self-report PedsQL Scores*

† In the past 7 days / ‡ Dummy Variables

**: p-value < .10 **: p-value < .05 ***: p-value < .01*

Table 34. Correlations between the Mother Proxy PedsQL Scores, and Physical Activity and Socio-demographic Conditions

	Total Score			Physical Health Summary Score			Psychosocial Health Summary Score		
	B	**β**	**Sig.**	**B**	**β**	**Sig.**	**B**	**β**	**Sig.**
Utilitarian Walking†									
Walking to school‡	140.476	.180	.149	57.292	.150	.229	83.185	.168	.177
Walking to a park‡	139.135	.181	.146	52.356	.139	.265	86.779	.178	.153
Walking to a friend's house‡	85.015	.111	.380	57.066	.154	.222	27.948	.057	.650
Walking to a store / shop‡	160.057	.211	**.091***	66.983	.183	.145	93.074	.194	.122
Taking school bus‡	99.333	.111	.380	74.833	.172	.170	24.500	.043	.734
Taking public bus‡	-2.273	-.002	.986	-30.455	-.060	.635	28.182	.042	.737
Physical Activity related to School†									
PE class activity	25.591	.074	.560	12.969	.067	.598	16.622	.065	.606
After school activity	-.700	-.003	.984	4.657	.035	.780	-5.357	-.031	.806
Weekend Physical Activity									
Saturday	-15.603	-.052	.683	-10.939	-.075	.554	-4.664	-.024	.847
Sunday	6.631	.021	.868	6.631	.021	.868	-.070	.000	.998
Sedentary Activity Patterns†									
Watching TV hours on weekdays	-35.146	-.151	.230	-4.585	-.041	.748	-30.561	-.207	**.098***
Watching TV hours in your bedroom on weekdays	-42.355	-.174	.165	-19.751	-.168	.182	-22.604	-.146	.244
Watching TV hours on weekend days	-13.812	-.070	.579	3.604	.038	.765	-17.416	-.139	.268
Playing hours of video/computer games or using computer on weekdays	11.317	.047	.708	14.120	.122	.333	-2.803	-.018	.884
Playing hours of video/computer games or using computer on weekend days	19.757	.098	.438	13.579	.139	.270	6.178	.048	.703
Socio-Demographic Conditions									
Age	-6.899	-.012	.924	-32.086	-.115	.359	25.186	.069	.580
Gender‡	-164.206	-.208	**.094***	-117.619	-.305	**.013****	-46.587	-.093	.457
Mother's marital status‡	99.250	.113	.366	37.125	.087	.489	62.125	.112	.371
Mother's education	21.042	.050	.699	2.477	.012	.925	18.565	.070	.584
Mother's employment status‡	50.414	.067	.593	57.629	.157	.208	-7.215	-.015	.904
Car ownership	35.503	.067	.594	17.392	.073	.559	15.111	.049	.695
Dog ownership	42.831	.057	.650	51.562	.140	.261	-8.732	-.018	.884
Sibling‡	-73.529	-.086	.495	-30.702	-.073	.560	-42.827	-.079	.530

***Dependent Variable**: Mother Proxy PedsQL Scores*
† In the past 7 days / ‡ Dummy Variables
**: p-value < .10 **: p-value < .05 ***: p-value < .01*

Compared to the PedsQL survey assessed by the children, there were fewer physical activity and socio-demographic variables that showed significant relationships with the PedsQL scores reported by maternal respondents. As described in Table 34, children's walking to stores or shops significantly correlated to the mother proxy total PedsQL score. In addition, increased TV viewing hours were negatively related to the mother proxy psychosocial health summary scores, which was statistically significant at the 0.1 level.

4.6.3.2. Results from the Sub Sample

From the bivariate results with the sub sample, more variables of children's utilitarian walking appeared to be marginally significant on the total PedsQL scores, as reported by the children. As shown in Table 35, walking to school or to a store or shop positively improved children's HRQOL. In addition, their PE class activities and weekend activities increased their PedsQL scores significantly. Similar to the full sample, longer TV viewing hours during the weekend significantly decreased children's HRQOL.

According to the results, in terms of the relationships between children's physical activity patterns, socio-demographic conditions, and the mother proxy PedsQL scores of the sub sample, walking to a store or shop regularly showed a significant relationship to the PedsQL scores. However, no variable from the physical activity related to school, weekend physical activity, and sedentary activity patterns of children appeared significant on the mother proxy PedsQL scores (See Table 36).

Table 35. Correlations between the Child Self-report PedsQL Scores, and Physical Activity and Socio-demographic Conditions

	Total Score			Physical Health Summary Score			Psychosocial Health Summary Score		
	B	β	Sig.	B	β	Sig.	B	β	Sig.
Utilitarian Walking†									
Walking to school‡	152.365	.216	**.094***	51.126	.190	.142	101.239	.207	.109
Walking to a park‡	65.165	.094	.473	53.764	.203	.117	11.401	.024	.856
Walking to a friend's house‡	68.479	.099	.447	32.900	.125	.337	35.579	.074	.569
Walking to a store / shop‡	149.382	.217	**.093***	58.683	.224	**.083***	90.699	.190	.142
Taking school bus‡	-33.017	-.040	.758	-6.877	-.022	.866	-26.140	-.046	.724
Taking public bus‡	-26.710	-.026	.841	-41.038	-.106	.418	14.328	.020	.877
Physical Activity related to School†									
PE class activity	78.875	.225	**.081***	21.251	.159	.221	57.624	.238	**.065***
After school activity	36.644	.148	.256	6.096	.064	.622	30.548	.178	.171
Weekend Physical Activity									
Saturday	108.892	.422	**.001*****	37.957	.386	**.002*****	70.935	.397	**.002*****
Sunday	71.697	.259	**.044****	32.775	.310	**.015****	38.922	.203	.117
Sedentary Activity Patterns†									
Watching TV hours on weekdays	-23.529	-.106	.415	-.668	-.008	.952	-22.861	-.149	.252
Watching TV hours in your bedroom on weekdays	-.387	-.002	.989	8.244	.101	.437	-8.631	-.058	.655
Watching TV hours on weekend days	-46.656	-.265	**.039****	-10.454	-.156	.231	-36.202	-.297	**.020****
Playing hours of video/computer games or using computer on weekdays	-23.091	-.105	.422	-9.986	-.119	.362	-13.105	-.086	.511
Playing hours of video/computer games or using computer on weekend days	-11.588	-.064	.624	-1.477	-.021	.870	-10.111	-.081	.536
Socio-Demographic Conditions									
Age	-90.605	-.186	.152	-20.802	-.112	.391	-69.803	-.207	.110
Gender‡	111.149	.158	.225	11.627	.043	.740	99.521	.204	.115
Mother's marital status‡	128.040	.156	.229	18.465	.059	.651	109.574	.193	.136
Mother's education	-25.177	-.064	.626	-5.115	-.034	.795	-20.062	-.073	.575
Mother's employment status‡	-35.403	-.051	.696	-19.090	-.072	.580	-16.313	-.034	.795
Car ownership	-3.581	-.008	.949	7.542	.046	.726	-11.123	-.037	.776
Dog ownership	-61.983	-.089	.493	-22.413	-.085	.516	-39.570	-.082	.528
Sibling‡	-152.885	-.182	.161	-13.341	-.042	.750	-139.543	-.240	**.063***

***Dependent Variable**: Child Self-report PedsQL Scores*

† In the past 7 days / ‡ Dummy Variables

**: p-value < .10 **: p-value < .05 ***: p-value < .01*

Table 36. Correlations between the Mother Proxy PedsQL Scores, and Physical Activity and Socio-demographic Conditions

	Total Score			Physical Health Summary Score			Psychosocial Health Summary Score		
	B	β	Sig.	B	β	Sig.	B	β	Sig.
Utilitarian Walking†									
Walking to school‡	162.955	.205	.125	61.396	.165	.220	101.558	.202	.131
Walking to a park‡	157.193	.200	.137	61.125	.166	.218	96.068	.193	.150
Walking to a friend's house‡	97.781	.126	.352	62.313	.171	.204	35.469	.072	.594
Walking to a store / shop‡	194.520	.252	**.059***	66.933	.185	.169	127.586	.261	**.050***
Taking school bus‡	98.422	.110	.417	59.012	.140	.298	39.410	.069	.608
Taking public bus‡	-20.089	-.018	.894	-50.00	-.096	.478	29.911	.043	.753
Physical Activity related to School†									
PE class activity	28.296	.070	.605	20.170	.106	.431	8.125	.032	.814
After school activity	.131	.000	.997	-1.599	-.012	.928	1.730	.010	.942
Weekend Physical Activity									
Saturday	-17.082	-.058	.666	-14.672	-.107	.428	-2.410	-.013	.923
Sunday	-1.035	-.003	.980	-3.450	-.024	.860	2.415	.012	.927
Sedentary Activity Patterns†									
Watching TV hours on weekdays	-33.343	-.135	.316	-8.982	-.078	.565	-24.360	-.156	.246
Watching TV hours in your bedroom on weekdays	-41.432	-.169	.210	-21.634	-.188	.162	-19.798	-.127	.345
Watching TV hours on weekend days	-17.730	-.090	.504	.408	.004	.974	-18.138	-.146	.278
Playing hours of video/computer games or using computer on weekdays	20.393	.080	.552	18.913	.159	.237	1.480	.009	.946
Playing hours of video/computer games or using computer on weekend days	25.431	.125	.935	15.621	.164	.223	9.809	.076	.573
Socio-Demographic Conditions									
Age	-11.581	-.020	.881	-32.570	-.122	.366	20.989	.058	.666
Gender‡	-118.074	-.146	.279	-87.399	-.230	**.085***	-30.676	-.060	.658
Mother's marital status‡	121.719	.136	.314	56.977	.136	.315	64.743	.114	.398
Mother's education	-8.632	-.020	.882	-18.274	-.091	.502	9.642	.035	.793
Mother's employment status‡	37.870	.049	.718	34.167	.094	.486	3.704	.008	.955
Car ownership	42.682	.088	.513	13.724	.061	.654	28.959	.095	.482
Dog ownership	6.204	.008	.953	9.537	.026	.846	-3.333	-.007	.960
Sibling‡	-26.944	-.028	.834	-43.194	-.097	.472	16.250	.027	.841

***Dependent Variable**: Mother Proxy PedsQL Scores*
† In the past 7 days / ‡ Dummy Variables
**: p-value < .10 **: p-value < .05 ***: p-value < .01*

4.7. Bivariate Analyses between Children's BMI, HRQOL and Landscape Spatial Patterns of Urban Forests

4.7.1. Characteristics of Landscape Spatial Patterns of Urban Forests

The landscape spatial patterns of urban forests and trees measured by landscape indices are summarized with mean values and standard deviations in Table 37. Since FMI requires regular geometric settings (e.g., a square or circle) to calculate values, it could not be applied for the network buffers, due to their variance in shapes.

Table 37. Characteristics of Landscape Spatial Patterns in Different Buffers (N=61)

Landscape Indices*	Half-mile Airline		Quarter-mile Airline		Half-mile Network		Quarter-mile Network	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
FMI	168.01	2.53	168.06	3.41	-	-	-	-
TA (m^2)	535502.79	139162.05	146484.61	54136.19	259699.01	106472.17	70014.54	46993.46
PLAND (%)	26.33	6.84	28.81	10.65	27.15	7.74	29.84	13.04
NP	3368.72	715.54	951.00	250.13	1828.23	666.86	515.89	261.24
PD	1656.07	351.76	1870.06	491.85886	1910.20	407.50	2247.45	606.12
TE (m)	165743.34	30162.57	45701.02	11711.53	86535.79	29107.37	23588.34	12485.34
LSI	57.564	7.1856	30.67	4.90	42.88	7.92	22.85	5.21
MPS (m^2)	167.34	58.48	164.23	75.78	148.54	54.80	141.07	79.74
MSI	1.25	.02	1.25	.03	1.25	.02	1.25	.04
MNN (m)	2.96	.39	2.92	.61	2.86	.43	2.81	.59
COHESION	98.20	.83	97.92	1.04	97.96	.88	96.94	2.36

* More detailed information for each landscape index in Table 6

From the results of the landscape indices calculated by FRAGSTATS, over 25 percent of the areas in each spatial setting (half-mile airline buffer, quarter-mile airline buffer, half-mile network buffer, and quarter-mile network buffer) were covered by trees (26.33%, 28.81%, 27.15%, and 29.84%, respectively). Half-mile airline buffers had the highest number of urban forest/tree patches (NP), the largest size of total area (TA), and the longest length of patch boundaries (TE) among all the settings. Both the half and quarter-mile airline buffers presented similar fragmented conditions (FMI).

In both the airline and network buffers, the half-mile buffers had a lower percentage of coverage area with urban forests and trees (PLAND) and lower values of patch density (PD). In addition, both half-mile airline and network buffers showed more disaggregated landscape spatial patterns (a greater LSI value), and a larger mean patch size (MPS), a slightly longer distance between each patch causing more isolated conditions (a greater MNN value), and more connected landscape patterns than quarter-mile buffers (COHESION). Across all of the different spatial settings, MSI values presented almost the same value as 1.25.

4.7.2. Bivatiate Analyses between Children's BMI and Landscape Spatial Patterns

Tables 38 and 39 summarize the unadjusted bivatiate analysis results, applying simple regression analyses to assess the correlations between children's BMI and landscape spatial patterns of urban forests within different settings. Since a pair of TA and PLAND and a pair of NP and PD should be considered as the same variables (correlation coefficients, r = 1.000 at the .01 level for both pairs, respectively; See Appendix 6) in the airline buffer due to the same sizes of quarter and a half-mile radius buffers, TA and PD were removed from the bivariate analyses using airline buffer measures.

From the results using a half-mile airline buffer, PLAND presented a negatively significant relationship with children's BMI at the .1 level, and TE showed a negative relationship with children's BMI at the .05 level. However, within the quarter-mile airline buffer, no landscape index showed a significant correlation with children's BMI.

Table 38. Correlations between Children's BMI and Landscape Spatial Patterns within Airline Buffers

Independent Variables[§]	Trees in Half-mile Airline Buffer			Trees in Quarter-mile Airline Buffer		
	B	β	Sig.	B	β	Sig.
FMI	-.229	-.112	.391	-.199	-.130	.317
PLAND	-.181	-.238	**.064***	-.078	-.160	.219
NP	-.001	-.071	.585	-.001	-.033	.800
TE	-.00004	-.262	**.041****	-.00001	-.162	.213
LSI	-.088	-.122	.350	-.078	-.073	.574
MPS	-.010	-.113	.388	-.007	-.101	.436
MSI	-18.404	-.079	.545	-4.856	-.024	.855
MNN	2.020	.152	.242	.789	.718	.476
COHESION	-1.141	-.181	.162	-.366	-.073	.576

***Dependent Variable**: Children's BMI / *: p-value < .10 **: p-value < .05 ***: p-value < .01*
[§] More detailed information about each landscape index in Table 6

Table 39. Correlations between Children's BMI and Landscape Spatial Patterns within Network Buffers

Independent Variables[§]	Trees in Half-mile Network Buffer			Trees in Quarter-mile Network Buffer		
	B	β	Sig.	B	β	Sig.
TA	-.00001	-.235	**.069***	-.00001	-.114	.380
PLAND	-.154	-.228	**.077***	-.045	-.112	.390
NP	.000	-.029	.824	.000	-.009	.946
PD	.000	-.012	.928	.000	-.018	.893
TE	-.00003	-.184	.156	-.00004	-.098	.451
LSI	-.061	-.093	.476	-.053	-.053	.685
MPS	-.015	-.157	.226	-.002	-.032	.808
MSI	-12.533	-.059	.654	-1.635	-.012	.929
MNN	1.844	.154	.237	1.563	.178	.169
COHESION	-.905	-.153	.239	-.014	-.006	.961

***Dependent Variable**: Children's BMI / *: p-value < .10 **: p-value < .05 ***: p-value < .01*
[§] More detailed information about each landscape index in Table 6

When a half-mile network buffer was used in simple regression analyses, TA and PLAD showed negatively significant associations with children's BMI. However, no landscape indices presented significant correlations with children's BMI in the quarter-mile network buffer (See Table 39).

4.7.3. Bivatiate Analyses between Children's HRQOL and Landscape Spatial Patterns

From the unadjusted bivatiate analysis results applying simple regression analyses, in terms of assessing correlations between the child self-report PedsQL scores and landscape spatial patterns within different settings, no indices showed any statistically significant relationships with the PedsQL scores (See Tables 40 and 41).

Table 40. Correlations between the Child Self-report Total PedsQL Scores and Landscape Spatial Patterns within Airline Buffers

Independent Variables§	Trees in Half-mile Airline Buffer			Trees in Quarter-mile Airline Buffer		
	B	β	Sig.	B	β	Sig.
FMI	4.817	.035	.788	1.173	.012	.930
PLAND	1.622	.032	.807	-.308	-.009	.942
NP	.051	.106	.417	.100	.072	.581
TE	.001	.052	.692	-.001	-.037	.780
LSI	2.103	.044	.739	-.253	-.004	.978
MPS	-.086	-.015	.911	.075	.016	.900
MSI	57.998	.004	.977	51.403	.004	.977
MNN	-60.754	-.069	.599	5.659	.010	.939
COHESION	-41.427	-.099	.450	-47.401	-.142	.275

***Dependent Variable**: Child Self-report Total PedsQL Score*
**: p-value < .10 **: p-value < .05 ***: p-value < .01*
§ More detailed information about each landscape index in Table 6

Table 41. Correlations between the Child Self-report Total PedsQL Scores and Landscape Spatial Patterns within Network Buffers

Independent Variables[§]	Trees in Half-mile Network Buffer			Trees in Quarter-mile Network Buffer		
	B	β	Sig.	B	β	Sig.
TA	.000	-.080	.540	.000	.026	.842
PLAND	.019	.000	.997	.971	.036	.780
NP	.014	.027	.834	.098	.074	.573
PD	.138	.162	.212	.053	.093	.476
TE	-.001	-.064	.625	.001	.037	.778
LSI	-.822	-.019	.886	4.634	.070	.594
MPS	-.322	-.051	.697	.143	.252	.802
MSI	-731.816	-.051	.695	503.373	.054	.679
MNN	-13.454	-.017	.898	-.614	-.001	.994
COHESION	-65.227	-.165	.203	5.487	.037	.775

***Dependent Variable**: Child Self-report Total PedsQL Score*

**: p-value < .10 **: p-value < .05 ***: p-value < .01*

[§] More detailed information about each landscape index in Table 6

4.8. Environmental Perceptions and Satisfaction of the Home Neighborhood

As mentioned in Chapter III, the respondents' environmental perceptions and satisfaction in terms of their home neighborhood were measured by a self-administrated survey. The survey consisted of 5 main parts including accessibility, comfort and convenience in walking, safety, attractiveness, and satisfaction. Respondents were asked to indicate whether they strongly agree (=5), agree (=4), neither agree nor disagree (=3), disagree (=2), or strongly disagree (=1) on each of the questions. All results listed in the tables report the findings gathered from both the full and the sub samples, separately.

4.8.1. Accessibility

From both samples, overall, children answered that recreational or playable places in their neighborhood were located within easily walkable distances from their home. Children strongly agreed that parks (mean = 4.09 in the full sample and 4.05 in the sub sample) in their neighborhoods were located within walking distance of their home, followed by friend's houses (mean = 3.82 and 3.67, respectively), open fields (mean = 3.81 and 3.74, respectively) and playgrounds (mean = 3.79 and 3.89, respectively). On the other hand, children reported that it was relatively difficult to walk from home to buffet restaurants, regular restaurants or taquerias, and fast food restaurants (See Table 42).

Table 42. Access to Places, Stores, Facilities, and Other Things

Variables*	Children			
	Sample[§]	N	Mean	Std. Deviation
It is easy for me to walk from home to …				
Places where I can buy food or drinks	F	91	3.49	1.40
	S	61	3.44	1.38
Fast food restaurants	F	91	2.95	1.52
	S	61	2.72	1.45
Buffet restaurants	F	91	2.63	1.47
	S	61	2.51	1.43
Regular restaurants or taquerias	F	91	2.86	1.48
	S	61	2.79	1.49
Places where I can buy things like clothes, books, CDs, DVDs, video games, and magazines	F	91	3.44	1.46
	S	61	3.26	1.55
Parks	F	91	4.09	1.34
	S	61	4.05	1.32
Playgrounds	F	91	3.79	1.36
	S	61	3.89	1.37
Streets where I can play	F	91	3.49	1.67
	S	61	3.49	1.69
Parking lots where I can play	F	91	3.24	1.70
	S	61	3.23	1.66
Driveways where I can play	F	91	3.30	1.76
	S	61	3.30	1.82
Vacant lots where I can play	F	90	2.76	1.59
	S	61	2.64	1.59
Open fields	F	91	3.81	1.45
	S	61	3.74	1.50
Schools other than my school where I can play	F	91	3.05	1.62
	S	61	3.03	1.68
Courtyards or small paved areas where I can play	F	91	2.85	1.67
	S	61	2.72	1.68
My friend’s houses	F	90	3.82	1.50
	S	61	3.67	1.62
My school	F	91	3.29	1.70
	S	61	3.00	1.74

** 5 points Likert-scale (1: Strongly disagree to 5: Strongly agree) / [§] F: Full sample / S: Sub sample*

4.8.2. Comfort and Convenience in Walking

Children showed higher comfort levels than their mothers on all questions regarding comfort and convenience in walking within their neighborhoods. These differences between children and mothers were statistically significant with regards to the existence of bike lanes and paths, the existence of street amenities including benches or resting places, and the amount of trees along the streets (See Table 43).

From both samples, as well as from both children and their mothers, the respondents strongly agreed that they were comfortable walking due to sufficient sidewalks along the streets (mean = 3.92 and 3.80 in the full and sub sample of children, and 3.55 and 3.40 in each sample of mothers, respectively). In addition, comfort levels regarding the amount of trees along the streets showed the highest mean values in the children's samples (mean = 4.02 and 3.90, respectively) as well as relatively high mean values in both samples of maternal respondents (mean = 3.46 and 3.29, respectively). But when mothers walked in their own neighborhoods, they felt more comfortable walking if there were trees along streets, and they stated that the presence of trees would affect their choice of walking routes (mean = 3.59 and 3.61 in both full and sub samples, respectively).

On the other hand, both children and mothers reported relatively lower comfort levels with regards to the existence of street amenities including benches or resting places (mean = 2.50 and 2.49 from both samples of children, and 1.94 and 1.75 from both samples of mothers).

Table 43. Comfort and Convenience in Walking for Yourself

Variables‡	Sample§	Children			Mothers			P-Value
		N	Mean	Std. Deviation	N	Mean	Std. Deviation	
There are sidewalks on most of the street in my neighborhood.	F	91	3.92	1.41	64	3.55	1.59	.233
	S	61	3.80	1.52	57	3.40	1.62	.157
There are bike lanes or paths on most of the street in my neighborhood.	F	91	3.15	1.56	64	2.53	1.68	**.007*** **
	S	61	3.26	1.61	57	2.33	1.61	**.001*** **
There are enough benches or other places to rest along the streets in my neighborhood.	F	90	2.50	1.57	64	1.94	1.38	**.052* **
	S	61	2.49	1.65	57	1.75	1.21	**.012** **
There are many trees along most of the streets in my neighborhood.	F	90	4.02	1.27	63	3.46	1.48	**.015** **
	S	61	3.90	1.36	56	3.29	1.47	**.007*** **
When I walk in my neighborhood, I choose where I walk based on whether there are trees.	F	-	-	-	64	3.59	1.46	-
	S	-	-	-	57	3.61	1.42	-

‡ 5 points Likert-scale (1: Strongly disagree to 5: Strongly agree)
**: p-value < .10 **: p-value < .05 ***: p-value < .01*
§ F: Full sample / S: Sub sample

Maternal respondents were also asked about barriers to walking for their children. Except the question regarding difficulty of walking due to parked cars along streets or sidewalks, all other questions presented significantly different results from the children's responses. Compared with the children's groups, mothers in both samples showed higher anxiety levels regarding walking barriers for their children, as described in Table 44.

Table 44. Walking Barriers for Children

Variables‡	Sample§	Children			Mothers			P-Value
		N	Mean	Std. Deviation	N	Mean	Std. Deviation	
It is difficult (for my child)+ to walk in my neighborhood because of things like …								
No sidewalks	F	91	1.98	1.45	64	2.89	1.72	**.000*** **
	S	61	1.80	1.34	57	3.05	1.72	**.000*** **
Bad sidewalks	F	91	2.44	1.52	64	3.09	1.60	**.020** **
	S	61	2.44	1.54	57	3.28	1.56	**.011** **
No shade along sidewalks	F	91	2.45	1.49	64	3.06	1.60	**.025** **
	S	61	2.51	1.53	57	3.25	1.56	**.013** **
Parked cars along streets or sidewalks	F	91	2.96	1.53	64	3.42	1.79	.247
	S	61	3.16	1.51	57	3.67	1.70	.174

‡ *5 points Likert-scale (1: Strongly disagree to 5: Strongly agree)*
**: p-value < .10 **: p-value < .05 ***: p-value < .01*
+ *Only added in the maternal survey*
§ *F: Full sample / S: Sub sample*

Children did not think that sidewalks were insufficient in their neighborhoods (mean 1.98 and 1.80 from both samples), whereas mothers expressed the belief that no sidewalk could be a walking barrier to their children's walking (mean = 2.89 and 3.05 from both samples). This difference was statistically significant at the .01 level. From both the children and the mothers' groups, the question of parked cars along streets or sidewalks was found to be a major barrier to walking.

4.8.3. Safety

From both samples, children expressed that they felt safer walking or biking in their neighborhood during the day than at night. Their mean values of daytime walking and biking safety were 3.71 and 3.56 in each sample, while their means for night time safe walking or biking were 2.22 and 2.31 in each sample, respectively. These patterns were similar to their mothers' results, and there was no statistically significant difference between the children and the mothers (See Table 45).

Considering their children's walking or biking during the day or at night within their neighborhoods, mothers showed higher anxiety levels regarding safety concerns when allowing their children to walk or bike in their neighborhoods. The mean value for their safety concerns during daytime walking or biking for mothers was 3.70 (3.60 in the sub sample), whereas the mean value for safety concerns during daytime walking or biking for their children decreased by 3.25 (3.16 in the sub sample). Similar patterns presented for night time walking; mothers expressed that their neighborhood conditions were less safe in terms of their children's walking or biking at night (mean = 1.80 in the full sample, and 1.81 in the sub sample), than for night time walking or biking for themselves (mean = 2.25 and 2.12 in each sample, respectively).

Their safety concerns regarding exhaust fumes or a strange smell in the air, or the level of noise in their neighborhoods, were relatively low, but significantly different between the children and mother groups, with mothers raising more concerns on these issues.

Table 45. Safety for Yourself

Variables‡	Sample§	Children N	Children Mean	Children Std. Deviation	Mothers N	Mothers Mean	Mothers Std. Deviation	P-Value
It is safe for me to walk or bike in my neighborhood during the day.	F	91	3.71	1.51	64	3.70	1.40	.678
	S	61	3.56	1.60	57	3.60	1.44	.902
It is safe to let my child go walking or biking in my neighborhood during the day.	F	-	-	-	64	3.25	1.57	-
	S	-	-	-	57	3.16	1.57	-
It is safe for me to walk or bike in my neighborhood at night.	F	91	2.22	1.43	64	2.25	1.51	.841
	S	61	2.31	1.49	57	2.12	1.45	.613
It is safe to let my child go walking or biking in my neighborhood during at night.	F	-	-	-	64	1.80	1.36	-
	S	-	-	-	57	1.81	1.38	-
The crime rate makes it unsafe to go walking or biking in my neighborhood during the day.	F	-	-	-	64	2.58	1.52	-
	S	-	-	-	57	2.68	1.50	-
The crime rate makes it unsafe to go walking or biking in my neighborhood at night.	F	-	-	-	63	2.89	1.63	-
	S	-	-	-	56	2.93	1.61	-
There are a lot of exhaust fumes or a strange smell in the air in my neighborhood.	F	91	2.08	1.28	64	2.47	1.47	**.054***
	S	61	2.11	1.37	57	2.56	1.45	**.048****
There is a lot of noise in the air in my neighborhood.	F	91	2.43	1.56	64	1.94	1.27	**.020****
	S	61	2.41	1.58	57	1.98	1.25	**.065***
People walking or biking on the streets can easily be seen by other people in their homes.	F	-	-	-	64	3.53	1.51	-
	S				57	3.40	1.53	-

‡ 5 points Likert-scale (1: Strongly disagree to 5: Strongly agree)
**: p-value < .10 **: p-value < .05 ***: p-value < .01*
§ F: Full sample / S: Sub sample

Maternal participants were also asked about safety concern for their children (See Table 46). Excluding the question asked about their concern regarding their children being injured when they walk or bike (or let their children walk or bike), and the question regarding concerns about when it is dangerous to walk or bike because of stray dogs or strangers, all other questions related to safety for children presented significantly different results between the children and their mothers. Compared to the children's groups, mothers in both samples expressed more concerns about walking or biking safety for their children within their neighborhoods.

Children in both samples expressed relatively lower levels of safety concerns while walking or biking in their neighborhoods because of stray dogs (mean = 2.91 and 2.02 in the full and sub samples, respectively), and strangers (mean = 2.92 and 2.93 in each sample). However, they did not worry significantly about traffic in their neighborhoods (mean = 1.85 and 1.87 in both samples, respectively) as compared to other safety variables.

Overall, mothers showed higher levels of safety concerns for their children's walking or biking in their neighborhoods. They reported higher mean values for all variables associated with safety concerns for their children, except in one question regarding concern about being injured when they let their children walk or bike in their neighborhoods. Especially, as shown in Table 46, maternal respondents' concerns regarding traffic, including the questions about traffic volume (too much traffic), traffic speed (cars going to fast), and street crossing conditions (no crosswalks, and no signals at crosswalks), were relatively higher than the children's perceptions. In addition, like children expressed that their mothers' anxiety levels regarding the children's walking or biking safety were higher about stray dogs (mean = 3.27 and 3.46 in each sample, respectively), and strangers (mean = 3.23 and 3.26, respectively).

Table 46. Safety for Children

Variables[‡]	Sample[§]	Children			Mothers			P-Value
		N	Mean	Std. Deviation	N	Mean	Std. Deviation	
I'm worried about (my child becoming)[+] being injured when I walk or bike in my neighborhood.	F	91	2.92	1.61	63	2.97	1.66	.589
	S	61	3.11	1.68	56	2.95	1.62	.582
It is dangerous (for my child)[+] to walk or bike in my neighborhood because of things like…								
Too much traffic	F	91	1.85	1.30	64	3.00	1.53	**.000*****
	S	61	1.87	1.37	57	3.14	1.49	**.000*****
Cars going to fast	F	91	2.57	1.54	64	3.53	1.58	**.000*****
	S	61	2.66	1.63	57	3.63	1.53	**.000*****
No crosswalks	F	91	2.11	1.45	64	3.33	1.64	**.000*****
	S	61	2.08	1.44	57	3.44	1.63	**.000*****
No signals at crosswalks	F	91	2.33	1.56	64	3.08	1.67	**.006*****
	S	61	2.43	1.63	57	3.16	1.66	**.013****
No lighting	F	91	2.14	1.51	64	2.63	1.52	**.011****
	S	61	1.89	1.36	57	2.68	1.50	**.010****
Stray dogs	F	91	2.91	1.57	64	3.27	1.62	.409
	S	61	3.02	1.61	57	3.46	1.54	.115
Gangs	F	91	2.23	1.51	64	2.89	1.60	**.004*****
	S	61	2.10	1.50	57	3.00	1.58	**.001*****
Strangers	F	91	2.92	1.59	64	3.23	1.55	.429
	S	61	2.93	1.69	57	3.26	1.54	.239

‡ 5 points Likert-scale (1: Strongly disagree to 5: Strongly agree)
**: p-value < .10 **: p-value < .05 ***: p-value < .01*
+ Only added in the maternal survey
§ F: Full sample / S: Sub sample

4.8.4. Attractiveness

In both samples, children and mothers showed significantly different perceptions of attractiveness in the questions regarding the chance of seeing attractive buildings, homes, or gardens, and the chance of seeing beautiful natural things in their neighborhoods. Child respondents reported higher mean values on those questions (See Table 47).

Table 47. Attractiveness of Your Neighborhood

Variables[‡]	Sample[§]	Children			Mothers			P-Value
		N	Mean	Std. Deviation	N	Mean	Std. Deviation	
My neighborhood has …								
Many attractive buildings, homes, or gardens to see	F	91	2.77	1.48	64	2.11	1.43	**.003*****
	S	61	2.59	1.47	57	1.95	1.34	**.007*****
Many beautiful natural things to see	F	90	3.18	1.50	64	2.31	1.48	**.003*****
	S	61	2.97	1.53	57	2.19	1.45	**.004*****
Lots of litter or trash	F	91	2.22	1.21	64	2.14	1.42	.471
	S	61	2.21	1.20	57	2.23	1.46	.857
Lots of graffiti	F	91	2.01	1.28	64	2.08	1.36	.475
	S	61	1.87	1.28	57	2.14	1.38	.217
Many parks	F	91	2.86	1.45	-	-	-	-
	S	61	2.90	1.46	-	-	-	-
Many other green spaces (e.g., parks, open fields, wooded areas, forests, greenbelts)	F	-	-	-	64	2.09	1.50	-
	S	-	-	-	57	1.95	1.42	-
I can see birds, squirrels, or rabbits in my neighborhood.	F	91	3.78	1.26	63	3.95	1.34	.308
	S	61	3.67	1.26	56	3.96	1.32	.309
I can hear sounds of nature in my neighborhood.	F	91	3.86	1.32	64	3.92	1.45	.757
	S	61	3.75	1.42	57	3.86	1.49	.950

‡ *5 points Likert-scale (1: Strongly disagree to 5: Strongly agree)*
**: p-value < .10 **: p-value < .05 ***: p-value < .01*
§ *F: Full sample / S: Sub sample*

In both samples of children and mothers, the variables regarding the chance to see birds, squirrels, or rabbits, and to hear natural sounds in their neighborhoods, showed relatively high mean values.

4.8.5. Neighborhood Satisfaction

The neighborhood satisfaction of children and mothers in both samples is summarized with both mean values and standard deviations in Table 48. Overall, they are satisfied with their neighborhoods. Specifically, children expressed the highest levels of satisfaction with sense of place (your neighborhood is a good place to live) showing 3.93 and 3.85 of mean values in each sample respectively. Mothers were strongly satisfied with the commuting time to their children’s schools (mean = 4.17 and 4.09 in each sample, respectively).

In addition, both children and mothers were satisfied with the overall walking and biking conditions of their neighborhoods. Children showed higher satisfaction levels regarding shade from trees when they walked or biked (mean = 3.63 and 3.70 in each sample, respectively) than was perceived by their mothers (mean = 3.56 and 3.41 in each sample, respectively).

Table 48. Neighborhood Satisfaction

Variables‡	Sample§	Children			Mothers			P-Value
		N	Mean	Std. Deviation	N	Mean	Std. Deviation	
How satisfied are you with… ?								
Walking in your neighborhood	F	91	3.63	1.37	64	3.70	1.27	.348
	S	61	3.49	1.43	57	3.63	1.23	.306
Biking in your neighborhood	F	91	3.74	1.27	64	3.53	1.26	.359
	S	61	3.72	1.29	57	3.47	1.23	.379
Shade from trees when you walk or bike	F	91	3.63	1.36	64	3.56	1.24	.672
	S	61	3.70	1.27	56	3.41	1.23	.226
Commuting time to your (child's) + school	F	91	3.26	1.36	63	4.17	1.25	**.000*** **
	S	61	3.00	1.53	56	4.09	1.30	**.000*** **
Parks in your neighborhood	F	90	3.59	1.43	64	3.72	1.34	.530
	S	61	3.54	1.44	57	3.60	1.35	.791
Other green spaces (e.g., parks, open fields, wooded areas, forests, greenbelts)	F	-	-	-	64	3.52	1.31	-
	S	-	-	-	57	3.40	1.32	-
Playgrounds in your neighborhood	F	91	3.46	1.49	64	3.59	1.18	.505
	S	61	3.41	1.53	57	3.54	1.15	.619
How many friends you have living near your houses	F	91	3.46	1.53	64	3.64	1.43	.477
	S	61	3.33	1.59	57	3.60	1.43	.627
Your neighborhood as a good place to live	F	91	3.93	1.27	64	3.83	1.30	1.00
	S	61	3.85	1.35	57	3.70	1.32	.518
Your neighborhood as a good place to raise children	F	-	-	-	64	3.67	1.35	-
	S	-	-	-	57	3.54	1.35	

‡ 5 points Likert-scale (1: Strongly disagree to 5: Strongly agree)

**: p-value < .10 **: p-value < .05 ***: p-value < .01*

+ Only added in the maternal survey

§ F: Full sample / S: Sub sample

4.9. Factor Analysis Findings

To reduce the number of variables for capturing environmental perceptions, a principal component analysis (PCA) was conducted.

Since respondents were asked biking related to questions only when they indicated that they had a bike, there were a different number of samples between the walking and biking questions. Thus, only variables associated with walking were entered into the factor analysis. In addition, due to the different attribute of the ways to ask questions regarding satisfaction and other categories assessing environmental perceptions such as accessibility, comfort, safety, and attractiveness, this research conducted separated PCA analyses; one entered only variables for satisfaction, and another included all environmental perception variables, excluding questions for assessing satisfaction. After applying the criteria for a factor analysis that was stated in Chapter III, three factors indicated variables associated with neighborhood satisfaction, and eleven factors were generated from those environmental perception variables except satisfaction. However, one factor in terms of park existence contained only one variable. Thus, this research used the original observed variable instead of a single factor.

The KMO and Bartlett's test results of the PCA analysis for variables measuring satisfaction for the neighborhood showed .600 at the 0.01 level ($p = .000$). Hence, the factor analysis with variables regarding neighborhood satisfaction was fit to be conducted. Three generated factors for satisfaction could explain 70.22% of the total variance explained. In addition, there was no factor loading value less than .4. Thus, all variables were considered in each appropriate factor (See Appendix 7).

The KMO and Bartlett's test results of the PCA analysis for variables assessing environmental perceptions excluding satisfaction presented at .561 (p = .000). Thus, the factor analysis of this research was acceptable for this research sample. In addition, generated factors could explain 65.38% of the total variance explained. There was no factor loading value less than .4. Thus, all variables were considered in each appropriate factor (See Appendix 7).

The final factors were aggregated into ten factors indicating environmental perceptions, and three factors representing neighborhood satisfaction as described in Tables 49 and 50 below.

Table 49. Factors with Variables in Neighborhood Satisfaction

Factor	Name	Variables
1	**Satisfaction of recreational facilities**	• How satisfied are you with: parks in your neighborhood? • How satisfied are you with: playgrounds in your neighborhood?
2	**Satisfaction of walking environments**	• How satisfied are you with: walking in your neighborhood? • How satisfied are you with: shade from trees when you walk or bike? • How satisfied are you with: your neighborhood as a good place to live?
3	**Satisfaction of proximity to friend and school**	• How satisfied are you with: how many friends you have living near your house with whom you can play? • How satisfied are you with: how much time it takes for you to get to school?

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

Table 50. Factors with Environmental Perception Variables excluding Satisfaction

Factor	Name	Variables
1	**Accessibility for utilitarian walking**	• It is easy for me to walk from home to buffet / all-you-can-eat restaurants. • It is easy for me to walk from home to fast food restaurants. • It is easy for me to walk from home to places where I can buy things like clothes, books, CDs, DVDs, video games, and magazines. • It is easy for me to walk from home to my school. • It is easy for me to walk from home to regular restaurants or taquerias. • It is easy for me to walk from home to places where I can buy food or drinks such as convenience stores, supermarkets, small grocery stores, or mobile food vendors.
2	**Safety concern**	• There are a lot of exhaust fumes or a strange smell in the air in my neighborhood. • There is a lot of noise in my neighborhood. • It is difficult to walk in my neighborhood because of things like bad sidewalks. • It is dangerous to walk or ride my bike in my neighborhood because of things like: cars going too fast. • It is dangerous to walk or ride my bike in my neighborhood because of things like: strangers. • It is dangerous to walk or ride my bike in my neighborhood because of things like: stray dogs. • It is dangerous to walk or ride my bike in my neighborhood because of things like: too much traffic.
3	**Accessibility for recreational walking**	• It is easy for me to walk from home to playgrounds where I can play with equipment such as swing sets and play houses. • It is easy for me to walk from home to parks where I can play. • It is easy for me to walk from home to streets where I can play. • It is easy for me to walk from home to my friends' houses. • It is easy for me to walk from home to open fields where I can play.
4	**Accessibility to playable places near home**	• It is easy for me to walk from home to parking lots where I can play. • It is easy for me to walk from home to driveways where I can play. • It is easy for me to walk from home to vacant lots where I can play. • It is easy for me to walk from home to courtyards or small paved areas within my apartment where I can play. • It is easy for me to walk from home to schools other than my school where I can play.
5	**Walking comfort**	• There are many trees along most of the streets in my neighborhood. • There are sidewalks on most of the streets in my neighborhood. • It is safe for me to walk or bike in my neighborhood during the day.
6	**Walking barriers**	• It is dangerous to walk or ride my bike in my neighborhood because of things like: no crosswalks. • It is dangerous to walk or ride my bike in my neighborhood because of things like: no lighting. • It is dangerous to walk or ride my bike in my neighborhood because of things like: no signals at crosswalks or intersections. • It is dangerous to walk or ride my bike in my neighborhood because of things like: gangs.
7	**Unattractiveness in walking conditions**	• It is difficult to walk in my neighborhood because of things like no sidewalks. • My neighborhood has lots of litter and trash. • My neighborhood has lots of graffiti.
8	**Exposed to natural elements**	• I can hear sounds of nature in my neighborhood. • My neighborhood has many beautiful natural things to see. • I can see birds, squirrels, or rabbits in my neighborhood.
9	**Night safety and street amenity**	• It is safe to walk or bike in my neighborhood at night. • My neighborhood has many attractive buildings, homes, or gardens to see. • There are enough benches or other places to rest along the streets in my neighborhood.
10	**Inconvenience of walking**	• It is difficult to walk in my neighborhood because of things like no shade along sidewalks. • I am worried about being injured when I walk or ride my bike in my neighborhood. • It is difficult to walk in my neighborhood because of things like parked cars along streets or on sidewalks.

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

4.10. Children's BMI, HRQOL, Socio-Demographic Characteristics, Environmental Perceptions, and Landscape Spatial Patterns

Multiple regression analyses were conducted to assess the overall relationships between children's BMI and HRQOL, and environmental perceptions and satisfaction, physical activity patterns, socio-demographic conditions, and landscape spatial patterns of urban forests. Following the four independent variable groups identified in the conceptual framework (as described in Chapter III), this research estimated ten separate regression models considering different buffers and dependent variables in order to draw conclusions about the impact of landscape spatial patterns on children's BMI and HRQOL, after controlling socio-demographic factors.

This research used multiple regression analyses with the backward stepwise method to get more inclusive statistical models with the selected variables. This research paid attention to the standardized coefficients (Beta) in order to compare the explanatory power between variables, as well as to seek the best predictor of children's BMI and HRQOL. Tests for normality on dependent variables revealed no violation of regression assumptions, and the combinations of landscape indices were considered based on correlation and multicollinearity tests.

4.10.1. Correlate between Children's BMI and Landscape Spatial Patterns with Other Confounding Variables

4.10.1.1. Regression Models Applying the Airline Buffer

To assess the role of children's socio-demographic conditions, physical activity patterns, environmental perceptions and satisfaction, and landscape spatial patterns of urban forests on children's BMI values, this study conducted multiple regression analyses. Table 51 presents the results of two regression models which are separated by different spatial settings. Children's BMI was used as the dependent variable. Both models used the same variables for all three independent variable groups such as socio-demographics, levels of physical activity, and environmental perceptions, and entered the same group of landscape indices including FMI, LSI, MSI, MNN, and COHESION to account for the multicollinearity issue.

The first model (HA1) for the half-mile airline buffer explained about 32% of the variance in children's BMI. The model was statistically significant at the .01 level. In the model, children's BMI was positively correlated with children's gender and the mother's employment status from the socio-demographic variables. Boys and children who have a working mother are significantly more likely to have higher BMI values. On the contrary, children's BMI was negatively associated with the mother's education. These results suggest that children who have a mother who achieves a higher level of education (above a college degree) are likely to have lower BMI values.

Interestingly, more walking trips to their school and more physical activity hours during weekend days were significantly correlated to children's higher BMI values at the .05 level. In addition, children's BMI was positively associated with the amount of time spent watching TV. Their BMI was negatively correlated with walking times to parks in their neighborhoods.

Regarding the variables associated with environmental perceptions and satisfaction, a regression analysis suggested that safety concerns only played a significant role in explaining children's higher BMI values at the .01 level, and that this issue was the most powerful predictor of children's BMI in this model. Additionally, accessibility to playable places near their home was negatively correlated with children's BMI values at the .05 level.

Among the selected landscape indices, both LSI and COHESION showed a negative relationship with children's BMI. Thus, children having more disaggregated (less compacted) and well-connected landscape spatial patterns of urban forests and trees within a half-mile area from their home were both significantly associated with lower BMI values.

As shown in Table 51, the model QA1 for the quarter-mile airline buffer showed a slightly different result as compared with the model HA1 of the half-mile airline buffer. In this model, all selected variables explained about 27% of the children's BMI, and the model was significant at the .01 level. Among the socio-demographic variables, the children's gender and the mothers' levels of education were significantly associated with a positive and negative relationship respectively. However, children's age had a significant role on their BMI values positively. From variables related to children's physical activity, children's BMI values were negatively influenced by longer walking times to parks in their neighborhoods, while these values were positively affected by more physical activity hours during weekend days.

Table 51. Final Regression Models (HA1 and QA1) of Children's BMI, and Socio-Demographic Factors, Physical Activity, Environmental Perceptions and Landscape Spatial Patterns within both Half-mile and Quarter-mile Airline Buffers

Trees in Half-mile Airline Buffer: Model HA1			**Trees in Quarter-mile Airline Buffer: Model QA1**		
Variables	**Beta**	**Sig.**	**Variables**	**Beta**	**Sig.**
Socio-Demographic Factors			**Socio-Demographic Factors**		
Child gender[a]	.278	.029**	Child gender[a]	.244	.035**
Mother's marital status[b]	-.176	.193	Child age	.294	.018**
Mother's education[c]	-.325	.023**	Mother's education[c]	-.239	.051*
Mother's employment status[d]	.241	.051*			
Number of cars[e]	.282	.107			
Physical Activity			**Physical Activity**		
Walking to school or not[f]	.360	.036**	Walking to park or not[f]	-.220	.083*
Walking to park or not[f]	-.237	.066*	Total weekend PA times	.259	.026**
Total weekend PA times	.247	.035**			
Total TV watching hours in a week	.248	.042**			
Environmental Perceptions and Satisfaction			**Environmental Perceptions and Satisfaction**		
Safety concern	.382	.003***	Satisfaction of walking environments	-.167	.144
Accessibility to playable places near home	-.274	.048**	Safety concern	.246	.041**
Unattractiveness in walking conditions	-.184	.146	Unattractiveness in walking conditions	-.162	.171
Landscape Spatial Patterns			**Landscape Spatial Patterns**		
LSI	-.252	.058*	LSI	-.157	.176
COHESION	-.278	.035**			
(Constant: Coeff. = 204.445**)			(Constant: Coeff. = 6.913)		
N=61			N=61		
Sig.=.001			Sig.=.002		
Adj. R^2=.322			Adj. R^2=.266		

***Dependent Variable**: Children's BMI*
Dummy variables: a. 0=girl, 1=boy, b. 0=living with no partner, 1=living with partner, c. 0=below college degree, 1=above college degree, d. 0=unemployment, 1=employment, e. 0=0 or 1 car, 1=1 car, 2=2 cars or more and f. 0=no, 1=yes
More detailed information about each landscape index in Table 6
**: p-value < .10 **: p-value < .05 ***: p-value < .01*

Considering the variables associated with environmental perceptions and satisfaction, a regression analysis suggested that safety concerns played a significant role in explaining children's higher BMI values at the .01 level, and it remained a relatively stronger predictor of children's BMI in the model.

Table 52 described the alternative models of HA2 and QA2. Among the selected landscape indices in the HA1 and QA1 model, FMI and LSI were replaced with PLAND and NP respectively. In general, the HA2 model showed results that were identical to the HA1. This model explained about 32% of the variance of children's BMI, and showed statistically significant at the 0.1 level. Compared to the HA1 model, unattractiveness in walking conditions became a significant and negative correlate to children's BMI. In addition, NP showed a negatively significant relationship with children's BMI. Thus, more urban forest patches or trees within a half-mile airline buffer would likely be associated with reduced BMI among children.

The QA2 model explained about 29% of children's BMI at the .01 level. This model showed similar results to the QA1 model in terms of the socio-demographic variables and physical activity variables. Among the variables associated with environmental perceptions and satisfaction, the existence of parks in the neighborhood was positively correlated with children's BMI. However, in the QA2 model, no landscape index played a significant role in children's BMI.

Table 52. Final Regression Models (HA2 and QA2) of Children's BMI, and Socio-Demographic Factors, Physical Activity, Environmental Perceptions and Landscape Spatial Patterns within both Half-mile and Quarter-mile Airline Buffers

Trees in Half-mile Airline Buffer: Model HA2			**Trees in Quarter-mile Airline Buffer: Model QA2**		
Variables	**Beta**	**Sig.**	**Variables**	**Beta**	**Sig.**
Socio-Demographic Factors			**Socio-Demographic Factors**		
Child gender[a]	.297	.023**	Child gender[a]	.270	.017**
Mother's marital status[b]	-.193	.154	Child age	.230	.067*
Mother's education[c]	-.303	.032**	Mother's education[c]	-.268	.027**
Mother's employment status[d]	.219	.073*			
Number of cars[e]	.275	.117			
Physical Activity			**Physical Activity**		
Walking to school or not[f]	.339	.045**	Walking to park or not[f]	-.193	.117
Walking to park or not[f]	-.249	.052*	Total weekend PA times	.211	.063*
Total weekend PA times	.265	.023**			
Total TV watching hours in a week	.256	.040**			
Environmental Perceptions and Satisfaction			**Environmental Perceptions and Satisfaction**		
Safety concern	.378	.003***	Satisfaction of walking environments	-.162	.146
Accessibility to playable places near home	-.268	.050*	Safety concern	.161	.182
Unattractiveness in walking conditions	-.241	.067*	My neighborhood has many parks.	.233	.055*
Landscape Spatial Patterns			**Landscape Spatial Patterns**		
NP	-.364	.023**			
MSI	-.207	.135			
COHESION	-.338	.023**			
(Constant: Coeff. = 296.626***)			(Constant: Coeff. = 4.862)		
N=61			N=61		
Sig.=.002			Sig.=.001		
Adj. R^2=.323			Adj. R^2=.289		

***Dependent Variable**: Children's BMI*
Dummy variables: a. 0=girl, 1=boy, b. 0=living with no partner, 1=living with partner, c. 0=below college degree, 1=above college degree, d. 0=unemployment, 1=employment, e. 0=0 or 1 car, 1=1 car, 2=2 cars or more and f. 0=no, 1=yes
More detailed information about each landscape index in Table 6
**: p-value < .10 **: p-value < .05 ***: p-value < .01*

4.10.1.2. Regression Models Applying the Network Buffer

Table 53 showed the results of two regression models using network buffer measures. Models used the same variables for three independent variable groups including socio-demographic variables, physical activity, environmental perceptions and satisfaction, and entered the same group of landscape indices including PLAND, NP, MSI, MNN, and COHESION to account for the multicollinearity problems.

Table 53. Final Regression Model (HN1 and QN1) of Children's BMI, and Socio-Demographic Factors, Physical Activity, Environmental Perceptions and Landscape Spatial Patterns within both Half-mile and Quarter-mile Network Buffers

Trees in Half-mile Network Buffer: Model HN1			Trees in Quarter-mile Network Buffer: Model QN1		
Variables	**Beta**	**Sig.**	**Variables**	**Beta**	**Sig.**
Socio-Demographic Factors			**Socio-Demographic Factors**		
Child gender[a]	.329	.007***	Child gender[a]	.237	.038**
Mother's marital status[b]	-.179	.179	Mother's education[c]	-.299	.015**
Mother's education[c]	-.403	.005***	Mother's employment status[d]	.193	.105
Mother's employment status[d]	.245	.044**			
Number of cars[e]	.343	.050*			
Physical Activity			**Physical Activity**		
Walking to school or not[f]	.292	.097*	Total weekend PA times	.255	.029**
Walking to park or not[f]	-.232	.069*	Total TV watching hours in a week	.169	.144
Total weekend PA times	.230	.050*			
Total TV watching hours in a week	.240	.046**			
Environmental Perceptions and Satisfaction			**Environmental Perceptions and Satisfaction**		
Safety concern	.281	.035**	Safety concern	.216	.082*
Accessibility to playable places near home	-.260	.058*	My neighborhood has many parks.	.288	.016**
My neighborhood has many parks.	.248	.042**			
Landscape Spatial Patterns			**Landscape Spatial Patterns**		
PLAND	-.178	.138			
(Constant: Coeff. = 20.081***)			(Constant: Coeff. = 17.932***)		
N=61			N=61		
Sig.=.002			Sig.=.001		
Adj. R^2=.316			Adj. R^2=.275		

***Dependent Variable**: Children's BMI*
Dummy variables: a. 0=girl, 1=boy, b. 0=living with no partner, 1=living with partner, c. 0=below college degree, 1=above college degree, d. 0=unemployment, 1=employment, e. 0=0 or 1 car, 1=1 car, 2=2 cars or more and f. 0=no, 1=yes
More detailed information about each landscape index in Table 6
*: p-value < .10 **: p-value < .05 ***: p-value < .01

The HN1 model, which was regressed on all selected variables and landscape indices calculated for the half-mile network buffer, explained about 32% of the variance in the children's BMI. In terms of socio-demographic variables and physical activity patterns of the children, the result of this model were similar to the HA1 model using the airline buffer. Children's BMI were positively correlated with the children's gender, the mother's employment status, and the number of cars, among the variety of variables within the socio-demographic factors. On the contrary, children's BMI values were negatively associated with the mother's education. The mother's education was the most powerful predictor of the children's BMI in this model.

The results in terms of the influence of children's level of physical activity on their BMI values showed almost identical results to the HA1 model. Longer walking times to their school and more physical activity hours during weekend days were significantly associated with higher BMI values in children. In addition, children's BMI values were positively related to more time to watch TV in a typical week, but were negatively correlated with longer walking times to parks in their neighborhoods.

Among the variables associated with environmental perceptions and satisfaction, accessibility to playable places near home was negatively related to children's BMI. On the other hand, their BMI values were positively correlated with safety concerns and the existence of parks.

In the QN1 model, there was no landscape index significantly correlated with the children's BMI. In this model, children's BMI values were negatively associated with the mother's education at the .05 level. On the contrary, children's gender, total physical activity time during a typical weekend, safety concerns, and the existence of parks in the neighborhood showed positive relationships with children's BMI.

4.10.2. Correlate between Children's HRQOL and Landscape Spatial Patterns with Other Confounding Variables

4.10.2.1. Regression Models Applying the Airline Buffer

This research estimated four regression models to measure the association between children's socio-demographic conditions, physical activity patterns, environmental perceptions and satisfaction, landscape spatial patterns of urban forests, and children's HRQOL.

Table 54 depicts the results of two regression models based on different spatial settings including a half and a quarter-mile airline buffer. The same variables of independent factors were used for both models, and FMI, LSI, MSI, MNN, and COHESION were selected for the models.

The HA3 model explained about 44% of the variance in the children's self-reported PedsQL scores. This model was significant at the .01 level. The children's PedsQL scores were positively correlated with the mother's employment status. This means that those children who had working mothers were more likely to have higher HRQOL. Their PedsQL scores were negatively associated with their age and the number of cars in their house. Thus, older children or those who had more cars in the household were more likely to have lower HRQOL.

More walking trips to parks and total physical activity hours during a typical weekend were significantly associated with children's HRQOL, while higher BMI (more obese condition) was correlated with reduced children's HRQOL.

Among the variables associated with environmental perceptions and satisfaction, unattractiveness in walking conditions was negatively related to children's HRQOL at the .01 level, whereas the existence of parks was positively associated with their HRQOL.

Table 54. Final Regression Models (HA3 and HA4) of Children's HRQOL, and Socio-Demographic Factors, Physical Activity, Environmental Perceptions and Landscape Spatial Patterns within a Half-mile Airline Buffers

Trees in Half-mile Airline Buffer: Model HA3			**Trees in Half-mile Airline Buffer: Model HA4**		
Variables	**Beta**	**Sig.**	**Variables**	**Beta**	**Sig.**
Socio-Demographic Factors			**Socio-Demographic Factors**		
Child age	-.366	.003***	Child age	-.287	.025**
Mother's employment status[d]	.191	.078*	Mother's marital status[b]	.188	.105
Number of cars[e]	-.210	.055*	Mother's employment status[d]	.157	.157
			Number of cars[e]	-.251	.029**
Physical Activity and BMI			**Physical Activity and BMI**		
Walking to park or not[f]	.184	.100	Walking to park or not[f]	.235	.045**
Total weekend PA times	.400	.000***	Total weekend PA times	.352	.002***
Children's BMI	-.318	.008***	Total TV watching hours in a week	-.155	.153
Environmental Perceptions and Satisfaction			**Environmental Perceptions and Satisfaction**		
Satisfaction of neighborhood recreational facilities	.154	.175	Satisfaction of neighborhood recreational facilities	.201	.088*
Unattractiveness in walking conditions	-.402	.001***	Safety concern	-.193	.098*
Exposed to urban natural elements	-.168	.106	Unattractiveness in walking conditions	-.314	.007***
My neighborhood has many parks.	.267	.030**	Exposed to urban natural elements	-.198	.061*
Landscape Spatial Patterns			My neighborhood has many parks.	.280	.023**
FMI	.386	.021**	**Landscape Spatial Patterns**		
LSI	-.218	.089*	PLAND	.474	.018**
COHESION	-.489	.008***	MNN	.285	.041**
			COHESION	-.452	.017**
(Constant: Coeff. = 15468.599***)			(Constant: Coeff. = 20220.753***)		
N=61			N=61		
Sig.=.000			Sig.=.000		
Adj. R^2=.442			Adj. R^2=.442		

***Dependent Variable**: Child Self-report Total PedsQL Score*

Dummy variables: a. 0=girl, 1=boy, b. 0=living with no partner, 1=living with partner, c. 0=below college degree, 1=above college degree, d. 0=unemployment, 1=employment, e. 0=0 or 1 car, 1=1 car, 2=2 cars or more and f. 0=no, 1=yes

More detailed information about each landscape index in Table 6

**: p-value < .10 **: p-value < .05 ***: p-value < .01*

Less fragmented conditions in the landscape spatial patterns (a higher FMI) played a positive role in the children's HRQOL. However, more disaggregated patterns (a higher LSI) and more connected landscape patterns (a higher COHESION) were negatively correlated with the HRQOL. In addition, total weekend physical activity times, unattractiveness in walking conditions, FMI, and COHESION were relatively stronger predictors in explaining children's HRQOL.

The HA4 model using PLAND, NP, MSI, MNN, and COHESION is summarized in Table 54. This model explains the children's self-reported PedsQL scores to approximately 44% and was significant at the .01 level. Among the socio-demographic variables, both the mother's marital status and employment status showed a positive association with the PedsQL scores, but neither was statistically significant. However, children's age and number of cars associated with the household were both negatively correlated with their PedsQL scores.

More frequent walking trips to the park and total time spent on physical activity during a regular weekend were both correlated with an improved HRQOL.

From the variables associated with environmental perceptions and satisfaction factors, satisfaction of neighborhood recreational facilities and the existence of parks in the neighborhood were positively associated with the children's HRQOL. In addition, safety concerns, unattractiveness in walking conditions, and exposure to urban natural elements showed significant negative relationships on the children's HRQOL. Among the selected landscape indices, PLAND and MNN represented positive relationships with the children's HRQOL, while COHESION showed a negative association with their HRQOL.

This research also tested the associations between the children's HRQOL and landscape spatial patterns of urban forests and trees within a quarter-mile airline buffer. However, their PedsQL scores were not affected by any landscape indices captured at this buffer distance (See Appendix 8).

4.10.2.2. Regression Models Applying the Network Buffer

The correlations between the children's HRQOL and landscape spatial patterns within each network buffer were assessed by several different models. However, no model represented significant associations between HRQOL and landscape indices.

Table 55 presents the results of two regression models to predict children's HRQOL using both sizes of network buffers. From both spatial settings, several variables for each of the three categories of socio-demographic factors, physical activity and BMI, and environmental perceptions and satisfaction were correlated with the children's PedsQL scores. Specifically, in both models the children's ages, the mother's education level, the children's BMI, unattractiveness in waking conditions, and exposure to urban natural elements were all negatively associated with the children's HRQOL. In addition, both models suggested that the mother's employment status, total time for physical activity during a weekend, and the existence of parks in the children's neighborhoods were all related to an increased HRQOL. However, again, there was no significant relationship between the children's PedsQL scores and any of the landscape indices.

Table 55. Final Regression Models (HN2 and QN2) of Children's HRQOL, and Socio-Demographic Factors, Physical Activity, Environmental Perceptions and Landscape Spatial Patterns within both Half-mile and Quarter-mile Network Buffers

Trees in Half-mile Airline Buffer: Model HN2			**Trees in Quarter-mile Airline Buffer: Model QN2**		
Variables	**Beta**	**Sig.**	**Variables**	**Beta**	**Sig.**
Socio-Demographic Factors			**Socio-Demographic Factors**		
Child age	-.306	.009***	Child gender[a]	.188	.072*
Mother's education[c]	-.195	.082*	Child age	-.262	.023**
Mother's employment status[d]	.249	.029**	Mother's education[c]	-.247	.030**
			Mother's employment status[d]	.201	.076*
Physical Activity and BMI			**Physical Activity and BMI**		
Total weekend PA times	.363	.001***	Total weekend PA times	.345	.002***
Children's BMI	-.250	.033**	Children's BMI	-.267	.029**
Environmental Perceptions and Satisfaction			**Environmental Perceptions and Satisfaction**		
Accessibility for recreational walking	.144	.168	Safety concern	-.151	.170
Walking barriers	.178	.084*	Accessibility for recreational walking	.149	.145
Unattractiveness in walking conditions	-.325	.002***	Walking barriers	.164	.105
Exposed to urban natural elements	-.202	.053*	Unattractiveness in walking conditions	-.286	.006***
My neighborhood has many parks.	.372	.002***	Exposed to urban natural elements	-.209	.041**
			My neighborhood has many parks.	.414	.001***
Landscape Spatial Patterns			**Landscape Spatial Patterns**		
(Constant: Coeff. = 3300.502***)			(Constant: Coeff. = 3115.996***)		
N=61			N=61		
Sig.=.000			Sig.=.000		
Adj. R^2=.423			Adj. R^2=.435		

***Dependent Variable**: Child Self-report Total PedsQL Score)*
Dummy variables: a. 0=girl, 1=boy, b. 0=living with no partner, 1=living with partner, c. 0=below college degree, 1=above college degree, d. 0=unemployment, 1=employment, e. 0=0 or 1 car, 1=1 car, 2=2 cars or more and f. 0=no, 1=yes
More detailed information about each landscape index in Table 6
**: p-value < .10   **: p-value < .05   ***: p-value < .01*

4.11. Summary

This chapter presented the results from statistical analyses associated with the research hypothesis and aims. According to their physical activity patterns, children showed a relatively low frequency of walking trips to utilitarian destinations including their school, parks, friends' houses, and stores or shops. About 60~65 percent didn't walk to school in a typical week. In addition, over 40 percent of children didn't walk to a park once per week. About 30 percent of children were engaged in physical activities two to three times during a regular weekend day. From the results of their sedentary activity patterns, children reported longer screening time spent watching TV during a typical weekend as compared with weekdays.

The child self-report PedsQL scores presented higher values than the scores assessed by their mothers. In addition, boys showed better HRQOL than girls in the child self-report PedsQL survey, while they indicated lower HRQOL, according to the mother proxy report.

The results of bivariate analyses between the children's BMI and HRQOL presented the conclusion that the children's BMI was negatively correlated with the HRQOL reported by maternal respondents, while there was no significant association between BMI and HRQOL answered by the children.

According to the bivariate analyses, landscape indices related to the size of patches were correlated with the children's BMI, when captured within the airline or the network buffer. Overall, children's BMI showed a less significant relationship to their physical activity patterns and socio-demographic factors. However, the results of a regression analysis indicated that those variables turned out to be significant correlates of BMI values. In addition, no landscape index represented a significant correlation with the children's HRQOL in all of the spatial settings.

Overall, the respondents shared a generally positive environmental perception of and satisfaction with their neighborhoods. Children perceived that they had adequate accessibility to recreational or playable places, and felt comfortable with walking or biking in their neighborhoods. However, the maternal respondents showed more anxiety and concerns related to comfort with walking, walking barriers, and safety concerns for their children. In addition, they reported perceiving their neighborhoods as less attractive visually than was perceived by their children.

The multiple regression analysis results assessing correlations between the children's BMI and landscape spatial patterns identified significant correlates and their impact on the variance of children's BMI and HRQOL. The four independent variable groups including: 1) socio-demographic, 2) physical activity, 3) factor scores of environmental perceptions and satisfaction, and 4) landscape indices were tested for their significance in predicting children's BMI and HRQOL. Based on multiple regression analyses, these findings are summarized in Tables 56 and 57. The rank of significant variables was based on the standardized coefficient (Beta) of each explanatory variable that showed a significant correlation to the dependent variables.

Table 56. Summary of Regression Results of Children's BMI

Dependent Variable: Children's BMI					
HA1 (Half-mile Airline Model 1)			**QA1(Quarter-mile Airline Model 1)**		
Rank	**Sign**	**Variables**	**Rank**	**Sign**	**Variables**
1	+	Safety concern***	1	+	Child age**
2	+	Walking to school or not**	2	+	Total weekend PA times**
3	-	Mother's education**	3	+	Safety concern**
4	+	Child Gender**	4	+	Child gender**
5	-	COHESION**	5	-	Mother's education*
6	-	Accessibility to playable places near home***	6	-	Walking to park or not*
7	-	LSI*			
8	+	Total TV watching hours**			
9	+	Total weekend PA times**			
10	+	Mother's employment status*			
11	-	Walking to park or not*			
HA2 (Half-mile Airline Model 2)			**QA2(Quarter-mile Airline Model 2)**		
Rank	**Sign**	**Variables**	**Rank**	**Sign**	**Variables**
1	+	Safety concern***	1	+	Child gender**
2	-	NP**	2	-	Mother's education**
3	+	Walking to school or not**	3	+	Park existence*
4	-	COHESION**	4	+	Child age*
5	-	Mother's education**	5	+	Total weekend PA times*
6	+	Child Gender**			
7	-	Accessibility to playable places near home*			
8	+	Total weekend PA times**			
9	+	Total TV watching hours**			
10	-	Walking to park or not*			
11	-	Unattractiveness in walking conditions*			
12	+	Mother's employment status*			
HN1 (Half-mile Network Model 1)			**QN1(Quarter-mile Network Model 1)**		
Rank	**Sign**	**Variables**	**Rank**	**Sign**	**Variables**
1	-	Mother's education***	1	-	Mother's education**
2	+	Number of cars*	2	+	Park existence**
3	+	Child Gender***	3	+	Total weekend PA times**
4	+	Walking to school or not*	4	+	Child gender**
5	+	Safety concern**	5	+	Safety concern*
6	-	Accessibility to playable places near home*			
7	+	Park existence**			
8	+	Mother's employment status**			
9	+	Total TV watching hours**			
10	-	Walking to park or not*			
11	+	Total weekend PA times*			

**: p-value < .10 **: p-value < .05 ***: p-value < .01*
More detailed information about each landscape index in Table 6

Table 57. Summary of Regression Results of Children's HRQOL

Dependent Variable: Children's HRQOL (Child Self-report Total PedsQL Scores)

HA3 (Half-mile Airline Model 3)			HA4 (Half-mile Airline Model 4)		
Rank	**Sign**	**Variables**	**Rank**	**Sign**	**Variables**
1	-	COHESION***	1	+	PLAND**
2	-	Unattractiveness in walking conditions***	2	-	COHESION**
3	+	Total weekend PA times***	3	+	Total weekend PA times***
4	+	FMI**	4	-	Unattractiveness in walking conditions***
5	-	Child age***	5	-	Child age**
6	-	Children's BMI***	6	+	MNN**
7	+	Park existence**	7	+	Park existence**
8	-	LSI*	8	-	Number of cars**
9	-	Number of cars*	9	+	Walking to park or not**
10	+	Mother's employment status*	10	+	Satisfaction of recreational facilities*
			11	-	Exposed to urban natural elements*
			12	-	Safety concern*

HN2 (Half-mile Network Model 2)			QN2(Quarter-mile Network Model 2)		
Rank	**Sign**	**Variables**	**Rank**	**Sign**	**Variables**
1	+	Park existence***	1	+	Park existence***
2	+	Total weekend PA times***	2	+	Total weekend PA times***
3	-	Unattractiveness in walking conditions***	3	-	Unattractiveness in walking conditions***
4	-	Child age***	4	-	Children's BMI**
5	-	Children's BMI**	5	-	Child age**
6	+	Mother's employment status**	6	+	Mother's education**
7	-	Exposed to urban natural elements*	7	-	Exposed to urban natural elements**
8	+	Mother's education*	8	+	Mother's employment status*
9	+	Walking barriers*	9	+	Child gender*

**: p-value < .10 **: p-value < .05 ***: p-value < .01*

More detailed information about each landscape index in Table 6

CHAPTER V

DISCUSSION AND CONCLUSIONS

5.1. Introduction

This chapter summarizes the key findings for each of the research aims, and discusses any counterintuitive results and limitations of this dissertation research. This chapter also includes recommendations for measuring and analyzing landscape spatial patterns for future behavioral and health research.

5.2. Discussion

5.2.1. Correlates of Childhood Obesity

Childhood obesity and its comorbidities have become a major public health challenge in the U.S. (Ogden et al., 2006). Recent evidence shows that well-designed built environments that support walking, bicycling and other healthy physical activities can help deal with this challenge. Supportive environments include connected sidewalks, safe street crossings, access to playgrounds, parks and other utilitarian destinations, and visual quality (Humpel et al., 2002; Lee and Moudon, 2004; Sallis et al., 2000). While the roles of land uses and transportation infrastructure have been examined in a number of studies, landscape spatial patterns shaped by urban forests, trees and grasses have not been scrutinized sufficiently. In addition to the many ecological benefits, urban forests can increase comfort and reduce stress for people using or viewing these spaces. They can also increase the overall aesthetic quality of the urban landscape. Urban natural environments can potentially influence public health by promoting physical activities and by helping to relieve daily stresses (Coley et al., 1997; Hartig et al., 2003; Kaplan, 1995; Nowak and Dwyer, 2007; Ulrich et al., 1991).

This research found significant correlations between children's BMI and landscape spatial patterns shaped by urban forests and trees, when measured using half-mile airline buffers. Specifically, regression models suggested that well-connected landscape spatial patterns (measured by COHESION) were significantly associated with lower BMI. In addition, within the same setting, more tree patches (NP) or more disaggregated landscape patterns (LSI) showed significant negative relationships with children's BMI. Furthermore, those landscape indices represented relatively higher standardized coefficient (beta) values as shown in Table 51 and Table 52, and therefore they appear to be strong predictors of children's BMI.

This result may be related to improving walking conditions in the neighborhoods. The results suggested that children were less likely to become obese because they engaged in more physical activity, when their neighborhoods have supportive walking environments with more street trees along well-connected sidewalk systems. However, landscape structures that are supportive of walking seem to require less aggregated tree patches because dense forest or tree patches along walking environments can block sufficient visual surveillance, and therefore could be considered a threat to personal safety and security. This is especially the case with inner-city and lower income neighborhoods like the one studied in this dissertation (Jorgensen et al., 2002; Schroeder and Anderson, 1985; Sugiyama and Ward Thompson, 2008).

In BMI regression models, there were a few findings that were counterintuitive or inconsistent with the previous literature. First, children who walked to school more frequently were more likely to have higher BMI values. This could be in part explained by their income status. The income levels of those who walked to school were significantly lower than those who did not walk to school (See Table 58). As reported in previous studies, obesity, diet, and physical activity patterns among children are strongly affected by their socio-economic status, such as household income (Banis et al., 1988; Gerald et al., 1994; Gordon-Larsen et al., 2002; Ogden et al., 2006; Ogden et al., 2002; Yen and Kaplan, 1998). Due to the high number of maternal respondents who refused to provide their current household income in this research (about 20 percent), this research had to rely solely on education level to capture the economic conditions of the household. Thus, to get more accurate results regarding this relationship between children's BMI and walking to school behaviors, income and diet variables should be considered in future studies. However, the method for capturing these variables accurately and completely remains a challenge, especially when studying low income, minority populations who are difficult to research due to their immigration status, complicated daily schedules, language barriers, etc.

Table 58. Children's Household Income and the Experience of Walking to School on a Typical Weekdays

	N	Mean of Household Income	Std. Deviation of Household Income	Sig.
Don't walk to school	33	3.52	1.77	.003
Do walk to school	18	2.06	1.16	
Total	51	3.00	1.72	

Household Income Variable = 1: less than $10,000, 2: $10,000~$20,000, 3: $20,001~$30,000, 4: $30,001~$40,000, 5: $40,001~$50,000, 5: more than $50,000

Second, walking to the park was correlated with lower BMI, contrasting with the walking to school behavior. Many previous researchers reported that the correlates of utilitarian walking on physical activity are different from recreational walking (Hoehner et al., 2005; Lee, 2007; Owen et al., 2004; Sugiyama and Ward Thompson, 2008). This could be explained by the different characteristics of utilitarian vs. recreational walking. Utilitarian walking tends to be shorter than recreational walking, and thus may not bring health benefits if walking environments are not safe (from traffic, exhaust fume from cars, crime, stray dogs, etc.) or conducive of walking. On the other hand, recreational walking is often long enough to bring health benefits, and walking to the park also involves additional physical activity opportunities once children arrive at the park.

Third, from the regression models examining a half-mile airline and network buffer within home neighborhoods, children's BMI values were positively associated with their physical activity times during the weekend. This relationship cannot be fully explained in this study. Although no significant relationships were found between children's weekend physical activity and marital status of maternal respondents or the child's gender, future studies may still benefit from considering the role of a father's physical activities. Children, especially boys' physical activities during the weekend has been shown to be influenced by paternal physical activity (Beets et al., 2007). Both samples in this research had higher BMI percentile values among boys than among girls, but this was because only maternal respondents participated in this study, and fathers' roles could not be investigated. Thus, the association between children and both parents' physical activity levels remains unexplored and is a question for future research.

Fourth, regression models in a half-mile airline buffer reported that children's BMI levels were negatively associated with unattractiveness in walking environments. This finding is expected because children who walk more (an activity that contributes to have lower BMI) will witness more unattractive features in their neighborhoods than those who do not walk as often. According to the logistic regression analysis (See Appendix 9), children who walked were 1.34 times more likely to have concerns with the attractiveness of walking conditions, as compared to children who did not walk during a typical week. Furthermore, from the environmental audit data conducted from the UH-PEAK project, a majority of the street segments in the study area had a lot of litter including broken bottles, cans, cigarette butts, and other debris. Therefore, the more walking experiences children had, the more opportunities children had to observe unattractive items along the street.

Finally, there was a positive relationship between children's BMI and the perceived presence of parks in several regression models. This is related to children's perceived natural environments and their real physical activity intentions. As described in Chapter IV, about 43 percent of children walked to a park in a regular week, which is a reasonably high percentage, but even those who did not walk to a park also reported that they still knew that there were several parks within easy walking distance from their homes (mean = 2.90 in the sub sample). This finding suggests that the number of parks is sufficient, but the quality of these parks is not such that they promote children's physical activity. If parks are designed with more attractive features and facilities for children's play and other physical activities, they would have the potential to help reduce childhood obesity.

5.2.2. Correlates of Children's Health-related Quality of Life

One's quality of life could be affected by the quality of one's space/environment. There exists strong evidence in terms of the significant role of trees and forests on human wellbeing. Numerous studies indicate that trees and forests can improve mental health by promoting such benefits as recovery from surgery (Ulrich, 1984) and from daily stresses (Hartig et al., 2003; Hartig et al., 1991; Kaplan and Kaplan, 1989; Kaplan, 1995; Ulrich et al., 1991). This research also found that less fragmented landscape spatial conditions (in the HA3 model) as well as larger areas of urban forests and tree patches (in the HA4 model) were positively correlated with children's HRQOL.

The level of physical activity or physical health condition strongly affects mental health conditions and human well-being. Previous studies have shown that a single bout of physical activity could enhance mood and sleep quality. In addition, being more active could provide a better sense of mental well-being (Banis et al., 1988; Fox, 1999). In addition, researchers have reported that obese children and adults presented significantly lower values of HRQOL than those having a normal weight (Fontaine and Bartlett, 1998; Kolotkin et al., 1995; Schwimmer et al., 2003).

As previous studies have reported, this research found that there were significant correlations between children's BMI, physical activity, and their HRQOL. Multivariate regression models suggested that the total amount of weekend physical activity was positively correlated with children's HRQOL. In addition, a negative relationship between children's BMI and their HRQOL were also found.

Several unexpected results were found from the HRQOL regression models. First, in some of the regression models, a greater exposure to urban natural elements had a negative relationship with children's HRQOL scores. This result might be explained by the study setting of this research. The study site is a Hispanic-dominant, low income, inner-city neighborhood within one of the largest cities in the US (Houston, TX) in close proximity to the central business district. This setting involves a highly built-up urban landscape with little space for high quality natural elements. According to the environmental audit conducted for the UH-PEAK project, frequently observed natural encounters were with crows, squirrels, and stray dogs or cats. In addition, one of the significant safety concerns for walking or biking was stray dogs, which was a significant correlate to the HRQOL. Moreover, from the environmental audit data, dogs' barking sounds were considered one of the significant noise pollutants that made walking unpleasant. Therefore, natural elements in this particular study setting may not be positive factors for these children's HRQOL. If the study was conducted in a higher income, suburban or rural neighborhood, the natural relationship between children's HRQOL and exposure to natural elements would likely be different.

Second, in the HN2 model using the half-mile network buffer, children's HRQOL scores were positively related to concerns of walking barriers. This result should be understood within the context of the children's walking patterns. Based on the logistic regression, children who walked to the park were more likely to observe walking barriers in their neighborhoods by 1.79 times and significant at the 0.05 level, as compared to those who didn't walk to the park in a regular week (See Appendix 9). More walking experiences in their neighborhoods could increase children's HRQOL. Thus, this result reflected that the more walking experiences children had, the greater the number of observations of walking barriers the children reported. Future studies with a larger sample size should consider the interaction terms in order to further explore the nature of interdependent relationships between these variables.

Third, more well-connected (COHESION) and more disaggregated (LSI) landscape spatial patterns of urban forests were negatively associated with children's BMI, as expected, but also were negatively associated with their HRQOL, not as expected. This result might be related to the limitations of the landscape indices. A sense of safety was found to be significantly related to children's HRQOL. In previous studies, a sense of safety was associated with landscape structure (Jorgensen et al., 2002; Schroeder and Anderson, 1985; Sugiyama and Ward Thompson, 2008). Although connected landscape spatial patterns in inner-city neighborhoods can contribute to reduce children's BMI by providing more opportunities for recreational physical activities (e.g., walking to the park), they could also affect their sense of safety due to the density of the landscape structure. One of the limitations in using landscape indices is that landscape spatial patterns cannot be interpolated by a single index. COHESION and LSI share the same issue. COHESION explains only the percentage of connectivity of patches corresponding to the same class, and LSI indicates levels of disaggregation among the patches. These indices do not capture the density of landscape spatial patterns. In addition, the DOQQ imagery used in this research provides only two-dimensional information (i.e., tree canopy) in terms of land cover types and it does not identify all layers of landscape structure.

Figure 11 illustrates examples of high and low connectivity landscape spatial patterns using both the real landscape from aerial photos and classified landscape images. Although there was no notable greenway system in the research area, the high connectivity landscape spatial pattern shows well-connected tree patterns along streets and parks. However, it is difficult to capture all ranges of sub-layers of landscape structure using the DOQQ imagery.

In addition, according to the environmental audit data, the area showing a higher COHESION had a greater number of street trees in public areas including street buffers than private areas. Thus, to create the enhanced walking conditions regarding well-connected landscape patterns and safety issues, effort from the public sector would be significant.

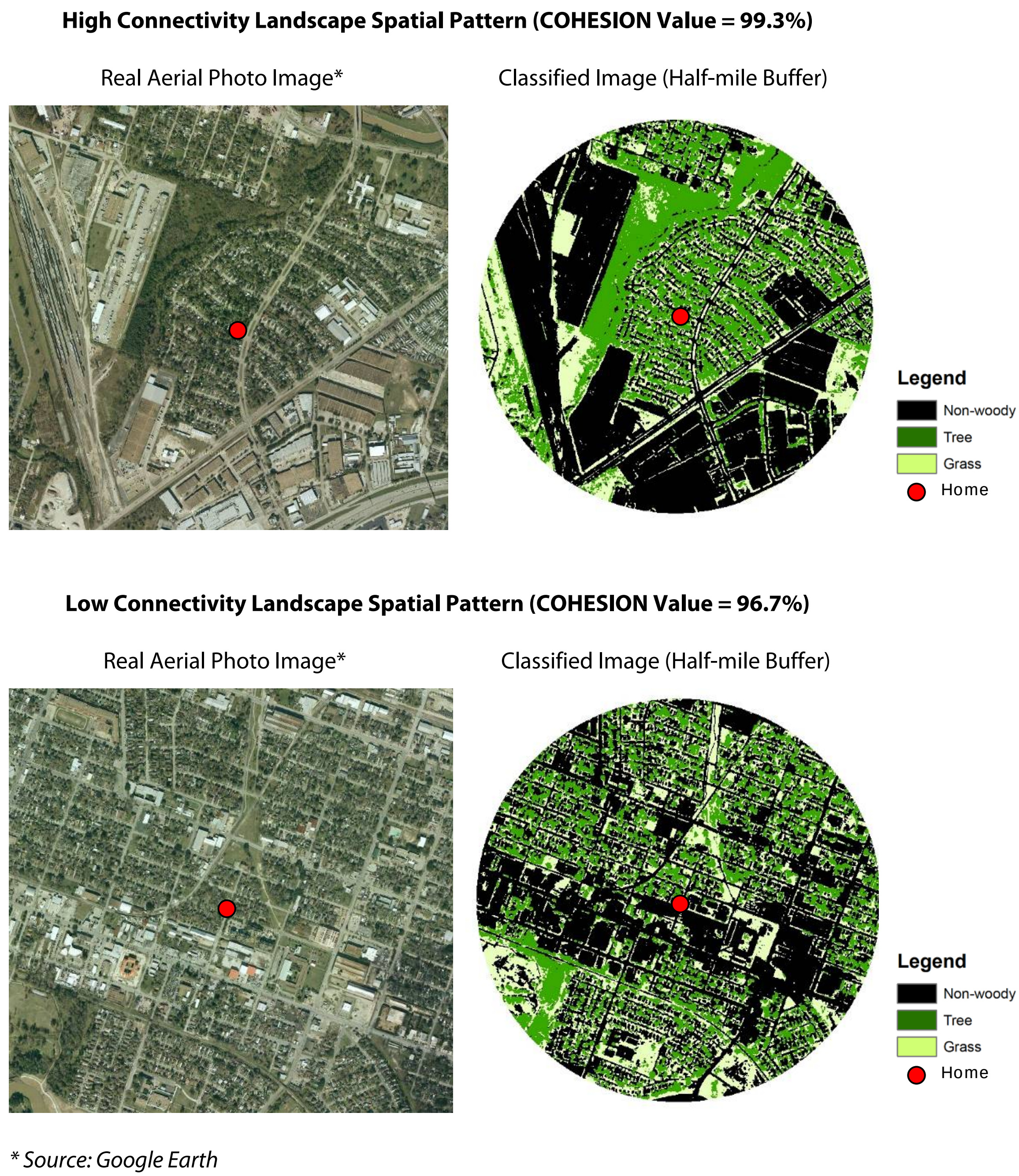


Figure 11. Examples of High and Low Connectivity Landscape Spatial Patterns.

In future research, advanced media detecting the full range of landscape structure, such as LIDAR (Light Detection and Ranging) satellite imagery, would be required to measure more detailed information including the density and the sub-layers of landscape structure. Moreover, more studies on the relationships between subjective and objective measurements of connectivity and compactness of landscape spatial patterns are needed.

5.3. Recommendations for Measuring Landscape Spatial Patterns

5.3.1. Data Sources and Scale for Measuring Landscape Patterns

Measuring landscape spatial patterns requires satellite multi-spectral imagery (e.g., Landsat, IKONOS, or Quickbird) or DOQQ imagery. Although previous research used Landsat satellite imagery for analyzing the degree of greenness by calculating NDVI (Liu et al., 2007; Tilt et al., 2007), using Landsat imagery may not be sufficient to capture detailed landscape patterns due to its coarse standard resolution of 30x30 meters. High resolution satellite imagery (less than 1x1 meters) is necessary for studies aimed at understanding the role of landscape structures on human behaviors, perceptions, and health, all of which are influenced by proximate and detailed environmental conditions. Therefore, finer results in the classification of land covers are needed.

Scale is one of the most significant considerations in landscape structure analysis (Forman, 1995a; McGarigal and Marks, 1995; Turner et al., 2001). The influences of spatial and temporal scale have to be considered in landscape ecology, because landscapes are spatially dynamic and heterogeneous, and they change over time (Turner, 1989). Since ecology is a science where the objects of interest or study can be described by units and dimensions, the patterns and processes associated with the operation of ecological systems are also described in terms of units and dimensions. Ecological patterns emerge from the analysis of data at characteristic space and time scales. The analysis of scaled quantities provides the means for understanding patterns and processes. Often, it is difficult to know what the appropriate resolution to a study should be. In this research, selecting a finer grain size could be a reasonable and safer choice. However, the technical capabilities and processing time in GIS should be considered. Therefore, it is possible to produce GIS images with too fine resolution for represented spatial data, resulting in a more complicated representation of the landscape than is able to be obtained from the data (McGarigal and Marks, 1995).

5.3.2. Post Classification Processing: Removing the Isolated Pixels

Single cells (isolated pixels) in high resolution imagery could affect the outputs of the analysis of landscape patterns. To test the effects of single cells, this research has classified the data into two land cover types: non-woody and woody areas based on tree canopies within a quarter and a half mile buffer of two groups of participants' home neighborhoods (Figure 12). According to the test using 1x1 resolution of DOQQ imagery, single cells had a significant impact on the results of most landscape indices captured using different buffer sizes. Especially, the results presented clear differences in NP (see Table 59). Presence of single cells did not produce significant differences in TA and PLAND, because the spatial extent used in these measures was the same as either the quarter-mile or half-mile buffer area. However, since the dramatic difference in NP can affect all other indices including PD, ED, MPS, MSI, MNN, and COHESION that share similar parameters in their formula such as the number, area, and the perimeter of each patch, all isolated pixels were removed in this study.

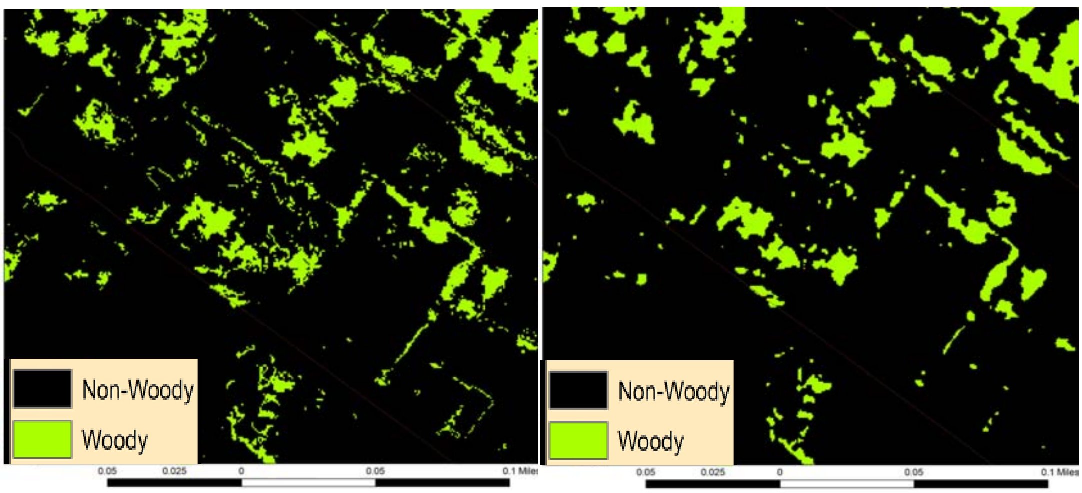


Figure 12. Example of Post Classification Processing: Filtering Effects on Single Cells.
(left: Classification image with single cells; right: Classification image after removing single cells)

Table 59. Results of Post Classification Processing on the Filtering of Single Cells

	TA (ha)	PLAND	NP	PD	ED	MPS (ha)	MSI	MNN (m)	COHE-SION
Quarter-mile buffer									
#1 w/ single cells	15.41	30.31	992	1950.80	1099.01	0.016	1.32	4.34	97.43
#1 w/o single cells	16.15	31.75	5233	10290.85	1858.86	0.003	1.13	1.96	96.54
#2 w/ single cells	6.18	12.16	850	1671.44	609.58	0.007	1.26	4.74	95.61
#2 w/o single cells	6.81	13.38	4019	7902.97	1144.37	0.002	1.13	2.09	93.78
Half-mile buffer									
#1 w/ single cells	53.79	26.45	3465	1703.37	988.08	0.016	1.31	4.49	97.99
#1 w/o single cells	56.35	27.70	18352	9021.71	1657.60	0.003	1.12	2.01	97.29
#2 w/ single cells	19.96	9.81	2594	1275.23	472.96	0.008	1.26	5.47	96.48
#2 w/o single cells	22.05	10.84	13380	6577.72	915.69	0.002	1.12	2.24	95.13

TA: Total Area, PLAND: Percentage of Landscape Area, NP: Number of Patches, PD: Patch Density, ED: Edge Density, MPS: Mean Patch Size, MSI: Mean Shape Index, MNN: Mean Nearest Neighborhood Distance, and COHESION: Patch Cohesion Index
More detailed information about each landscape index in Table 6

5.3.3. Setting Extent for Measuring Landscape Patterns and Physical Activity

The spatial extent of the research area can influence landscape indices independently of grain size. Since urban nature continuously extends into landscape territories, it is not uniformly shaped and mutual exclusive individually. Thus, if the research has an inappropriate spatial extent, it may cause problems with an artificial truncation of the landscape patterns. This may result in biased measurements when using landscape indices. However, it is not always obvious what a minimum spatial extent should be in order to avoid these measurement errors (Turner et al., 2001). With a focus on landscape patterns and physical activity studies, walking distance could be a good criterion for determining the spatial extent. However, a consideration of multiple spatial extents is recommended when no clear evidence is available to guide the selection of a particular spatial extent. Issues affecting the area based on the application of landscape indices in physical activity or walking studies is discussed below.

Buffer Analysis: To examine neighborhood environments, a quarter-mile and a half-mile radius airline buffer around the centroid of each participant’s property could be generated to capture landscape spatial patterns and other built environmental conditions. At the same time, network buffers could be also used to capture landscape spatial patterns within a walkable distance from home, by examining the actual street networks. The buffer distance of a quarter-mile (approximately 400 meters) was determined based on the previous results showing this distance as a maximum walking distance to transit stops. The buffer distance of a half-mile (approximately 800m) was considered to be a likely threshold for other types of walking (Ewing, 1995; Lee and Moudon, 2006; Lee et al., 2006).

Route Analysis: If researchers could capture activity routes by using global positioning system (GPS) or detailed route mapping, buffers along the individual street segments would be useful for assessing people's preferred routes for walking and other activities. Although the buffer width will depend upon the type of streets, buffers wide enough to touch or slightly overlap the property lines but fully including the public right-of-way would be appropriate.

Activity Location: The specific places that people use for physical activity can be captured subjectively by self-reporting surveys, or objectively using wearable GPS devices. GPS would allow for analyzing physical activity behaviors such as walking along with the detailed attributes of the locations where the activities occurred such as walking along a sidewalk, walking along the streets lined with trees, and walking a longer route where there are attractive features along the way rather than a shorter route with no such features. Some of the specific locations such as parks, open fields, streets, and vacant lots were reported to be used for physical activities (Booth et al., 2000; Hoehner et al., 2005; Lee and Moudon, 2004; Powell et al., 2003).

Using GPS to Analyze Preferred Routes: As was mentioned above, advanced techniques like GPS could reveal more detailed information in terms of people's preferred routes. There are several ways to analyze GPS data combined with landscape spatial patterns.

Basically, each GPS time stamp contains a specific set of data such as date, time, speed, and location. Thus, after selecting the time stamps that are of interest (i.e., selecting only the appropriate time stamps collected during specific time periods, or in specific locations), researchers can calculate how many times participants reside near or pass specific landscape patterns. If a researcher focuses on the influence of street trees on the choice of routes or walking patterns, it will be possible to calculate the percentage of time stamps taken under the street trees. For example, there were a total of 969 time stamps collected in Figure 13. This participant recorded 490 minutes of activities over two days. Since 449 time stamps were located under street trees among all of the time stamps, 46.33% of outdoor activities could be related to street trees (assuming that the time stamps were collected at equal intervals). This is almost 227 minutes of the total activity time.

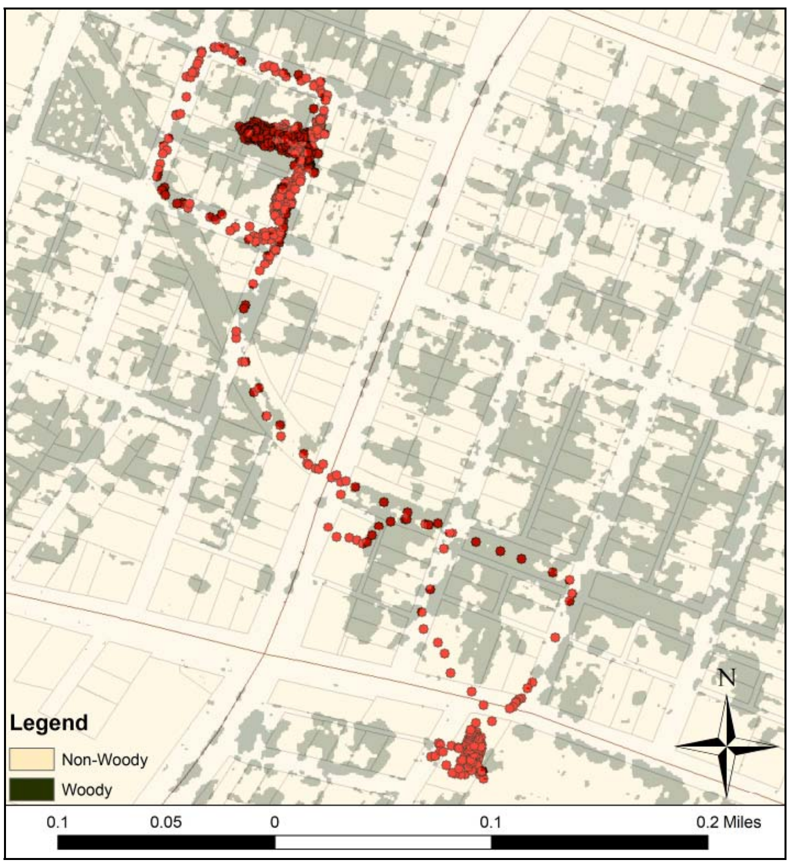


Figure 13. Example of Preferred Routes Analysis Using GPS.

5.3.4. Classification of Land Cover

The categories selected for landscape analysis have a strong impact on the numerical results of landscape indices (Turner et al., 2001). Proper classification and sufficient prior testing is needed to ensure the validity of a study involving landscape pattern analysis. Through different classification methods, the results of landscape pattern analysis can vary. Therefore, appropriate categories must be chosen to address the particular research question.

While satellite classification tends to cover the areas at the regional scale and allows for automated algorithms, it is difficult to ensure sufficient accuracy for certain studies. Classification by using aerial photographs such as DOQQ images offers a finer level of resolution appropriate for studies requiring detailed analyses of a smaller study area. Because of the lack of spectral band information in DOQQ images, the manual classification (i.e., on-screen digitizing) may offer a good option for converting landscape patterns into polygons with the same categories for smaller research areas, as opposed to using remote sensing software. Since the manual classification method depends mainly on researchers' bare eyes and experiences as well as needs labor-intensive work, it may produce more accurately characterized outputs based on texture, patterns, brightness, and context of the features in the aerial photos. Otherwise, GIS and remote sensing programs or geospatial image analyzing software (e.g., ENVI, ERDAS, or ERMapper) could be used to measure types of landscape cover.

5.3.5. Landscape Indices

There exist numerous landscape indices that have been developed and tested. There are inherent limitations such as uniqueness, sensitivity, redundancy, and scale issues (Gustafson, 1998; Haines-Young and Chopping, 1996; Li and Wu, 2004; O'Neill et al., 1988; Riitters et al., 1995) because the basic formula for most landscape indices is based on the number, area and perimeter of each patch. With this limitation, there is no ideal single index that performs better than the others, and landscape patterns cannot be captured by any singe index. However, these indices are useful for estimating the interrelationships between human activities and the ecosystem, as well as for deriving more accurate statistical evidence through quantitative approaches (Bogaert et al., 2000; Gustafson, 1998; Haines-Young and Chopping, 1996; Li and Wu, 2004; O'Neill et al., 1988; Riitters et al., 1995; Turner, 2005).

To be useful for quantifying landscape patterns, a set of landscape indices should meet several criteria. For example, the selected indices should have a particular purpose to their analysis and the indices should be independent of each other. In addition, the behavior of the indices should be discrete and the measured values should cover the full range of potential values (Haines-Young and Chopping, 1996; Turner et al., 2001).

5.4. Limitations

This research has several limitations. First, it is a cross-sectional study. Hence, a causal relationship cannot be established. To better understand the casual relationships formed between environmental perceptions, landscape spatial patterns, and children's BMI and HRQOL, future research should conduct longitudinal studies.

The study population of this research is limited to Hispanic children and their mothers, and the research site is an inner-city neighborhood with a lower SES. Although this population group and setting are important to study a high-risk group for obesity and other health problems, it limits the external validity of this research. The findings of this research can only be generalized to urbanized areas with concentrated Hispanic populations with low education levels and low economic conditions. Future research may need to consider other settings such as suburban or rural environments, as well as more diverse populations groups.

Because this study captured a large number of variables (both objective and subjective measures) through labor intensive recruitment and data collection methods to ensure completeness of the data and the match of the child-mother pairs, only a small sample could be recruited. This small sample size limited the ability to capture all significant variables and the interactions between those variables. The threat of statistical conclusion validity (statistical power) may be associated with the sample size. Bivariate analyses suggested that additional significant correlations may exist among environmental perceptions, landscape spatial patterns, physical activity, children's BMI and HRQOL. A larger sample size would guarantee a stronger statistical power in multiple regression analysis. Future research will benefit from having larger samples.

For examining the landscape spatial patterns of urban forests and trees, this research used DOQQ imagery. This imagery could only analyze two-dimensional landscape patterns determined by the tree canopy. To understand more detailed information in terms of a full range of layers in landscape structure, more advanced media such as the LIDAR imagery should be considered.

5.5. Conclusions

There is no doubt that improving children's physical activity levels will help reduce and eventually stop the obesity epidemic. To find significant determinants of physical activity in children, research will need to use appropriate objective measures of physical activity and the built environment, along with frequently used subjective measures (Lee et al., 2006; Taylor and Sallis, 1997). In addition, to determine more explicit associations between physical activity and the built environment, further research will need to asses different physical activity patterns and perceptions of different population groups in addition to evaluating physical activity in specific settings such as homes, parks, and schools (Lee, 2007; Taylor and Sallis, 1997).

Since patterning is a fundamental method for understanding various relationships, quantifying landscape patterns has been used to characterize both landscape structure and composition in order to determine factors which affect the interpretation of landscape analysis (Gustafson, 1998; Turner et al., 2001). Landscape spatial patterns have received an increased amount of attention as an important consideration in the designing and planning of neighborhoods for improving residents' quality of life (Alberti, 2005; McDonnell et al., 1997). Previous studies have attempted to identify the benefits and human behaviors related to artificial and natural settings, and as such they contributed to the environment-physical activity research associated with urban and landscape planning. However, few studies have looked at landscape structure or the pattern of urban forests and their relationship to physical activity. This study is one of the first attempts to show that landscape spatial patterns are an important element of the built environment that is associated with walking, outdoor activity, obesity and health-related quality of life among children. More empirical studies are needed to confirm the findings of this study and to reveal additional relationships that the landscape structures have with physical activity, obesity and health conditions among children and adults, and among different ethnic groups.

This dissertation is possibly the first empirical study assessing associations between children's BMI, HRQOL, and landscape spatial patterns of urban forests captured by landscape indices. This dissertation includes five research aims. The first aim examined the association between landscape spatial patterns of urban forests and childhood obesity. Previous studies reported evidence of a positive relationship between landscape structure and physical activity or health conditions. However, although there exist a few attempts to examine associations between greenness calculated by aggregated land use data, or NDVI, and physical health conditions (Bell et al., 2008; Liu et al., 2007; Sugiyama and Ward Thompson, 2008; Tilt et al., 2007), no study attempted to explain those relationships considering spatial patterns of landscape structure using objective measurements. This study extends knowledge in terms of this correlation. It revealed that landscape spatial patterns such as connectivity, number of trees, and patch compactness played a significant role in reducing children's BMI.

The second aim assessed the correlates between landscape spatial patterns and the HRQOL among Hispanic children. Although numerous researchers reported that there were significant correlations between landscape patterns and mental health conditions (Hartig et al., 2003; Hartig et al., 1991; Kaplan and Kaplan, 1989; Kaplan, 1995; Ulrich, 1984; Ulrich et al., 1991), only few studies attempted to assess those relationships regarding landscape spatial patterns measured objectively. This research continues the expansion of knowledge on those relationships. Results revealed that less fragmented conditions and a larger size of urban forest affected positive associations in the children's HRQOL, while connectivity and levels of disaggregation of the landscape spatial patterns of urban forests were negatively associated with children's HRQOL.

The third aim of this dissertation examined the association between childhood obesity and children's HRQOL. Previous studies found evidence of a negative relationship between BMI and HRQOL (Banis et al., 1988; Fontaine and Bartlett, 1998; Kolotkin et al., 1995). However, few studies have focused on the association between childhood obesity and their the children's HRQOL (Schwimmer et al., 2003). The results of this research revealed a similar finding to that of previous studies. Children's BMI showed a significantly negative influence on the HRQOL assessed by mothers reflecting their children's observable behaviors.

The fourth aim of this research was to understand the physical activity patterns of Hispanic children and to examine gender differences on obesity and HRQOL. Many pervious studies reported that Hispanic children and adolescents were vulnerable to health conditions such as a high rate of sedentary activity patterns, obese conditions, nonfinancial barriers to health care access, and an impaired quality of care (Flores et al., 2002; Schwimmer et al., 2003). Thus, a better understanding of their activity patterns and quality of life would be required to provide more effective interventions. The results showed that Hispanic children demonstrated a relatively low frequency of walking to several destinations including schools, parks, friends' houses, and stores. In addition, results also showed a longer screening time of watching TV during a typical weekend. Moreover, the perceived existence of or accessibility to each destination did not incite Hispanic children to pursue more opportunities to walk in their neighborhoods. Thus, more efforts to link their perceptions of destinations and real intentions to walk or bike would be required. In addition to their physical activity patterns, boys showed higher HRQOL than girls in the child self-report PedsQL survey, although boys had higher BMI values. However, boys' HRQOL scores indicated by their mothers were lower than the girls' HRQOL.

Finally, some landscape indices played as more powerful indicators in capturing the landscape structural attributes associated with children's obesity and HRQOL. According to multiple regression models, well-connected landscape spatial patterns measured by COHESION played a significant role in explaining both children's BMI and HRQOL within a half-mile airline buffer. In addition, LSI and NP were significant in indicating children's BMI, and FMI, LSI, PLAND, and MNN indicated significant relationships with children's HRQOL.

Hispanic populations possess more serious conditions related to physical inactivity and obesity, and they are more likely to be economically challenged and suffer from poverty and limited access to healthcare. Since walking is the cheapest and easiest way to get exercise, it may be a feasible means of achieving healthy physical activity by incorporating the practice into their daily routines. One of the significant roles of urban and landscape planning is to improve the quality of life of community members. Because landscape structures are important elements in the built environment, shown to improve psychological and physical health, they should be considered important neighborhood components that require proper planning and management.

This type of multi-disciplinary research on landscape structures, while still in its exploratory stage, showed the potential to serve as a viable framework for guiding decision-making in the planning field and to develop more effective environmental assessment strategies in order to understand built environments for research, policy and intervention purposes. This study could lead to developing urban or neighborhood design guidelines with ecological planning considerations, which could in turn help promote physical activity and quality of life.

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APPENDIX 1

PedsQL^{TM}: PEDIATRIC QUALITY OF LIFE INVENTORY VERSION 4.0

1. Child Report (Ages 8~12)
2. Parent Report for Children (Ages 8~12)

** Permission to use both instruments obtained by Dr. James Varni and Mapi Research Trust on Mar. 25, 2009*

ID#

Date:

PedsQL™
Pediatric Quality of Life Inventory

Version 4.0

CHILD REPORT (ages **8-12**)

DIRECTIONS

On the following page is a list of things that might be a problem for you. Please tell us **how much of a problem** each one has been for you during the **past ONE month** by circling:

0 if it is **never** a problem
1 if it is **almost never** a problem
2 if it is **sometimes** a problem
3 if it is **often** a problem
4 if it is **almost always** a problem

There are no right or wrong answers.
If you do not understand a question, please ask for help.

*In the past **ONE month**, how much of a **problem** has this been for you …*

ABOUT MY HEALTH AND ACTIVITIES *(problems with…)*	Never	Almost Never	Some-times	Often	Almost Always
1. It is hard for me to walk more than one block	0	1	2	3	4
2. It is hard for me to run	0	1	2	3	4
3. It is hard for me to do sports activity or exercise	0	1	2	3	4
4. It is hard for me to lift something heavy	0	1	2	3	4
5. It is hard for me to take a bath or shower by myself	0	1	2	3	4
6. It is hard for me to do chores around the house	0	1	2	3	4
7. I hurt or ache	0	1	2	3	4
8. I have low energy	0	1	2	3	4

ABOUT MY FEELINGS *(problems with…)*	Never	Almost Never	Some-times	Often	Almost Always
1. I feel afraid or scared	0	1	2	3	4
2. I feel sad or blue	0	1	2	3	4
3. I feel angry	0	1	2	3	4
4. I have trouble sleeping	0	1	2	3	4
5. I worry about what will happen to me	0	1	2	3	4

HOW I GET ALONG WITH OTHERS *(problems with…)*	Never	Almost Never	Some-times	Often	Almost Always
1. I have trouble getting along with other kids	0	1	2	3	4
2. Other kids do not want to be my friend	0	1	2	3	4
3. Other kids tease me	0	1	2	3	4
4. I cannot do things that other kids my age can do	0	1	2	3	4
5. It is hard to keep up when I play with other kids	0	1	2	3	4

ABOUT SCHOOL *(problems with…)*	Never	Almost Never	Some-times	Often	Almost Always
1. It is hard to pay attention in class	0	1	2	3	4
2. I forget things	0	1	2	3	4
3. I have trouble keeping up with my schoolwork	0	1	2	3	4
4. I miss school because of not feeling well	0	1	2	3	4
5. I miss school to go to the doctor or hospital	0	1	2	3	4

ID# ___________________________

Date: ________________________

PedsQL™

Pediatric Quality of Life Inventory

Version 4.0

PARENT REPORT for **CHILDREN** (ages **8-12**)

DIRECTIONS

On the following page is a list of things that might be a problem for **your child**. Please tell us **how much of a problem** each one has been for **your child** during the **past ONE month** by circling:

0 if it is **never** a problem
1 if it is **almost never** a problem
2 if it is **sometimes** a problem
3 if it is **often** a problem
4 if it is **almost always** a problem

There are no right or wrong answers.
If you do not understand a question, please ask for help.

*In the past **ONE month,** how much of a **problem** has your child had with …*

PHYSICAL FUNCTIONING *(problems with…)*	Never	Almost Never	Some-times	Often	Almost Always
1. Walking more than one block	0	1	2	3	4
2. Running	0	1	2	3	4
3. Participating in sports activity or exercise	0	1	2	3	4
4. Lifting something heavy	0	1	2	3	4
5. Taking a bath or shower by him or herself	0	1	2	3	4
6. Doing chores around the house	0	1	2	3	4
7. Having hurts or aches	0	1	2	3	4
8. Low energy level	0	1	2	3	4

EMOTIONAL FUNCTIONING *(problems with…)*	Never	Almost Never	Some-times	Often	Almost Always
1. Feeling afraid or scared	0	1	2	3	4
2. Feeling sad or blue	0	1	2	3	4
3. Feeling angry	0	1	2	3	4
4. Trouble sleeping	0	1	2	3	4
5. Worrying about what will happen to him or her	0	1	2	3	4

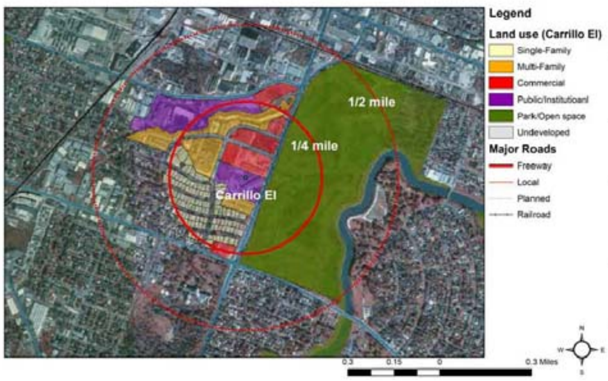
SOCIAL FUNCTIONING *(problems with…)*	Never	Almost Never	Some-times	Often	Almost Always
1. Getting along with other children	0	1	2	3	4
2. Other kids not wanting to be his or her friend	0	1	2	3	4
3. Getting teased by other children	0	1	2	3	4
4. Not able to do things that other children his or her age can do	0	1	2	3	4
5. Keeping up when playing with other children	0	1	2	3	4

SCHOOL FUNCTIONING *(problems with…)*	Never	Almost Never	Some-times	Often	Almost Always
1. Paying attention in class	0	1	2	3	4
2. Forgetting things	0	1	2	3	4
3. Keeping up with schoolwork	0	1	2	3	4
4. Missing school because of not feeling well	0	1	2	3	4
5. Missing school to go to the doctor or hospital	0	1	2	3	4

APPENDIX 2

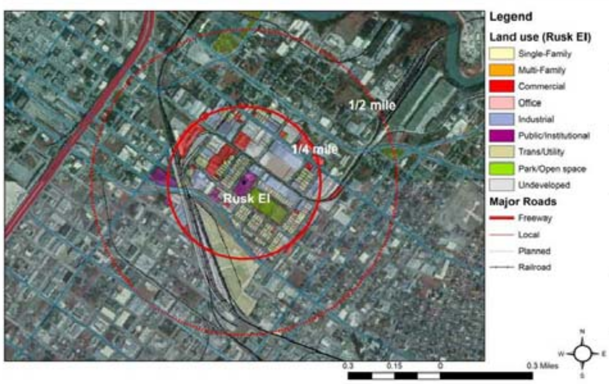
NEIGHBORHOOD ENVIRONMENTAL CHARACTERISTICS AROUND SELECTED SCHOOLS

Carrillo Elementary School



Distance to the nearest park (Miles)	0.08	Non-residential Area (% in area within 1/4 mile)	78.10
Nearest Park	Gus Wortham	Single Family (% in area within 1/4 mile)	10.83
Size of Park (Acre)	161.08	Multi-Family (% in area within 1/4 mile)	11.07
Avg. Block Size (Acre in area within 1/4 mile)	7.37	Street Type	Local
Pop. Density* (#/acre)	7.52	Median Income* ($)	24,500
Housing Density* (#/acre)	2.25	Median Property Value ($)	130,465 (Single-Family)

Rusk Elementary School



Distance to the nearest park (Miles)	0.03	Non-residential Area (% in area within 1/4 mile)	85.14
Nearest Park	Settegast	Single Family (% in area within 1/4 mile)	14.78
Size of Park (Acre)	4.61	Multi-Family (% in area within 1/4 mile)	0.09
Avg. Block Size (Acre in area within 1/4 mile)	12.96	Street Type	Arterial Railroad
Pop. Density* (#/acre)	5.56	Median Income* ($)	20,000
Housing Density* (#/acre)	1.48	Median Property Value ($)	55,081 (Single-Family)

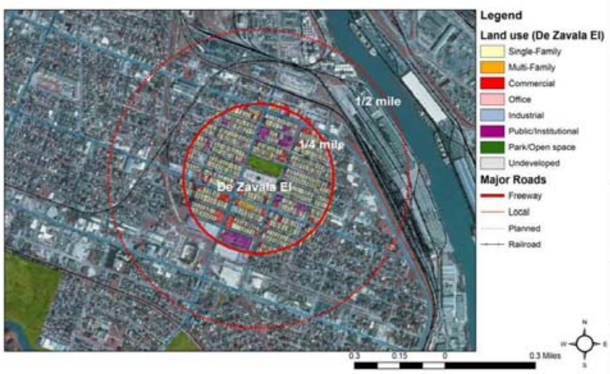
Henderson JP Elementary School

Distance to the nearest park (Miles)	0.55	Non-residential Area (% in area within 1/4 mile)	61.80
Nearest Park	Fonde	Single Family (% in area within 1/4 mile)	37.17
Size of Park (Acre)	8.18	Multi-Family (% in area within 1/4 mile)	1.04
Avg. Block Size (Acre in area within 1/4 mile)	8.43	Street Type	Local
Pop. Density* (#/acre)	11.21	Median Income* ($)	27.800
Housing Density* (#/acre)	3.29	Median Property Value ($)	78,484 (Single-Family)

Briscoe Elementary School

Distance to the nearest park (Miles)	0.17	Non-residential Area (% in area within 1/4 mile)	83.04
Nearest Park	Gus Wortham	Single Family (% in area within 1/4 mile)	16.36
Size of Park (Acre)	161.08	Multi-Family (% in area within 1/4 mile)	0.60
Avg. Block Size (Acre in area within 1/4 mile)	8.68	Street Type	Local
Pop. Density* (#/acre)	7.64	Median Income* ($)	27,000
Housing Density* (#/acre)	2.34	Median Property Value ($)	59,650 (Single-Family)

De Zavala Elementary School



Distance to the nearest park (Miles)	0.03	Non-residential Area (% in area within 1/4 mile)	42.10
Nearest Park	De Zavala	Single Family (% in area within 1/4 mile)	55.85
Size of Park (Acre)	2.76	Multi-Family (% in area within 1/4 mile)	2.05
Avg. Block Size (Acre in area within 1/4 mile)	9.71	Street Type	Local
Pop. Density* (#/acre)	8.81	Median Income* ($)	22,700
Housing Density* (#/acre)	2.70	Median Property Value ($)	43,397 (Single-Family)

* from Census block group

APPENDIX 3

RESULT OF THE ANOVA ANALYIS OF BOYS' AND GIRLS' BMI BY AGE

1. Full sample

1.1. Descriptive of Boys' and Girls' BMI by Age

Gender	Age	N	Mean	Std. Deviation
Boy	9	6	23.77	4.23
	10	20	23.04	6.10
	11	12	24.07	6.26
	12	1	18.40	-
	Total	39	23.35	5.76
Girl	9	5	20.16	3.61
	10	29	18.95	4.18
	11	20	21.29	4.55
	12	3	25.07	3.85
	Total	57	20.20	4.44

1.2. Result of the ANOVA Analysis of Boys' and Girls' BMI by Age

		Sum of Squares	df	Mean Square	F	Sig.
Boys' BMI	Between Groups	33.629	3	11.210	.319	.811
	Within Groups	1228.888	35	35.111		
	Total	1262.517	38			
Girls' BMI	Between Groups	140.011	3	46.670	2.566	.064*
	Within Groups	964.129	53	18.191		
	Total	1104.140	56			

**: p-value < .10 **: p-value < .05 ***: p-value < .01*

2. Sub sample

2.1. Descriptive of Boys' and Girls' BMI by Age

Gender	Age	N	Mean	Std. Deviation
Boy	9	5	23.42	4.64
	10	12	20.74	4.59
	11	7	26.69	6.29
	12	0	-	-
	Total	24	23.03	5.56
Girl	9	5	20.16	3.61
	10	20	19.61	4.67
	11	11	22.75	4.94
	12	1	28.50	-
	Total	37	20.86	4.83

2.2. Result of the ANOVA Analysis of Boys' and Girls' BMI by Age

		Sum of Squares	df	Mean Square	F	Sig.
Boys' BMI	Between Groups	157.148	2	78.574	2.972	.073*
	Within Groups	555.106	21	26.434		
	Total	712.253	23			
Girls' BMI	Between Groups	131.802	3	43.934	2.043	.127
	Within Groups	709.489	33	21.500		
	Total	841.291	36			

**: p-value < .10   **: p-value < .05   ***: p-value < .01*

APPENDIX 4

RESULT OF THE ANOVA ANALYSIS OF THE CHILDREN'S PedsQL SCORES BY GENDER

1. Result of the ANOVA Analysis of the Children's PedsQL Scores by Gender (Full sample)

		Sum of Squares	df	Mean Square	F	Sig.
Child self-report mean PedsQL score	Between Groups	751.18	1	751.18	3.913	.051*
	Within Groups	17853.37	93	191.97		
	Total	18604.542	94			
Child self-report total PedsQL score	Between Groups	397372.81	1	397372.81	3.913	.051*
	Within Groups	9444429.83	93	101553.01		
	Total	9841802.63	94			
Child self-report physical health summary score	Between Groups	26004.39	1	26004.39	1.696	.196
	Within Groups	1425614.04	93	15329.18		
	Total	1451618.42	94			
Child self-report psychosocial health summary score	Between Groups	220070.18	1	220070.18	4.516	.036**
	Within Groups	4532192.98	93	48733.26		
	Total	4752263.16	94			
Mother proxy report mean PedsQL score	Between Groups	763.79	1	763.79	2.897	.094*
	Within Groups	16875.76	64	263.68		
	Total	17639.56	65			
Mother proxy report total PedsQL score	Between Groups	404046.94	1	404046.94	2.897	.094*
	Within Groups	8927278.82	64	139488.73		
	Total	9331325.76	65			
Mother proxy report physical health summary score	Between Groups	207303.15	1	207303.15	6.574	.013**
	Within Groups	2018009.35	64	31531.40		
	Total	2225312.50	65			
Mother proxy report psychosocial health summary score	Between Groups	32522.99	1	32522.99	.561	.457
	Within Groups	3709115.27	64	57954.93		
	Total	3741638.26	65			

**: p-value < .10 **: p-value < .05 ***: p-value < .01*

2. Result of the ANOVA Analysis of the Children's PedsQL Scores by Gender (Sub sample)

		Sum of Squares	df	Mean Square	F	Sig.
Child self-report mean PedsQL score	Between Groups	339.97	1	339.97	1.506	.225
	Within Groups	13317.45	59	225.72		
	Total	13657.42	60			
Child self-report total PedsQL score	Between Groups	179842.16	1	179842.16	1.506	.225
	Within Groups	7044932.43	59	119405.63		
	Total	7224774.59	60			
Child self-report physical health summary score	Between Groups	1968.06	1	1968.06	.111	.740
	Within Groups	1048605.72	59	17772.98		
	Total	1050573.77	60			
Child self-report psychosocial health summary score	Between Groups	144183.66	1	144183.66	2.560	.115
	Within Groups	3323521.26	59	56330.87		
	Total	3467704.92	60			
Mother proxy report mean PedsQL score	Between Groups	342.15	1	342.15	1.196	.279
	Within Groups	15735.73	55	286.10		
	Total	16077.88	56			
Mother proxy report total PedsQL score	Between Groups	180995.51	1	180995.51	1.196	.279
	Within Groups	8324201.86	55	151349.13		
	Total	8505197.37	56			
Mother proxy report physical health summary score	Between Groups	99166.80	1	99166.80	3.085	.085*
	Within Groups	1768026.18	55	32145.93		
	Total	1867192.98	56			
Mother proxy report psychosocial health summary score	Between Groups	12216.45	1	12216.45	.198	.658
	Within Groups	3386358.11	55	61570.15		
	Total	3398574.56	56			

**: p-value < .10 **: p-value < .05 ***: p-value < .01*

APPENDIX 5

RESULT OF THE ANOVA ANALYSIS OF THE CHILDREN'S PedsQL SCORES BY AGE

1. Result of the ANOVA Analysis of the Children's PedsQL Scores by Age (Full sample)

		Sum of Squares	df	Mean Square	F	Sig.
Child self-report mean PedsQL score	Between Groups	398.48	3	132.83	.664	.576
	Within Groups	18206.06	91	200.07		
	Total	18604.54	94			
Child self-report total PedsQL score	Between Groups	210794.70	3	70264.90	.664	.576
	Within Groups	9631007.93	91	105835.25		
	Total	9841802.63	94			
Child self-report physical health summary score	Between Groups	52110.25	3	17370.08	1.129	.341
	Within Groups	1399508.17	91	15379.21		
	Total	1451618.42	94			
Child self-report psychosocial health summary score	Between Groups	80756.29	3	26918.76	.524	.667
	Within Groups	4671506.87	91	51335.24		
	Total	4752263.16	94			
Mother proxy report mean PedsQL score	Between Groups	1809.38	3	603.13	2.362	.080*
	Within Groups	15830.18	62	255.33		
	Total	17639.56	65			
Mother proxy report total PedsQL score	Between Groups	957160.46	3	319053.49	2.362	.080*
	Within Groups	8374165.30	62	135067.18		
	Total	9331325.76	65			
Mother proxy report physical health summary score	Between Groups	205374.18	3	68458.06	2.101	.109
	Within Groups	2019938.32	62	32579.65		
	Total	2225312.50	65			
Mother proxy report psychosocial health summary score	Between Groups	373661.28	3	124553.76	2.293	.087*
	Within Groups	3367976.97	62	54322.21		
	Total	3741638.26	65			

**: p-value < .10 **: p-value < .05 ***: p-value < .01*

2. Result of the ANOVA Analysis of the Children's PedsQL Scores by Age (Sub sample)

		Sum of Squares	df	Mean Square	F	Sig.
Child self-report mean PedsQL score	Between Groups	495.06	3	165.02	.715	.547
	Within Groups	13162.36	57	230.92		
	Total	13657.42	60			
Child self-report total PedsQL score	Between Groups	261887.87	3	87295.96	.715	.547
	Within Groups	6962886.72	57	122155.91		
	Total	7224774.59	60			
Child self-report physical health summary score	Between Groups	17629.33	3	5876.44	.324	.808
	Within Groups	1032944.44	57	18121.83		
	Total	1050573.77	60			
Child self-report psychosocial health summary score	Between Groups	176259.17	3	58753.06	1.017	.392
	Within Groups	3291445.75	57	57744.66		
	Total	3467704.92	60			
Mother proxy report mean PedsQL score	Between Groups	1774.54	3	591.51	2.192	.100
	Within Groups	14303.34	53	269.87		
	Total	16077.88	56			
Mother proxy report total PedsQL score	Between Groups	938732.53	3	312910.84	2.192	.100
	Within Groups	7566464.84	53	142763.49		
	Total	8505197.37	56			
Mother proxy report physical health summary score	Between Groups	218599.23	3	72866.41	2.343	.084*
	Within Groups	1648593.75	53	31105.54		
	Total	1867192.98	56			
Mother proxy report psychosocial health summary score	Between Groups	330469.09	3	110156.36	1.903	.140
	Within Groups	3068105.47	53	57888.78		
	Total	3398574.56	56			

**: p-value < .10 **: p-value < .05 ***: p-value < .01*

APPENDIX 6

CORRELATIONS BETWEEN LANDSCAPE INDICES

1. The Half-mile Airline Buffer

		FMI	TA	PLAND	NP	PD	TE	LSI	MPS	MSI	MNN	COHESION
FMI	Pearson Correlation	1										
	Sig. (2-tailed)											
	N	61										
TA	Pearson Correlation	.891**	1									
	Sig. (2-tailed)	.000										
	N	61	61									
PLAND	Pearson Correlation	.891**	1.000**	1								
	Sig. (2-tailed)	.000	.000									
	N	61	61	61								
NP	Pearson Correlation	-.315*	-.161	-.161	1							
	Sig. (2-tailed)	.014	.215	.215								
	N	61	61	61	61							
PD	Pearson Correlation	-.315*	-.161	-.161	1.000**	1						
	Sig. (2-tailed)	.014	.215	.215	.000							
	N	61	61	61	61	61						
TE	Pearson Correlation	.537**	.733**	.732**	.509**	.509**	1					
	Sig. (2-tailed)	.000	.000	.000	.000	.000						
	N	61	61	61	61	61	61					
LSI	Pearson Correlation	-.136	.047	.047	.928**	.928**	.710**	1				
	Sig. (2-tailed)	.297	.721	.721	.000	.000	.000					
	N	61	61	61	61	61	61	61				
MPS	Pearson Correlation	.813**	.806**	.806**	-.688**	-.688**	.218	-.510**	1			
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.091	.000				
	N	61	61	61	61	61	61	61	61			
MSI	Pearson Correlation	.297*	.229	.229	-.356**	-.356**	.102	-.128	.382**	1		
	Sig. (2-tailed)	.020	.076	.076	.005	.005	.436	.324	.002			
	N	61	61	61	61	61	61	61	61	61		
MNN	Pearson Correlation	-.040	-.223	-.223	-.779**	-.779**	-.653**	-.767**	.327*	.452**	1	
	Sig. (2-tailed)	.759	.084	.084	.000	.000	.000	.000	.010	.000		
	N	61	61	61	61	61	61	61	61	61	61	
COHESION	Pearson Correlation	.712**	.716**	.716**	-.623**	-.623**	.217	-.450**	.835**	.270*	.235	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.093	.000	.000	.035	.068	
	N	61	61	61	61	61	61	61	61	61	61	61

**: p-value < .05 **: p-value < .01*

2. The Quarter-mile Airline Buffer

		FMI	TA	PLAND	NP	PD	TE	LSI	MPS	MSI	MNN	COHESION
FMI	Pearson Correlation	1										
	Sig. (2-tailed)											
	N	61										
TA	Pearson Correlation	.916**	1									
	Sig. (2-tailed)	.000										
	N	61	61									
PLAND	Pearson Correlation	.916**	1.000**	1								
	Sig. (2-tailed)	.000	.000									
	N	61	61	61								
NP	Pearson Correlation	-.242	-.028	-.028	1							
	Sig. (2-tailed)	.061	.830	.830								
	N	61	61	61	61							
PD	Pearson Correlation	-.242	-.028	-.028	1.000**	1						
	Sig. (2-tailed)	.061	.830	.830	.000							
	N	61	61	61	61	61						
TE	Pearson Correlation	.611**	.801**	.801**	.519**	.519**	1					
	Sig. (2-tailed)	.000	.000	.000	.000	.000						
	N	61	61	61	61	61	61					
LSI	Pearson Correlation	-.008	.217	.217	.887**	.887**	.752**	1				
	Sig. (2-tailed)	.950	.093	.093	.000	.000	.000					
	N	61	61	61	61	61	61	61				
MPS	Pearson Correlation	.872**	.847**	.847**	-.521**	-.521**	.392**	-.277*	1			
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.002	.031				
	N	61	61	61	61	61	61	61	61			
MSI	Pearson Correlation	.136	.150	.150	-.170	-.170	.185	.140	.227	1		
	Sig. (2-tailed)	.297	.249	.249	.191	.191	.153	.281	.079			
	N	61	61	61	61	61	61	61	61	61		
MNN	Pearson Correlation	-.320*	-.520**	-.520**	-.676**	-.676**	-.809**	-.785**	-.080	.082	1	
	Sig. (2-tailed)	.012	.000	.000	.000	.000	.000	.000	.542	.528		
	N	61	61	61	61	61	61	61	61	61	61	
COHESION	Pearson Correlation	.803**	.774**	.774**	-.475**	-.475**	.376**	-.272*	.858**	.093	-.095	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.003	.034	.000	.477	.466	
	N	61	61	61	61	61	61	61	61	61	61	61

**: p-value < .05 **: p-value < .01*

3. The Half-mile Network Buffer

		TA	PLAND	NP	PD	TE	LSI	MPS	MSI	MNN	COHESION
TA	Pearson Correlation	1									
	Sig. (2-tailed)										
	N	61									
PLAND	Pearson Correlation	.770**	1								
	Sig. (2-tailed)	.000									
	N	61	61								
NP	Pearson Correlation	.468**	-.004	1							
	Sig. (2-tailed)	.000	.979								
	N	61	61	61							
PD	Pearson Correlation	.004	-.008	.651**	1						
	Sig. (2-tailed)	.976	.951	.000							
	N	61	61	61	61						
TE	Pearson Correlation	.896**	.531**	.795**	.339**	1					
	Sig. (2-tailed)	.000	.000	.000	.008						
	N	61	61	61	61	61					
LSI	Pearson Correlation	.601**	.186	.950**	.603**	.890**	1				
	Sig. (2-tailed)	.000	.152	.000	.000	.000					
	N	61	61	61	61	61	61				
MPS	Pearson Correlation	.646**	.818**	-.332**	-.558**	.266*	-.165	1			
	Sig. (2-tailed)	.000	.000	.009	.000	.038	.205				
	N	61	61	61	61	61	61	61			
MSI	Pearson Correlation	.028	.167	-.289*	-.261*	-.041	-.072	.274*	1		
	Sig. (2-tailed)	.831	.197	.024	.042	.756	.582	.033			
	N	61	61	61	61	61	61	61	61		
MNN	Pearson Correlation	-.406**	-.454**	-.540**	-.717**	-.542**	-.579**	.044	.331**	1	
	Sig. (2-tailed)	.001	.000	.000	.000	.000	.000	.734	.009		
	N	61	61	61	61	61	61	61	61	61	
COHESION	Pearson Correlation	.441**	.710**	-.443**	-.494**	.087	-.302*	.818**	.103	-.030	1
	Sig. (2-tailed)	.000	.000	.000	.000	.505	.018	.000	.429	.816	
	N	61	61	61	61	61	61	61	61	61	61

**: p-value < .05 **: p-value < .01*

4. The Quarter-mile Network Buffer

		TA	PLAND	NP	PD	TE	LSI	MPS	MSI	MNN	COHESION
TA	Pearson Correlation	1									
	Sig. (2-tailed)										
	N	61									
PLAND	Pearson Correlation	.632**	1								
	Sig. (2-tailed)	.000									
	N	61	61								
NP	Pearson Correlation	.660**	.071	1							
	Sig. (2-tailed)	.000	.584								
	N	61	61	61							
PD	Pearson Correlation	-.036	.015	.482**	1						
	Sig. (2-tailed)	.784	.907	.000							
	N	61	61	61	61						
TE	Pearson Correlation	.943**	.487**	.853**	.200	1					
	Sig. (2-tailed)	.000	.000	.000	.123						
	N	61	61	61	61	61					
LSI	Pearson Correlation	.672**	.291*	.916**	.549**	.867**	1				
	Sig. (2-tailed)	.000	.023	.000	.000	.000					
	N	61	61	61	61	61	61				
MPS	Pearson Correlation	.579**	.885**	-.134	-.389**	.338**	.018	1			
	Sig. (2-tailed)	.000	.000	.304	.002	.008	.888				
	N	61	61	61	61	61	61	61			
MSI	Pearson Correlation	.144	.421**	-.070	-.001	.148	.209	.387**	1		
	Sig. (2-tailed)	.268	.001	.593	.993	.255	.107	.002			
	N	61	61	61	61	61	61	61	61		
MNN	Pearson Correlation	-.481**	-.650**	-.405**	-.453**	-.529**	-.569**	-.354**	-.156	1	
	Sig. (2-tailed)	.000	.000	.001	.000	.000	.000	.005	.229		
	N	61	61	61	61	61	61	61	61	61	
COHESION	Pearson Correlation	.601**	.845**	.220	.040	.537**	.435**	.760**	.549**	-.625**	1
	Sig. (2-tailed)	.000	.000	.089	.760	.000	.000	.000	.000	.000	
	N	61	61	61	61	61	61	61	61	61	61

**: p-value < .05   **: p-value < .01*

APPENDIX 7

ROTATED COMPONENT MATRIX (FACTOR LOADING SCORES)

1. Factor Analysis with Variables in Neighborhood Satisfaction

	Component		
	1	2	3
How satisfied are you with: parks in your neighborhood?	.933	.185	-.029
How satisfied are you with: playgrounds in your neighborhood?	.926	.105	.115
How satisfied are you with: walking in your neighbor hood?	.043	.833	-.012
How satisfied are you with: shade from trees when y ou walk or bike?	.125	.782	.051
How satisfied are you with: your neighborhood as a good place to live?	.220	.624	.342
How satisfied are you with: how many friends you h ave living near your house with whom you can play?	.224	-.071	.820
How satisfied are you with: how much time it takes f or you to get to school?	-.153	.249	.660

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 4 iterations.

2. Factor Analysis with Environmental Perception Variables excluding Satisfaction

	Component										
	1	2	3	4	5	6	7	8	9	10	11
It is easy for me to walk from home to buffet / all-you-can-eat restaurants.	.803	.016	-.108	.005	.064	-.013	.141	-.035	.041	.148	.081
It is easy for me to walk from home to fast food restaurants.	.736	-.071	.146	-.042	-.058	.085	-.112	.110	.033	.324	.032
It is easy for me to walk from home to places where I can buy things like clothes, books, CDs, DVDs, video games, and magazines.	.718	-.014	.035	.150	-.033	.019	-.092	.061	-.011	-.211	-.064
It is easy for me to walk from home to my school.	.531	-.105	.390	-.040	.091	.149	.049	.185	-.210	-.124	-.237
It is easy for me to walk from home to regular restaurants or taquerias.	.528	.189	-.041	.105	.089	.162	.158	-.209	.429	-.137	.108
It is easy for me to walk from home to places where I can buy food or drinks such as convenience stores, supermarkets, small grocery stores, or mobile food vendors.	.442	.104	.386	.399	.165	-.033	.057	.014	-.043	-.221	.055
There are a lot of exhaust fumes or a strange smell in the air in my neighborhood.	-.024	.739	-.135	-.027	-.008	.048	-.037	-.153	.051	.090	.018
There is a lot of noise in my neighborhood.	.151	.663	.040	-.209	.090	.084	.366	.139	.137	.022	.032
It is difficult to walk in my neighborhood because of things like bad sidewalks.	.173	.561	.155	.158	-.320	-.123	.097	.091	-.072	-.065	.204
It is dangerous to walk or ride my bike in my neighborhood because of things like: cars going too fast.	-.111	.535	.103	-.021	-.010	.448	.067	-.028	.145	.002	-.004
It is dangerous to walk or ride my bike in my neighborhood because of things like: strangers.	-.155	.513	.155	-.351	-.209	.269	-.031	.187	.237	-.301	.051

(cont'd)

	1	2	3	4	5	6	7	8	9	10	11
It is dangerous to walk or ride my bike in my neighborhood because of things like: stray dogs.	-.012	.453	-.043	.057	-.367	.251	.181	.328	-.080	-.044	.089
It is dangerous to walk or ride my bike in my neighborhood because of things like: too much traffic.	-.142	.435	.027	-.004	-.027	.361	.388	-.157	-.029	.086	-.139
It is easy for me to walk from home to playgrounds where I can play with equipment such as swing sets and play houses.	.061	.100	.838	-.003	.070	-.012	.030	.096	.140	.192	.088
It is easy for me to walk from home to parks where I can play.	.097	-.009	.731	-.014	.113	-.024	.004	.185	.072	-.064	-.053
It is easy for me to walk from home to streets where I can play.	-.060	-.101	.577	.361	.321	.178	-.171	-.139	-.190	.165	.216
It is easy for me to walk from home to my friends' houses.	-.008	-.138	.534	.299	-.068	.020	.154	-.011	.219	-.390	-.102
It is easy for me to walk from home to open fields where I can play.	-.113	.203	.457	.314	.150	.135	-.066	.106	.406	-.093	-.228
It is easy for me to walk from home to parking lots where I can play.	.021	-.019	-.030	.801	-.073	.019	-.174	.141	-.059	.064	.063
It is easy for me to walk from home to driveways where I can play.	-.071	-.184	.058	.689	.181	-.008	-.082	.051	.030	.202	.151
It is easy for me to walk from home to vacant lots where I can play.	.167	-.089	.138	.649	.040	-.075	.222	.315	.356	.136	-.140
It is easy for me to walk from home to courtyards or small paved areas within my apartment where I can play.	.330	.161	.194	.586	.188	-.084	.309	-.038	.100	-.201	-.162
It is easy for me to walk from home to schools other than my school where I can play.	.345	.191	.161	.443	.120	.081	.093	-.139	-.008	.098	-.426
There are many trees along most of the streets in my neighborhood.	.097	.056	.034	.060	.773	-.010	-.247	.147	.118	-.161	.011
There are sidewalks on most of the streets in my neighborhood.	-.035	-.163	.212	.181	.722	-.073	-.052	.064	-.032	.020	.077
It is safe for me to walk or bike in my neighborhood during the day.	.113	-.117	.247	-.032	.545	-.340	.285	.257	.049	.029	-.021
It is dangerous to walk or ride my bike in my neighborhood because of things like: no crosswalks.	.170	.040	-.066	-.044	-.023	.751	.204	-.001	-.141	.013	.131
It is dangerous to walk or ride my bike in my neighborhood because of things like: no lighting.	.172	-.056	.154	-.008	-.214	.592	.269	-.170	.124	-.094	.139
It is dangerous to walk or ride my bike in my neighborhood because of things like: no signals at crosswalks or intersections.	.100	.350	-.086	.114	.103	.562	.099	.105	-.326	.106	-.149
It is dangerous to walk or ride my bike in my neighborhood because of things like: gangs.	-.155	.329	.134	-.093	-.180	.557	.032	-.062	.335	-.238	.040
It is difficult to walk in my neighborhood because of things like no sidewalks.	.178	-.011	.115	-.051	-.130	.139	.760	-.130	.065	.092	.110
My neighborhood has lots of litter and trash.	.029	.159	-.102	-.020	-.071	.119	.739	.101	-.033	.010	.057
My neighborhood has lots of graffiti.	-.198	.144	.018	.053	-.033	.175	.544	-.034	-.122	-.233	-.001
I can hear sounds of nature in my neighborhood.	-.031	.064	.182	.020	-.010	-.111	-.034	.783	-.025	-.033	-.130
My neighborhood has many beautiful natural things to see.	.038	-.070	-.142	.193	.318	.049	-.073	.576	.418	.177	.117

(cont'd)

	1	2	3	4	5	6	7	8	9	10	11
I can see birds, squirrels, or rabbits in my neighborhood.	.239	-.026	.220	.240	.245	-.048	-.031	.543	-.056	-.010	.052
My neighborhood has many parks	.087	.155	.212	-.010	.021	-.096	-.066	.021	.697	.032	.071
It is safe to walk or bike in my neighborhood at night.	.001	.019	-.005	.158	-.162	-.099	-.028	-.003	-.037	.769	-.142
My neighborhood has many attractive buildings, homes, or gardens to see.	-.065	-.028	.061	.211	.184	.142	.069	.379	.411	.479	-.040
There are enough benches or other places to rest along the streets in my neighborhood.	.166	.268	.316	.181	.375	.049	.008	-.168	.125	.425	-.241
It is difficult to walk in my neighborhood because of things like no shade along sidewalks.	.070	.078	-.019	.128	.096	.243	.099	-.215	.059	-.181	.724
I am worried about being injured when I walk or ride my bike in my neighborhood.	-.147	.398	.033	-.010	.139	-.112	.273	.266	.261	-.121	.513
It is difficult to walk in my neighborhood because of things like parked cars along streets or on sidewalks.	.240	.341	.274	-.048	-.282	.093	.082	.039	-.378	.102	.443

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
Rotation converged in 17iterations.

APPENDIX 8

CORRELATION BETWEEN CHILDREN'S HRQOL AND LANDSCAPE PATTERNS WITHIN A QUARTER-MILE AIRLINE BUFFER

Trees in Quarter-mile Airline Buffer		
Variables	**Beta**	**Sig.**
Socio-Demographic Factors		
Child gender[a]	.185	.077*
Child age	-.265	.021**
Mother's education[c]	-.247	.029**
Mother's employment status[d]	.216	.054*
Physical Activity and BMI		
Total weekend PA times	.355	.001***
Children's BMI	-.280	.022**
Environmental Perceptions and Satisfaction		
Safety concern	-.144	.188
Accessibility for recreational walking	.141	.167
Walking barriers	.183	.068*
Unattractiveness in walking conditions	-.279	.007***
Exposed to urban natural elements	-.200	.049**
My neighborhood has many parks	.418	.001***
Landscape Spatial Patterns		

(Constant: Coeff. =3136.522***)

N=61

Sig.=.000

Adj. R^2=.454

***Dependent Variable**: Child Self-report Total PedsQL Score*

Dummy variables: a. 0=girl, 1=boy, b. 0=living with no partner, 1=living with partner, c. 0=below college degree, 1=above college degree, d. 0=unemployment, 1=employment, e. 0=0 or 1 car, 1=1 car, 2=2 cars or more and f. 0=no, 1=yes

**: p-value < .10 **: p-value < .05 ***: p-value < .01*

More detailed information about each landscape index in Table 6

APPENDIX 9

RESULTS OF LOGISTIC REGRESSION MODELS

1. Unadjusted Logistic Regression Model explaining the Likelihood of the Walking Child observing more Unattractiveness Conditions in Their Neighborhood. (Reference Group = Non-walking to School Children Group)

							95.0% C.I. for Exp (B)	
	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Unattractiveness in walking conditions	.292	.261	1.254	1	.263	1.340	.803	2.235
Constant	-.416	.265	2.460	1	.117	.660		

-2LL=80.480, Nagelkerke R^2=.028

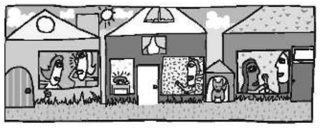
2. Unadjusted Logistic Regression Model explaining the Likelihood of the Walking Child observing more Walking Barriers in Their Neighborhood. (Reference Group = Non-walking to Park Children Group)

							95.0% C.I. for Exp (B)	
	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
Walking barriers	.584	.288	4.127	1	.042	1.794	1.021	3.153
Constant	.384	.276	1.933	1	.164	1.468		

-2LL=78.470, Nagelkerke R^2=.101

APPENDIX 10

NEIGHBORHOOD ENVIRONMENTAL PERCEPTIONS AND SATISFACTION SURVEY FOR CHILDREN



1

ID: ____________________

NEIGHBORHOOD (CHILD)

Environmental Perception

Access to stores, facilities, and other things in your neighborhood

Please choose the answer that best applies to your neighborhood. Check Only One.

It is easy for me to WALK from home to:	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
1. Places where I can buy food or drinks such as convenience stores, supermarkets, small grocery stores, or mobile food vendors.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
2. Fast food restaurants, such as McDonald's, Burger King, Taco Bell, Wendy's, and Jack in the Box, where I can buy things like hamburgers, French fries, or tacos.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
3. Buffet / all-you-can-eat restaurants where I can eat anything I want.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
4. Regular restaurants or taquerias.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
5. Places where I can buy things like clothes, books, CDs, DVDs, video games, and magazines.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
6. Parks where I can play.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
7. Playgrounds where I can play with equipment such as swing sets and play houses.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
8. Streets where I can play.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
9. Parking lots where I can play.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
10. Driveways where I can play.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
11. Vacant lots where I can play.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
12. Open fields where I can play.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
13. Schools other than my school where I can play.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
14. Courtyards or small paved areas within my apartment where I can play.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
15. My friends' houses.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
16. My school.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

NEXT

Comfort and **convenience** in walking, biking and living in your neighborhood

Please choose the answer that best applies to your neighborhood. ***<u>Check Only One</u>***.
Neighborhood *is the immediate or surrounding area within an* ***EASY WALKING DISTANCE*** *from your* ***home***.

	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
17. There are sidewalks on most of the streets in my neighborhood.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
18. There are bike lanes or paths on most of the streets in my neighborhood.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
19. There are enough benches or other places to rest along the streets in my neighborhood.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
20. There are many trees along most of the streets in my neighborhood.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
21. It is easy to get lost in my neighborhood.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
22. There are many places where I can play in my neighborhood (e.g., parks, playgrounds, vacant lots, open fields).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

Please choose the answer that best applies to your neighborhood. ***<u>Check Only One</u>***.

It is difficult to <u>WALK</u> in my neighborhood because of things like:	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
23. No sidewalks	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
24. Bad sidewalks (e.g., bumps, cracks, holes)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
25. No shade along sidewalks	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
26. Parked cars along streets or on sidewalks	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
It is difficult to ride my <u>BIKE</u> in my neighborhood because of things like: ☐ **I do not have a bike that I can ride.→ Skip to Safety**.	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
27. No bike lanes or bike paths	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
28. Bad streets or bike lanes / paths (e.g., bumps, cracks, holes)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
29. Too many curbs and stairs	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
30. No shade along streets or bike lanes / paths	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
31. Parked cars along streets or on bike lanes / paths	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

Safety of your neighborhood

Please choose the answer that best applies to your neighborhood. Check Only One.
Neighborhood *is the immediate or surrounding area within an* ***EASY WALKING DISTANCE*** *from your home.*

	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
32. It is safe to walk or bike in my neighborhood <u>during the day</u>.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
33. It is safe to walk or bike in my neighborhood <u>at night</u>.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
34. I am worried about being injured (by falling, etc.) when I walk or ride my bike in my neighborhood.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
35. There are a lot of exhaust fumes (from cars, buses, etc.) or a strange smell in the air in my neighborhood.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
36. There is a lot of noise in my neighborhood (e.g., traffic, factories, businesses, sirens).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

Please choose the answer that best applies to your neighborhood. Check Only One.

It is dangerous to WALK or ride my BIKE in my neighborhood because of things like:	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
37. Too much traffic	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
38. Cars going too fast	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
39. No crosswalks	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
40. No signals at crosswalks or intersections	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
41. No lighting	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
42. Stray dogs	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
43. Gangs	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
44. Strangers	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

Attractiveness of your neighborhood

***Please choose the answer that best applies to your neighborhood. <u>Check Only One</u>. Neighborhood** is the immediate or surrounding area within an **EASY WALKING DISTANCE** from your home.*

	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
45. My neighborhood has many attractive buildings, homes, or gardens to see.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
46. My neighborhood has many beautiful natural things to see (e.g., flowers, trees, forests).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
47. My neighborhood has lots of litter and trash.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
48. My neighborhood has lots of graffiti.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
49. My neighborhood has many parks.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
50. I can see birds, squirrels, or rabbits in my neighborhood.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
51. I can hear sounds of nature in my neighborhood (e.g., birds singing, bugs chirping, rustling sounds from trees).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

Satisfaction with your neighborhood

Below are things about how satisfied you are about your neighborhood. Please be open and honest with your answer. <u>Check Only One</u>.

How satisfied are you with:	Very Dissatisfied	Somewhat Dissatisfied	Neither Satisfied nor dissatisfied	Somewhat Satisfied	Very Satisfied
52. Walking in your neighborhood?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
53. Riding a bike in your neighborhood?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
54. Shade from trees when you walk or bike?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
55. How much time it takes for you to get to school?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
56. Parks in your neighborhood?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
57. Playgrounds in your neighborhood?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
58. Other places where you can play in your neighborhood, such as streets, vacant lots, and open fields?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
59. How many friends you have living near your house with whom you can play?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
60. Your neighborhood as a good place to live?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

Thank you for your time!

APPENDIX 11

SURVEY FOR PHYSICAL ACTIVITY AND SEDENTARY BEHAVIOR OF CHILDREN

Physical Activity and Sedentary Behavior (Child)

ID: ______________________________ Date:______________________________

We are trying to find out about your physical activity ***over the LAST 7 DAYS*** (*last week*). This includes sports or dances that make you sweat, make your legs feel tired, or activities that make you breathe hard, like running and other activities.

Remember:

- There are no right and wrong answers --- this is not a test.
- Please answer all the questions as honestly as you can --- this is very important, because you are teaching us what kids your age do.

1. Physical activity **OUTSIDE OF SCHOOL PE** (on your own, with friends, team, class, etc): Have you done any of the following activities in the past 7 days? Check one answer for each activity.

	Activity	No, 0 times	1-2 times	3-4 times	5-6 times	7 times or more
1.	Baseball/softball/t-ball	☐	☐	☐	☐	☐
2.	Basketball	☐	☐	☐	☐	☐
3.	Bicycling	☐	☐	☐	☐	☐
4.	Soccer	☐	☐	☐	☐	☐
5.	Cheerleading/drill team	☐	☐	☐	☐	☐
6.	Dance – what kind? _______	☐	☐	☐	☐	☐
7.	Football	☐	☐	☐	☐	☐
8.	Frisbee/disk golf	☐	☐	☐	☐	☐
9.	Golf/miniature golf	☐	☐	☐	☐	☐
10.	Gymnastics	☐	☐	☐	☐	☐
11.	Hiking	☐	☐	☐	☐	☐
12.	Hockey – what kind? ______	☐	☐	☐	☐	☐
13.	Horseback riding	☐	☐	☐	☐	☐
14.	Ice skating	☐	☐	☐	☐	☐
15.	Jumping rope	☐	☐	☐	☐	☐
16.	Kickball	☐	☐	☐	☐	☐

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Activity		No, 0 times	1-2 times	3-4 times	5-6 times	7 times or more
17.	Martial arts (judo, karate, etc.)	☐	☐	☐	☐	☐
18.	Roller-skating/rollerblading	☐	☐	☐	☐	☐
19.	Running or jogging for exercise	☐	☐	☐	☐	☐
20.	Skateboarding	☐	☐	☐	☐	☐
21.	Swimming	☐	☐	☐	☐	☐
22.	Tag or chase	☐	☐	☐	☐	☐
23.	Tennis	☐	☐	☐	☐	☐
24.	Volleyball	☐	☐	☐	☐	☐
25.	Walking for exercise	☐	☐	☐	☐	☐
26.	Bowling	☐	☐	☐	☐	☐
27.	Catch	☐	☐	☐	☐	☐
28.	Hacky sack	☐	☐	☐	☐	☐
29.	Hopscotch	☐	☐	☐	☐	☐
30.	Trampoline	☐	☐	☐	☐	☐
31.	Playground (playing on swings, slides, etc.)	☐	☐	☐	☐	☐
32.	Yoga	☐	☐	☐	☐	☐
33.	Other __________	☐	☐	☐	☐	☐

2. Have you done any of the following activities in the past 7 days? Check one answer for each activity. If you walked “to” and “from” school, you walked 2 times.

	No, 0 times	1-2 times	3-4 times	5-6 times	7 times or more
1. Walking to/from school	☐	☐	☐	☐	☐
2. Bicycling to/from school	☐	☐	☐	☐	☐
3. Taking the school bus to/from school	☐	☐	☐	☐	☐
4. Walking to/from park	☐	☐	☐	☐	☐
5. Bicycling to/from park	☐	☐	☐	☐	☐
6. Walking to/from a friend’s house	☐	☐	☐	☐	☐

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	No, 0 times	1-2 times	3-4 times	5-6 times	7 times or more
7. Bicycling to/from a friend's house	☐	☐	☐	☐	☐
8. Walking to/from a store/shop	☐	☐	☐	☐	☐
9. Bicycling to/from a store/shop	☐	☐	☐	☐	☐
10. Taking a public bus or light rail	☐	☐	☐	☐	☐
11. Walking to/from other places:	☐	☐	☐	☐	☐
12. Bicycling to/from other places:	☐	☐	☐	☐	☐

3. In the last 7 days, ***DURING YOUR PE CLASSES,*** how often were you very active (playing hard, running, jumping, throwing)? (Check one)

☐ I don't have PE
☐ Hardly ever
☐ Sometimes
☐ Quite often
☐ Always

4. In the last 7 days, what did you do most of the time ***AT RECESS?*** (Check one)

☐ Sat down (talking, reading, doing school work)
☐ Stood around or walked around
☐ Ran or played a little bit
☐ Ran around and played quite a bit
☐ Ran and played hard most of the time

5. In the last 7 days, what did you usually do ***AT LUNCH*** (besides eating lunch)? (Check one)

☐ Sat down (talking, reading, doing school work)
☐ Stood around or walked around
☐ Ran or played a little bit
☐ Ran around and played quite a bit
☐ Ran and played hard most of the time

6. In the last 7 days, on how many days ***AFTER SCHOOL (before dinner)*** did you play sports, dance, or do physical activities (for example: go to karate class or basketball practice, play tag or baseball in the front yard) in which you were very active? (Check one)

☐ None
☐ 1 day last week
☐ 2 or 3 days last week
☐ 4 days last week
☐ 5 days last week

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7. What sports or physical activities do you do after school? ___________________________

8. Physical activity ***LAST WEEKEND:***

   a) ***Last Saturday,*** how many times did you play sports, dance, or do physical activities in which you were very active (for example: soccer team game, ballet lesson, family bike ride)?

   ☐ None
   ☐ 1 time
   ☐ 2-3 times
   ☐ 4-5 times
   ☐ 6 or more times

   b) ***Last Sunday,*** how many times did you play sports, dance, or do physical activities in which you were very active?

   ☐ None
   ☐ 1 time
   ☐ 2-3 times
   ☐ 4-5 times
   ☐ 6 or more times

9. Which ONE best describes you ***FOR THE LAST 7 DAYS,*** outside of PE class? Read *all five* sentences before deciding on the one answer that describes you.

   ☐ I never did sports, dance, or physical activity outside of PE class. All of my time was spent doing things that involved little physical effort
   ☐ I sometimes (1 -2 times last week) did sports, dance, or physical activity (e.g. played sports, went running, swimming, bike riding, etc.)
   ☐ I often (3 – 4 times last week) did sports, dance, or physical activity
   ☐ I quite often (5 – 6 times last week) did sports, dance, or physical activity
   ☐ I very often (7 or more times last week) did sports, dance, or physical activity

10. **FOR EACH DAY** of the last week, mark how often you did physical activities that made you sweat or breathe hard, **in and out of PE class** (like playing sports, dance, or other physical activities)

	Never	**A little**	**In the middle**	**Often**	**Very often**
1. Monday	☐	☐	☐	☐	☐
2. Tuesday	☐	☐	☐	☐	☐
3. Wednesday	☐	☐	☐	☐	☐
4. Thursday	☐	☐	☐	☐	☐
5. Friday	☐	☐	☐	☐	☐
6. Saturday	☐	☐	☐	☐	☐
7. Sunday	☐	☐	☐	☐	☐

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11. Were you sick last week, or did anything stop you from doing your usual physical activities? (Check one)

- ☐ Yes
- ☐ No

If Yes, what stopped you?

____
____
____

Physical Education, Athletic Classes, and Sports Teams

12. Normally, about how many days a week do you participate in physical education or athletics classes?

- ☐ 1-2 days a week
- ☐ 3-4 days a week
- ☐ More than 4 days a week

13. How much do you enjoy physical education or athletics classes?

- ☐ Enjoy a lot
- ☐ Enjoy
- ☐ So so
- ☐ Dislike
- ☐ Dislike a lot

14. During the past 12 months, on how many sports teams did you play? (Include any teams run by your school or community groups.)

- ☐ 0 teams
- ☐ 1 team For which sport? ________________________
- ☐ 2 teams For which sports? ________________________
- ☐ 3 or more teams For which sports? ________________________

Sedentary Behavior

15. On an average school day, how many hours do you watch TV?

- ☐ I do not watch TV on an average school day
- ☐ Less than 1 hour per day
- ☐ 1 hour per day
- ☐ 2 hours per day
- ☐ 3 hours per day
- ☐ 4 hours per day
- ☐ 5 or more hours per day

16. On an average school day, how many hours do you watch TV in *your bedroom?*

- ☐ I do not watch TV on an average school day
- ☐ Less than 1 hour per day
- ☐ 1 hour per day
- ☐ 2 hours per day
- ☐ 3 hours per day
- ☐ 4 hours per day
- ☐ 5 or more hours per day

17. How many hours do you watch TV during the weekend?

- ☐ I do not watch TV during the weekend
- ☐ Less than 1 hour per day
- ☐ 1 hour per day
- ☐ 2 hours per day
- ☐ 3 hours per day
- ☐ 4 hours per day
- ☐ 5 or more hours per day

18. On an average school day, how many hours do you play video or computer games or use a computer for something that is not schoolwork? (Include activities such as Nintendo, Game Boy, Play Station, Xbox, computer games, and the Internet.)

- ☐ I do not play video or computer games or use a computer for anything that is not school work on an average school day
- ☐ Less than 1 hour per day
- ☐ 1 hour per day
- ☐ 2 hours per day
- ☐ 3 hours per day
- ☐ 4 hours per day
- ☐ 5 or more hours per day

19. How many hours do you play video or computer games or use a computer for something that is not schoolwork on the weekend? (Include activities such as Nintendo, Game Boy, Play Station, Xbox, computer games, and the Internet.)

- ☐ I do not play video or computer games or use a computer for anything that is not school work on the weekend
- ☐ Less than 1 hour per day
- ☐ 1 hour per day
- ☐ 2 hours per day
- ☐ 3 hours per day
- ☐ 4 hours per day
- ☐ 5 or more hours per day

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APPENDIX 12

SURVEY FOR SOCIO-DEMOGRAPHIC CHARACTERISTICS OF CHILDREN

Demographics (Child)

ID: ____________________ **Date:** _______________

1. **When is your birthday?** ________ month _______ day __________ year **Age:** ________ years

2. **Are you a:** (Check one) ☐ Boy ☐ Girl

3. **What grade are you in?** (Check one) ☐ 3rd ☐ 4th ☐ 5th ☐ 6th

4. **Are you of Hispanic, Latino, or Mexican descent?** ☐ Yes ☐ No ☐ Don't Know

5. **Where were you born?** (Check one)
   ☐ US ☐ *Mexico ☐ *Central America ☐ *Other ____________
   * If Mexico, Central America or other, how many years have you been living in the US? ________

5. **How many people live in your household?** (Indicate number, include yourself) _______________

6. **Of the following people, check all who you live with:**
   ☐ Mom only ☐ Mother and Father ☐ Sister or Brother ☐ Other relatives
   ☐ Dad only ☐ Parent and Step-parent ☐ Grandparents

Electronic Equipment Scale

7. **How many of the following items do you have at home?** (*Circle one response per question*)

1. TV sets	0	1	2	3+
2. TV set in bedroom	0	1	2	3+
3. VCR/DVD player	0	1	2	3+
4. Computers	0	1	2	3+
5. Video game consoles	0	1	2	3+
6. Telephone	0	1	2	3+
7. Cell phone	0	1	2	3+
8. Music player	0	1	2	3+

APPENDIX 13

NEIGHBORHOOD ENVIRONMENTAL PERCEPTIONS AND SATISFACTION SURVEY FOR MOTHERS

1

NEIGHBORHOOD (Maternal Guardian)

Environmental Perception

ID: ______________________

Access to stores, facilities, and other things in your neighborhood

Neighborhood *is the immediate or surrounding area within an* ***EASY WALKING DISTANCE*** *from your home.*

1. Do you have food or other retail shops in your neighborhood, such as restaurants, grocery stores, drug stores, and clothing stores?

☐ Yes

☐ No → **Skip to Question 2**

Please indicate which of the following do you have in your neighborhood			If **Yes**, about how long would it take to get from your home to the nearest business if you **walked** there?				
	Yes	No	1-5 min	6-10 min	11-15 min	16-20 min	21 + min
Example: Gas station	☑ 1	☐ 0	___	___	√	___	___
Convenience store	☐ 1	☐ 0	___	___	___	___	___
Supermarket	☐ 1	☐ 0	___	___	___	___	___
Small grocery store	☐ 1	☐ 0	___	___	___	___	___
Fruit / vegetable market	☐ 1	☐ 0	___	___	___	___	___
Bakery / panaderia	☐ 1	☐ 0	___	___	___	___	___
Mobile food vendor	☐ 1	☐ 0	___	___	___	___	___
Clothing store	☐ 1	☐ 0	___	___	___	___	___
Fast food restaurant (where you can buy hamburgers, French fries, tacos, etc.)	☐ 1	☐ 0	___	___	___	___	___
Regular restaurant	☐ 1	☐ 0	___	___	___	___	___
Taqueria	☐ 1	☐ 0	___	___	___	___	___
Buffet / all-you-can-eat restaurant	☐ 1	☐ 0	___	___	___	___	___
Video store	☐ 1	☐ 0	___	___	___	___	___
Pharmacy / drug store	☐ 1	☐ 0	___	___	___	___	___

NEXT

2. Do you have institutional or service facilities in your neighborhood, such as clinics, libraries, banks, post offices or dry cleaners?

☐ Yes

☐ No → **Skip to Question 3**

Please indicate which of the following are present in your neighborhood			If **Yes**, *about how long would it take to get from your home to the nearest business if you* ***walked*** *there?*				
	Yes	No	1-5 min	6-10 min	11-15 min	16-20 min	21 + min
Laundry / dry cleaner	☐ 1	☐ 0	___	___	___	___	___
Post office	☐ 1	☐ 0	___	___	___	___	___
Library	☐ 1	☐ 0	___	___	___	___	___
Bank / credit union	☐ 1	☐ 0	___	___	___	___	___
Salon / barber shop	☐ 1	☐ 0	___	___	___	___	___
Bus stop	☐ 1	☐ 0	___	___	___	___	___
Clinic / dentist office	☐ 1	☐ 0	___	___	___	___	___
Hospital / emergency room	☐ 1	☐ 0	___	___	___	___	___
School	☐ 1	☐ 0	___	___	___	___	___
Church or other religious institutions	☐ 1	☐ 0	___	___	___	___	___

3. Do you have recreational or open spaces in your neighborhood, such as parks, trails, gyms, and natural green spaces?

☐ Yes

☐ No → **Skip to Question 4**

Please indicate which of the following are present in your neighborhood			If **Yes**, *about how long would it take to get from your home to the nearest place if you* ***walked*** *there?*				
	Yes	No	1-5 min	6-10 min	11-15 min	16-20 min	21 + min
Park	☐ 1	☐ 0	___	___	___	___	___
Walking or biking path	☐ 1	☐ 0	___	___	___	___	___
Community / recreation center	☐ 1	☐ 0	___	___	___	___	___
Fitness / gym facility	☐ 1	☐ 0	___	___	___	___	___
Natural green space (e.g., open field, wooded area, forest, greenbelt)	☐ 1	☐ 0	___	___	___	___	___
Water feature (e.g., creek, pond, lake)	☐ 1	☐ 0	___	___	___	___	___

NEXT

4. Do you have places in your neighborhood where ***your child*** can play?

☐ Yes

☐ No → **Skip to Question 5**

Please indicate which of the following play spaces are available for your child in your neighborhood			*If **Yes**, about how long would it take to get from your home to the nearest place if you **walked** there?*				
	Yes	No	1-5 min	6-10 min	11-15 min	16-20 min	21 + min
Park	☐ 1	☐ 0	___	___	___	___	___
Playground (with play equipment such as swing sets and play houses)	☐ 1	☐ 0	___	___	___	___	___
Street	☐ 1	☐ 0	___	___	___	___	___
Parking lot	☐ 1	☐ 0	___	___	___	___	___
Driveway	☐ 1	☐ 0	___	___	___	___	___
Vacant lot	☐ 1	☐ 0	___	___	___	___	___
Open field	☐ 1	☐ 0	___	___	___	___	___
School other than my child's school	☐ 1	☐ 0	___	___	___	___	___
Courtyard or small paved area within my apartment	☐ 1	☐ 0	___	___	___	___	___
Others, specify:	☐ 1	☐ 0	___	___	___	___	___

5. Do you have any other places within an easy walking distance from your home that were not mentioned in the previous questions?

☐ Yes → **Please write in the space below where those places are.**

☐ No → **Skip to Question 6**

Others, specify: ________________________________

Others, specify: ________________________________

6. Do you have any of the following conditions or facilities in your neighborhood that are dangerous or undesirable **for your child**?

	Yes	No
Highways or roads with heavy or high-speed traffic	☐ 1	☐ 0
Drainage ditch where my child may fall	☐ 1	☐ 0
Other dangerous or hazardous sites that are unsafe for my child to be near (e.g., railways, oil refineries, factories, power plants, junk yards)	☐ 1	☐ 0
Undesirable land uses for my child (e.g., liquor stores, sexually oriented businesses, prisons, car dealerships/repair shops, taverns)	☐ 1	☐ 0
Others, specify:		
Others, specify:		

Comfort and convenience in walking, biking and living in your neighborhood

Please choose the answer that best applies to you and your neighborhood. Check Only One.

*Please keep in mind that your **neighborhood** in this survey is the immediate or surrounding area within an **EASY WALKING DISTANCE** from your home.*

In my neighborhood,	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
7. There are sidewalks on most of the streets.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
8. The sidewalks are well maintained (e.g., paved, even, and not a lot of cracks).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
9. There are enough spaces (e.g., grass strip, trees) between the sidewalks and the vehicular roadways.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
10. There are bike lanes or paths on most of the streets in my neighborhood.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
11. Bike lanes/paths or trails are well maintained (e.g., paved, even, and not a lot of cracks).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
12. There are enough benches and other places to rest along the streets.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
13. There are enough trees along most of the streets.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
14. When I walk in my neighborhood, I choose where I walk based on whether there are trees.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
15. It is easy to get lost.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
16. I do **NOT** feel I have enough privacy.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

Please choose the answer that best applies to your neighborhood. Check Only One.

It is difficult for my child to WALK in my neighborhood because of things like:	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
17. No sidewalks	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
18. Bad sidewalks (e.g., bumps, cracks, holes)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
19. No shade along sidewalks	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
20. Parked cars along streets or on sidewalks	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
It is difficult for my child to ride his/her BIKE in my neighborhood because of things like: ☐ My child does not have a bike that he/she can ride. → Skip to Safety.	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
21. No bike lanes or bike paths	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
22. Bad streets or bike lanes / paths (e.g., bumps, cracks, holes)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

NEXT

23. Too many curbs and stairs	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
24. No shade along streets or bike lanes / paths	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
25. Parked cars along streets or on bike lanes / paths	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

Safety of your neighborhood

Please choose the answer that best applies to your neighborhood. Check Only One.

In my neighborhood,	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
26. It is safe to walk or bike **during the day**.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
27. It is safe to walk or bike **at night**.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
28. The crime rate makes it unsafe to go walking or biking **during the day**.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
29. The crime rate makes it unsafe to go walking or biking **at night**.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
30. It is safe to let my child go walking or biking **during the day**.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
31. It is safe to let my child go walking or biking **at night**.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
32. I am worried about my child becoming injured (by falling, etc.) when he/she walks or rides his/her bike.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
33. There are a lot of exhaust fumes (from cars, buses, etc.) or a strange smell in the air.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
34. There is a lot of noise from the surroundings (e.g., traffic, factories, businesses).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
35. People walking or biking on the streets can easily be seen by other people in their homes (from windows, porches, gardens, etc.).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

Please choose the answer that best applies to your neighborhood. Check Only One.

It is dangerous for my child to WALK or ride his/her BIKE in my neighborhood because of things like:	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
36. Too much traffic	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
37. Cars going too fast	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
38. No crosswalks	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
39. No signals at crosswalks or intersections	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
40. No lighting	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
41. Stray dogs	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
42. Gangs	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

43. Strangers	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

Attractiveness of your neighborhood environment

Please choose the answer that best applies to your neighborhood. Check Only One.

In my neighborhood,	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
44. There are many attractive buildings, homes or gardens to see.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
45. There are many beautiful natural things to see (e.g., flowers, trees, forests).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
46. There are many other green spaces (e.g., parks, open fields, wooded areas, forests, greenbelts)	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
47. There are many abandoned houses or vacant lots.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
48. There is graffiti on buildings, signs, or walls.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
49. There are abandoned cars.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
50. There are condoms, needles, syringes, or drug-related paraphernalia.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
51. There is litter, trash, broken glass, or discarded items.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
52. I think homes, apartments, and gardens are well maintained.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
53. I can see birds, squirrels, or rabbits.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
54. I can hear the sounds of nature (e.g., birds singing, bugs chirping, rustling sounds from trees).	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

Satisfaction with your neighborhood

Below are things about how satisfied you are about your neighborhood. Please be open and honest with your answer. Check Only One.

How satisfied are you with:	Very Dissatisfied	Somewhat Dissatisfied	Neither Satisfied nor Dissatisfied	Somewhat Satisfied	Very Satisfied
55. Walking in your neighborhood?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
56. Riding a bike in your neighborhood?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
57. Shade from trees when you walk or bike?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
58. Your commuting time to your child's school?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
59. Your commuting time to your work?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
		☐ No job outside the home			

NEXT

How satisfied are you with:	Very Dissatisfied	Somewhat Dissatisfied	Neither Satisfied nor Dissatisfied	Somewhat Satisfied	Very Satisfied
60. The quietness (e.g., free of noise from traffic, factories, businesses, sirens)?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
61. The quality of schools?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
62. The quality of parks?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
63. The quality of other green spaces (e.g., open fields, wooded areas, forests, greenbelts)?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
64. The quality of retail and service facilities (e.g., restaurants, supermarkets, banks, post offices)?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
65. The quality of playgrounds?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
66. The quality of other places where your child can play (e.g., streets, vacant lots, open fields)?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
67. How many friends you have living near your house with whom you can socialize?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
68. Your neighborhood as a good place to live?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
69. Your neighborhood as a good place to raise children?	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

People in your neighborhood

Please choose the answer that best applies to your neighborhood. Check Only One.

	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
70. Many people bike in my neighborhood.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
71. Many people walk in my neighborhood.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
72. I am **NOT** proud of my neighborhood.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
73. I feel connected to people in my neighborhood.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5
74. I do **NOT** know many people in my neighborhood.	☐ 1	☐ 2	☐ 3	☐ 4	☐ 5

DONE!

Thank you for your time!

APPENDIX 14

SURVEY FOR SOCIO-DEMOGRAPHIC CHARACTERISTICS OF MOTHERS

Demographics (Maternal Guardian)

ID________________________ Date:_____________________

Instructions: Check the box or fill in your response for each question.

1. When were you born? ___________ month ________ day ___________ year Age: ________ years

2. Where were you born? (Check one)
   ☐ US ☐ Mexico ☐ Central America ☐ Other _____________
   * If Mexico, Central America or other, how many years have you been living in the US? ________

3. [Check the box for the statement that best applies to you. Check **only** one.]
   ☐ You were born in Mexico or other Latin country.
   ☐ You were born in USA; either parent born in Mexico or other Latin country.
   ☐ You were born in USA, both parents born in USA and all grandparents born in Mexico or other Latin country.
   ☐ You and your parents born in the USA and all grandparents born in the USA.

4. What is your marital status?
   ☐ Single, never married
   ☐ Married
   ☐ Living w/ partner
   ☐ Divorced, widow, separated
   ☐ Other (Specify):_________________________

5. (a) What is the last grade you completed in school?
   ☐ Elementary - 6
   ☐ 7 - 8
   ☐ 9 - 12
   ☐ 1 - 2 years of college
   ☐ 3 - 4 years of college
   ☐ College graduate or higher
   ☐ Vocational/ technical

   (b) What is the last grade your spouse/ partner completed in school? (if there is no spouse go to next question)
   ☐ Elementary - 6
   ☐ 7 - 8
   ☐ 9 - 12
   ☐ 1 - 2 years of college
   ☐ 3 - 4 years of college
   ☐ College graduate or higher
   ☐ Vocational/ technical
   ☐ Don't Know

   (a) In what country? ______________________ (b) In what country? ________________

NEXT

6. (a) Are you currently:

- ☐ Employed for wages
- ☐ Self-employed
- ☐ Out of work for more than 1 year
- ☐ Out of work for less than 1 year
- ☐ A Homemaker
- ☐ A Student
- ☐ Retired
- ☐ Unable to work
- ☐ No others
- ☐ Refused

(b) Is your spouse/ partner currently:
(if there is no spouse go to next question)

- ☐ Employed for wages
- ☐ Self-employed
- ☐ Out of work for more than 1 year
- ☐ Out of work for less than 1 year
- ☐ A Homemaker
- ☐ A Student
- ☐ Retired
- ☐ Unable to work
- ☐ No others
- ☐ Refused

7. (a) What is your current occupation?

- ☐ Managerial/ Professional
- ☐ Technician/ Sales
- ☐ Administrative Support
- ☐ Service/ Skilled Worker
- ☐ Manual Laborer
- ☐ Retired
- ☐ Housewife
- ☐ Unemployed

(b) What is your spouse's / partner's current occupation?
(if there is no spouse go to next question)

- ☐ Managerial/ Professional
- ☐ Technician/ Sales
- ☐ Administrative Support
- ☐ Service/ Skilled Worker
- ☐ Manual Laborer
- ☐ Retired
- ☐ Housewife
- ☐ Unemployed
- ☐ Don't Know

8. How many family members live in your household? ____________________________

9. Who lives in your household? (Check **ALL** that apply)

- ☐ Mother
- ☐ Father
- ☐ Spouse/ partner
- ☐ Children
- ☐ Grandparents
- ☐ Other relatives
- ☐ Other (specify)______

10. How many cars do you have in your household?__________

11. How many dogs are in your household?

- ☐_____ (write number)
- ☐ None
- ☐ Don't Know/Not Sure
- ☐ Refused

12. When did you first move to the current place where you live now?

- ☐ Year: __________
- ☐ Don't know/ Not sure
- ☐ Refused

13. What are the factors that influenced where you chose to live? (Check **ALL** that apply)

- ☐ Housing affordability
- ☐ Quality of neighborhood
- ☐ Good school
- ☐ Close to school
- ☐ Good neighbors
- ☐ Close to work
- ☐ Close to family, relatives, or friends
- ☐ Close to open spaces (i.e. parks)
- ☐ Close to recreation facilities
- ☐ Easy to walk to retails and services
- ☐ Easy access to transit services
- ☐ Safe neighborhood
- ☐ Other, please specify: ________________
- ☐ Don't know/Not sure
- ☐ Refused

NEXT

14. How long do you intend to stay in your current place where you live?
- ☐ 1-5 years
- ☐ 6-10 years
- ☐ 11 or more years
- ☐ For the rest of my life
- ☐ Don't know/Not sure
- ☐ Refused

15. What is your current address? OR What street and major intersection do you live near?

_____________________________ _______________________________________

_____________________________ _______________________________________

16. Do you own or rent?
- ☐ Own
- ☐ Rent
- ☐ Don't know/Not sure
- ☐ Refused

17. How many hours do you spend in paid employment in an average week? (Skip question if you are not employed)
- ☐ 20 or less
- ☐ > 21 - 30
- ☐ > 31 - 40
- ☐ > 41 - 50
- ☐ > 51 - 60
- ☐ > 60
- ☐ Not sure

18. What is your family income (per year)?
- ☐ < $10,000
- ☐ $10,000 - $20,000
- ☐ $20,001 - $30,000
- ☐ $30,001 - $40,000
- ☐ $40,001 - $50,000
- ☐ > $50,000
- ☐ Not sure
- ☐ Refused

19. Do you have health insurance?
- ☐ Yes
- ☐ No

20. Does your child have health insurance?
- ☐ Yes
- ☐ No

21. Would you say that in general your health is:
- ☐ Very Good
- ☐ Good
- ☐ Average
- ☐ Poor
- ☐ Very Poor
- ☐ Not sure
- ☐ Refused

22. How likely are you to be physically active in the next week?
- ☐ Very likely
- ☐ Likely
- ☐ Somewhat likely
- ☐ Unlikely
- ☐ Very unlikely
- ☐ Not sure

VITA

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ADDRESS

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