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Link Park Access with Obesity Risk Reduction: Case Study of Austin, Texas

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Link Park Access with Obesity Risk Reduction:
Case Study of Austin, Texas

by

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Report

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Dedication

This professional report is dedicated to my Mom and Sister for believing, encouraging, and supporting me as I pursued a Master's Degree in a land far, far from home. Thank you for all of your prayers and love. I also thank the One who has captured my heart, mind, and soul and has never, ever let me go. You have carried me far beyond the shores of this planet, and have held my hand and heart when I needed You most.

Acknowledgements

I wish to acknowledge all of my professors, classmates, and co-workers for providing inspiration and guidance for this professional report. The UTSOA community has been an influential resource to me over the past three years, and I know the Eyes of Texas will always be upon me no matter where I land next.

Abstract

Link Park Access with Obesity Risk Reduction: Case Study of Austin, Texas

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The University of Texas at Austin, 2016

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Previous research has determined that public transportation options are severely limited in certain neighborhoods. These so-called “transit deserts” prevent many residents from relying on public transportation to get to and from home and work. But is access to public parks any better? As cities continue to reinvest in their public parks, residents will be motivated to visit them, so long as all modes of transportation are available: walking, bicycling, driving, and bus routes/rail lines for public transportation. And if the bus routes and rail lines ran frequently with actual stops near the parks, that would be even better.

This project examined the overlay of mean childhood obesity scores and Austin city parks data, including distance from bus stops to park centers using GIS, correlation and regression methods. The park amenity data was multiplied by a standard MET (metabolic equivalent) value. Maps were created to spatially show the relationships between city parks, transit routes, and obesity scores in block groups. The results revealed that Austin city parks and bus routes are spread throughout the city. The outskirts of Austin lack public parks but the bus routes extend further than the city park

system. But only 61% of Austin city parks are reached within a quarter-mile bus stop service area.

The obesity data revealed a wide range in mean childhood obesity levels, from 7% in West Austin to 47% in East Austin. Sixteen neighborhood parks are located within a quarter-mile bus stop service area and high childhood obesity block groups. There is, however, no correlation between block group obesity scores, distance from bus stops to neighborhood parks, park amenity scores, and park acreage. Although the data does not show a correlation between the presence of neighborhood park amenities and estimated obesity rates for children, peer reviewed studies have made this connection. Even though the statistical analysis does not show that park access by transit explains childhood obesity prevalence, park access does matter, and policy makers should pay attention to more than just park amenities. Improving access to parks may increase use, thus reducing childhood obesity trends in the long term.

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I. Introduction

Accessibility is derived from the words "access," a person or place able to be reached or approached easily, and "ability," the quality of being able to accomplish a task (The Free Dictionary, 2016). Often accessibility is interchanged with mobility, the movement of individuals or groups from place to place (The Free Dictionary, 2016), but in urban planning terms, accessibility refers to "the potential of opportunities for interaction," as defined by Walter G. Hansen (Hansen, 1959). Numerous studies on accessibility modeling have been published, but these studies mostly examine transportation through employment opportunities and travel time (El-Geneidy and Levinson, 2011; Geurs and Östh, 2016).

In general, accessibility can refer to distance, frequency of transit, ease of using transit, emotional response caused by entrance gates and other physical structures, the perception of safety, the perception of belonging, the ease of walking through and the use of the physical facilities. While this professional report will define "access" as the proximity from public transit to park, it is important to note all of the definitions that encompass the word access.

Obesity is caused by consuming more calories than expending them on a daily basis. According to the Centers for Disease Control and Prevention, childhood obesity is defined as a Body Mass Index (BMI) at or above the 95th percentile for children of the same age and sex. Childhood obesity has been on the rise in Texas since 2005, with the exception of a small dip in 2009 (*see Figure 1*). In 2013, 15.7% of Texas youth in grades 9-12 were considered obese (Center for Health Statistics, Texas Department of State Health Services, 2013).

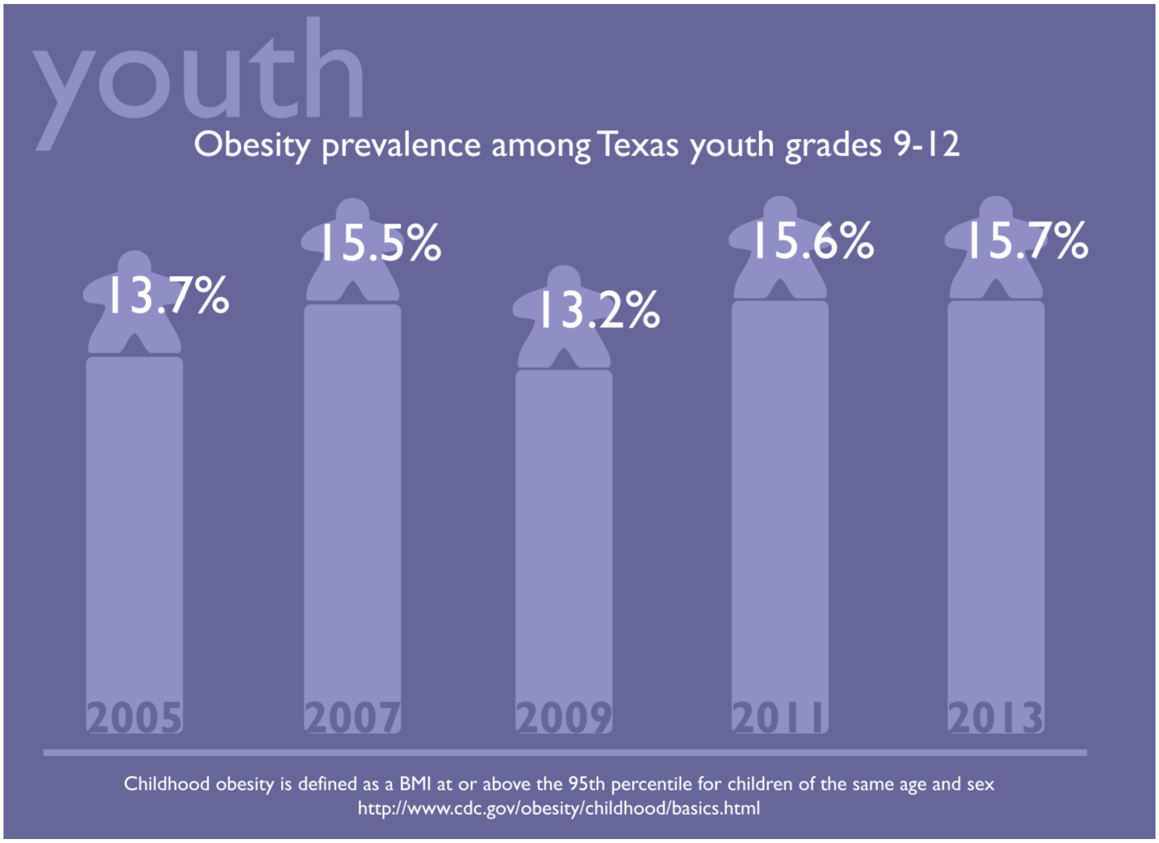


Figure 1. Texas Youth Obesity Prevalence (2005-2013) (Texas Department of State Health Services, 2013).

There are also severe health ramifications for obese individuals, including a high risk for type 2 diabetes, cardiovascular illness, early onset of arthritis, and asthma. Obesity can negatively affect the quality of a child's life and lead to poor self-esteem, depression, sleep apnea, bullying, discrimination, lack of physical ability to be active, lack of energy or stamina, and an overall lower quality of life (Children's Optimal Health, 2011).

It is well-established that physical activity helps prevent obesity and related medical problems. There is also increasing evidence that providing parks for city residents to exercise can improve health (Gies, 2006). For a park system to improve health and physical well-being, however, it must be accessible to the public. One factor that determines accessibility is park location: city parks are more likely to be used if they are near to where people, live, work, and recreate. The further a park is from where people are located, the less likely it is to be used on a regular basis. Another factor is ease of getting to the park. Transportation systems and road networks can make parks accessible, even if they are located relatively far from where people live. Parks need to be accessible via all modes of transportation, including walking, biking, driving, and public transit, to make them attractive to visit. But the decision to visit a park is conditional on more than just its location and the ease of transportation. Parks also need amenities that are appealing to residents of the community. And such playgrounds, multipurpose fields, basketball courts, swimming pools, community centers, and trails need to be safe, accessible, well-maintained and open to the public outside of school and business hours in order to facilitate people's use of city parks.

In the case of Austin, park deficits, particularly in low-income communities in Austin, have been examined through the lens of household income, ethnicity, and crime rates (Crompton, 2008). The results from Crompton's analysis support the hypothesis that park locations and amenities are not equally distributed across the City of Austin. The quantity of parks in non-white areas and higher crime rate areas are substantially lower than in white areas.

However, little research has examined whether transit access to parks matters to childhood obesity. Despite this lack of research, a 2015 study from Jiao and Nichols has been done examining transit deserts in five cities in Texas (Austin, Dallas, Fort Worth, Houston and San Antonio). A transit desert is a geographic area where there is a lack of transit service (Jiao and Nichols, 2015); i.e. where the demand for transit is greater than the supply. To calculate a transit desert, transit dependent populations were first identified as a measure of transit demand, then the transit supply was calculated, and lastly the supply was subtracted from the demand. The data in the Jiao and Nichols study used to make these calculations came from the U.S. Census Bureau in the form of the 2012 American Community Survey, as well as municipalities and transit agencies, and included population counts by block group, street networks, bike routes, sidewalks, and transit stops. Transit frequencies were collected from Google's General Transit Feed Specifications (GTFS), which is a common online format for storing public transportation schedules and their associated geographic information. The gap or difference between supply and demand determines whether or not the area is considered a transit desert (Jiao and Dillivan, 2013). In the research conducted in Austin, Jiao and Nichols found that Austin has one of the lowest intersection densities out of the five Texas cities (64.98 intersections/area), more than twice as many trips are made within a 24-hour period on a weekday in Austin than in Fort Worth (144,158 vs. 56,832), and that Austin has a weekday transit ridership almost four times higher than Fort Worth (123,000 vs. 33,000) when bus and are rail combined. Despite having a relatively high transit supply, there are transit deserts clustered in certain areas in Austin which could be attributed to population density and the high concentration of students surrounding The University of Texas (Jiao and Nichols, 2015) (*see Tables 1 and 2; Figure 2*).

Table 1: Transit and Built Environment Characteristics of Texas Cities

Measurements	Austin	Dallas	Fort Worth	Houston	San Antonio
Population (2013 estimate, July 2013)	885,400	1,257,676	792,727	2,195,914	1,409,019
Transit Dependent Population	130,146.56	329,386.94	178,058.99	839,284.33	334,529.53
Percent Transit Dependent	14.70%	26.19%	22.46%	38.22%	23.74%
Area (sq. mi.)	297.9	340.52	339.82	599.59	460.93
Density (pop/sq. mi.)	2,972.14	3,693.40	2,332.79	3,662.36	3,056.90
Routes	80 bus 1 rail	113 bus 6 rail	47 bus 1 rail	134 bus 1 rail	111 bus
Stops Within City Limits	2,620	7,653	1,977	9,182	6,810
Average Weekday Ridership	120,500 bus 2,500 rail	128,511 bus 103,789 rail	25,000 bus 8,000 rail	236,402 bus 42,652 rail	139,335 bus
Trips (24 hr, weekday)	144,158	350,969	56,832	528,367	559,984
Length, bike routes (mi)	623.81	320.59	310.21	505.69	238.19
Length, sidewalks (mi)	2,306.73	6,199.98	2,326.00	N/A	4,777.34
Length, low-speed roads (mi)	2,653.93	5,159.37	3,714.45	6,748.78	4,859.63
Intersections	19,357	65,823	26,217	61,686	47,242
Intersection density (intersections/area)	64.98	193.30	77.15	102.88	102.49

Table 1. Transit and Built Environment Characteristics of Texas Cities (Jiao and Nichols, 2015).

Largest and Smallest Transit Gaps in Austin		
Largest Gaps		
Rank	**Neighborhood Block Groups**	**Gap**
1	West Campus (25th Street)	-12.90
2	West Campus (22nd Street)	-5.87
3	West Campus (27th Street)	-5.58
4	Pleasant Valley (East Riverside Drive)	-4.84
5	West Campus (26th Street and Shoal Creek)	-4.78
Smallest Gaps		
1	Downtown	2.09
2	North Campus	2.04
3	UT Campus (Northeast)	1.65
4	Heritage (Between Lamar and Guadalupe)	1.59
5	North Downtown & Capitol	1.55

Table 2. Largest and Smallest Transit Gaps in Austin. The data was calculated from the transit dependent populations per block group area converted to Z-scores. Gap is the difference between supply and demand (Jiao and Nichols, 2015).

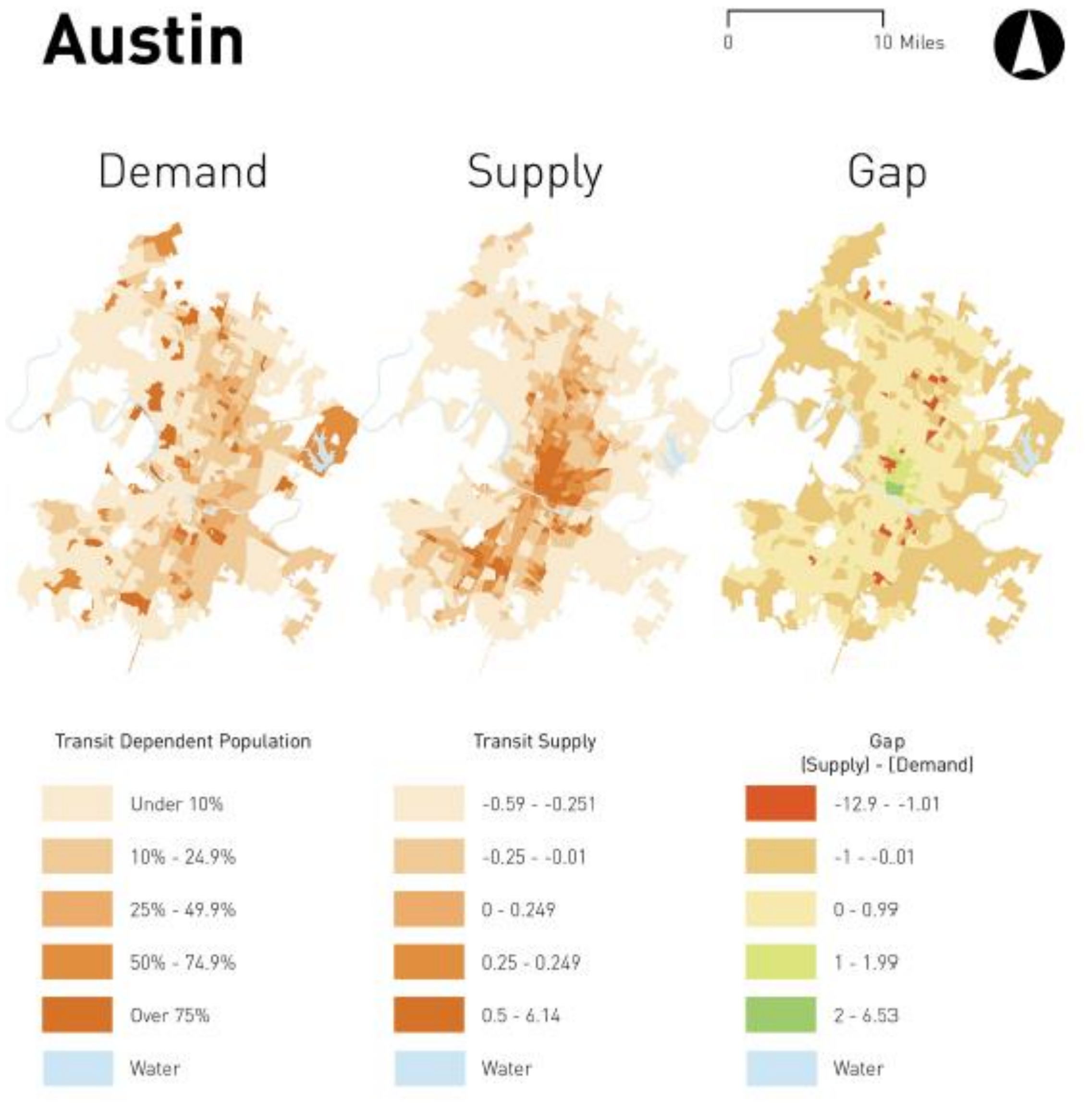


Figure 2. Transit Deserts Analysis in Austin, Texas. The data was calculated from the transit dependent populations per block group area converted to Z-scores. Gap is the difference between supply and demand (Jiao and Nichols, 2015).

The purpose of this Professional Report is to test if there is a connection between park accessibility and public transportation options, and youth obesity in Austin. Because of a lack of access to automobile transportation coupled with an incomplete sidewalk network, lack of safe bicycling routes, and poorly developed transit services, youth have poor access to neighborhood parks with organized programming designed for physical activity. Specifically, I ask the following research question: does access to neighborhood parks by transit matter to childhood obesity?

The assumptions are that all city parks are transit accessible, all neighborhood parks with organized programming are located in block groups with lower obesity scores, and park acreage does not factor in to the quantity of organized programming offered at the park. Preliminary research from a previous study indicates that not all city parks in Austin are transit accessible, so the focus will be on the 45 neighborhood parks in Austin with existing transit access and how well the amenities of those parks can promote exercise. By examining parks with transit access, it is understood that at least one mode of transportation will take youth to a neighborhood park. Examining the amenities in the parks quantifies how much that particular park can promote physical activity.

While it is fairly easy for city planners to proclaim solutions to equity gaps with regards to park access or transit access, it takes communication and real action to make a change in a community. Although this project provides a GIS analysis that demonstrates spatial relationships between park locations and transit data, future research should include interviews with city officials, community leaders, and residents to add qualitative analysis to an otherwise quantitative project. However, my analysis suggests that there is no correlation between childhood obesity levels and access to neighborhood parks.

In the following Chapter, I present background information on childhood obesity in Austin; how parks can help with the obesity crisis; race, income, and park use; and transit for park use. In Chapter III, I present methods for analysis. Chapter IV entails the findings from the analysis. Lastly, Chapters V and VI are the discussion and conclusion from the analysis.

II. Background

CHILDHOOD OBESITY IN AUSTIN

In 2007, the Austin Independent School District (AISD) and AISD Student Health Services collaborated with the Children's Optimal Health organization to raise community awareness about the childhood obesity epidemic. In November 2009, COH released their first report *Child Obesity by Neighborhood and Middle School: Volume 1* displaying 2007-2008 school year data. In 2010, *Child Obesity by Neighborhood and Middle School: Volume 2* was released with 2008-2009 school year data.

This report references the latest available school year data, 2009-2010, which was released in 2011 in *Child Obesity by Neighborhood and Middle School: Volume 3*. The *Volume 3* report includes data from 10,628 middle school students enrolled in the AISD from 2009-2010 (67% of 15,944 students). Middle School includes 6th, 7th, and 8th Grades.

The findings from *Volume 3* indicate that the percentage of overweight and obese students varied widely between middle schools in Austin, ranging from 18.7% to 48.1%. If the data were examined across a normal distribution, the target percentage of overweight and obese students would be 15% of the Austin middle school student population. Obesity percentages separated from overweight percentages also varied by middle school, with a range of 4.7% to 30.2%. Based upon a normal distribution of the Austin middle school student population, the target percentage of obese students would be 5% of the students. Additionally, higher concentrations of obesity rates were found just north and south of U.S. 183. Of the 19 middle schools studied, 11 schools revealed a decrease in obesity rates from the 2008-2009 school year, 7 schools showed an increase, and 1 school had insufficient data (*see Table 3*).

Obesity Rates by AISD Middle School					
School	% of tested students who were obese	Change in % from SY08-09 to SY09-10	School	% of tested students who were obese	Change in % from SY08-09 to SY09-10
Ann Richards	12.4%	▼ 3.7%	Lamar	18.3%	▼ 3.0%
Bailey	10.8%	▲ 2.5%	Martin	30.2%	▼ 1.0%
Bedicheck	26.4%	▲ 0.4%	Mendez	29.4%	▼ 0.6%
Burnet	26.1%	▲ 3.6%	Murchison	6.5%	▼ 6.1%
Covington	21.8%	▲ 0.8%	O Henry	13.8%	▼ 1.0%
Dobie	17.4%	▲ 1.1%	Paredes	19.3%	▼ 1.8%
Fulmore	19.1%	▼ 8.1%	Pearce	22.3%	▼ 5.8%
Garcia	22.8%	▼ 0.9%	Small	11.7%	▲ 1.9%
Gorzycki*	4.7%	-	Webb	23.9%	▼ 6.4%
Kealing	16.5%	▲ 1.4%			

* Gorzycki was not open in SY08-09.

Note: The SY08-09 maps can be found in *Child Obesity: Volume 2* located on the web at www.childrensoptimalhealth.org.

Table 3. Obesity Rates by AISD Middle School (2009-2010) (Children's Optimal Health, 2011).

The obesity situation among high school youth in Austin is similar to averages across the state of Texas. Across 15 high schools in Austin, obese or severe obese percentages range from 5.1% to 27.4%, with an average of 14.9%. Across 19 middle schools, obese or severe percentages range from 4.8% (although this figure is from a school missing large amounts of data) to 34.8%, with an average of 21.3%. Lastly, across 79 elementary schools, obese or severe percentages range from 4.1% to 46.6%, with an average of 21.8%. The data collected in the 2011-2012 academic year at the local level reveals an increase in obesity rates for younger children, a possible reflection of a more sedentary lifestyle.

PARKS CAN HELP THE OBESITY CRISIS

Many community factors can contribute to childhood obesity, including the lack of neighborhood grocery stores, the presence of fast food restaurants, and safety concerns while playing outside (Zhang et al, 2013). However, there is still an urgent need to increase physical activity and promote healthy eating to combat the rise in obesity and other related medical problems. The idea of improving the built environment to combat sedentary behavior has been gaining traction since the early 90s.

It is no secret that daily physical activity can lead to positive effects for children and youth. Research studies have found exercise improves many health outcomes, including: fitness, decreased risk of cardiovascular and metabolic diseases in adulthood, decreased risk of developing type 2 diabetes in childhood and adulthood, and improvements in bone health and development, mental health and well-being, cognitive and academic performance, and motor control and physical functioning (National Physical Activity Plan Alliance, 2015).

The *2008 Physical Activity Guidelines for Americans* recommends children and teenagers (aged 6 to 17) participate in one hour or more of physical activity daily. This should include aerobic (moderate or vigorous intensity), and age-appropriate muscle-strengthening and bone-strengthening activities at least three days per week. Examples for the three classifications of physical activities are: running, hopping, skipping, jumping rope, swimming, dancing, and bicycling for aerobic; unstructured or structured activities, such as using playgrounds, climbing trees, playing tug-of-war, lifting weights, or using resistance bands for muscle-strengthening; and intense impact with the ground, such as running, jumping rope, basketball, tennis, and hopscotch for bone-strengthening (Buchner et al, 2008).

Although the benefits of physical exercise are clear, *The 2014 United States Report Card on Physical Activity for Children and Youth* assesses current physical activity in children and youth. The *Report Card* also suggests there are barriers for youth to engage in physical activity and explains the related health outcomes of these activities. Some barriers to physical activity include neighborhood safety, access to parks and trails, electronic equipment at home, social climate among peers, physical weather, and walk to school programs. The *Report Card* reveals the intersection between policy and the physical environment and how both influence an active lifestyle (*see Figure 3*). Health care policies/incentives, zoning codes, development regulations, transportation investments and regulations, public recreation investments, and physical education polices and funding in schools all contribute to access to physical activity for youth. As a result of these barriers, according to the 2012 National Health and Nutrition Examination Survey (NHANES) and National Youth Fitness Survey (NNYFS), only 24.8% of children and youth (aged 6-15) obtain 60 minutes or more of moderate-to-vigorous physical activity at least five days per week. Results varied by gender, age, and ethnicity, but males, younger children, and non-whites were more physically active than females, older children, and whites (National Physical Activity Plan Alliance, 2015).

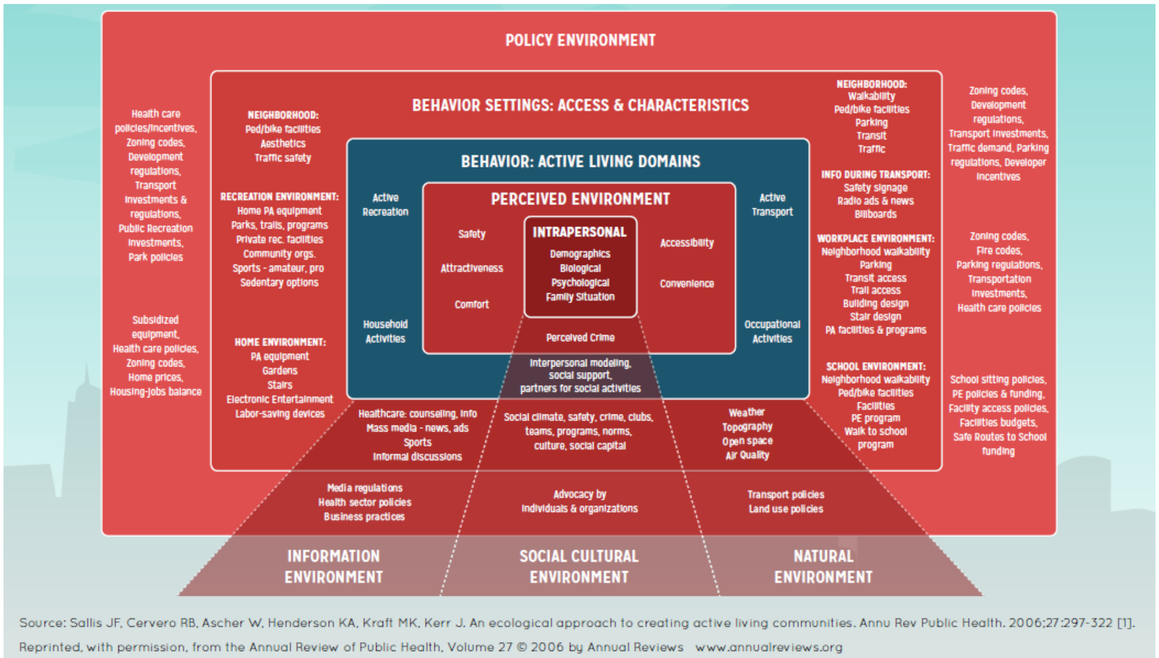


Figure 3. The Ecological Model of Four Domains of Active Living (National Physical Activity Plan Alliance, 2015).

To help promote physical activity in Americans, the U.S. National Physical Activity Plan (NPAP) was created by the National Physical Activity Plan Alliance, a coalition of national organizations committed to promoting physical activity in the American population. The Alliance is governed by a Board of Directors composed of at-large experts on physical activity and public health as well as representatives from 23 organizational partners, such as Active Living Research, American Diabetes Association, American Physical Therapy Association, and National Academy of Sports Medicine. In addition, there are two federal partners, the Centers for Disease Control and Prevention and the U.S. Department of Agriculture. The Alliance crafted this comprehensive, evidence-based strategic plan as a set of policies, programs, and initiatives offering recommendations across nine societal sectors: Business and Industry; Community Recreation, Fitness and Parks; Education; Faith-Based Settings; Healthcare; Mass Media;

Public Health; Sport; and Transportation, Land Use, and Community Design. The sector most relevant to my professional report is Community Recreation, Fitness and Parks because of its five strategies:

Strategy 1: Communities should develop new, and enhance existing community recreation, fitness, and park programs that provide and promote healthy physical activity opportunities for diverse users across the lifespan.

Strategy 2: Communities should improve availability of and access to, safe, clean, and affordable community recreation, fitness, and park facilities to support physical activity for all residents.

Strategy 3: Community recreation and park organizations, the fitness industry and private business should recruit, train, and retain a diverse group of leaders, staff, and volunteers to promote, organize, lead, and advocate for initiatives that encourage physical activity in their communities.

Strategy 4: Community recreation and park organizations, the fitness industry and private business should advocate for increased and sustainable funding and resources to create new, or enhance existing, physical activity facilities and services in areas of high need.

Strategy 5: Community recreation and park organizations and the for- and not-for-profit fitness industry should improve monitoring and evaluation of participation in community-based physical activity programs to gauge their effectiveness in promoting increased levels of physical activity for all.

Strategy 2 implies that access to safe and clean neighborhood parks and recreation facilities is a way to encourage residents to be more physically active. Specifically, the recommendations regarding Community Recreation, Fitness and Parks includes five strategies and 24 tactics aimed directly at communities, organizations, agencies, and individuals for implementation in order to improve close-to-home park access (National Physical Activity Plan Alliance, 2016).

But just simply improving the ease of getting youth to neighborhood parks is not going to solve the obesity crisis. There are many factors that contribute to park access including physical proximity (location) to neighborhoods, size of the park, qualities of amenities inside the park, quantities of facility types at the park, and safety while using the park (Zhang et al, 2011).

The proximity to neighborhood parks is especially important for youth who are unable to drive and rely upon walking, bicycling, or public transit to visit parks. A randomly selected sample of 1,556 girls from six middle schools in 6th Grade across Washington, DC and Baltimore, Maryland; Columbia, South Carolina; Minneapolis, Minnesota; New Orleans, Louisiana; Tucson, Arizona; and San Diego, California revealed an increase in physical activity the closer the students lived to their neighborhood park (Cohen, et al, 2006).

Any additional minutes of non-school moderate/vigorous physical activity increased metabolic rates an average of 4%-6% for each individual girl. Activities included using walking paths, running tracks, playgrounds, and basketball courts. Parks with streetlights and floodlights were also used after dark and were included in increased metabolic rates. However, skate parks and special-use parks did not increase metabolic rates (Cohen, et al, 2006).

A study tracking physical activity levels in 799 adolescents between the ages of 11 and 15 (with 53% girls and 43% ethnic minority) in San Diego County discovered that the quantity of nearby recreation facilities and parks had a positive correlation with girls but not so much for boys. Intersection density had a surprising negative correlation despite being known as a positive correlator of physical activity. Neither community design nor access to recreation facilities correlated with BMI rates. While community design and access to recreational facilities is related to physical activity, the variance was only 2-3%. While this is a small variance, the impacts on public health have the potential to be significant as environmental factors often influence physical activity (Norman et al, 2006).

A 2013 report examining neighborhood parks found that parks and playgrounds do make children more fit due to a reduction in BMI (Fan and Jin, 2013). These results were both statistically and economically significant and dependent upon additional socioeconomic factors such as gender, age, race, household income, neighborhood safety, and other neighborhood amenities (community centers or children's clubs and presence of sidewalks or walking paths). The presence of parks and playgrounds had a greater effect on girls than boys between the ages of 10 and 13 compared to adolescents between the ages of 14 and 17. Parks had a greater effect on non-Hispanic whites than blacks or Hispanics, as well as children in low-income households compared to high-income households. Neighborhood safety also played a role on the effect parks and playgrounds had on the children (Fan and Jin, 2013).

The data for this study came from the 2007 National Survey of Children's Health and involved two groups, a control and treated group. The presence of a neighborhood park or playground reduced the probability of being overweight or obese by three percentage points for males and five to six percentage points for females (Fan and Jin, 2013). Fan and Jin also accounted for unobserved individual characteristics and neighborhood attributes to prevent skewing of the data. Two falsification tests were included to eliminate the bias that families chose to live in neighborhoods with more parks and playgrounds because they were already health conscious, and that some neighborhoods already have better access to healthcare providers. Children's weights were substituted for asthma in the model with no change in result (Fan and Jin, 2013).

Neighborhood safety also mattered. More than 70% of neighborhoods with parks and playgrounds also contained community centers or children's clubs, compared to less than 40% of neighborhoods lacking those same amenities (Fan and Jin, 2013).

As the obesity endemic escalates among youth and low-income communities, perhaps this research can continue conversations as to why cities should continue to invest, and reinvest, in their public park systems. It is clear that parks can promote physical activity for youth if they have enough amenities to do so. But exercise alone cannot combat obesity levels. There are many factors contributing to childhood obesity, including physical – lack of exercise; socioeconomic – household income and access to health care or health insurance; environmental – food insecurity; and even cultural – eating habits or family recipes that use excessive sugar, butter, or fat (Children's Optimal Health, 2011). Another powerful factor in the war against obesity is genetics and a pre-disposed probability that youth will be obese simply through their blood line.

RACE, INCOME AND PARK USE

In addition to the physical attributes of neighborhood parks, the socioeconomic demographics of the neighborhood also dictate whether or not youth are using the park for physical activity. A different study of 50 neighborhood parks in a large Southern California city showed parks in low-income neighborhoods are used less frequently than parks in high-income neighborhoods (Cohen, et al, 2012).

Local residents surveyed about visiting the neighborhood parks as well as users actually observed at the parks increased when both types of users knew the dedicated staff at the parks and when there were organized activities at the parks. Knowing the full and part-time staff at the parks also increased the visitors' perception of park safety. However, gender and race still factored into park attendance as women and minorities in this study were reported as using the parks less compared to men and whites. Females were more likely to sit or use the playground area, while males were more likely to be playing sports, such as basketball, soccer, or baseball. In high-poverty neighborhood parks, men were observed sitting more than in middle or low-poverty neighborhood parks, and if they were active, they were more likely to play soccer than baseball. Women had fewer differences in activity participation across neighborhood poverty levels (Cohen, et al, 2012).

Of the surveyed neighborhood visitors and observed park users, observed park users were more likely to be Latino (74.8% vs. 62.0%), younger (38 years vs. 42 years), reported more visits per week (2.8 days vs. 0.9), and lived further away from the neighborhood parks (1.16 miles vs. 0.5 miles) (Cohen, et al, 2012).

These two separate Cohen et al studies relate to Zhang et al's article by explaining that while proximity (location) to parks is a contributing factor to whether or not parks are used by youth, the income level compositions of the neighborhoods where youth live also contribute to park use, with parks in low-income neighborhoods having less use than parks in high-income neighborhoods. While the articles show that parks have different levels of use in different socioeconomic demographics, it is important to remember that in order for parks to help combat obesity, they must be used by the residents in the community.

TRANSIT FOR PARK USE

In general, there is a lack of focus on children in transportation literature. Articles were found examining the presence and condition of sidewalks and bike lanes, as well as the presence of crosswalks, street connectivity, and access to destinations. Public transportation use by children is lacking in the literature. A 2004 study from Australia found that parental perception of heavy traffic and limited public transportation options led to lower rates of walking and cycling among children between the ages of 5 and 6. For children between the ages of 10 and 12, if the youth perceived a lack of nearby parks, and the parents perceived their children had to cross too many streets to get to said parks (particularly if the streets were lacking traffic lights and crosswalks), as well as limited public transportation options, the youth were less likely to walk or cycle to the parks (Timperio et al, 2004).

To summarize, children tend to be more physically active if there are sidewalks in their neighborhoods, they have specific destinations to go to, public transportation options are available, street intersections have traffic lights and crosswalks, and traffic density is low (Davison and Lawson, 2006). A review of numerous articles by Davison and Lawson concluded there are not consistent differences by gender or ethnic group for these findings.

In conclusion, all of the readings from the literature review have shaped my methods and analysis by providing confirmation that park access can improve physical activity and thus be a factor in reducing obesity. But for parks to improve physical activity, they must be spatially accessible and have amenities that encourage and promote exercise. It is important to note that proximity alone is not enough to increase the use of parks because other factors, such as safety, amenities, etc. determine whether or not youth are using neighborhood parks as a form of physical activity.

The City of Austin was chosen as the case study because I have been living and working in this city and using its city parks for the past three years. By determining which neighborhood parks are transit accessible, I am focusing on only 45 parks, with the understanding that combatting childhood obesity would begin at the neighborhood level. While any sized park can be used for physical activity, the other types of City of Austin parks that are transit accessible were not included to keep the scope small. Because the obesity data included factors for household income, race and gender, those additional variables were not included in the model.

III. Methods

INTRODUCTION

GIS was used to determine which of the 292 Austin city parks are accessible via public transit. Previous studies determining accessibility to parks have used GIS as an analytical method. By using the Network Analyst tool in GIS, I spatially defined a "Service Area" around any site located on a "network," i.e., the street grid. A Service Area is a region that encompasses all of the parks that can be reached via the street network within a specific period of time or distance. Any impedance, such as speed limits, traffic signals, or congestion can also be factored into the network to refine the analysis. The Network Analyst tool can also specify the "Closest Facility" to a specific point. I used this function to find the actual distance from park centroid to bus stop for the distance category. Park amenity data was collected from the City of Austin website and the acreage data came from the GIS shapefile. The park amenity data was multiplied by a standard MET (metabolic equivalent) value from *The Compendium of Energy Expenditures for Youth* (Ridley et al, 2008). Obesity data was collected from the Centers for Disease Control and Prevention also in the form of a GIS shapefile. The 45 neighborhood parks were given a score combining transit distance, amenity values, and size in acres. Correlations were made between the three independent variables (distance, amenities, and size) and the dependent variable (obesity) using Excel. Regressions were done to find the significance values. Scatter plots were drawn to spatially show the relationship between the independent and dependent variables. GIS maps were also created to spatially show the relationships between city parks, transit routes, and obesity scores in block groups. These methods refute my assumptions that all city parks are transit accessible, all neighborhood parks with organized programming are located in block groups with lower obesity scores, and park acreage does not factor in to the quantity of organized programming offered at the park.

GIS ANALYSIS

Shapefiles of rail and bus routes were gathered from the Capital Metropolitan Transportation Authority (Capital Metro). Capital Metro has been Austin's regional public transportation provider since 1985 with over 32 million boardings every year. Parks data were obtained from the City of Austin Parks Department in the form of GIS shapefiles. Park amenity data, including bike rack counts, were collected from the Austin Parks Foundation and City of Austin websites. Additional streets data were gathered from the City of Austin. Austin city limits and waterbodies data were gathered from the Texas State Data Center.

Next, city boundaries, waterbodies, and obesity data were "Projected" to NAD 1983 State Plane Texas Central FIPS 4203 (feet). Streets, waterbodies, parks, CapMetro Service Area, bus routes, and bus stops shapefiles were clipped to Austin city limits. Then, a GIS analysis using CapMetro bus routes and stop data and parks data from the Parks Department was conducted using the Network Analyst and the Intersect tool. Network Analyst was used to determine a quarter-mile buffer from the bus stops to the parks. The parks and transit data were both buffered by a quarter-mile. The "Intersect" tool was used in GIS to determine precisely how many parks were in each bus stop service area. The parks were then separated by classification type and management to determine more specific data about the parks that were captured in the bus stop service area. The "Intersect" tool in ArcMap 10.3.1 was used to determine which parks intersect the bus stops at the quarter-mile distance.

Network Analyst for services areas was used to determine the accessibility of the city parks to the bus stops. A new Network Dataset was created to model the street and transportation network. The distance that defines the service area was 0.25 miles. It is important to note that the standard service area of a bus stop is a quarter-mile, but the standard service area of a park is a ten minute walk, or half-mile radius. Generally transit walksheds should use sidewalk data and not the street network to measure distance. Due to the unreliability of sidewalk data in Austin, the street network was used instead to run the Network Analyst tool. The Closest Facility function under the Network Analyst tool was used to determine the distance from the closest bus stop to the center of the neighborhood park. While some parks are served by multiple bus stops, using the one closest to the park centroid allowed for a specific distance to measure accessibility.

Inventory from the City of Austin revealed a very robust collection of information in the park GIS shapefile. The data included 292 parks classified into eleven types: cemetery, district, golf course, greenbelt, metropolitan, nature preserve, neighborhood, planting strips/triangles, pocket, school, and special. The data also included service areas for each park type. This information ranged from 0-0.5, 0-5, 0-25, and 0-100 miles (*see Appendix B*). According to the metadata on the City of Austin website, these classifications are from NRPA (National Recreation and Park Association). While it was recommended to map the city parks into these eleven different categories, I decided to selectively separate the parks into only six categories of interest: district, golf course, greenbelt, metropolitan, nature preserve, and neighborhood.

It should be noted that I believe standards drawn from NRPA's 1996 *Park, Recreation, Open Space and Greenway Guidelines* are an antiquated way to classify parkland. These ranges are based upon driving distance, not walking distance, and to increase physical activity, city residents should be walking or biking to parks or walking to transit to take them to parks. Relying upon standards dependent upon access to an automobile should not be the deciding factor of the reaches of a park.

OBESITY DATA AT A NATIONAL LEVEL

Predicted childhood obesity scores were used from the Centers for Disease Control and Prevention. This data consists of the average percentage of children between the ages of 10 and 17 classified as obese in each block group in Austin. In the past, health surveys from the National Health and Nutrition Examination Survey (NHANES), the National Survey of Children's Health (NSCH), and the Youth Risk Behavior Survey (YRBS) were used to collect data on national or state childhood obesity rates. Obtaining obesity data at a small scale or in neighborhoods or communities was costly and therefore not collected.

In 2013, researchers from the Centers for Disease Control and Prevention (CDC) conducted a multilevel, model-based, small-area study at the county and zip code level using various demographic characteristics (age, sex, and race/ethnicity) from the NSCH 2007 to estimate childhood obesity prevalence at the Census block group level. Although research has been published using small-area estimates (SAEs) to determine obesity prevalence among adults, this was the first study using SAEs to estimate obesity prevalence in children (Zhang et al, 2013).

The 2013 Zhang et al study included 44,906 children between the ages of 10 and 17 with a confirmed obesity outcome, i.e., known as obese. The children were from 2,618 counties and 13,291 zip codes across all 50 states and the District of Columbia. Sample sizes by state ranged from 736 in Nevada to 947 in North Dakota. The mean was 865 and the median was 876 (in Vermont). The sheer size and geographic diversity of the sample validates the data collected.

The age of the children were categorized into two groups (10-14 years old and 15-17 years old) to be consistent with age classifications in block group population data. Racial/ethnic categories included white, black, Asian, Hispanic, American Indian/Alaska Native, Native Hawaiian/Pacific Islander, multiracial, and other race.

The multilevel logistic regression model to determine a child's obesity status in the 2007 NSCH also included median household income, lifestyle classifications, and urbanization levels, calculated as follows:

NSCH child obesity status (yes or no) = sex + age + race/ethnicity (individual level) + median household income + lifestyle classifications + urbanization levels (zip-code level) + median household income + urban-rural (county-level) + random effects (state- and county-levels)

The model used to determine small-area estimates of childhood obesity prevalence at the block group level was similar:

A child's predicted obesity risk = sex + age + race/ethnicity (individual-level) + median household income + lifestyle classifications + urbanization levels (block-group level) + median household income + urban-rural (county-level) + random effects (state-level)

It was assumed that the block group and zip code level were at similar geographic scales, thus having the same influences on childhood obesity.

There were some interesting results from the study which was used as a basis for the estimation method. Even after controlling for age, sex, race/ethnicity, and zip code level median household income and lifestyle, county level median household income and rural-urban status were not significantly associated with childhood obesity. Zip code urbanization levels were also not significant, so these variables, as well as county level variables, were excluded from the final multilevel model (estimation method) predicting childhood obesity risk in a neighborhood (Zhang et al, 2013).

The national and county model-based estimates for each state were similar to the 2007 NSCH direct survey estimates and fell within the 95% Confidence Level. The model revealed 16.8% obesity among children aged 10 to 17 years old compared to 16.4% of children with the same age from the survey (with a <2.5% difference). When a paired t-test was conducted, there appeared no significant difference between the results of the model and the direct survey (Zhang et al, 2013).

E-mail communication with Dr. Stephen J. Onufrak, Epidemiologist with the National Center for Chronic Disease Prevention and Health Promotion and one of the co-authors of the 2013 paper, confirmed the model-based estimates were appropriate for identifying places where obesity prevalence is expected to be the highest and will thus work fine for the hypotheses: does access to neighborhood parks by transit matter to childhood obesity? Because of the positive results from the paper and the feedback from the co-author, the CDC obesity data was found to be reliable and thus used for this project.

OBESITY SCORING

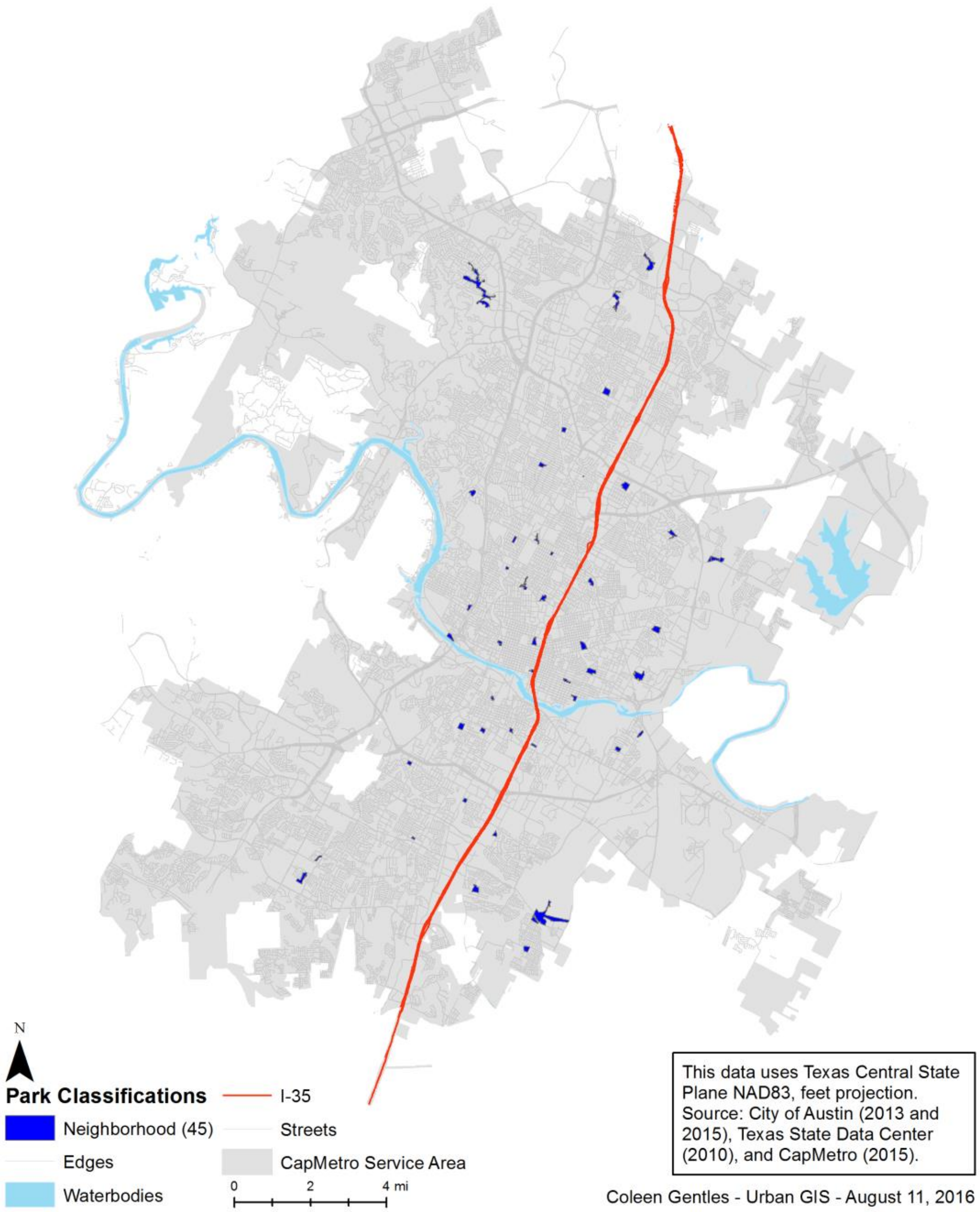
I determined obesity levels by collecting the predicted obesity prevalence (or mean of each block group) for each block group where the park was located. This percentage data was already calculated for me from the CDC and given to me in a GIS shapefile. The "Intersect" tool in GIS revealed that 177 parks are within a quarter-mile of the bus stops, i.e., are transit accessible. Of the 177 parks, 45 of them are classified as neighborhood parks. These 45 neighborhood parks are primarily located around I-35 (*see Figure 4*). Of the 45 neighborhood parks that are considered transit accessible, 37 completely fell within the boundaries of a single block group, seven parks fell within two block groups (i.e., they were not completely within the boundaries of a single block group), and one park was located in four block groups. This matters for my analysis because to capture an accurate obesity score surrounding each park, I want to capture all block groups included in the park's boundaries. For the eight parks located in more than one block group, a weighted average was used for obesity score. Population counts for children between the ages of 10 and 17 were collected from the 2010 U.S. Census for those block groups where the parks fell in more than one block group. This value was multiplied by the existing predicted obesity prevalence in the block group. Each block group was then added together and divided by the total population in each block group for a weighted average, as follows:

$$\text{Revised Obesity Score} = \frac{(O_1 \times P_1) + (O_2 \times P_2)}{(P_1 + P_2)}$$

Where: O = Original Obesity Score, and

P = Age 10-17 Population in each Block Group

Figure 4. Transit Accessible Neighborhood Parks within Austin



Distance From Bus Stop to Park

The total distance from the closest bus stop to each park was calculated from the Closest Facility function under the Network Analyst tool. GIS determined the park centroid (or center of the park), and using the bus stop, calculated a distance from one point to the next point. While some parks are served by multiple bus stops, using the one closest to the park centroid allowed for a specific distance to measure transit accessibility.

Park Amenity Scoring (Tracking Energy Expenditures in Youth)

Measuring both energy intake and energy expenditure is required to accurately determine if physical activity is influencing health. But very few studies have examined energy expenditure in youth activities. An Australian study created a compendium of energy costs for youth between the ages of 6 and 17.9 based on the 1993 *Compendium of Physical Activities* for adults (Ainsworth, et al, 1993). This new *Compendium of Energy Expenditures for Youth* (Ridley et al, 2008) utilizes existing literature and research on the energy costs of activities in U.S. children and teenagers and provides current metabolic equivalent (MET) values for youth. MET values express the energy cost of physical activities and are defined as the rate of energy consumption compared to the resting metabolic rate (1 kcal/kg/hour).

Unfortunately, of the 244 adult activities listed in the *Compendium*, only 35% of them were based on data measured in youth and thus calculated to youth MET values. Since this research project only examined fourteen amenities in city parks, it was determined the MET values provided the best information currently available to measure physical activity. I therefore scored the parks' amenity value by summing the total count of fourteen amenities promoting physical activity and multiplying this number by the standard MET value provided in the *Compendium* (Ridley et al, 2008).

Because not every park amenity had a MET activity level equivalent, some amenities used a standard value of 6.3 (unstructured outdoor play - hard effort). All MET values used were classified as “hard effort” from the *Compendium* (Ridley et al, 2008) to maximize the amount of energy expended on each activity. There were, however, two exceptions: tenpin bowling and aerobics/health hustle - moderate effort from the *Compendium* (Ridley et al, 2008) as those two activities did not have a “hard effort” value (*see Table 4*).

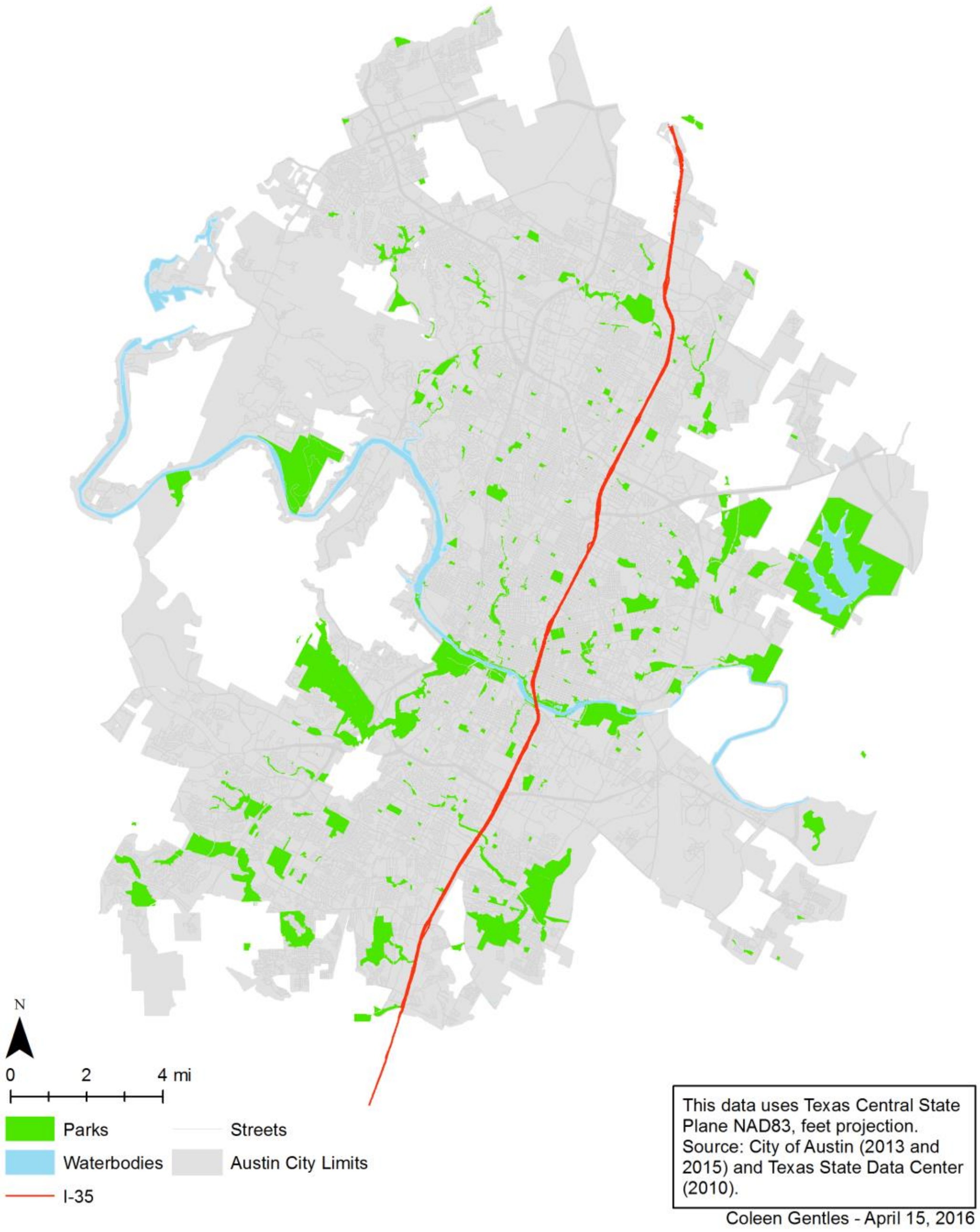
The Compendium of Energy Expenditures for Youth - Select Activities		
Park Amenities	**MET**	**Activity**
Baseball Fields	4.4	cricket - hard effort
Basketball Courts	10.1	basketball - hard effort
Bocce Ball Courts	4.9	tenpin bowling
Multipurpose Fields	11.0	soccer (field/indoor) - hard effort
Playgrounds	6.3	playground equipment (e.g. monkey bars) - hard effort
Skateboard Area	6.3	unstructured outdoor play - hard effort
Soccer Fields	11.0	soccer (field/indoor) - hard effort
Softball Fields	4.4	cricket - hard effort
Splash Pad	6.3	unstructured outdoor play - hard effort
Swimming Pools	11.6	swimming laps - hard effort
Tennis Courts	6.3	hand tennis (four-square) - hard effort
Trails (Distance in Miles)	7.8	riding a bicycle/bike - hard effort
Volleyball Courts	6.2	aerobics/health hustle - moderate effort
Wading Pools	6.3	unstructured outdoor play - hard effort

Table 4. Select city park amenities and their associated MET values.

IV. Findings and Analysis

The Austin Parks Map reveals 292 Austin city parks owned by the Austin Parks and Recreation Department. This list does not include parkland owned by the Austin Water Utility, Wildland Conservation Division; Texas Parks and Wildlife Department (within Austin), or Travis County Parks (within Austin). These other entities were excluded to only focus on city owned parks (*see Figure 5*).

Figure 5. Austin City Parks



There are 87 bus routes (including 13 UT shuttle routes), one Metrorail route, and 2,619 bus stops managed by CapMetro within Austin (*see Figures 6 and 7*). A quarter-mile buffer was drawn using Network Analyst around the 2,619 bus stops within Austin (*see Figure 8*). The "Intersect" tool revealed 177 parks within a quarter-mile of the bus stops. This equates to almost 61% of Austin city parks (*see Table 5*).

Parks Reached by Bus Stops		
Distance	**Number of Parks**	**Percentage**
Quarter-Mile	177	60.6%
Total Parks:	292	

Table 5. Austin city parks reached by bus stops within a quarter-mile buffer.

Note that some of the larger, iconic parks to the west (such as Emma Long Metro Park and Barton Creek Greenbelt and Wilderness Park south of the river) are not reached by transit (*see Figure 9*).

Figure 6. Bus Routes and Metrorail within Austin

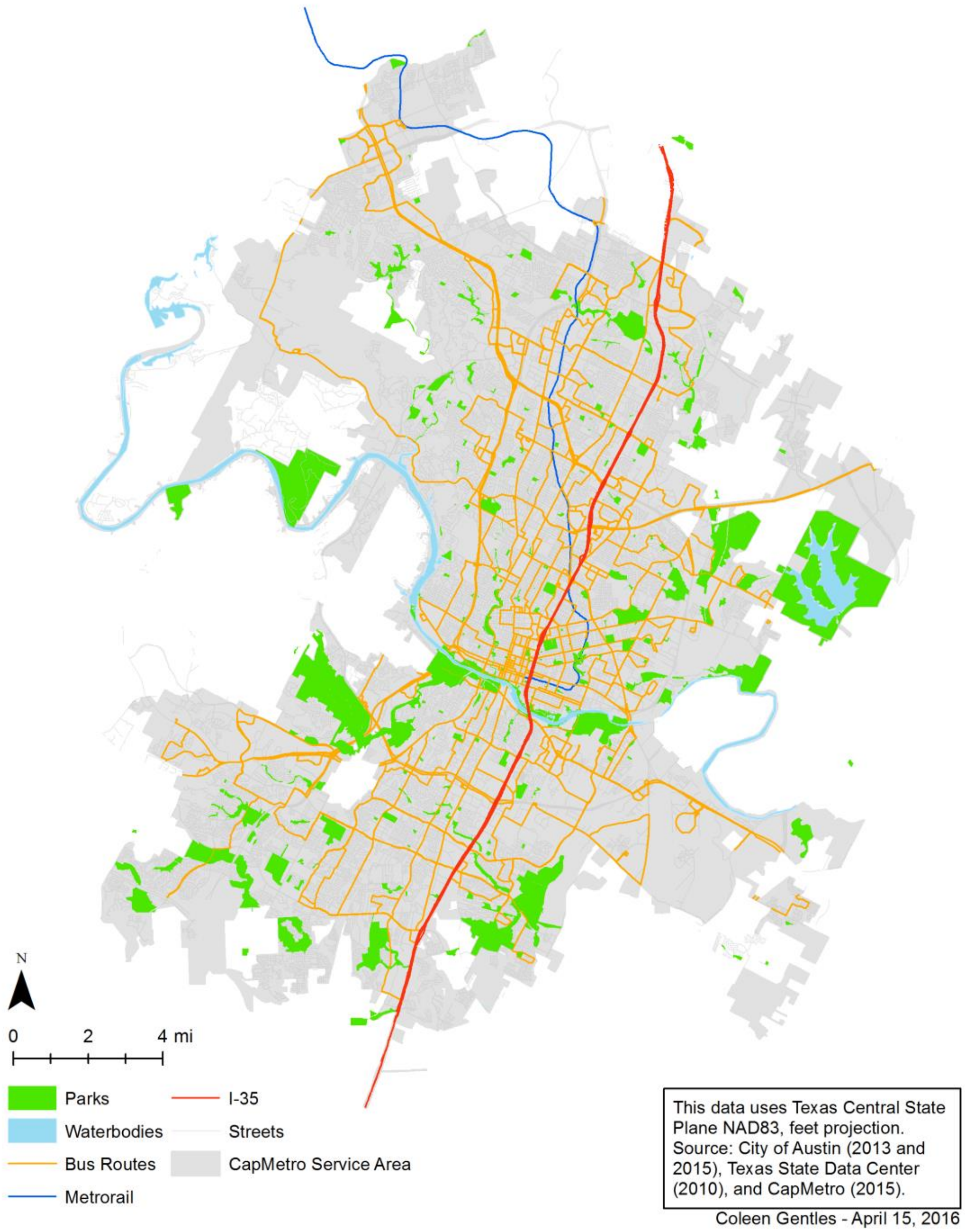


Figure 7. Bus Stops within Austin

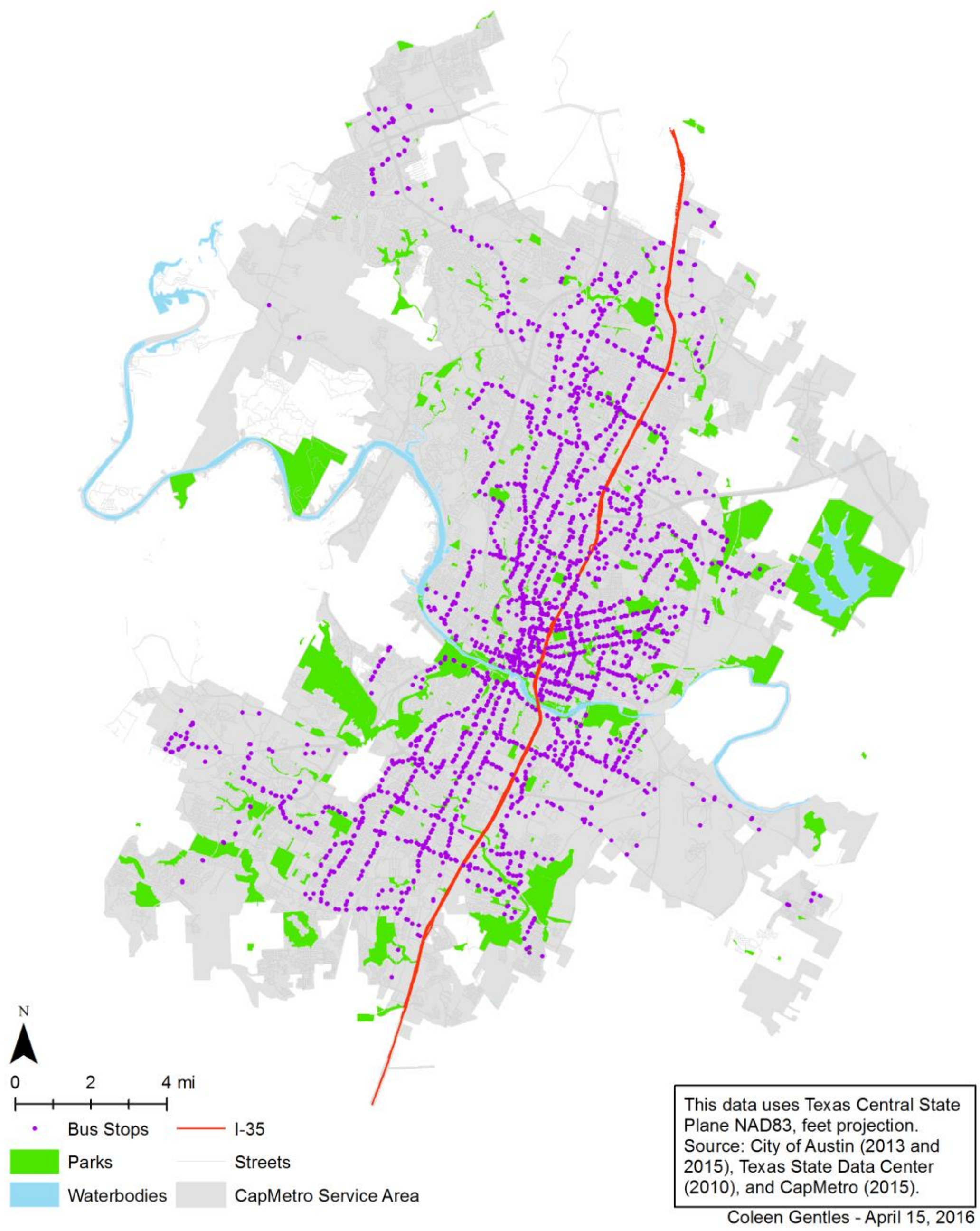


Figure 8. Quarter-Mile Bus Stop Service Areas within Austin

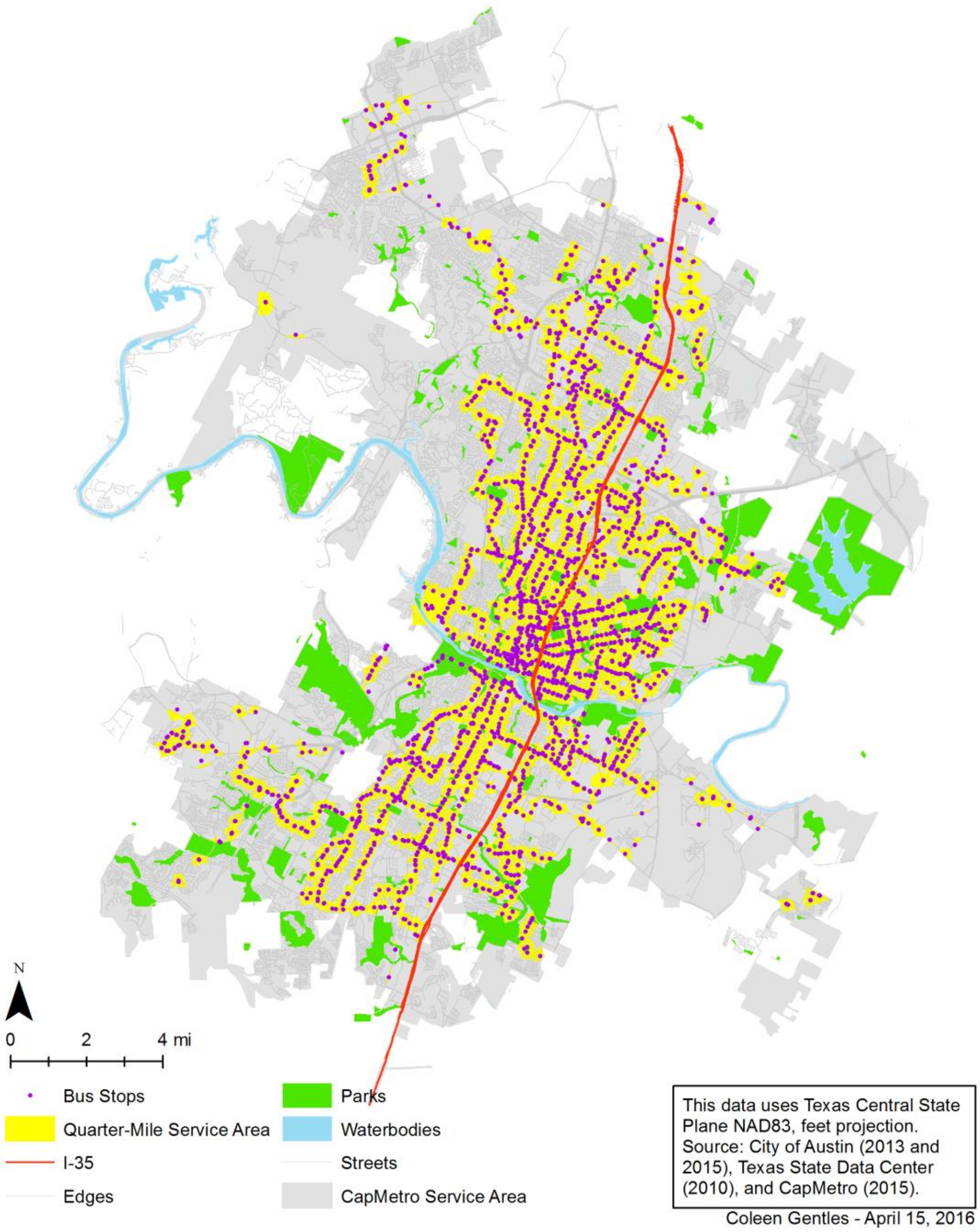
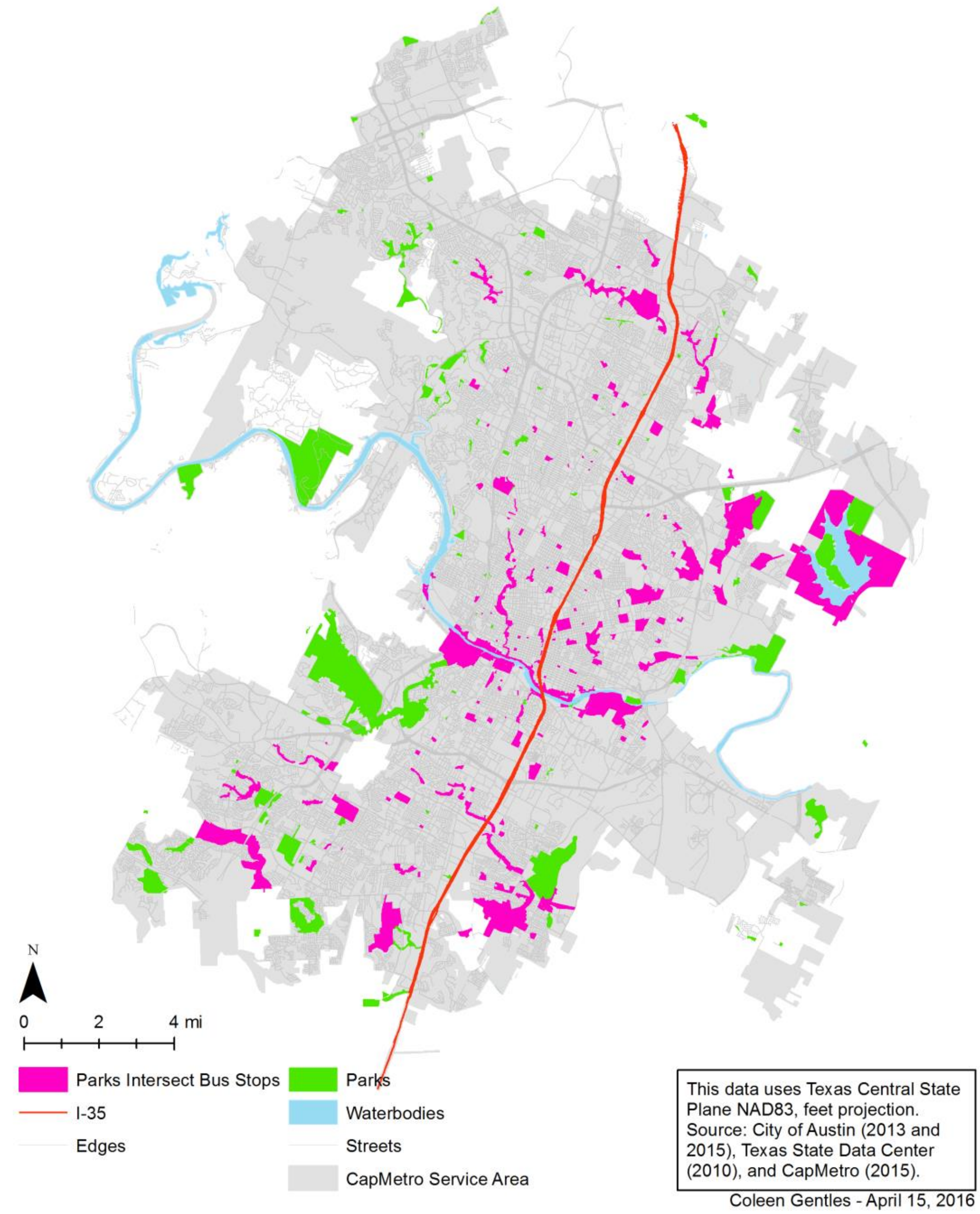


Figure 9. Parks Intersect Bus Stops in Quarter-Mile Service Areas within Austin

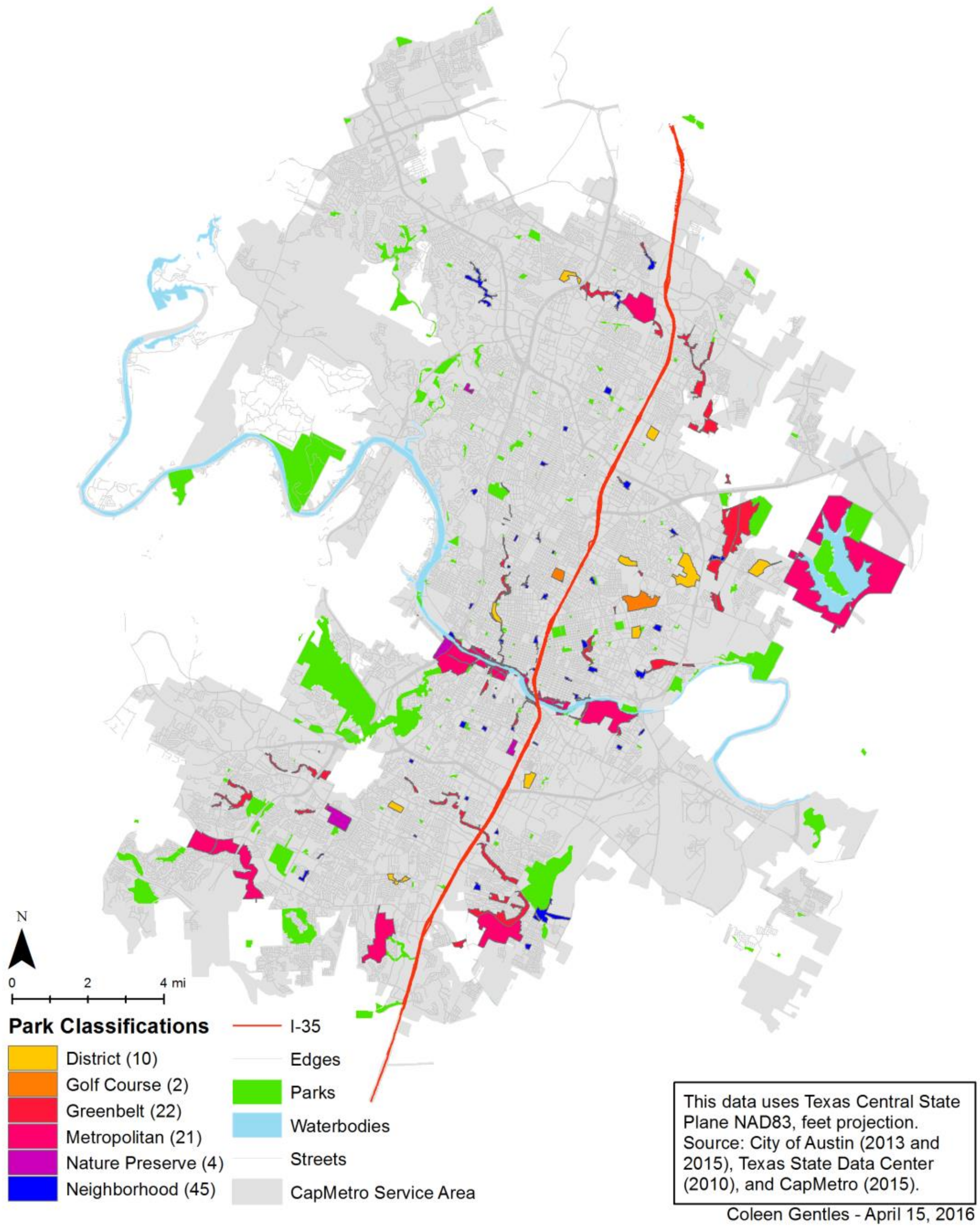


When the parks are separated by select types, eight of the eleven parks types (Cemetery, District, Greenbelt, Metropolitan, Neighborhood, Pocket, School, and Special) are above 50% in terms of number of parks reached by a quarter-mile buffer (*see Table 6 and Figure 10*).

Number and Percentage of Parks Reached by Park Type Classification			
Type	**Count (Quarter-mile)**	**Total Counts**	**Percent in Quarter-mile**
Cemetery	5	5	100.0%
District	10	15	66.7%
Golf Course	2	5	40.0%
Greenbelt	22	43	51.2%
Metropolitan	21	25	84.0%
Nature Preserve	4	15	26.7%
Neighborhood	**45**	**85**	**52.9%**
Planting Strips/Triangles	3	8	37.5%
Pocket	19	26	73.1%
School	16	23	69.6%
Special	30	42	71.4%
Total Parks:	177	292	

Table 6. Number and percentage of Austin city parks reached by bus stops separated by park type within a quarter-mile buffer.

Figure 10. Select Parks Classified by Type in Quarter-Mile Service Areas within Austin



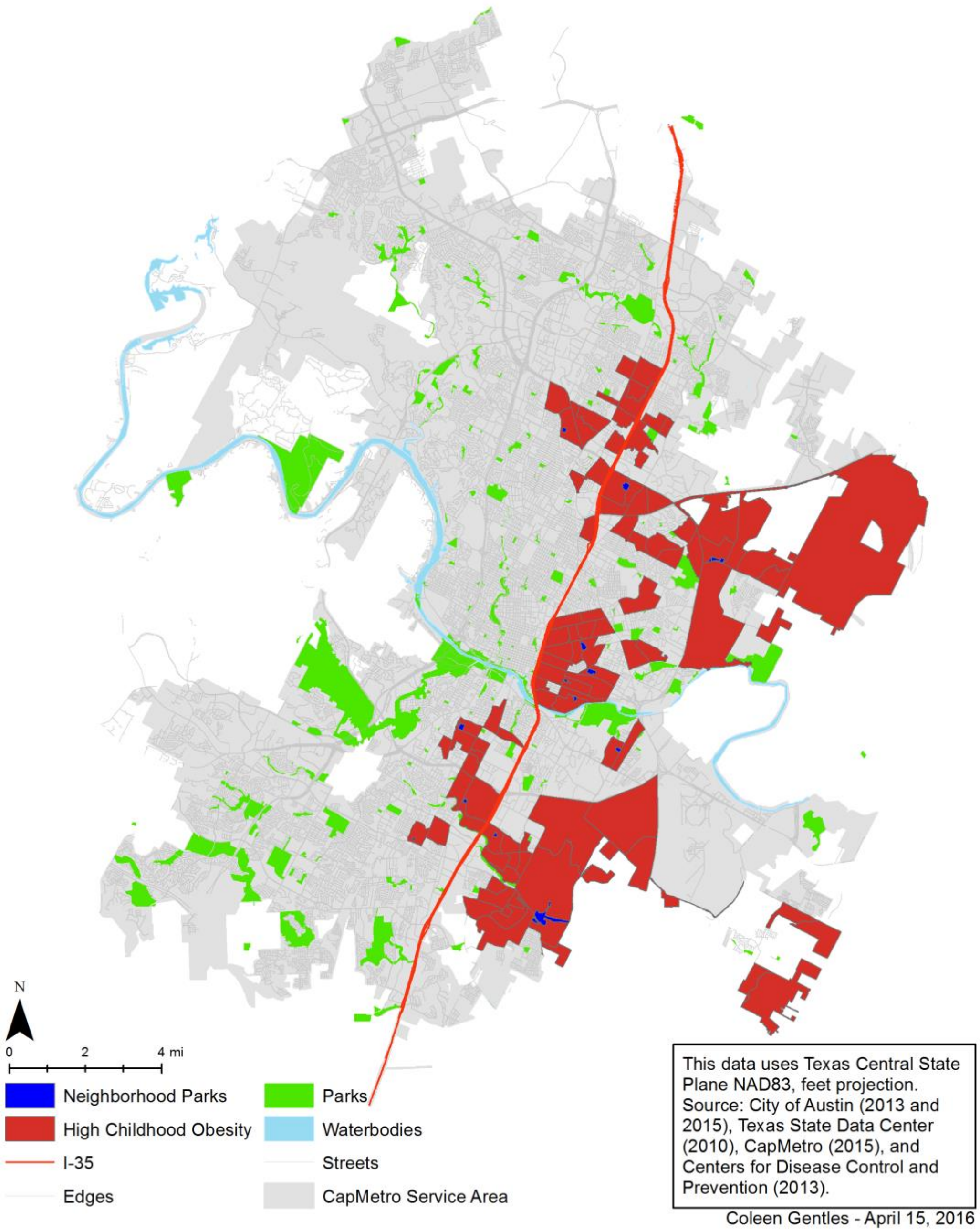
There are 14 neighborhood parks that intersect bus stops within a quarter-mile service area of 16 high obesity block groups (*see Table 7*). High obesity block groups were determined from quantiles using the Natural Breaks (Jenks) classification method. Two parks, South Austin Neighborhood Park and Springfield Neighborhood Park, are located in two high obesity block groups. The other 12 parks are located in only one block group. Parks located on the border of high obesity block groups were not included in the analysis (*see Figure 11*).

Neighborhood Parks in Quarter-Mile Service Areas and High Childhood Obesity Block Groups

Name	Acres	Management
Armadillo Neighborhood Park	2.46	Natural Area
Battle Bend Neighborhood Park	4.75	Mixed-Use Park
Buttermilk Neighborhood Park	16.60	Active Park
Davis/White Northeast Neighborhood Park	19.25	Active Park
Highland Neighborhood Park	0.25	Special Use Area
Metz Neighborhood Park	6.55	Active Park
Montopolis Neighborhood Park	7.60	Active Park
Oswaldo A.B. Cantu/Pan-American Recreation Center	5.23	Active Park
Parque Zaragoza Neighborhood Park	15.39	Active Park
Ponciana Neighborhood Park	5.22	Natural Area
Rosewood Neighborhood Park	14.22	Active Park
South Austin Neighborhood Park*	11.79	Active Park
Springfield Neighborhood Park*	97.63	Natural Area
Wooten Neighborhood Park	6.58	Active Park

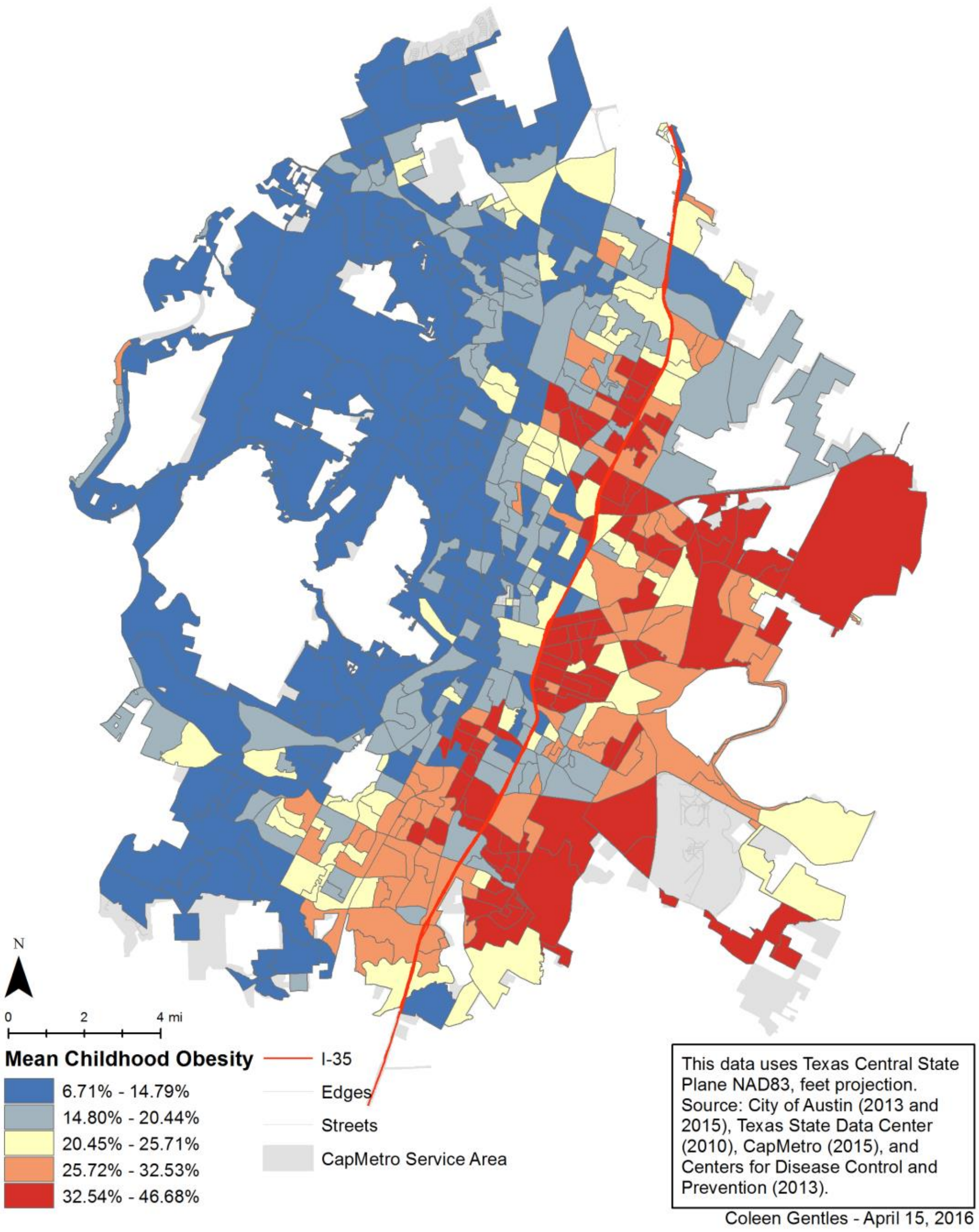
Table 7. Neighborhood parks located in high childhood obesity block groups and also accessible by bus within a quarter-mile buffer. Asterisk denotes park is in more than one block group.

Figure 11. Neighborhood Parks in Quarter-Mile Service Areas and High Childhood Obesity Block Groups within Austin



Mean childhood obesity data at the Census block group level was divided into quantiles using the Natural Breaks (Jenks) classification method. The data ranged from 7.0% to 47% and can be seen dramatically increasing West to East roughly after crossing I-35 (*see Figure 12*).

Figure 12. Childhood Obesity Block Groups within Austin



The obesity scores, distance scores, park amenity scores, and park acreage counts for 45 neighborhood parks were analyzed using correlation and regression methods (*see Table 8*).

Obesity, Distance, Amenity, and Acreage Values for 45 Neighborhood Parks in Quarter-Mile Service Areas						
Name	**Management**	**Block Group Obesity Score**	**Distance from Bus Stop to Park Centroid (miles)**	**Park Amenity Score**	**Park Acreage**	**Park Supply/Block Group Area**
Adams-Hemphill Neighborhood Park	Mixed-use Park	0.1718	0.17693265636	37.5	9.98	6.81%
Armadillo Neighborhood Park	Natural Area	0.3522	0.18889329526	2.652	2.46	1.73%
Bailey Neighborhood Park	Active Park	0.1233	0.11961978139	42.4	2.40	1.28%
Battle Bend Neighborhood Park	Mixed-use Park	0.3735	0.21426915821	26.5	4.75	2.84%
Big Stacy Neighborhood Park	Active Park	0.1801	0.27273173851	11.6	4.46	1.77%
Brentwood Neighborhood Park	Active Park	0.244	0.33560104714	67.9	8.22	4.82%
Buttermilk Neighborhood Park	Active Park	0.3388	0.37256816031	74.88	16.60	5.62%
Civitan Neighborhood Park	Active Park	0.2903	0.09831522802	76.86	6.92	0.76%
Davis/White Northeast Neighborhood Park	Active Park	0.3441	0.15826871770	31.57	19.25	7.14%
Dottie Jordan Neighborhood Park	Active Park	0.2715	0.00676466939	53.82	11.29	6.81%
Duncan Neighborhood Park	Mixed-use Park	0.1553	0.17827830667	2.808	5.11	0.98%
Eastwoods Neighborhood Park	Active Park	0.1671	0.17485376045	66.6	9.52	2.22%
Eilers (Deep Eddy) Neighborhood Park	Active Park	0.2376	0.04830571534	25.66	9.72	4.17%
Gillis Neighborhood Park	Active Park	0.2869	0.16927657780	51.44	6.83	8.68%
Govalle Neighborhood Park	Active Park	0.2909	0.06455141306	59.7	26.27	2.88%
Gracywoods Neighborhood Park	Active Park	0.2123	0.65418656982	26.54	21.57	2.08%
Grand Meadow Neighborhood Park	Natural Area	0.2353	0.01180955556	0	9.99	0.70%
Great Hills Neighborhood Park	Active Park	0.1449	0.67988592715	14.88	76.05	10.32%
Heritage Oaks Neighborhood Park	Active Park	0.2202	0.22512857062	0	3.53	3.89%
Highland Neighborhood Park	Special Use Area	0.3323	0.18038661316	19.8	0.25	0.30%
Joslin Neighborhood Park	Active Park	0.1019	0.21162680300	89.06	5.36	1.76%
Kendra Page Neighborhood Park	Active Park	0.3047	0.14521334808	14.06	15.27	5.89%
Metz Neighborhood Park	Active Park	0.3734	0.26677682965	95.5	6.55	3.71%
Montopolis Neighborhood Park	Active Park	0.3619	0.07278531402	60.2	7.60	4.52%
Nicholas Dawson Neighborhood Park	Active Park	0.1625	0.13614104192	7.08	3.30	1.14%
Oswaldo A.B. Cantu/Pan-American Recreation Center	Active Park	0.3636	0.10298296667	38.058	5.23	3.98%
Parque Zaragoza Neighborhood Park	Active Park	0.3565	0.05641729188	48.7	15.39	8.96%
Patterson Neighborhood Park	Active Park	0.2207	0.22293072760	100.88	9.31	3.10%
Perry Neighborhood Park	Active Park	0.0766	0.15166323785	54.12	10.39	3.80%
Piney Bend Neighborhood Park	Active Park	0.2687	0.18165986237	6.3	4.20	1.52%
Ponciana Neighborhood Park	Natural Area	0.3796	0.22827411586	1.56	5.22	2.76%
Quail Creek Neighborhood Park	Active Park	0.1798	0.01517101595	16.4	16.36	28.50%
Ramsey Neighborhood Park	Active Park	0.2038	0.13630349678	61.7	5.27	3.87%
Rosewood Neighborhood Park	Active Park	0.3321	0.10467205985	41.5	14.22	6.93%
Scofield Farms Neighborhood Park	Active Park	0.1877	0.53437295665	19.54	25.17	5.39%
Shipe Neighborhood Park	Active Park	0.141	0.09408214735	68	2.46	1.40%
Silk Oak Neighborhood Park	Active Park	0.2232	1.50116675103	12.5	17.68	3.72%
Sir Swante Palm Neighborhood Park	Active Park	0.1553	0.17152507884	46.2	3.24	0.62%
South Austin Neighborhood Park	Active Park	0.3654	0.09905642068	50.1	11.79	4.15%
Springdale Neighborhood Park	Active Park	0.2798	0.00913548193	7.86	16.37	2.26%
Springfield Neighborhood Park	Natural Area	0.3610	0.37734260700	5.46	97.63	4.05%
Triangle Commons Neighborhood Park	Active Park	0.18	0.12279456664	12.14	6.02	2.02%
Waterloo Neighborhood Park	Mixed-use Park	0.2098	0.00367483712	13.32	10.01	2.51%
Westenfield Neighborhood Park	Active Park	0.1238	0.24506601776	64.998	4.94	2.83%
Wooten Neighborhood Park	Active Park	0.4067	0.27153665264	59.5	6.58	2.84%

Table 8. Individual park scores including obesity values from block groups, distance to parks, and amenity values. Acreage was included as a non-calculated value.

A correlation was done to determine if multicollinearity exists between the dependent variable, obesity score, and the three independent variables: distance, park amenity score, and park acreage. A correlation coefficient of +1 or -1 indicates a perfect positive or perfect negative correlation. A correlation coefficient near 0 indicates no correlation. As predicted, the three independent variables have extremely small coefficients, meaning they are not related to each other. The distance score and park amenity variables are negatively related to the obesity score while the park acreage score is positively related to the obesity score. The distance score is negatively related to the park amenity score and positively related to the park acreage score, while the park amenity score is negatively related to the park acreage score (*see Table 9*).

	Block Group Obesity Score	*Distance from Bus Stop to Park Centroid (miles)*	*Park Amenity Score*	*Park Acreage*
Block Group Obesity Score	1			
Distance from Bus Stop to Park Centroid (miles)	-0.093645807	1		
Park Amenity Score	-0.008781141	-0.123690737	1	
Park Acreage	0.076980375	0.329013611	-0.202513664	1

Table 9. Correlation scores between obesity, distance, amenities, and acreage.

A regression was done to determine how the independent variables relate to the dependent variable, obesity score. The regression line is:

Y = 0.2536 – 0.0488*Distance – 0.0000*Park Amenity Score + 0.0006*Park Acreage

The closer the R Square value is to 1, the better the regression line fits the data. In this model, the R Square is 0.0218 and the Adjusted R Square is -0.0498. This indicates that only 2% of the variation in the obesity score is explained by the independent variables. Significance F and P-values determines if the results are reliable. Because Significance F is greater than 0.05 and all three P-values for the independent variables are also greater than 0.05, the results of the regression are not statistically significant (*see Table 10*). Residuals for each variable are available in Appendix D.

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.147646764							
R Square	0.021799567							
Adjusted R Square	-0.049776075							
Standard Error	0.092213648							
Observations	45							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	3	0.007769522	0.002589841	0.304566839	0.82191336			
Residual	41	0.348637635	0.008503357					
Total	44	0.356407156						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	0.253593888	0.029172406	8.692936882	7.56753E-11	0.194679018	0.312508758	0.194679018	0.312508758
Distance	-0.048778479	0.059892844	-0.814429158	0.420104572	-0.169734531	0.072177574	-0.169734531	0.072177574
Park Amenity Score	-2.68434E-06	0.000503815	-0.005328032	0.995774706	-0.00102016	0.001014791	-0.00102016	0.001014791
Park Acreage	0.00062404	0.000858413	0.726969709	0.471375176	-0.00110956	0.00235764	-0.00110956	0.00235764

Table 10. Regression scores between obesity, distance, amenities, and acreage.

Three scatter plots were also created to graphically show the relationship between the dependent variable and each independent variable (*see Figures 13, 14, and 15*).

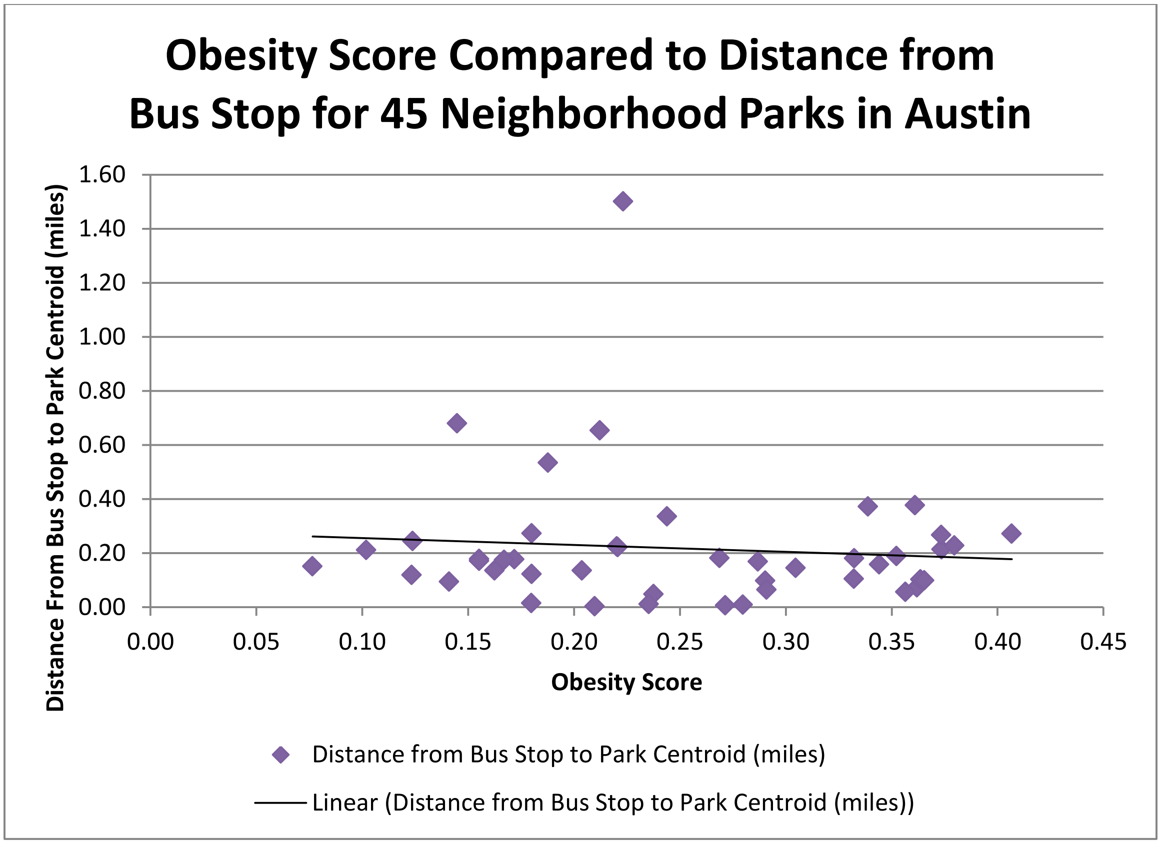


Figure 13. Obesity scores and distance scores.

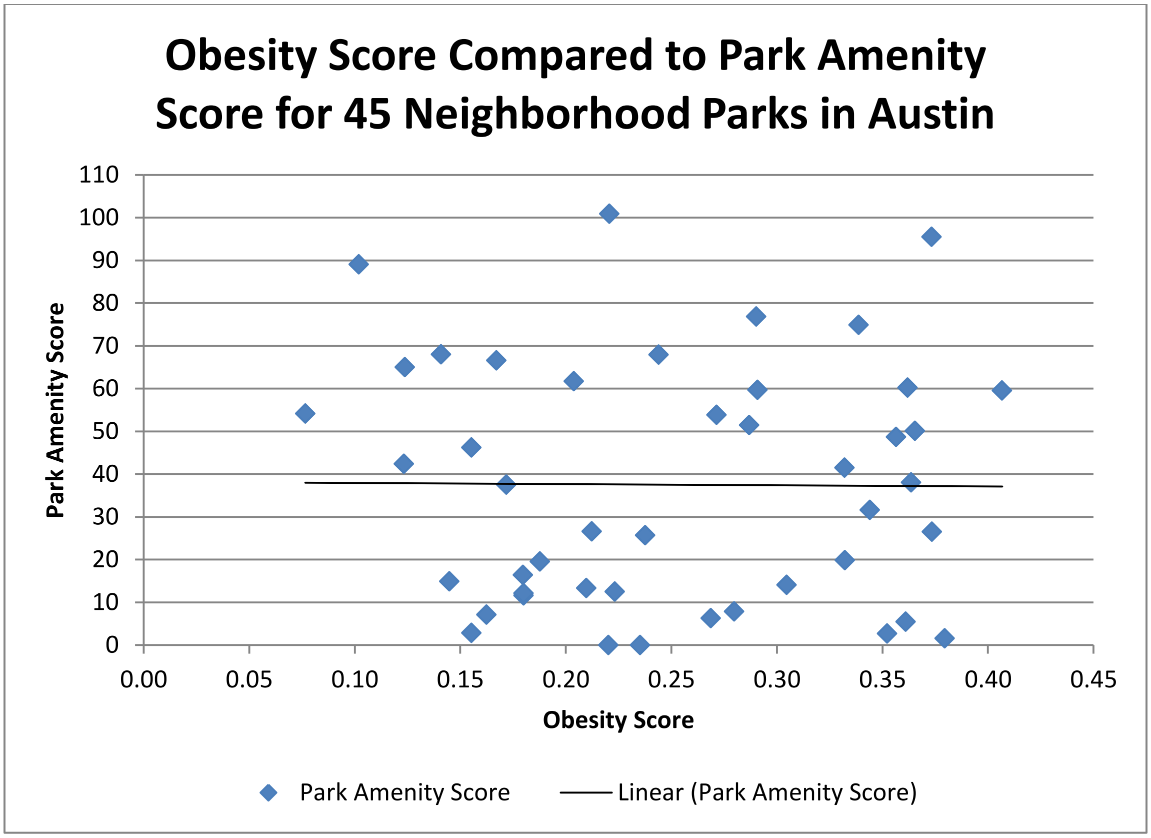


Figure 14. Obesity scores and amenity scores.

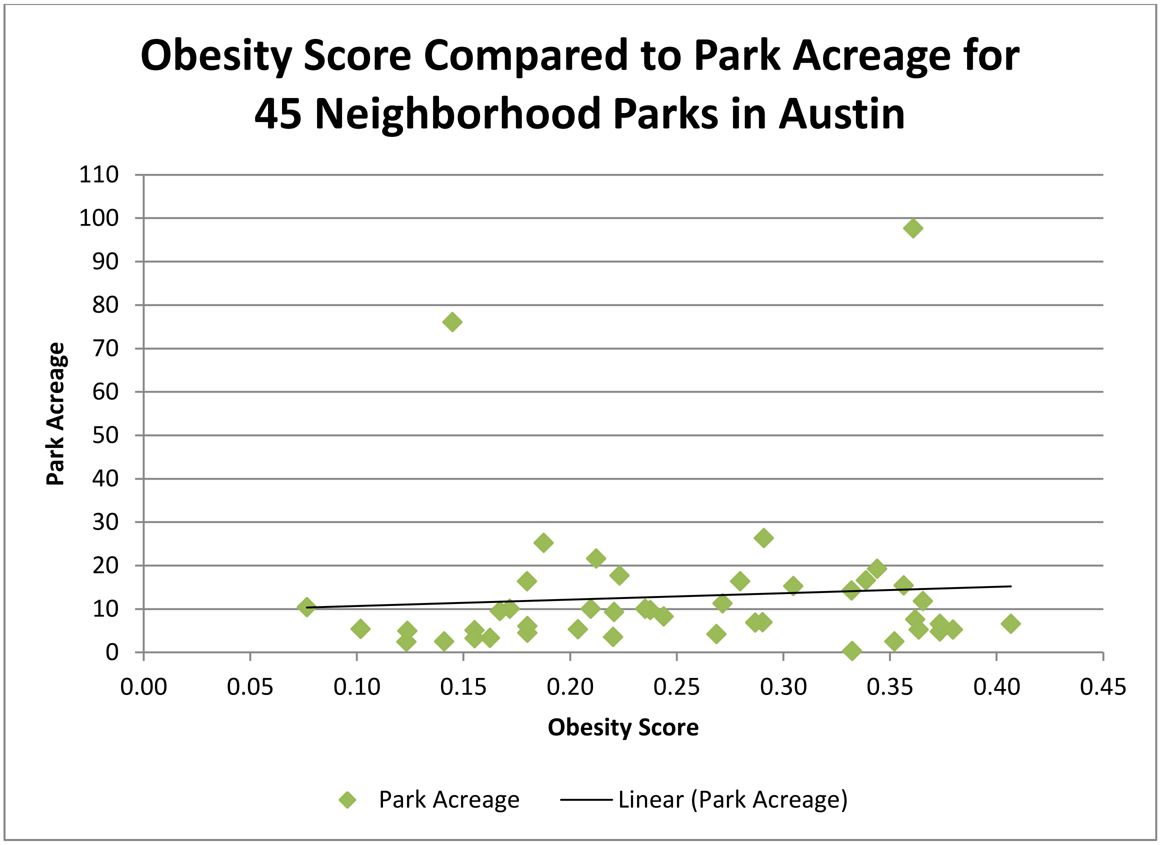


Figure 15. Obesity scores and acreage.

In general, Austin city parks are spread throughout the city. The outskirts of Austin lack public parks although the bus routes extend further than the city park system. A population density map by park need indicates high need near the I-35 and 183 interchange (*see Appendix A*). According to Table 3, only 61% of Austin city parks are reached within a quarter-mile bus stop service area. Of the number and percentage of Austin city parks reached by bus stops separated by park type within a quarter-mile buffer, three types, Golf Courses, Nature Preserves, and Planting Strips/Triangles, are below 50% (*see Table 6*).

The regression analysis revealed no significant relationship between obesity scores, distance values, park amenity scores, and park acreage. Of the three independent variables, park acreage had the better best fit line, which was not surprising. Typically larger parks do not necessarily have more amenities. Often they are mostly natural areas with the occasional hike and bike trail.

The distance in miles from bus stop to neighborhood park ranged from 0.003 (Waterloo Neighborhood Park) to 1.5 miles (Silk Oak Neighborhood Park). The range in distance reflects the size of the parks – larger parks will have a center point far deeper in the park than smaller parks. As previously mentioned, some parks are served by multiple bus stops. Those parks that do have multiple bus stops may also have further distances than what is captured in Table 8.

Additional collected data revealed that most parks (42 parks or 93%) had sidewalk access and only three did not, but not every park was bicycle accessible (24 parks or 53%). Even less parks had bike racks available for locking up a bicycle (23 parks or 51%). It is important to note that not every park with bike accessibility had a bike rack; some parks had both, none, or only one.

It is more important though to have sidewalk and transit access to parks than bike lanes, trails, or quiet streets for biking. City of Austin code states that a person may ride a bicycle on the sidewalk except in specific areas (downtown and Guadalupe just west of UT). In addition, city buses provide racks for two-three bikes, so youth could conceivably bus to and from a park and then bike through a trail in the park.

Park amenity counts revealed quite a plethora of activity options available in the 45 neighborhood parks. The most common amenity was playgrounds (33 parks had at least one), followed by walking trails (26 parks), and basketball courts (22 parks). While it is important to count the presence of playgrounds, splash pads, and wading pools as a form of physical activity for children, the obesity scores were for children between the ages of 10 and 17 and children over the age of 12 would be less likely to use a playground, splash pad, or wading pool as a form of exercise. Some parks also had unusual or specialty amenity options such as a skatepark or BMX park.

Limitations for this project included using the CapMetro Service Area as the boundary for the parks and bus stops rather than the Austin city limits. This decision was made because CapMetro does not service all of Austin.

V. Discussion and Recommendations

Public transit extends the reach of a park and is a critical mode of travel to those individuals without access to an automobile. One recommendation is that sidewalk, bicycle and bus services should be improved to facilitate access to neighborhood parks with organized programming for physical activity, particularly for children between the ages of 10 and 17. According to Figure 7, there are parks still not reached by bus stops, particularly large natural parks such as Emma Long Metro Park and Barton Creek Greenbelt and Wilderness Park south of the river. Because the City of Austin classifies their parks by management, it can be determined which specific types of parks are accessible from a quarter-mile service area (*see Table 11; Appendix C*).

Number and Percentage of Parks Reached by Management Type

Type	Count (Quarter-mile)	Total Counts	Percent in Quarter-mile
Active Park	76	111	68.5%
Corridor	12	19	63.2%
Historical/Cultural	4	4	100.0%
Mixed-use Park	13	17	76.5%
Natural Area	31	84	36.9%
Passive Park	6	11	54.5%
Special Use Area	35	46	76.1%
Total Parks:	177	292	

Table 11. Number and percentage of Austin city parks reached by bus stops separated by management type within a quarter-mile buffer.

The park types that are in most need of bus access could be targeted locations for additional bus stops. One of the limitations to examining just the absence or presence of a park is that it by no means portrays the quality of the park. Some parks have amenities that are in poor shape, a direct effect of low operating and maintenance budgets. Some parks have amenities that are not heavily used depending on the racial and ethnic demographic of the park visitors. While neighborhood demographics change over time, it is important when deciding to build new parks or renovate existing parks that the needs of the neighborhoods and communities are addressed. If these needs are not met, then the future or existing park will continue to not be used as intended. And as the literature above stated, parks are only useful at keeping residents healthy and physically active if they are actually used.

But the mere presence of a park does not guarantee a healthier population. Individual parks, and entire city park systems, should be designed and programmed to help people become more fit (Harnik and Welle, 2011). And unfortunately, there are other studies that reveal that proximity to parks and playgrounds does not have a positive correlation with physical activity. Although the data from this professional report does not show a correlation between the presence of neighborhood park amenities and estimated obesity rates for children, peer reviewed studies have made this connection.

Even though the statistical analysis does not show that park access by transit explains childhood obesity prevalence, it does not imply that park access does not matter. Policy makers should pay attention to more than just park amenities. Improving access to parks may increase use. But alone it is not enough to reduce obesity.

Using the predicted childhood obesity scores from the Centers for Disease Control and Prevention was a powerful dataset that spatially showed heartbreaking trends in Austin. Figure 12 confirmed much of what history tells us about Austin, how people of color were forced to relocate to east of I-35, how there is an abundance of fast food restaurants, and a general lack of healthy food sources, including grocery stores selling fresh produce. There was also no evidence that park access was incorporated into the CDC equation determining predicted childhood obesity rates.

Additionally, there was no evidence that transit access was incorporated into the CDC equation either. Despite this oversight, it is well known that transit access to city amenities increase use, whether those amenities are jobs, housing, commercial, or recreational. This critical connection tells me it is absolutely important to encourage local, state, and federal governments to continue funding transportation planning. I believe future research needs can show a correlation to park access by transit and a reduction in obesity.

Most importantly, I learned that increasing physical activity in youth not only decreases their health problems but has positive outcomes for them physically, mentally, emotionally, and socially. And the good news is that all is not lost and youth obesity levels can be reversed! Education takes a village, but the more information that is available to youth and their parents, the sooner health trends can be reversed before entering adulthood.

Appendix A

Definitions for "Service Area," or the radius from within which a majority of the visitors travel to the site, from the GIS metadata on the City of Austin website:

a) 0-0.5 miles – Approximately a 10-20 minute walk time; mainly immediate residents within the neighborhood or surrounding blocks.

b) 0-5 miles – Up to a 10 minute drive, though may also be accessed via walking, biking or transit; mainly residents in the surrounding area up to 3 neighborhoods away or the entire jurisdiction in smaller municipalities.

c) 0-25 miles – Up to a 30 minute drive; primarily people from the entire county, entire jurisdiction or several jurisdictions in a suburban or rural area.

d) 0-100 miles – Approximate 30-120 minute drive; primarily day users from the surrounding region.

e) 0-100 or more miles – Approximate 2-6 hour drive; attracts visitors from within the state and adjacent states with a mix of day use and overnight opportunities.

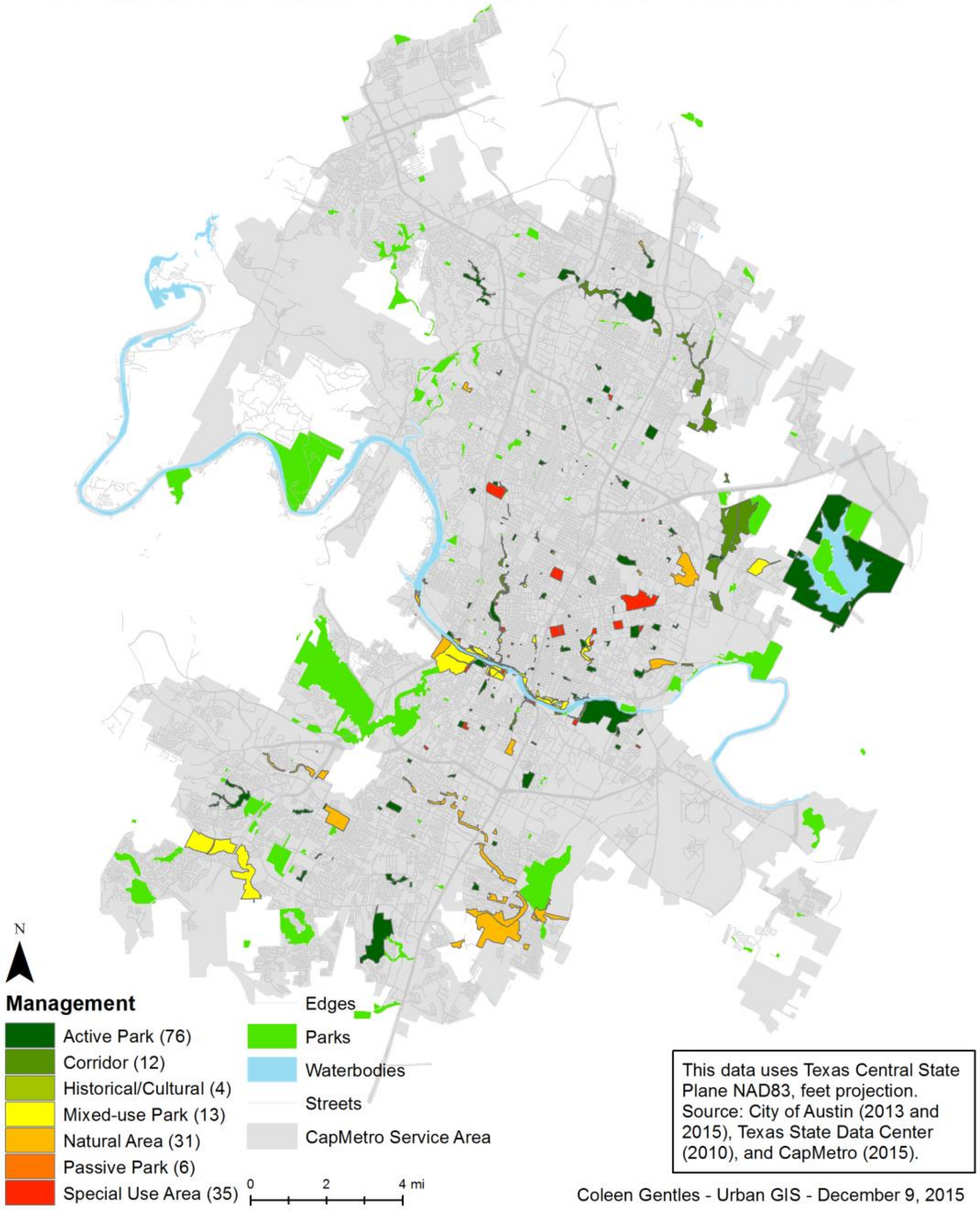
Appendix B

Definitions for "Management" from the GIS metadata on the City of Austin website:

a) Active Park – Developed and primarily intended for active recreational uses by the public.
b) Corridor – A linear park that may contain trails, rivers, water-frontage or beaches, medians or tree-related street frontages, and/or greenways, blue ways or parkways. The corridor may connect parks, have a transportation use or feature contiguous parklands and facilities.
c) Historical/Cultural – Managed to preserve and conserve historic properties and/or districts, perhaps allowing education and related events.
d) Mixed-use Park – Developed with separate passive and active areas in the park; or containing park features in addition to other priorities such as Natural, Historical or Special Use areas.
e) Natural Area – Managed primarily for value of natural resources as buffers, conservation and/or habitat protection, perhaps allowing access for hiking, nature study, or even a nature/EE center.
f) Passive Park – Developed and primarily intended for passive recreational uses by the public.
g) Special Use Area – A property dedicated to a single purpose such as a sports stadium or arena, athletic complex encompassing the entire park, an event center, fairgrounds, cemetery, or formal garden.

Appendix C

Figure 16. Select Parks Classified by Management in Quarter-Mile Service Areas within Austin



Appendix D

RESIDUAL OUTPUT		
Observation	*Predicted Y*	*Residuals*
1	0.251092566	-0.079259232
2	0.245911065	0.106288935
3	0.24914422	-0.12584422
4	0.24603626	0.12746374
5	0.243041643	-0.062969275
6	0.24217297	0.00182703
7	0.245580207	0.093219793
8	0.252912311	0.037391322
9	0.257801184	0.086298816
10	0.260166539	0.011333461
11	0.248078002	-0.092778002
12	0.250824647	-0.083745235
13	0.257235251	-0.019635251
14	0.249459659	0.037440341
15	0.266675761	0.024224239
16	0.235071098	-0.022799267
17	0.259254499	-0.023954499
18	0.267849165	-0.122992022
19	0.244816526	-0.024616526
20	0.244896488	0.087403512
21	0.246375099	-0.144475099
22	0.256000983	0.048699017
23	0.244409064	0.128990936
24	0.254622755	0.107277245
25	0.248992968	-0.086492968
26	0.251729005	0.111870995
27	0.260312137	0.096187863
28	0.248257979	-0.027557979
29	0.252536548	-0.175936548
30	0.247338807	0.021361193
31	0.245715069	0.133884931
32	0.263017297	-0.083217297
33	0.250067031	-0.046267031
34	0.25725232	0.07484768
35	0.243179892	-0.055479892
36	0.250356537	-0.109356537
37	0.191370181	0.031829819
38	0.247126528	-0.091826528
39	0.255983665	0.10945965
40	0.263340469	0.016459531
41	0.296101003	0.064944753
42	0.251329445	-0.071329445
43	0.259625209	-0.049825209
44	0.244550535	-0.120750535
45	0.244296208	0.162403792

Table 12. Residual scores for the 45 neighborhood parks.

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