ADOLESCENT OVERWEIGHT AND OBESITY: A GEOGRAPHIC INQUIRY

By

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TABLE OF CONTENTS

Page

LIST OF TABLES

Table **Page**

LIST OF FIGURES

Figure **Page**

ABSTRACT

This study analyzed the variances of BMI status of adolescents based on their dietary intake, physical activity, and method of weight loss methods among five urban school districts across the United States. Variances in nutrition and physical activity environments across five school districts was also examined as well as their possible relationship with BMI status. Multinomial logistic regression was used to analyzed BMI status and dietary intake, physical activity, and weight loss methods across each school district. The Kruskall-Wallis test was used to examine the variances in nutrition and physical activity environments among all school districts. Variances between two different school districts was determined by using the Mann-Whitney test.

Taking diet pills, powders, or liquids to lose weight was significant in three out of the five districts analyzed. Variances in access to nutritional environments as well as physical activity environments were seen among all school districts. A relationship among school districts and the access to nutritional environments, physical activity environments and BMI status could not be found.

In conclusion, BMI status is more related to weight loss methods, taking diet pills, powders or liquids and age, than physical activity and dietary intake. A relationship between BMI status and access to nutritional and physical activity environments could not be determined. Although, a significant variance was found across school districts in both nutritional and physical activity environments.

I. INTRODUCTION

The prevalence of overweight and obese adolescents in the United States has increased at alarming rates. Obesity has become an epidemic in the United States and beyond, and is a major public health problem. The proportion of children and adolescents overweight between the ages of six through nineteen has increased three and half times since 1963 (Centers for Disease Control, 2016 and Ogden et al. 2002). According to the Center for Disease Control and Prevention (CDC) (2016), the National Health and Nutrition Examination Survey revealed the percentages of 12 to 19 year olds who were obese was 5% in 1963-1970, 6% in 1971-1974, 5% in 1976 -1980, 11% in 1988-1994, 16% in 1999-2002, and 18.4% in 2011-2014. Overall females had slightly higher rates of obesity, 21.0%, than males, 20.1% between 2011 and 2014. Hispanic youths had the highest rates of obesity (21.9%) compared to non-Hispanic Asian (8.6%), non-Hispanic black (19.5%), and non-Hispanic white (14.7%). The obesity pattern among females was higher in Hispanic females (21.4%) when compared to non-Hispanic Asian (5.3%), non-Hispanic black (20.7%), and non-Hispanic white (15.1%). The obesity pattern in males is also highest in Hispanics (22.4%) when compared with non-Hispanic Asian (11.8%), non-Hispanic black (18.4%), and non-Hispanic white 14.3%). Data from the 2011 to 2014 National Health and Nutrition Examinations Survey showed an adult prevalence of obesity of 36% (Ogden et al. 2016). Obesity was higher among middle aged and older adults, 40.2% and 37.0% respectively, than younger adults (32.3%). Obesity can increase morbidity risks from chronic diseases (Talkwalker and McCarty 2016 and National Heart, Lung, and Blood Institute 1998). According to Talkwalker and McCarty (2016), the top two chronic conditions treated during physical visits for adult obesity was hypertension and hyperlipidemia. Hypertension and hyperlipidemia are major causes of heart disease which can lead to death. Approximately 280,000 deaths are attributed to being overweight or obese in the United States each year (Allison et al. 1999).

Background

Overweight adolescents have a higher tendency to become overweight/obese adults, than those who remain at normal weight. Therefore, overweight adolescent are at a higher risk for associated adult health problems, including heart disease, type II diabetes, stroke, several types of cancer, osteoarthritis, sleep apnea, and gallbladder disease (US Surgeon General 2007). Overweight adolescents are also at increased risk for poor self-esteem, depression from social discrimination, major long-term medical, and psychological problems (Jacobs 2005, Kim et al. 2011). Approximately 208,000 persons under the age of 20 have been diagnosed with diabetes (types 1 and 2) (CDC 2014). As obesity rates of have increased in children and adolescents, so have the rates of type II diabetes. Type II diabetes used to primarily affect adults over the age of 45 and now we are seeing it in children and adolescents (National Institute of Diabetes and Digestive and Kidney Disease 2017). The unhealthy lifestyles established are associated with overweight and obese youth have led to coronary artery disease and strokes resulting in early adulthood deaths (US Surgeon General 2007).

Overweight and obese adolescents pose large financial burdens on the community and health care systems. The demand for health services over a person's lifespan increases when overweight begins at an early age. According to the CDC (2017), the total direct and indirect cost of diabetes was nearly $132 billion in 2002 and rose to $174 billion in 2007. The cost of health care is expected to increase with the increased number of adolescents affected with type II diabetes. Crowley et al. (2012) suggests the overall estimated health care costs of obesity related illnesses are $192 billion or 21% of annual medical expenditures in the United States. The direct costs for childhood obesity are estimated to be $142 billion. As these children become adults that number is expected to rise. In the United States, average hospital costs for being overweight/obese averaged $147 billion U.S. dollars in 2008 year (Finkelstein et al. 2009). Medical costs were also significantly higher for obese people, $1,429 more than normal weight people (Finkelstein et al. 2009).

Numerous researchers have tried to explain the obesity epidemic; however, no theory has adequately explained all factors that play a role in the overweight and obesity problem (Booth et al. 2005). For example, even though genes may increase the likelihood of obesity, no specific gene has been discovered that causes obesity (Bouchard 1995). While there has been an emphasis on modifying and understanding individual characteristics that influence physical and dietary activity patterns (Booth et al. 2005; Giles-Corti and Donovan 2003; Yen and Kaplan 1998; Young and Nestle 2003), little advancement has been made in eliminating the obesity epidemic (Booth et al. 2005). Consequently, researchers have started to focus on the interaction between environmental factors (Booth et al. 2005), access to fast food and fresh food outlets, behaviors, and the progression of overweight and obesity.

Purpose of the Study

This dissertation involves the analysis of a large dataset obtained from the Centers of Disease Control (CDC) Youth Risk Behavior Surveillance System (YRBSS) of grade 9-12 students attending five school districts across the United States. It is a geographic analysis of behavior and access to fresh food, fast foods, bicycle routes, and parks for students from these school districts and their association with students' health status related to overweight and obesity. Body mass index (BMI) was used to determine if an adolescent was overweight or obese and its connection with dietary intake, weight loss methods, or physical activity deficiencies was investigated. BMI is a person's weight in kilograms divided by the square of height in meters. BMI is age and sex specific and is broken down into four categories and percentile ranges. An adolescent who falls within the range of less than the 5^{th} percentile they are considered underweight. A percentile range between the 5^{th} percentile to less than the 85^{th} percentile adolescents are considered normal or healthy weight. An adolescent who is in between the 85^{th} to less than 95^{th} percentile is overweight. Finally, if an adolescent is equal to or greater than the 95^{th} percentile they are considered obese (CDC 2017). BMI is recommended by the CDC as a screening tool for obesity rather than a diagnostic tool as it does not measure body fat directly. This is an inexpensive and easy method to screen for weight categories.

A secondary purpose of this study is to evaluate if access to nutritional environments (restaurants and fresh foods) play a role in BMI status. The final objective of this study is to determine if access to bicycle routes or parks affect BMI status.

Geographic information system is utilized to perform geographic analysis of the data as well as statistical methods.

This study contributes to the literature by analyzing five school districts and their differences in nutritional environments (access to restaurants and fresh foods) as well as access physical activity environments (access to parks and bike routes) as a cause for overweight and obese students. The five school districts utilized in this study are Boston Public Schools (PS), Boston, MA; Dallas Independent School District (ISD), Dallas, TX; Memphis Independent School District (ISD), Memphis, TN; Miami-Dade County Public Schools (PS), Miami-Dade County, FL; and San Diego Unified School District (USD), San Diego, CA. These five districts were chosen due to their similar demographics. Current studies only examine one to two possible factors associated with adolescent obesity.

Research Questions and Hypotheses

This research adopts a multifaceted approach to analyzing adolescent obesity. This dissertation will address the following research questions:

1. Does BMI status vary among adolescents based on dietary, physical activity and method of weight loss behaviors?

   $H1_{O:}$ Dietary intake, physical activity and method of weight loss behavior are not associated with BMI status in adolescents.

   $H1_{A}$: Dietary intake, physical activity, and method of weight behavior are associated with BMI status in adolescents.

2. Do nutritional environments vary across school districts? If so, is there a relationship between access to restaurants and fresh foods outlets, and BMI status?

$H2_O$: Access to restaurants and fresh food outlets to High Schools does not vary across school districts. Access of restaurants and fresh food outlets across school districts are not related to BMI status.

$H2_A$: Access to restaurants and fresh foods outlets to High Schools varies across school districts. Access of restaurants and fresh food outlets across school districts are related to BMI status.

3. Does access to bike routes and parks vary across school districts? Is there a relationship among school districts between availability of bike routes and parks, and BMI status?

   $H3_O$: Access to bike routes and parks do not vary across school districts. There is not a relationship among school districts between access to bike routes, parks and BMI status.

   $H3_A$: Access to bike routes and parks vary across school districts. There is a relationship among school districts between access to bike routes, parks, and BMI status.

Dissertation Outline

The dissertation is organized as follows: Chapter 2 includes a literature review on the background on overweight and obese adolescents, possible factors influencing overweight and obese adolescents, and gaps in the literature. Chapter 3 describes the methodology of this research and the conceptual model being used in this dissertation. A description of the study, data, and analysis are also included. Chapter 4 presents the results of the analysis preformed in this dissertation. Chapter 5 summarizes the contributions of this dissertation and implications.

II. LITERATURE REVIEW

This chapter explores the multiple factors and influences have been found to contribute to overweight and obese adolescents. It summarizes the contributions that have been made in the area of adolescent obesity.

Overweight and Obesity in Adolescents

A major determinate for overweight and obesity has been linked to the built environment (Booth et al. 2005, Oreskovic et al. 2015). The built environment consists of land use, available public transportation, and urban design (Handy et al. 2002). The built environment can increase or decrease physical activity and healthful eating (Jackson and Kochtitzky 2001; Giles-Corti et al. 2003).

In addition to the built environment, behavior can influence an adolescent's weight. An adolescent is at risk of becoming overweight when they consume too many calories and decrease their physical activity. The intake of fat, low energy, physical inactivity, and frequent television viewing may contribute to obesity (Pratt 1994). A strong risk factor for adolescent obesity is television watching (Gortmaker et al. 1990). Television watching may be a stimulus for eating or snacking when adolescents are continually eating in front of the television (Epstein et al. 1995). Pearson and Biddle (2011) found adolescents adopting a sedentary lifestyle resulted in unhealthy dietary behaviors.

The physical environment can impact behavior by availability of resources and lack of accessibility to those resources (Story et al. 2002). Community settings can also affect dietary behaviors such as schools, shopping malls, convenience stores, fast-food places and restaurants, and vending machines (Story et al. 2002).

Prevalence and Trends in the United States

According to the National Health and Nutrition Examination Survey (NHANES), 67% of American adults are overweight or obese and 34% are obese based on body mass index (BMI). From 1980 to 2000, the proportion of children and adolescents overweight between the ages of six through nineteen has tripled since 1963 (Ogden et al. 2002). According to the Center for Disease Control and Prevention (CDC), the percentages of 12 to 19 year olds who were obese was 5% in 1963-1970, 6% in 1971-1974, 5% in 1976 - 1980, 11% in 1988-1994, and 16% in 1999-2002. The 2005-2006 NHANES survey showed 18 % of youth's age 12-19 were overweight compared to 10.5% in 1988-1994. The 2007 Youth Risk Behavioral Surveillance Survey (YRBSS) showed 15.8% of adolescents in 9th-12th grades were overweight and 13% were obese as compared to 10.7% in 1999 (CDC 2007). An analysis of BMI among US children and adolescents (2 to 19 years of age) between 1999 and 2010 found there was no differences in the rate of obesity in females or males between the years 2007-2008 and 2009-2010. The analyses did show however, a significant increase of obesity in males between 1999-2000 and 2009-2010 of the ages of 12 and 19. The prevalence of obesity in females for the same 2 year cycle did not increase. The nationwide adolescent obesity rate remains at 16.9% (Ogden et al. 2012).

According to the nationwide 2013 YRBSS survey 13.7% of students were obese and 16.6% of students were overweight (Kann et al. 2014). The 2013-2014 NHANES revealed the percentage of adolescents between the ages of 12 and 19 years to be considered obese was 20.5% with males at 20.1% and females at 21%; and extremely obese, above 120% of the sex-specific 95th percentile, was 7.8% with males at 7.7% and females at 8% (Ogden et al. 2016).

Wang and colleagues (2014) analyzed data from the 2012 Team Up for Healthy Living. This is a clustered randomized trial that targets adolescents in Southern Appalachia that are in a Lifetime Wellness class. The study found 19.8% of the students were overweight and 26.6% were obese. These rates were highest among boys than girls (50.5% vs 42.3%).

The most recent results of the 2015 YRBSS have been published and revealed the prevalence of obesity nationwide was 13.9% (Kann et al. 2016). This rates was higher among males at 16.8% and 10.8% of females. The prevalence of students being overweight was 16% of students nationwide with higher rates among females at 16.6% than males at 15.5%.

Health Consequences

The health consequences of childhood and adolescent obesity in the United States are a growing concern. For most children and adolescents, complications from being overweight are not apparent for years, but others can suffer severe morbidity. A review of the literature Must and Strauss (1999) classified the consequences into several categories: immediate consequences, intermediate consequences, and long-term consequences. Immediate consequences entail orthopedic, neurological, pulmonary, gastroenterological, and endocrine problems. Obesity can affect growth plates and bones in children. Back pain was found to be an issue in overweight and obese adolescents (Lazorick et al. 2011). Neurological problems can arise including vomiting, blurred vision, and headaches. Pulmonary problem can occur in the form of asthma (Gilliland et al. 2009, Trent et al.

2009, Lazorick et al. 2011, and Del-Rio-Navarro et al. 2010). Gastroenterological disorders are also an immediate consequence which includes the development of gallstones, fatty liver, liver fibrosis, and cirrhosis. In addition, endocrine disorders include diabetes, menstrual abnormalities, and polycystic ovarian syndrome. Intermediate consequences represent the increased likelihood of developing a particular disease such as cardiovascular disease risk factors including high cholesterol, increased sodium concentrations, and high blood pressure. Long-term consequences include adult morbidity and adult mortality. The risk of developing cancer and having a stroke as an adult is also increased.

Sleep disturbances have been seen in children and adolescents for example, obstructive sleep apnea (Lazerick et al. 2011 and Mirza et al. 2004), sleep disruptions (Fiese et al. 2009), and snoring (Mirza et al. 2004).

A prevalence of psychological/behavioral disorders such as, attention-deficit – hyperactivity disorder, has been found to be higher in obese and overweight children (Kim et al. 2011). Increased rates of anxiety and depression were found in females (Anderson et al. 2006). Bell et al. 2011 found overweight and obese children complained about bouts of depression and anxiety.

Measurement

Body Mass Index (BMI) is the most common measure for evaluating obesity in children and adolescents. BMI is an index of weight relative to height. An adolescent's weight (kg) divided by height squared (m^2). Growth curves have been developed to signify underweight, normal weight, overweight, and obese according to sex and age, since children and adolescents go through periods of fatness as they age. The Centers for

Disease Control and Prevention (CDC) developed the sex- and age-specific growth curves which were based on children's national surveys measuring weight and height between 1963 and 1980. The curves represent a historical distribution of weight and height for children over this period (predominantly the 1970s) and use two cut points developed by a panel of health experts in 1998 to screen for risk of overweight (85^{th} percentile or higher of the sex-age distribution) and obesity (95^{th} percentile or higher of the sex-age distribution) (CDC 2006).

BMI values indicating obesity among children and adolescents (95^{th} percentile or above) have also been found to predict high levels of insulin, systolic blood pressure, and cholesterol; all are associated with cardiovascular disease later in life (Freedman et al. 1999). Despite BMIs validity as a measure of health risk, the CDC advises parents and health officials to use BMI and growth curves as a screening tool for obesity rather than as a diagnostic tool. Since body weight varies by fatness and muscle mass, it is possible for a child or adolescent to be labeled obese due to above average muscle density. The CDC recommends following-up a positive screening for obesity with a physical exam using more precise measures of body fatness and seeking counseling about strategies for reducing weight if the BMI is valid (CDC 2006).

A limitation in determining the prevalence of obesity in populations is the use of self-reported height and weight. Since it is expensive to measure individuals in person for large national surveys, many extensive data collection efforts such as the Youth Risk Behavior Surveillance System (YRBSS) ask adolescents to self-report their height and weight. It has been documented that adolescents underreport their weight and may over-report their height (Strauss 1999; Goodman et al. 2000; Brener et al. 2003), which tends to create under-reporting of the BMI based overweight problem. The YRBSS is administered by the CDC every two years in public and private schools. The YRBSS is voluntary so not all schools may participate in the process.

Factors Influencing Overweight and Obesity in Adolescents

There are many speculations on contributing factors of overweight and obesity. The factors range from genetics, neighborhood environments (such as walkability, park accessibility, traffic safety, accessibility of bicycle routes, crime, fast food accessibility, and fresh food inaccessibility), behavioral influences (such as dietary intake, physical inactivity, and weight loss methods), sociodemographics characteristics, parental attitudes; and social norms. Other possible contributing factors are the increased size of portions for ready to eat foods and drinks over the last four decades (Nielson and Popkin 2003).

This dissertation will discuss several factors influencing overweight and obesity in adolescents: Behavioral influences such as dietary intake, physical inactivity and weight loss methods; neighborhood environments such as fast food accessibility, fresh food accessibility, park accessibility, and bicycle route accessibility; genetics such as race/ethnicity, gender; as well as social and cultural aspects of income, and education.

Behavioral Influences

Individual adolescent behavior is one of many contributing factors in generating weight outcome. Dietary intake and physical activity have been researched extensively over the last three decades to understand their role in the overweight and obesity epidemics. Several behavioral influences will be discussed below including physical activity, dietary intake and weight loss methods.

Physical Activity

Physical inactivity seems to be a major contributing factor to an increase in overweight adolescents. There has been a steady decline over the past several decades of adolescent physical activity (Gortmaker et al. 1990, Mitchell and Byun 2013). A study performed in Nebraska on elementary students found that the average child spent 24 to 27 hours watching television per week and 25 minutes a week doing physical activity (Lowry et al. 2002). When female children become older, they are less active than boys. Sallis et al. (1993) found children were more physically active if there were more outdoor places near home. In addition, adolescent physical activity has decreased over the years due to more hours spent watching television and being on the internet (French et al. 2001).

According to Healthy People 2020 initiative, children and adolescents should be involved in at least 60 minutes of physical active on a daily basis. This includes aerobic activity, muscle strengthening, and bone strengthening of at least three days a week. In 2005, only 36% of students were physically active for at least 60 minutes a day for greater three days a week. Of those, 44% were male and 28% were female. Physical activity was greatest among white males at 47%, black males at 38%, and Hispanic males at 39% than white females at 30%, black females at 21%, and Hispanic females at 26% respectively. Physical activity also varied among grade levels with ninth graders having higher rates at 37% compared to 12th graders at 33% (CDC 2006). The 2013 YRBSS revealed 15.2% of students nationwide participated in at least 60 minutes of physical activity at least one day a week with females having the highest participation at 19.2% and males 11.2%. Physical activity was greatest among white females at 16.1%, black females at 27.3%, and Hispanic females at 20.3% than white males at 9.2%, black males at 15.2%, and Hispanic males at 12.1% respectively. The percentage of students who were active at least 60 minutes a day for five or more days was 47.2% nationwide with males having the highest participation at 57.3% and females at 37.3%. Physical activity was greatest among white males at 59.6%, black males at 53.3%, and Hispanic Males at 54.4% than white females at 40.5%, black females at 29.3%, and Hispanic females at 35.4% respectively (Frieden et al. 2014). Unfortunately, one cannot compare 2005 to 2013 YRBSS results due to the elimination of the question asking students if they exercised for at least 60 minutes for greater than three days a week. Districts can eliminate questions from the survey as they see fit.

A cross sectional study using the National Youth Physical Activity and Nutritional Study (NYPANS) was conducted by the Centers of Disease Control and Prevention (CDC). This study collected information from adolescents in grades 9 through 12. The questionnaire was designed to explore the association between physical activity, sedentary behaviors with dietary behaviors. Findings demonstrated that daily physical activity was associated with fruit and vegetable consumption. It also found lower fruit and vegetable consumption as well as high fast food consumption was associated with sedentary behaviors such as watching TV and playing video games. (Lowry et al. 2015).

Dietary Intake

Being overweight or obese is a direct result of calorie surplus which is more calories is being consumed than expended. Food portion sizes have increased dramatically in fast food restaurants since the 1970s (Nielson and Popkin 2003; Young and Nestle 2002). The average food portion consumed per eating incident among children aged 2 to 18 years of age over the last three decades has increased in the US by 184 kcal/d (Piernas and Popkin 2011; Mooreville et al. 2015). Also the consumption of soft drinks has increased over the last 30 years. Wang, Bleich and Gortmaker (2008) found the consumption of sugar-sweetened beverages between 1988 -2004 had increased by at least 10% in adolescents. Approximately 67% of sugar-sweetened beverages were consumed by adolescents (Wang, Bleich, and Gortmaker, 2008). Between 55% and 70% of the sugar-sweetened beverages consumed by adolescents was done in the home environment (Wang, Bleich, Gortmaker, 2008).

The prevalence of consumption of sugar-sweetened beverages (soda) is starting to decline within adolescents. According to the 2015 YRBSS 26.2% of the students surveyed did not drink soda seven days before the survey (Kann et al. 2016). This is a significant increase since 2007 when the percentage was only 18%. Students' drinking one or more sodas per day was 20.4% which is a significant decrease from 33.8% in 2007 (Kann et al. 2016). A student drinking two or more sodas per day during the seven days, before the survey, was 13% which is a decrease from 24% in 2007. Additionally, a significant decrease from 14.4% in 2007 to only 7.1% in 2015 was revealed, in the consumption of three or more sodas per day during the seven days before the survey.

Adolescents are inclined to adopt eating habits from their parents. There is a 40% chance of a child having a weight problem if one parent is overweight. There is an 80% chance of a child being overweight if both parents are overweight (Dietz, 1998).

School food choices have been a concern among researchers and parents alike. Kubik et al. (2003) found schools having an a la carte program had lower consumption of fruits and vegetables and more calories from saturated fat which exceed daily recommended levels. The prevalence of not eating vegetables has increased from 4.2% to 6.7% between 1999 and 2015 according the 2015 YRBSS (Kann et al. 2016). In the same survey researchers also found a slight increase in the consumption of vegetables eaten three or more times seven days before the survey between 1999 and 2015 from 14.0% to 14.8% respectively (Kann et al. 2016). No significant changes were noted of not eating fruit or drinking 100% fruit juice, eating fruit or drinking 100% fruit juice once or twice per day between 1999 and 2015 (Kann et al. 2016). There was a slight decrease in fruit consumption or drinking 100% fruit juices between 1999 and 2015 24.9% to 24.0% respectively (Kann et al. 2016).

Unhealthy Weight Loss Methods

Dieting is prevalent among adolescent females and it is important to evaluate the related practice and have a better understanding of the health implications (French et al. 1995). This is important due to the increasing prevalence of obesity among adolescents in the United States (French et al. 1995; Gortmaker et al. 1987; Kuczmarski et al. 1994; and Serdula et al. 1993). Unhealthy weight-loss methods such as, laxative use or self-induced vomiting, result in inadequate nutrient intake and can be potentially very dangerous for adolescents because they are in an active growth stage and development (Neumark-Sztainer et al. 2000).

French et al. (1995) conducted a survey study of 1,015 female 9th – 12th graders. Specific weight loss behaviors were analyzed such as taking diet pills, vomiting, skipping meals, reducing calorie intake, etc. in order to lose weight. BMI was calculated from height and weight. The study found BMI was weakly related to unhealthy weight control, 20.6% in overweight versus 14.2% in normal-weight participants. Neumark-Sztainer et al. (1999) found girls in the highest BMI category were at greatest risk for unhealthy weight loss behaviors. Stephen and colleagues (2014) found females were more likely to use diet pills and purging to lose or maintain weight who perceived their BMI to be high. Serdula et al. (1993) established 21% of adolescent females reported using diet pills to lose weight and 5% of adolescent males at one time or another. They also established 14% of adolescent females and 4% of adolescent males have vomited as a way of weight loss.

Between 1999 and 2013 there was a significant decrease in the prevalence of taking diet pills, powders, or liquids to keep from gaining weight in adolescents 7.6% to 5.0% respectively (Kann et al. 2013). There was no change identified between 2011 and 5.0% in 2013 (Kann et al. 2013). Females were more likely than males to take diet pills, powders, or liquids to try to lose weight or keep from gaining weight. The percentage of adolescents who tried to keep from gaining weight or tried to lose weight by vomiting or taking laxatives had a slight decrease from 4.3% to 4.1% from 1995 to 2013 (Kann et al. 2013). Females were more likely than males to use laxatives or vomit to lose weight or to keep from losing weight, 6.6% to 2.2% during this period (Kann et al. 2013).

Neighborhood Environments

Neighborhood environments can promote or hinder healthy eating and physical activity. Neighborhoods that offer well connected travel routes encourage more bicycling and walking for transportation (Booth et al. 2005, Leslie et al. 2010). Neighborhoods with little or no physical activity resources have higher rates of overweight population. A neighborhood with a high density of fast food restaurants can promote unhealthy food choices.

Morland (2006) found there was a correlation between the availability of supermarkets and the prevalence of overweight and obesity. He found that with an increase in supermarkets there was a decrease in overweight and obesity. Neighborhoods with an increase in the convenience stores and smaller grocery stores had an increase in obese and overweight people. It has been found that poorer neighborhoods have fewer supermarkets than higher income neighborhoods, thus limited access to healthy foods.

Safety within neighborhoods is a concern to many residents and can determine whether or not residents are active. Timperio et al. (2006) conducted a study on the perception of neighborhoods and walking and cycling among children in Australia. The study found that if there was a perception of needing to cross a street that had no lights or proper crosswalk, limited public transportation in the area, and there were no parks or sports grounds near their home, the children were less likely to walk or cycle. A cross-sectional study in California investigated Safe Routes to School (SR2S) legislation to determine a relationship between walking and cycling to school and urban form changes (Boarnet et al 2005). The study found children were more likely to walk or ride bicycles to school with completed safe routes projects.

Parks

Park characteristics are important when it comes to promoting physical activity such as having basketball courts, tennis courts, walking or bicycling trails (French et al 2001). The amenities a park has increases the probability the park will be used for physical activity. The size of the park also needs to be taken into consideration when assessing a park for physical activity use. The National Recreation and Park Association (NRPA) recommend a community with 20,000 residents have at least one community pool within a 15 to 30 minute travel-time radius (French et al 2001 and NRPA 1983). National estimates show a community with a population of 53,000 has access to one community pool and only 56% of city and county recreation and park departments provide a community swimming pool (French et al. 2001).

Giles-Corti et al. (2005) found that adults who had access to attractive and large public open spaces were 50% more likely to achieve high levels of walking. Closer in proximity homes are to each other and greater recreational areas and parks in the neighborhood were associated with increased physical activity in children (Roemmich et al. 2006). Recurrent use of parks was linked to proximity to children and adolescent neighborhoods (Grow et al. 2008).

A study conducted through the California Health Interview Survey (CHIS), which is a random-digit-dial telephone study found having safe access to parks was associated with regular physical activity. Adolescents who did not feel safe in their neighborhood were less likely to use parks for physical activity (Babey et al. 2008 and Meaney et al. 2016).

Park amenities as well as activities play a role in the utilization of parks. Floyd et al. (2011) analyzed 2712 children and adolescents in random park in Durham, NC. The use and physical activity in the park was linked to basketball courts, and other various activities. A study in southern California performed by Cohen et al. (2010) observed and surveyed over 30 parks and 4257 park users. Their results revealed the more park activities a park offers, such as sport events, the more a park is used for physical activity.

Bicycle Routes

In the literature cycling as well as walking are considered active modes of transportation. Utilizing anything motorized such as a car, taxi, bus, moped, motorcycle are categorized as passive modes of transportation. Active transport to school declined between 1986 and 2006 among adolescent students (Buling, Mitra, and Faulkner 2009). Little research has been done on active commuting to school and its effects on BMI status. The research that has been done has had mixed outcomes.

Heelan et al. (2005) and Rosenberg et al. (2006) did not find an association between active commuting to school and BMI status. Landsberg et al. 2008 used the Kiel Obesity Prevention Study; they did not find a link between BMI status and active commuting until distance is factored in. The further students had to walk or ride their bicycles to school the lower their fat mass.

Recent studies have found links between active transport to school or work and lower BMI status. A longitudinal study compared weight status and cycling to school in two cities, Rotterdam, Netherlands and Kristiansand, Norway. Bere et al. (2011) found adolescents had lower odds of being overweight if they rode their bicycles to school than those who did not. In addition, the odds were greater for being overweight when adolescents stopped riding their bicycle to school during the study.

A Danish study found that adolescents who cycled to school had lower BMI status in adolescents (Ostergaard et al. 2012). Additionally, they found students who walked to school had low odds of being obese or overweight than students who used passive transportation. A cross-sectional study analyzed active commuting to school and the wellbeing of adolescents and children in China (Sun, Liu, and Tao 2015). Children and adolescents who participate in active commuting had lower BMI status than those who used passive transport to school.

Cooper et al. (2008) and Andersen et al. 2011) conducted a longitudinal study to determine if transportation to school changes from non-cycling to cycling over a six year period was associated with improved cardiovascular fitness. The study followed 384 children in Denmark over a six-year period. The study found adolescents who cycled to school were more physically active than those who did not. The children and adolescents who cycled to school had an increased cardio-respiratory fitness.

Perceived safety is a concern for parents, children, and adolescent in active commuting to school. Consistency in walking or cycling to school in adolescents in New South Wales, Australia was due to the perceived safety of the route within the neighborhood to school (Merom et al 2005). In Melbourne, Australia Hume and colleagues (2009) found adolescents where more likely to ride their bicycles or walk to school if there were traffic lights and pedestrian crossings in the neighborhood. Parental perception of a neighborhood environment, inadequate traffic lights and crossings, predicted if a students would walk or ride their bicycle to school (Timperio et al. 2006). In the same study though, students were more inclined to walk or right their bicycle to school if the distance to school as less than 800 meters (Timperio et al. 2006).

Fresh Food Access

Between 1970 and 1995 the availability of fresh fruits and vegetables has increased by 19% (French et al. 2001 and Putnam 1997). In the mid-1970s, supermarkets carried approximately 150 produce items, in the 1980s they carried 250 items, and now they carry over 400 items (French et al. 2001 and Putnam 1997). Even though fruit and vegetable availability has increased over the past four decades, only 21% of adolescents eat the recommended daily amount of fruits and vegetables.

Increased access to chain supermarkets has been associated with a lower BMI among adolescents (Powell et al. 2007). The increased availability of convenience stores is significantly related with higher BMI and overweight (Powell et al. 2007). Inagami et al. (2006) conducted a study in 65 neighborhoods and consisted of 2,620 adults within Los Angeles County. Surveys are administered to the participants asking various questions regarding their income, education, employment, where they shopped for groceries, and weight. The results showed people who lived in disadvantaged areas had an increased BMI and people who shop at grocery stores located in disadvantaged neighborhoods had an increased BMI.

Morland et al. (2002) analyzed the allocation of food service places and food stores by neighborhood characteristics such as income and race. The study investigated cities across the United States that were part of the Atherosclerosis Risk in Communities (ARIC) study. This study found wealthier neighborhoods had three times as many supermarkets than lower income areas. Lower income neighborhoods contain an increased number of smaller grocery stores and convenience stores than higher income neighborhoods. In addition, the prevalence of supermarkets in White neighborhoods is four times greater than that of Black neighborhoods.

The above findings were also true for Moore and Roux (2006) who found four times as many small grocery stores in low-income areas as higher income neighborhoods and half as many supermarkets. Additionally, twice as many grocery stores were in low income neighborhoods than white neighborhoods. Moorland and Filomena (2007) conducted a study in Brooklyn and the availability of fruits and vegetables and racially segregated neighborhoods. The authors found Black neighborhoods had low variety and availability and of fresh foods. Furthermore, Hosler and colleagues (2008), assessed the availability of fruits and vegetables in both rural and urban communities. They found there was low accessibility to fresh fruits and vegetables in urban minority neighborhoods due to the lack of supermarkets.

Weight status has been associated with access to supermarkets. High BMIs in adults is linked to the access of small grocery stores and low BMIs when there is access to supermarkets (Morland and Evenson 2009). Improvements in weight status in children can be attributed to increased fruit and vegetable intake and proximity to supermarkets (Fiechtner et al. 2016). Conversely, supermarket prices are linked to high BMIs, but not the proximity to one (Drewnowski et al. 2012).

Fast Food Access

It is estimated that on average, an adolescent frequents a fast food restaurant twice a week (Kipke et al. 2007 and Paeratakul et al. 2003), with this includes a decrease in fruit, vegetable and milk intake and increase in french fries, pizza, soft drinks, total fat, and total calories (Kipke et al. 2007 and French et al. 2000). Adolescents living near more fast food outlets eat at them more than adolescents living in healthier environments (Babey, Wolstein, and Diamant 2011). Watching TV and easting fast food has been associated with high BMIs in women, but not men (Jeffrey, Simone, and French 1998).

A cross-sectional study using the Project Eats dataset found adolescents who ate fast food for family meals at home more than three days a week had higher intake of salty snack foods and parents had a higher weight status (Boutelle et al. 2007). A longitudinal study conducted in the United Kingdom analyzed the relationship between obesity and fast food access (Fraser et al. 2012). Data were collected between 2004 and 2008 on 4827 adolescents at ages 13 and 15 years of age. They found adolescents with high BMIs was associated with the consumption of fast food and higher body fat percentages.

Research into the proximity and clustering of fast food outlets and obesity has resulted in analysis into various distances from a particular area. Austin et al (2005) examined the clustering of fast food restaurants around schools in the Chicago area. They found the median distance to a fast food restaurant from a school is about a third of mile or a 5-minute walk. Simon et al. (2008) examined the proximity of fast food restaurants to schools, proximity of neighborhood income, and by elementary, middle and high school levels in Los Angeles County, California; they found 23% of the schools had at least one fast food restaurant within 400 m and 64.8% of schools had one or more fast food restaurants within 800m. High schools had a greater proximity to fast food restaurants than middle and elementary schools. In addition, low income and highly commercial neighborhoods had an increase in the number of fast food restaurants. Most researchers use 400m and 800 m as the standard in proximity analysis for fast food and fresh food access.

Proximity to fast food outlets has been researched with mixed results in regards to BMI status. Jeffrey and colleagues (2006) found a negative relationship between high BMIs and fast food outlets proximity to work or home. A study analyzing ninth grade students in California and the proximity of fast food outlets to schools, found there was not an association with higher BMIs (Howard, Fitzpatrick, and Fulfrost 2011). French et al. (2001) found a negative relationship between high BMIs and the frequency of adolescents purchasing fast food. Additionally, a study between walkability of a neighborhood and food environments were analyzed to predict obesity in New York City (Rundle et al. 2009). The high density of fast food outlets or food stores did not produce a higher prevalence of obese or overweight BMIs (Rundle et al. 2009).

Positive associations of BMI and density of fast food has been found in the literature. A state level cross-sectional study found a correlation between the density of food outlets per square mile and obesity prevalence in the state (Maddock 2004). Mehta and Chang (2008) analyzed weight status and the availability of restaurants across the United State. High density areas of fast food outlets were associated with higher BMIs (Mehta and Chang 2008). A study conducted in metropolitan Portland Oregon investigated 120 neighborhoods and the density of fast food outlets (Li et al. 2009). The authors found a positive association between high BMIs (Obese> 30) and the density of fast food outlets (Li et al. 2009).

Proximity of fast food outlets to schools has also produced mixed outcomes in adolescent obesity. Davis and Carpenter 2009 found adolescents whose school was within a half mile of a fast food outlets were more likely to be overweight than adolescents who had schools further away. Another study revealed obesity rates were higher when a school was within a mile of a fast food outlet (Aviola et al. 2014). Additionally, Currie et al. (2010) examined obesity and weight gain in ninth graders and the proximity of fast food outlet to schools. There was an increased obesity rate of 5.2% when a school had a fast food outlet within one tenth of a mile. However, a study conducted in Otago, New Zealand found food outlets surrounding schools only play a minor role in an adolescent's diet (Clark et al. 2014).

Powell et al. (2007) examined associations between income, racial and ethnic characteristics, and the accessibility of fast food and full-service restaurants. The study found predominately Black neighborhoods had a higher proportion of fast food restaurants than predominately White neighborhoods which may be a factor in ethnic differences in obesity rates. Hispanic neighborhoods, had an increase in the number of full service and fast food restaurants than non-Hispanic neighborhoods. Forsyth and colleagues (2012) found Hispanics, Native Americans, and Black adolescents lived near more fast food outlets than Asian and white adolescents, and ate at them more frequently also.

The distribution of fast food outlets have been found to concentrated in areas of low socioeconomics. Cummins, McKay, and MacIntyre (2005) found a high prevalence of McDonald's restaurants in low income areas than in higher income areas in Scotland. Block, Scribner, and DeSalvo (2004) found a similar finding in New Orleans, LA. The density of fast food outlets was higher per square mile in low income areas than in higher income neighborhoods. A study conducted in New York City found higher densities of fast food outlets in Black areas, both high and low income areas than white areas (Kwate et al. 2009). However, Hurvitz and colleagues (2009) found there was no association with fast food outlet density and census tract minority status. Though, they did find a relationship between low income housing and high fast food outlet density. Schools, also, in low economic areas have higher densities of fast food outlets than schools in higher income areas (Walker, Block, and Kawachi 2014).

Genetics

The advancement of genetic mapping technology has allowed scientists to research genotyping extends as it pertains to obesity. Genetic loci that influence BMI have been identified predominantly in adults of European descent (Graff et al. 2016; Locke et al. 2015; Speliotes et al 2010). Prior to this technology, scientists would research families, both parents and children, and their influences on weight. Early studies researching BMI in families were done in adoptive families. Researchers examined BMIs of adopted children and compared it to the BMIs of their biological parents and BMIs of their adoptive parents. Biron and colleagues (1977) found no association of BMI between parents and their adoptive children, but was significant with their natural children. Similarly, an adoption study completed in the Netherlands examined over 540 adoptees (Stunkard et al 1986). The researchers found there was no association of BMI between adoptees and their adoptive parents, but was associated with biological parents.

These former studies guided researchers to examine relationships within biological families of fraternal and identical twins. A literature review of familial BMI found similarities of more than 25,000 twin pairs there was a mean correlation of 0.74 for identical twins and 0.32 for fraternal twins (Maes et al. 1997). Genetic influences can describe about 67% of the differences in this study. Environmental factors cannot be ruled out, which contributed to about 7% of correlation across twins.

A study conducted by Wardel et al. (2001) suggests that children who have obese parents are at a higher risk for adult obesity than children of normal weight parents. This study showed children from overweight or obese families had a preference of fatty foods, did not care for vegetables, and over ate. Wardel 2001, also found them to be more sedentary, although, there was no difference in the frequency of eating high fat foods.

Ethnic groups with high prevalence's of obesity have been utilized to explain genetic contributions. The Viva La Familia study attempts to genetically map childhood obesity and environmental influences in obesity in the Hispanic population of Houston, TX (Butte et al, 2006). There were 319 families, 1030 children, and 631 parents ranging in age from four to nineteen years of age. Approximately 82% of the participants in the study were second generation. Fifty-seven percent of parents were obese and 34% were overweight. Children classified as overweight was 51%, and of those 47% were in the greater than 99^{th} percentile. The researchers found significant heritabilities coefficients influencing BMI for diet and physical activity ranging between 0.32 and 0.69, and risk factors for diabetes ranging from 0.25 to 0.73. The authors conclude "The Viva la Familia provides evidence of a strong genetic contribution to the high prevalence of obesity and its comorbidities in Hispanic Children."

Race, Ethnicity and Gender

Popkin and Uldry (1998) found that Blacks and Mexican Americans are more likely to be overweight than Whites. Also, the rate at which obesity is growing is higher in Black children and other children of color than their white counterparts (Alleyne and LaPoint, 2004). A study done by Popkin and Uldry (1998) determined that Hispanics and Asian-American adolescent who were second generation or higher were twice as likely to be obese than the first generation.

Kimbro et al. (2007) established that Hispanic children 3 years of age were almost twice as likely as White children to be overweight or obese. Hispanic children also had twice the odds of overweight or obesity than did Black children despite similar family socioeconomic profiles. These results imply childhood overweight issues begin earlier than previously thought.

A study conducted by Kimm et al. (2001) using data from the National Heart, Lung, and Blood Institute (NHLBI). This study was a 10-year longitudinal multicenter study (the NHLBI Growth and Health Study [NGHS] and conducted between 1985 and 1995). NHLBI was established to find correlations in obesity among adolescent black and white girls and their risk for cardiovascular disease, psychosocial factors and environmental factors. Two thousand seventy nine Black and White girls between the ages of 9 and 10 years of age participated in the study. Kimm and colleagues (2001) found black girls had a significantly increased BMI than white girls after 12 years of age and after menarche.

Falbe and colleagues (2016) conducted an observational study using the California school-based fitness test and found racial and ethnic disparities in the occurrence of high BMIs. The ethnicities that saw an increase in the occurrence of high BMIs was girls of African American and Hispanic Dissents. An increase in the occurrence of high BMIs in American Indian boys was also found.

The 2015 YRBSS analyzed an adolescent's prevalence of obesity and overweight status by gender and ethnicity (Kann et al. 2016). Obesity prevalence was higher between black and Hispanic students, 16.8% and 16.4% respectively, than white students at 12.4%. Obesity was also higher between black female and Hispanic females, 15.2% and 13.3 % respectively, than white females (9.1%). Hispanic males had higher rates of obesity than white males, 19.4% and 15.6% respectively. The overweight prevalence was highest among both black females and males, 21.2% and 13.6% respectively. Hispanic students had higher rates of being overweight than white students, 18.4% to 15.4% respectively. Overweight between females was highest among black and Hispanic females than white females, 21.1%, 20.0%, and 14.6% respectively.

Socioeconomics

Education Attainment

Research has linked educational attainment and obesity among adults and children. A study conducted in Mun-SI Portugal found children with parents having a low education level had a higher prevalence of obesity (Rito et al. 2015). Similarly, students with parents with less than a high school education, had an extremely higher obesity risk with gender and ethnicity removed (Fradkin et al. 2015).

Robinson et al. (2009) established families with low parental education had higher obesity prevalence's among young Black males and females, but there were no significant gender difference in white males and females. A gender and education attainment study by Ogden et al. (2010), found women with less than a high school education had an obesity rate of 42.1% compared to 23.4% of women with a college degree. There were no significant differences between men.

An interesting study on a global scale examined 70 different countries and found poor countries had higher rates of obesity within the highly educated groups than low education attainment (Kinge et al. 2015). Furthermore, rich countries had higher rates of obesity within lower educated populations. Additionally, men in Thailand with a university education had a higher prevalence of being overweight or obese. This was the opposite for woman with a university education. (Akeplakorn et al. 2014).

Income

Socioeconomic status has been linked to overweight and obesity rates. A study using the Twins Early Development Study conducted in the United Kingdom between 1994 and 1996 analyzed socioeconomic status and obesity rates among parents and children (Semmler et al 2009). Over 214 families participated in the study as well as 214 sets of twins. There was a follow-up conducted seven years later on 346 children. The results revealed the children with obese parents and low socioeconomic status had an increase in adiposity. There was no change in children's weight in lean parents and low socioeconomic status.

Frederick, Snellman, and Putnam (2013) investigated adolescent obesity and socioeconomic disparities using the 1988 – 2010 National Health and Nutrition Examination (NHANES) and the 2003-2011 National Survey of Children's Health (NSCH). The authors concluded obesity rates of adolescents of low socioeconomic status increased dramatically when compared with adolescents of higher socioeconomic status.

A longitudinal study analyzing young adolescent obesity was conducted across three school districts within three location, Birmingham, AL, Los Angeles County, CA, and Houston, Texas (Fradkin et al. 2015). The researchers used data from Healthy Passages Survey. The data was collected when students were in the fifth grade and then again in grade seven. The results of this study revealed students of low economic status were twice as likely to be obese than students in a higher economic status. This was true in both fifth and seventh grades.

A study comparing socioeconomic and overweight and obesity prevalence adolescents from Wuhan China and Southern California was completed by Johnson and colleagues (2006). Their finding showed socioeconomic status was not significant for high obesity prevalence in southern California, but was significant for adolescent in China. The adolescents in China who were of higher economic status had higher prevalence of being overweight and obese. This is due to the better access to energy-dense foods with financial success.

Several international studies have found similar results as the Wuhan China study. Wrotniak et al. (2011) conducted a study in Botswana investigating adolescent obesity and socioeconomic status in private and public schools. Students with higher economic status had a higher prevalence of overweight and obesity than those of lower economic status, 20.0% and 11.2% respectively. A Thai study on adults and the prevalence of obesity and socioeconomic status was examined using the National Health Examination Surveys from 1991-2009 (Aekplakorn et al. 2014).

Gaps in research

Nutritional environments as well as physical activity environments have been researched extensively within community neighborhoods and proximity to schools. Mixed results have ensued between access to fresh foods and fast foods, and increased BMI status. Aviola and colleagues (2014) found an increase in obesity rates with fast food outlets within one mile of a school. Currie et al (2010) also found that a proximity of fast food outlets within one tenth of a mile of a school has increased obesity rates in ninth graders. However, Howard, Fitzpatrick, and Frost (2011) found the proximity of fast food outlet and supermarkets were not associated with overweight students.

Mixed results have also been found in physical environment research and BMI status. Mendoza et al. 2011 found an inverse association between riding bicycles to school and increased BMI. Unlike Ostergaard and colleagues (2012), who found a decreased odds in adolescents being overweight or obese who cycled to school than those who did not? Bere et al (2011) also found adolescents who cycled to school had a lower probability of being overweight.

Summary

The prevalence of overweight and obesity of adolescents and adults is significant here in the United States and around the world. Heath consequences have been documented as a result of this increased prevalence. Multiple factors have been researched into the reason why this is occurring. Behavioral factors such as physical activity, dietary intake, and unhealthy weight loss methods have been studied. Most adolescents are not getting the proper exercise needed to maintain their weight. Adolescents lead a more sedentary lifestyle than they did 40 years ago. They are also not eating the adequate amount of fruits and vegetables like they should. Taking diet pills as a method of weight loss has dropped slightly in recent years though.

The analysis of built environments has become a common research theme to attempt to explain overweight and obesity in children, adolescents and adults. These studies have produced mixed results in exploring access to parks and bicycle routes, and access to fresh foods and fast food outlets. A consensus in this research are low income areas have less access than higher income areas.

Familial and twin research has assisted in linking genetic predispositions of obesity. Specific ethnic groups have been investigated with positive results. Higher rates of being overweight and obesity are most prevalent in African Americans and Hispanics. Females are more likely to be overweight or obese than males.

Education attainment and income has been linked to the prevalence of being overweight and obese. Children whose parents have less than a high school education are more likely to be overweight or obese in developed countries. In developing nations, parents who have higher education attainment, children are more likely to overweight weight. This is due to the accessibility of more food. Income status has also been connected to being overweight or obese. Developed and developing countries have revealed similar findings with education attainment. Low income statuses in developed countries have a higher prevalence of being overweight or obese. The opposite occurs in developing countries. There is a higher prevalence of being overweight or obese in a status of high income

III. DATA AND METHODS

This chapter provides a detailed description of the data and methods used in this study. Section 3.1 outlines the conceptual approach to this study. Section 3.2 explains the data being used and study area. Section 3.3 summaries the methodology utilized for this study

Conceptual Approach

The conceptual model connects neighborhood environments, behaviors, genetics, and social and cultural factors to Body Mass Index (BMI) (Figure 1). This model is built upon the understanding that an individual's health status measured by BMI is related to four aspects and four categories of factors. The first aspect contains factors that form the "backcloth" for one's life and daily practices; these can be ambient (e.g. built environment of daily activity space). The second aspect encompasses inherited characteristics by way of genetic (such as ethnicity and gender). The third aspect refers to an individual's response to his/her health "backcloth" and is highlighted as "behavior," including various actions to keep a healthy and balanced lifestyle. The fourth aspect is related to "obtained characteristics" that may mediate the response of the "behavior" aspect to the "backcloth" aspect. These are mainly socially and culturally related factors, including educational attainment and income level. With a given set of genetic "backcloth," it is hypothesized that an individual's BMI status is related to the neighborhood built environment that defines his/her routine activity spaces. More specifically, adolescents who live in neighborhoods with increased accessibility to parks, bike routes, and fresh foods tend to have a normal BMI, and those who live in neighborhoods with abundant fast food outlets tend to have increased BMIs.

With both genetic and built environment “backcloth” controlled, it is hypothesized that individual’s behavior when responding to the “backcloth” has effects on his /her BMI status. Is a healthy lifestyle being maintained, especially dietary and physical activity? Behavior plays a role in adolescents with increased dietary intake. Physical inactivity is positively related to an increased BMI. Weight loss methods can affect BMI as well.

When connecting the “behavior” aspect with the “backcloth” aspect, it is widely recognized that proper “behavior” frequently fails to respond to certain “backcloth” characteristics. The group of factors connecting these two is mainly social and cultural – people with different socioeconomic resources and/or education background tend to behave differently when compared with the same “backcloth.”

The conceptual model for this study focusses on four major components, behavior, life and daily practices, social and cultural, genetics and their impacted on BMI status. BMI is the dependent variable within this study. The behavior component, which is an independent variable, focusses on dietary intake, physical activity, and weight loss. The genetics subcomponent which contains race, ethnicity, and gender are independent variables. Analysis of the behavior and genetics components will address question one. The life and daily practices component contains the built environment and is a confounding independent variable within the study. The built environment contains food outlets, fresh food accessibility, access to parks and bike routes. These subcomponents will be analyzed to answer questions two and three. The social and cultural component in the model contains education attainment and income. This component will be addressed in the literature, but will not be analyzed in this study.

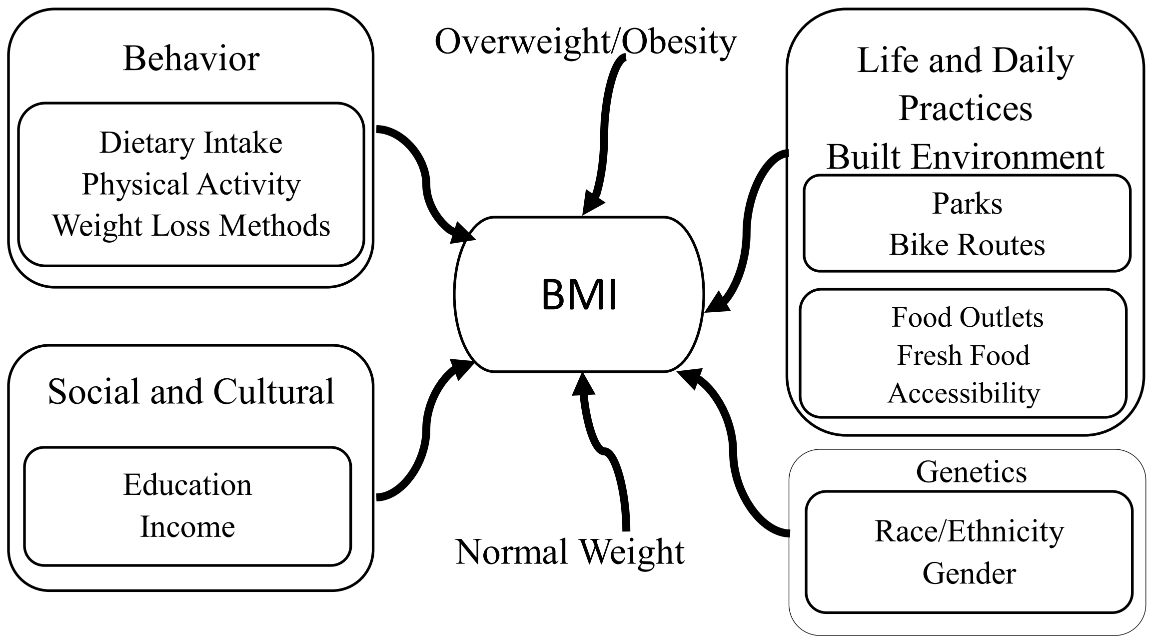

Figure 1 Diagram of conceptual framework outlining the possible contributing factors in adolescent obesity

Data and Study Area

The study area for this dissertation consists of five metropolitan school districts across the United States: Dallas Independent School District (ISD), Dallas, TX; San Diego Unified School District (USD), San Diego, CA; Memphis Independent School District (ISD), Memphis, TN; Boston Public Schools (PS), Boston, MA; and Miami-Dade County Public Schools (PS), Miami FL (Figure 2).

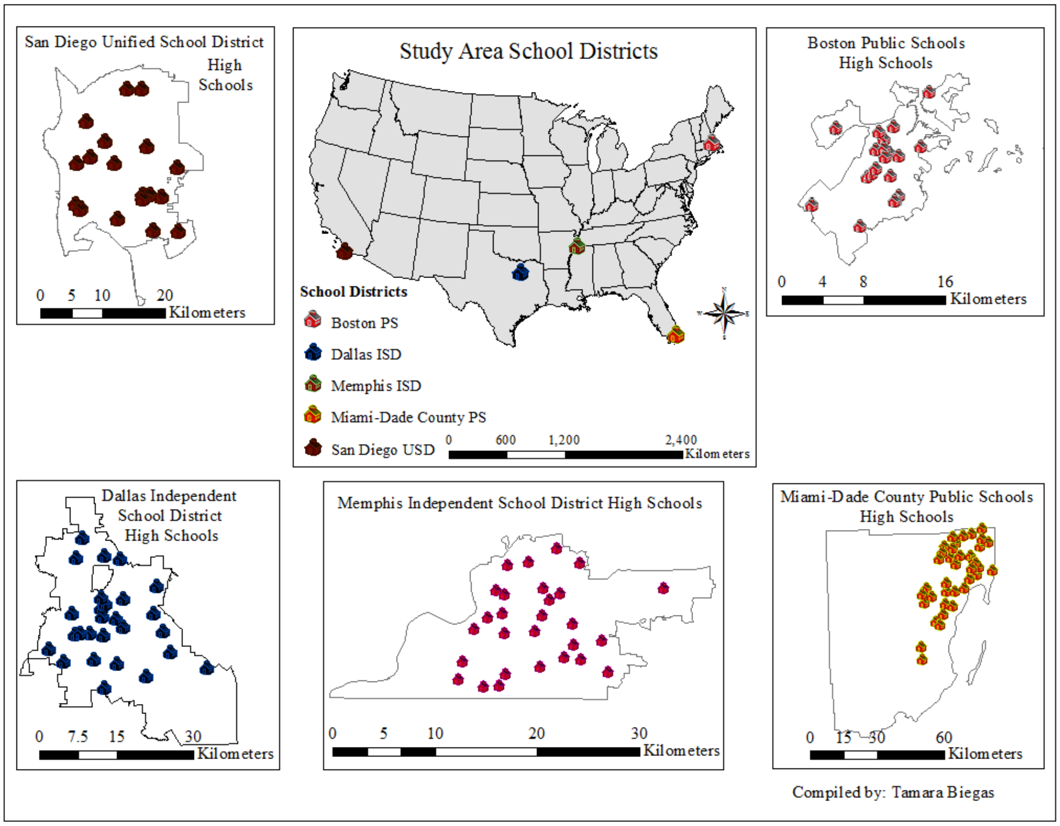

Figure 2 School District Study Areas

These five school districts were chosen due to their data availability and demographics. The focus was to compare major school districts with similar races/ethnicities and economic statuses in various parts of the country. The 2000 US Census was used to examine population, demographics, education attainment, and the economic status of each of the five school districts to find similarities. This information can be found in the following tables: Table 1 shows the population and economic status of each school district. Table 2 shows the demographic information of each school district. Tables 3 through 7 show the Education attainment for the population 25+ for Boston Public Schools, Dallas Independent School District, Memphis Independent

School District, Miami-Dade County Public Schools, and San Diego Unified School District respectively.

Table 1 Population and Economic Status of School Districts

School District Name	Population	Median Household Income
Boston PS	588,977	$39,629
Dallas ISD	1,007,186	$36,307
Memphis ISD	699,926	$34,212
Miami-Dade County PS	2,253,100	$35,995
San Diego USD	984,454	$42,870

**Based on 2000 US Census aggregated from ESRI Business Analyst*

Table 2 Demographics of School Districts

School District Name	White	Black/African American	Native American	Asian	Hispanic
Boston PS	53.3%	24.8%	0.4%	7.4%	14.1%
Dallas ISD	41.5%	22.8%	0.5%	1.6%	33.7%
Memphis ISD	37.6%	57.8%	0.2%	1.5%	2.9%
Miami-Dade County PS	46.8%	13.6%	0.1%	0.9%	38.5%
San Diego USD	54.6%	8.2%	0.6%	14.4%	22.2%

**Based on 2000 US Census aggregated from ESRI Business Analyst*

Table 3 Boston Public Schools Education Attainment for Population 25 Plus

Population 25+ by Educational Attainment	**Population**	**Percent**
Total	377,426	100.0%
Less than 9th Grade	34,316	9.1%
9th - 12th Grade, No Diploma	45,301	12.0%
High School Graduate	90,514	24.0%
Some College, No Degree	54,800	14.5%
Associate Degree	18,310	4.9%
Bachelor's Degree	76,401	20.2%
Master's/Professional/ Doctorate Degree	57,784	15.3%

*Based on 2000 US Census aggregated from ESRI Business Analyst

Table 4 Dallas Independent School District Education Attainment for Population 25 Plus

Population 25+ by Educational Attainment	Population	Percent
Total	616,507	100.0%
Less than 9th Grade	106,213	17.2%
9th - 12th Grade, No Diploma	101,701	16.5%
High School Graduate	129,985	21.1%
Some College, No Degree	111,322	18.1%
Associate Degree	23,582	3.8%
Bachelor's Degree	93,074	15.1%
Master's/Professional/ Doctorate Degree	50,630	8.2%

*Based on 2000 US Census aggregated from ESRI Business Analyst

Table 5 Memphis Independent School District Education Attainment for Population 25 Plus

Population 25+ by Educational Attainment	Population	Percent
Total	431,044	100.0%
Less than 9th Grade	30,177	7.0%
9th - 12th Grade, No Diploma	66,325	15.4%
High School Graduate	118,089	27.4%
Some College, No Degree	100,089	23.2%
Associate Degree	21,000	4.9%
Bachelor's Degree	60,851	14.1%
Master's/Professional/ Doctorate Degree	34,513	8.0%

*Based on 2000 US Census aggregated from ESRI Business Analyst

Table 6 Miami-Dade County Public Schools Education Attainment Population 25 Plus

Population 25+ by Educational Attainment	Population	Percent
Total	1,491,591	100.0%
Less than 9th Grade	219,050	14.7%
9th - 12th Grade, No Diploma	260,262	17.4%
High School Graduate	332,969	22.3%
Some College, No Degree	262,099	17.6%
Associate Degree	93,870	6.3%
Bachelor's Degree	183,961	12.3%
Master's/Professional/ Doctorate Degree	139,380	9.3%

*Based on 2000 US Census aggregated from ESRI Business Analyst

Table 7 San Diego Unified School District Education Attainment Population 25 Plus

Population 25+ by Educational Attainment	Population	Percent
Total	629,593	100.0%
Less than 9th Grade	51,855	8.2%
9th - 12th Grade, No Diploma	57,570	9.1%
High School Graduate	108,943	17.3%
Some College, No Degree	150,681	23.9%
Associate Degree	47,924	7.6%
Bachelor's Degree	131,536	20.9%
Master's/Professional/ Doctorate Degree	81,084	12.9%

*Based on 2000 US Census aggregated from ESRI Business Analyst

Survey data for this study was obtained from the 2005 national school-based Youth Risk Behavior Survey (YRBS) administered by the Centers for Disease Control and Prevention (CDC). This survey monitors the prevalence of youth behaviors that influence health (CDC 2003). The survey was developed to collect data that is comparable between national, state, and local samples of youth. The survey covers six priority risk behaviors (unintentional injuries and violence, tobacco use, alcohol and other drug use, sexual, unhealthy diet, and physical inactivity) and 98 core questions. The YRBS is a self-administered paper-and-pencil questionnaire, conducted in classrooms of high school students in metropolitan statistical areas under the supervision of trained staff. Demographic information for each school district was collected at the time of the survey (Table 8 through 12). The participants may not be a true representation of the population in the district as the survey is given in high schools, it is voluntary, and parental permission is required.

Table 8 Boston Public Schools Survey Demographics

	n	%
Age		
12	4	0.1
13	n/a	n/a
14	96	6.2
15	349	24.2
16	413	25.4
17	467	24.2
18	328	19.9
Missing	5	
Total	1662	
Sex		
Female	845	51.2
Male	808	48.8
Missing	9	
Total	1662	
Race		
American Indian or Alaska Native	20	0.6
Asian	184	4.5
Black or African American	669	47.5
Hispanic or Latino	391	27.1
Native Hawaiian or Other Pacific Islander	21	0.5
White	195	15.5
Multiple - Hispanic	61	1.8
Multiple - Non-Hispanic	96	2.6
Missing	25	
Total	1637	
Grade in School		
9	432	30.8
10	387	25.1
11	472	22.3
12	350	21.8
Ungraded or other Grade	1	0.1
Missing	20	
Total	1662	

Table 9 Dallas Independent School District Survey Demographics

	n	%
Age		
14	130	13.8
15	291	28.9
16	281	23.7
17	249	20.3
18	175	13.3
Missing	0	
Total	1126	
Sex		
Female	631	50.4
Male	494	49.6
Missing	1	
Total	1126	
Race		
American Indian or Alaska Native	8	0.2
Asian	18	0.4
Black or African American	388	35.9
Hispanic or Latino	568	55.2
Native Hawaiian or Other Pacific Islander	6	0.2
White	106	7.4
Multiple - Hispanic	17	0.4
Multiple - Non-Hispanic	13	0.3
Missing	2	
Total	1126	
Grade in School		
9	352	38.4
10	291	23.3
11	230	20.3
12	247	17.9
Ungraded or other Grade	2	0.1
Missing	4	
Total	1126	

Table 10 Memphis Independent School District Demographics

	n	%
Age		
12	7	0.4
13	2	0.2
14	117	8.5
15	348	23.7
16	458	30.1
17	286	22.1
18	144	15.1
Missing	1	
Total	1363	
Sex		
Female	714	51.7
Male	643	48.3
Missing	6	
Total	1363	
Race		
American Indian or Alaska Native	14	0.3
Asian	27	0.8
Black or African American	1,091	85.5
Hispanic or Latino	36	0.8
Native Hawaiian or Other Pacific Islander	5	0.1
White	105	10.8
Multiple - Hispanic	13	0.3
Multiple - Non-Hispanic	63	1.4
Missing	9	
Total	1363	
Grade in School		
9	434	32.5
10	452	26.6
11	304	21.6
12	161	19.2
Ungraded or other Grade	2	0.2
Missing	10	
Total	1363	

Table 11 Miami-Dade County Public Schools Demographics

	n	%
Age		
12	7	0.3
13	5	0.3
14	192	12
15	530	28.1
16	599	25.4
17	665	22.4
18	394	11.5
Missing	7	
Total	2399	
Sex		
Female	1256	49.3
Male	1131	50.7
Missing	12	
Total	2399	
Race		
American Indian or Alaska Native	11	0.2
Asian	35	0.5
Black or African American	611	28.1
Hispanic or Latino	1361	59.7
Native Hawaiian or Other Pacific Islander	19	0.3
White	176	9.8
Multiple - Hispanic	139	1.3
Multiple - Non-Hispanic	14	0.2
Missing	33	
Total	2399	
Grade in School		
9	522	32.6
10	604	26.5
11	580	21.8
12	686	19
Ungraded or other Grade	1	0.1
Missing	6	
Total	2399	

Table 12 San Diego Unified School District Demographics

	n	%
Age		
12	5	0.3
13	5	0.3
14	211	16.3
15	412	27.3
16	475	25.8
17	418	21.2
18	168	8.8
Missing	1	
Total	1695	
Sex		
Female	863	50.1
Male	821	49.9
Missing	11	
Total	1695	
Race		
American Indian or Alaska Native	5	0.2
Asian	169	15.1
Black or African American	190	14.1
Hispanic or Latino	574	37.4
Native Hawaiian or Other Pacific Islander	146	5.3
White	359	28.2
Multiple - Hispanic	105	3.8
Multiple - Non-Hispanic	133	5
Missing	14	
Total	1695	
Grade in School		
9	364	29.3
10	457	26.9
11	468	23.4
12	382	19.9
Ungraded or other Grade	9	0.5
Missing	15	
Total	1695	

To compile a comprehensive list of restaurant locations the yellow pages website was used to acquire address locations within and nearby area. A python script was written that scraped the internet yellow pages within each school district. Cross checking of restaurant locations was performed using Fast Food Source website and Reference USA website. Supermarket locations were gathered from Reference USA. Restaurants and Supermarkets were searched in Reference USA based on their major Standard Industrial Classification (SIC) code. The SIC codes selected for supermarkets and restaurants for this study were: Supermarkets and Grocery Stores (541105), restaurants (581208), and restaurants – family dining (58125). Supermarkets were determined based on annual revenue of more than $25 million. Fast food restaurants and sit down restaurants were also used. A nice feature within Reference USA is the ability to add x and y coordinates to your report, which eliminates the need to geocode.

School district boundaries and high school locations were obtained from state or local agencies. Park locations, bicycle routes, and road networks were also obtained from local or state agencies. Park locations were verified via the location's Department of Parks and Recreation. Population and income data were acquired from ESRI Business Analyst using the school district boundary. ESRI Business Analyst allows you to import shape files and request demographic and income data for a particular boundary. Business Analyst determines the demographic and income using an algorithm.

Permission was needed from the CDC or a contact person for a particular school district in order to obtain the dataset. Permission was also granted by the Internal Review Board (EXP2009H2691) at Texas State University to use this survey dataset for this dissertation (Appendix A).

Data Preparation

Youth Risk Behavioral Surveillance Survey

The YRBS examines six behaviors of adolescents which include: 1) behaviors that contribute to unintentional injuries and violence; 2) tobacco use; 3) alcohol and other drug use; 4) sexual behaviors related to unintended pregnancy and sexually transmitted infections (STIs), including human immunodeficiency virus (HIV) infection; 5) unhealthy dietary behaviors; and 6) physical inactivity (Kann et al. 2015). Furthermore, the survey examines the prevalence of asthma and obesity. The YRBS is administered by the Centers for Disease Control (CDC) as well as the state and local education departments and health agencies. The survey is conducted in large urban school districts every two, odd number, years in the spring semester. In addition, it is also given at the national, state, territorial, and tribal district level. There are procedures in place to prevent overlap in administering the survey. If a school participates at the national level, it will not be chosen to participate at the state level. At the time of this study, 19 urban school districts, in grades 9 through 12, participated in the survey (Eaton et al. 2006). Students record their responses on scantron sheet.

BMI was be broken into three categories: Normal (BMI < 85th percentile) and recoded as one, Overweight (85th ≤ BMI < 95th percentile) and recoded as two, and Obese (BMI ≥ 95th percentile) and recoded as three. Normal BMI was used as the reference category.

Dietary behavior was measured with the following question "Green Salad Consumption: During the past 7 days, how many times did you eat green salad?" had seven response categories ranging from "I did not eat green salad during the last 7 days" to “4 or more times per day (Table 13). These were coded as one through seven and modeled as a covariates.

Physical activity was assessed with the subsequent questions, “On how many of the past 7 days did you exercise or participate in physical activity for at least 20 minutes that made you sweat and breathe hard, such as basketball, soccer, running, swimming laps, fast bicycling, fast dancing, or similar aerobic activities?” and “On how many of the past 7 days did you participate in physical activity for at least 30 minutes that did not make you sweat or breathe hard, such as fast walking, slow bicycling, skating, pushing a lawn mower, or mopping floors?” Eight responding options were provided ranging from zero to seven days. The data was recoded as one through eight to represent the times per week and modeled as a covariate (Table 14).

The method of weight loss was evaluated using four questions: “During the past 30 days, did you eat less food, fewer calories, or foods low in fat to lose weight or keep from gaining weight?”, ”During the past 30 days, did you go without eating for 24 hours or more (also called fasting) to lose weight or to keep from gaining weight?”, “During the past 30 days, did you take any diet pills, powders, or liquids without a doctor's advice to lose weight or to keep from gaining weight?”, “During the past 30 days, did you vomit or take laxatives to lose weight or to keep from gaining weight?” For each item there were two responses “No” and “Yes”. Answers were coded as one or two and modeled as covariates (Table 15).

Demographic characteristics such as age, gender, and race/ethnicity were included in the models as factors. The ages in the survey ranged from 12 years of age to 18 years of age or older and coded as one through seven (Table 16). Gender of students was designated as one for female and two for male (Table 17). Race and ethnicity were combined into five categories, white, black/African American, Hispanic and multiple Hispanic, Asian, and other (American Indian, Native Hawaiian, and multiple) and coded as one through five respectively (Table 18).

Table 13 Dietary Behavior Questions, Codes and Labels

Question	***Code***	***Label***
(Q73) Green Salad Consumption: During the past 7 days, how many times did you eat green salad?	1	I did not eat green salad during the past 7 days
	2	1 to 3 times during the past 7 days
	3	4 to 6 times during the past 7 days
	4	1 time per day
	5	2 times per day
	6	3 times per day
	7	4 or more times per day

Source: CDC YRBS 2005

Table 14 Physical Activity, Codes and Labels

Question	***Code***	***Label***
(Q78) On how many of the past 7 days did you exercise or participate in physical activity for at least 20 minutes that made you sweat and breathe hard, such as basketball, soccer, running, swimming laps, fast bicycling, fast dancing, or similar aerobic activities?	1	0 days
	2	1 days
	3	2 days
	4	3 days
	5	4 days
	6	5 days
	7	6 days
	8	7 days
(Q79) On how many of the past 7 days did you participate in physical activity for at least 30 minutes that did not make you sweat or breathe hard, such as fast walking, slow bicycling, skating, pushing a lawn mower, or mopping floors?	1	0 days
	2	1 days
	3	2 days
	4	3 days
	5	4 days
	6	5 days
	7	6 days
	8	7 days

Source: CDC YRBS 2005

Table 15 Weight Loss Methods Codes and Labels

Question	*Code*	*Label*
(Q67) During the past 30 days, did you eat less food, fewer calories, or foods low in fat to lose weight or keep from gaining weight?	1 2	Yes No
(Q68) During the past 30 days, did you go without eating for 24 hours or more (also called fasting) to lose weight or to keep from gaining weight?	1 2	Yes No
(Q69) During the past 30 days, did you take any diet pills, powders, or liquids without a doctor's advice to lose weight or to keep from gaining weight?	1 2	Yes No
(Q70) During the past 30 days, did you vomit or take laxatives to lose weight or to keep from gaining weight	1 2	Yes No

Source: CDC YRBS 2005

Table 16 Age

Age	*Code*
12	1
13	2
14	3
15	4
16	5
17	6
18 or older	7

Source: CDC YRBS 2005

Table 17 Gender

Gender	*Code*
Female	1
Male	2

Source: CDC YRBS 2005

Table 18 Recoded Race Descriptions

Race	*Code*
White	1
Black (African-American)	2
Hispanic and Multiple Hispanic	3
Asian	4
Other (American Indian, Native Hawaiian, Multiple)	5

Source: CDC YRBS 2005

Analysis

BMI Status and Behaviors

Multinomial logistic regression was used to address BMI status change in adolescents based on dietary, physical activity and method of weight loss behaviors in research question one. According to Starkweather and Moske (2016), multinomial logistic regression has the ability to predict categorical data on dependent variables based on multiple independent variables. It does have multiple assumptions, such as dependent variables should be nominal; dependent variables are in their own categories, and no multicollinearity. In addition, it does not assume homoscedasticity, linearity, or normality.

Nutritional Environment Assessment

Geocoding

Geocoding is the processes of spatially referencing point features based on the address of the feature and knowledge of an address range for a linear network (Bolstad 2008). It is also known as linear referencing. It requires street addresses with a set of linear features.

Restaurant data for Dallas ISD and San Diego USD did not need to be geocoded, due to the creation of a python script that assigned x and y coordinates to the address locations. Geocoding was performed using ArcGIS 10.x on Boston PS, Memphis ISD and Miami-Dade County PS. The match rate was highest among Boston PS and low for both Memphis ISD and Miami-Dade County PS. Table 20 shows the geocoding results.

Since the matching rates were low for Memphis ISD and Miami-Dade County PS a python script was then written to convert the addresses into x and y coordinates. The original excel spreadsheet of address locations of each restaurant needed to be modified to accommodate the python script. The address, city, state, and zip code columns were combined into one column. A concatenate formula was created to add the address, city, state, and zip into one column.

Once the files were in the appropriate format, I was able to run the script. The script was able to assign all restaurants within the Memphis ISD and Miami-Dade County PS file with an x and y coordinate. The returned restaurant results needed further cleaning. A concatenate formula was created again to separate the x and y coordinates information so they could be entered into separate columns.

Table 19 Geocoding Matching Results

	Boston PS	Memphis ISD	Miami-Dade County PS
Matched	8,229	2,227	4,369
Unmatched	481	400	1,099
Matching Rate	94%	78%	75%

Proximity Analysis

A new road network dataset was built for each school district using network analyst. The network contains lines or edges and points or junctures. The edges denote a road and junctures the intersection of two roads. The network dataset needs to be done to ensure connectivity from the road layer.

Using the road network dataset, a service area (buffer) of 400 meters and 800 meters was created around schools using the network analyst tool. This is similar to a buffer, but follows the road network. It has been estimated that an adult can walk 400 m in approximately 5 minutes and 800 m in 10 minutes (Pikora et al. 2002). The 800 meter service area also contained the 400 meter service area so an extraction of the 400 meter area was completed.

Once the service areas were built, restaurants and supermarkets were able to be removed from outside the 800 meter area. The remaining restaurants and supermarkets resided within either the 400 or 800 meter areas. Spatial joins were used to capture restaurants, supermarkets within the 400 m and 800 m service areas. The results of the spatial joins enabled counts of each of these features within the 400 m and 800 m to be calculated within the attribute table.

Kruskall-Wallis Test

The Kruskall-Wallis test was used to explore whether or not my study areas varied across nutritional environments. The Kruskall-Wallis test is a nonparametric statistical method used for two or more independent groups. It is comparable to one-way analysis of variance (ANOVA). This test does not assume the population is normally distributed or equal in variance (Burt, Barber, and Rigby 2009). The Kruskall-Wallis test ranks all observations without concern to the population. The Kruskall-Wallis equation is as follows:

$$H = \frac{12}{n(n+1)} \sum_{j-1}^{k} \frac{R_j^2}{n_j} - 3(n+1) \quad (1)$$

In the above equation, k is the number of groups (school districts), n_1, n_2, …., n_k denotes the sample size, n_j is the size of the *j*th group, and R_j is the rank sum of the jth group. A five percent error (α – 0.05) is accepted. Since there are more than five observations, H follows the chi square (X^2) distribution which is controlled by the degrees of freedom (Burt, Barber, and Rigby 2009). The degrees of freedom (df) is k-1, k being the number of groups. The df equals four. The critical X^2 to reject the null hypothesis is 9.48773. The null hypotheses is there is no variation in nutritional environments. The alternative hypothesis is there is a variation in nutritional environments.

The Kruskall-Wallis test was conducted in SPSS 23. Schools districts were coded as follows: Boston PS = 1, Dallas ISD= 2, Memphis ISD = 3, Miami-Dade County PS = 4, and San Diego USD = 5. The number of restaurants were calculated around each school at 400 m and 800 m. The same was completed for supermarkets. Three variables were created within SPSS for restaurants, 400 m, 800m and all. The same was also done for supermarkets. The determination of whether the data was normally distributed or not, skewness, kurtosis and histograms were performed on each variable.

The BMI was also analyzed using the Kruskall-Wallis test between all districts. The null hypothesis being there is no difference between BMI across school districts. The alternative being there is a difference in BMI across school districts.

Mann-Whitney Test

The Mann-Whitney tests was used to test the nutritional environment differences between two school districts. The Mann-Whitney U test is a nonparametric test that is equivalent to a *t*-test. The test assumes the two populations have the same distributions, dependent variable is ordinal and observations are independent of each other. This test was performed because I wanted to see if there were differences between two school districts, instead of all of them together. The Mann-Whitney equation is as follows:

$$\mu_S = \frac{n_x(n_x + n_y + 1)}{2} \qquad (2)$$

In the above equation, S is the sum of the ranks and *n* is the size of the sample. The restaurants and supermarkets were ranked in order to run this test. The null hypothesis is there are no differences in nutritional environments between two districts. The alternative is there are differences in nutritional environments between two districts.

Bike Route and Park Access

The service areas of 400 m and 800m used in assessing nutritional environments was also used in determining bike route access and access to parks within the boundary. Spatial joins were used to capture bike routes and parks within the 400 m and 800 m service areas. The number of bike routes and parks within the 400 m and 800 m of a school was calculated from the spatial join.

The Kruskall-Wallis test was also used to assess whether or not all school districts varied in bike route access and park access (See equation 1). Again, schools districts were coded as follows: Boston PS = 1, Dallas ISD = 2, Memphis ISD= 3, Miami-Dade County PS = 4, and San Diego USD = 5. The number of bike routes and supermarkets were calculated around each schools at 400 m and 800 m. The determination of whether the data was normally distributed or not, skewness, kurtosis and histograms were performed on each variable.

The Mann-Whitney test was used to evaluate there were differences in bike route access and access to parks between two school districts (See equation 2). The null hypothesis is there are no differences in bike route access or park access between two districts. The alternative is there are differences in bike route access to park access between two districts.

Limitations of Data

This study uses secondary data for analysis. When using secondary data, accuracy can be an issue. The school district YRBSS datasets do not include which school the survey was conducted in nor does it reveal where the student lives due to confidentiality reasons. In addition, districts can remove questions from the survey as they see fit. Subsequently, not all districts will ask the same questions, which can impair comparison analysis.

Accuracy can be an issue with the bike route, park, road, school district boundary, restaurant, and/or supermarket data. The bike routes, parks, roads, and school district boundary were downloaded from state and/or local municipal sources. Updates to the data or human error could cause inaccuracies. It is possible the data was not up to date or human error could play a role in its accuracy. Since restaurant and supermarket data were obtained from the internet yellow pages or Reference USA, data could have been omitted or added. Also, locations of these facilities could be incorrect. In addition, if the road layer had errors, the road network dataset would also have errors.

IV. RESULTS

This chapter provides the results of the analysis performed in this study. The goal is to answer research questions 1, 2, and 3 given in Chapter I. Research question 1 attempted to analyze variations in BMI status among adolescents based on dietary, physical activity and method of weight loss behaviors. This was completed by performing multinomial logistic regression using SPSS. The results of question 1 are broken out by school districts. Question 2 attempts to analyze nutritional environments across school districts and BMI status. ArcGIS 10.3 was used for mapping nutritional environments. The Kruskall-Wallis and Mann-Whitney test were used to determine variation among districts using SPSS. Questions 3 attempts to analyze access to bike routes and parks, variance across school districts and BMI status? ArcGIS 10.3 was also used in mapping bike routes and parks. A Kruskall-Wallis and Mann-Whitney test were again used to determine variation among districts using SPSS.

BMI Status and Behaviors

Dallas ISD Descriptive Statistics Multinomial Logical Regression

The descriptive statistics of the Dallas ISD sample was comprised of 50.4% female and 49.6% male. The ethnic diversity of the Dallas ISD sample was 35.9% Black, 55.2% Hispanic, 7.4% White, 0.4% Asian, and 0.7% other. The rate of overweight between Black, Hispanics, White, Asian and Other was 16.5%, 16.6%, 13.2%, 5.6%, and 18.8% respectively for the Dallas ISD. Obesity rate in Blacks, Hispanics, White, Asian, and Other was 19.8%, 21.2%, 14.1%, 11% and 25% respectively for the Dallas ISD. The overall percentage of students overweight was 16.7% and 20.7% were obese Females were more overweight than males 16% and 17% respectively. But males were more obese than females 21.6% and 17% respectively. See Table 21 for overweight and obesity percentages by gender.

Table 20 Dallas ISD Overweight and Obesity Rates by Gender

Gender	%Overweight	% Obese
Female	16%	17%
Male	14%	21.6%
Both	16.7%	20.7%

The multinomial logistic regression results of the Dallas ISD normal weight adolescents being the reference category and overweight adolescents being the dependent variable, the odds ratio (OR) and p-value demonstrate an association between adolescents who took laxatives and/or vomited to lose weight (Table 21). Due to the OR being below 1.00 the adolescents who took laxatives or vomited to lose weight were likely to be of normal weight.

Table 21 Dallas ISD (Overweight) Multinomial Logistic Regression Results

Variable	Odds Ratio (95% CI)	Significance Level (p-value)
Green Salad	0.845 (0.674-1.058)	0.142
Vigorous Activity	0.980 (0.903-1.064)	0.627
Light Activity	0.959 (0.885-1.039)	0.302
Go without eating for 24 hrs. or more to lose weight or keep from gaining weight	1.563 (0.840-2.907)	0.159
Taken diet pills, powders, or liquids to lose weight	0.626 (0.285-1.372)	0.242
Vomit or take laxatives to lose weight	**0.333 (0.169-0.657)**	**0.001***
Gender		
Female	0.867 (0.590-1.274)	0.467
Male	Referent	Referent
Race		
Non-Hispanic White	0.728 (0.377-1.407)	0.345
Black	1.210 (0.814-1.799)	0.347
Hispanic	0.429 (0.137-1.339)	0.145
Asian	NA	NA
Other	Referent	Referent
Age		
12 years old	N/A	N/A
13 years old	N/A	N/A
14 years old	0.701 (0.341-1.438)	0.332
15 years old	1.081 (0.618-1.891)	0.786
16 years old	0.993 (0.563-1.751)	0.979
17 years old	0.918 (0.514-1.639)	0.772
18 years old or older	Referent	Referent

***Statistically significant**
Normal weight is reference
NA= Not available

The multinomial logistic regression results of the Dallas ISD normal weight adolescents being the reference category and obese adolescents being the dependent variable, the odds ratio (OR) and p-value demonstrate an association between adolescents who took diet pills, exercised vigorously for more than 20 minutes, where White, and female (Table 22). Due to the OR being below 1.00 the adolescents who exercised vigorously for more than 20 minutes, where white, and female were likely to be of normal weight.

Table 22 Dallas ISD (Obese) Multinomial Logistic Regression Results

Variable	Odds Ratio (95% CI)	Significance Level (p-value)
Green Salad	0.938 (0.770-1.143)	0.528
Vigorous Activity	**0.897 (0.830-0.969)**	**0.006***
Light Activity	1.007 (0.935-1.083)	0.859
Go without eating for 24 hrs. or more to lose weight or keep from	1.44 (0.806-2.580)	0.2179
Taken diet pills, powders, or liquids to lose weight	**0.235 (0.121-0.459)**	**<0.001***
Vomit or take laxatives to lose weight	0.967 (0.444-2.104)	0.9323
Gender		
Female	**0.542 (0.380-0.773)**	**<0.001***
Male	Referent	Referent
Race		
Non-Hispanic White	**0.478 (0.249-0.921)**	**0.027***
Black	1.14 (0.783-1.645)	0.504
Hispanic	0.497 (0.189-1.305)	0.156
Asian	NA	NA
Other	Referent	Referent
Age		
12 years old	N/A	N/A
13 years old	N/A	N/A
14 years old	0.986 (0.489-1.989)	0.968
15 years old	1.568 (0.900-2.733)	0.112
16 years old	1.631 (0.937-2.840)	0.084
17 years old	1.330 (0.749-2.362)	0.331
18 years old or older	Referent	Referent

***Statistically significant**
Normal weight is reference
NA = Not available

San Diego Unified School District Descriptive Statistics and Multinomial Logical Regression

Descriptive statistics for San Diego USD was 14% Black, 40% Hispanic, 28% White, 10% Asian, and 6% other. The percent of students who were overweight was 13.6% and 12.6% were obese. San Diego USD students who were overweight by Race/ethnicity was 14.2% Black, 15.3% Hispanics, 9.7% White, 7.6% Asian, and 15.9% Other. Obesity rates were 9.5% Black, 14.1% Hispanics, 7.5% White, 6.6% Asian, and 14.5% other. Females were more overweight than males 9.6% and 5.8% respectively. Males had higher rates of being obese than females 10.9% and 5.8% receptively (Table 23).

Table 23 San Diego USD Overweight and Obese Descriptive

Gender	%Overweight	%Obese
Female	9.6%	6.0%
Male	5.8%	10.9%
All	13.6%	12.6%

Normal weight adolescents being the reference category and overweight adolescents being the dependent variable, the odds ratio (OR) and p-value multinomial logistic regression for San Diego USD demonstrated an association between adolescents who exercised vigorously for more than 20 minutes, where 15 years of age, female, White or Asian (Table 24). Due to the OR being below 1.00 the adolescents who exercised vigorously for more than 20 minutes, White, and Asian are likely to be of normal weight. Age was significant, if one were age 15 he/she is likely to be overweight.

Table 24 San Diego USD (Overweight) Multinomial Logistic Regression Results

Variable	Odds Ratio (95% CI)	Significance Level (p-value)
Green Salad	1.036 (0.878-1.221)	0.678
Light Activity	1.030 (0.966-1.097)	0.371
Go without eating for 24 hrs. or more to lose weight or keep from gaining weight	1.028 (0.614-1.718)	0.918
Taken diet pills, powders, or liquids to lose weight	0.755 (0.391-1.455)	0.401
Vomit or take laxatives to lose	1.557 (0.694-3.490)	0.283
Gender		
Female	**0.622 (0.446-0.867)**	**0.005***
Male	Referent	Referent
Race		
Non-Hispanic White	**0.474 (0.307-0.731)**	**0.001***
Black	0.707 (0.419-1.194)	0.195
Hispanic	0.704 (0.404-1.225)	0.214
Asian	0.386 (0.234-0.638)	0.000
Other	Referent	Referent
Age		
14 years old	2.041 (0.973-4.282)	0.059
15 years old	**2.062 (1.069-3.979)**	**0.031***
16 years old	1.774 (0.921-3.419)	0.087
17 years old	1.737 (0.891-3.383)	0.105
18 years old or older	Referent	Referent

***Statistically significant**
Normal weight is reference

San Diego USD multinomial logistic regression was performed with normal weight adolescents being the reference category and obese adolescents being the dependent variable. The odds ratio (OR) and p-value demonstrated an association between students who exercised vigorously for more than 20 minutes, exercised lightly for more than 30 minutes, 14 years of age, female, White, African-American, or Asian (Table 25). Due to the OR being below 1.00 the adolescents who exercised vigorously for more than 20 minutes, exercised lightly for more than 30 minutes, were White or African-American are likely to be of normal weight.   Age was significant. If one were age 14 he/she is likely to be obese.

Table 25 San Diego USD (Obese) Multinomial Regression Results

Variable	Odds Ratio (95% CI)	Significance Level (p-value)
Green Salad	0.858 (0.712-1.035)	0.109
Vigorous Activity	**0.897 (0.832-0.967)**	**0.005***
Light Activity	0.939 (0.874-1.010)	0.089
Go without eating for 24 hrs. or more to lose weight or keep from gaining weight	1.178 (0.667-2.079)	0.573
Taken diet pills, powders, or liquids to lose weight	0.816 (0.387-1.725)	0.595
Vomit or take laxatives to lose weight	1.309 (0.555-3.084)	0.539
Gender		
Female	**0.258 (0.178-0.374)**	**<0.001***
Male	Referent	Referent
Race		
Non-Hispanic White	**0.426 (0.265-0.685)**	**<0.001***
Black	**0.520 (0.288-0.938)**	**0.030***
Hispanic	0.759 (0.429-1.344)	0.344
Asian	**0.308 (0.180-0.529)**	**<0.001***
Other	Referent	Referent
Age		
14 years old	**2.167 (1.110-4.231)**	**0.023***
15 years old	0.899 (0.475-1.700)	0.743
16 years old	1.245 (0.681-2.276)	0.477
17 years old	1.200 (0.649-2.217)	0.561
18 years old or older	Referent	Referent

*Statistically significant
Normal weight is reference

Boston Public Schools Descriptive Statistics and Multinomial Logical Regression

Descriptive statistics for Boston PS revealed a demographic make-up of 18.9% White, 38.9% Black, 28.5% Hispanic, 11.6% Asian, and 2.2% other. Sixty-nine percent of students were of normal weight, 18.1% were overweight, and 13% were considered obese. Boston PS students who were overweight by Race/Ethnicity was 14% White, 19% Black, 17% Hispanic, 22% Asian, and 14.6% other. Boston PS students who were obese by Race/Ethnicity was 12% White, 14.7% Black, 13% Hispanic, 13.5% Asian, and 7.3% Other. Females were more overweight than males 13% and 9.6% respectively. Males were more obese than females 13.6% and 7.2% respectively (Table 26).

Table 26 Boston PS Percentage of Overweight and Obese Students by Gender

Gender	**%Overweight**	**%Obese**
Female	13	7.2
Male	9.6	13.6
All	18.1	13

Normal weight adolescents was used as the reference category and overweight adolescents being the dependent variable. The odds ratio (OR) and p-value multinomial logistic regression for Boston PS demonstrated an association between adolescents who took diet pills, powders, or liquids to lose weight, were female. Due to the OR being below 1.00 the adolescents who took diet pills, powders, or liquids to lose weight, were female are likely to be of normal weight (Table 27). If one were age 14 he/she is likely to be overweight.

Table 27 Boston PS (Overweight) Multinomial Regression Results

Variable	Odds Ratio (95% CI)	Significance Level (p-value)
Green Salad	0.902 (0.097-1.007)	0.181
Vigorous Activity	0.971(0.906-1.041)	0.043
Light Activity	1.077 (1.002-1.157)	0.404
Go without eating for 24 hrs. or more to lose weight or keep from gaining weight	1.052 (0.627-1.763)	0.849
Taken diet pills, powders, or liquids to lose weight	**0.312 (0.133-0.733)**	**0.008***
Vomit or take laxatives to lose weight	0.732 (0.296-1.809)	0.499
Gender		
Female	**0.578 (0.407-.0822)**	**0.002***
Male	Referent	Referent
Race		
Non-Hispanic White	0.679 (0.235-1.960)	0.876
Black	1.598 (0.579-4.415)	0.474
Hispanic	1.014 (0.363-2.835)	0.979
Asian	0.313 (0.0906-1.041)	0.051
Other	Referent	Referent
Age		
12 years old	96.234 (96.234-96.234)	N/A
13 years old	N/A	N/A
14 years old	**2.779 (1.310-5.893)**	**0.008***
15 years old	1.703(0.981-2.957)	0.059
16 years old	1.608 (0.947-2.733)	0.079
17 years old	1.458 (0.863-2.465)	0.159
18 years old or older	Referent	Referent

***Statistically significant**
Normal weight is reference
N/A= Not available

Boston PS multinomial logistic regression was performed with normal weight adolescents being the reference category and obese adolescents being the dependent variable. The odds ratio (OR) and p-value demonstrated an association between students who took diet pills, powders, or liquids to lose weight and female are more likely to be normal weight (Table 28).

Table 28 Boston PS (Obese) Multinomial Logistic Regression Results

Variable	Odds Ratio (95% CI)	Significance Level (p-value)
Green Salad	0.951 (0.791-1.144)	0.596
Vigorous Activity	0.989 (0.905-1.082)	0.812
Light Activity	1.015 (1.002-1.115)	0.759
Go without eating for 24 hrs. or more to lose weight or keep from gaining weight	0.928 (0.488-1.766)	0.819
Taken diet pills, powders, or liquids to lose weight	**0.274 (0.097-0.772)**	**0.014***
Vomit or take laxatives to lose weight	1.918 (0.534-6.894)	0.318
Gender		
Female	**0.139 (0.085-0.226)**	**<0.001***
Male	Referent	Referent
Race		
Non-Hispanic White	1.343 (0.0240-7.515)	0.737
Black	3.846 (0.716-20.648)	0.116
Hispanic	0.253 (0.038-1.688)	0.156
Asian	1.806 (0.333-9.813)	0.493
Other	Referent	Referent
Age		
12 years old	4.888 (0.00)	0.977
13 years old	N/A	N/A
14 years old	2.503 (0.932-6.725)	0.069
15 years old	1.476 (0.755-2.886)	0.255
16 years old	0.860 (0.550-2.048)	1.061
17 years old	0.757 (0.579-2.118)	1.108
18 years old or older	Referent	Referent

***Statistically significant**
Normal weight is reference
N/A= Not available

Miami-Dade County Public Schools Descriptive Statistics and Multinomial Logical Regression

Descriptive statistics for Miami-Dade County PS was 8.5% White, 25.2% Black, 63.9% Hispanic, 1.4% Asian, and 1% Other. The percentage of students who were overweight was 16.5% and 11.8% were obese. Miami-Dade County PS students who were overweight by Race/Ethnicity was 13% White, 18.9% Black, 13% Hispanic, 5.7% Asian, and 26.6% Other. Students who were considered obese ranged from 5.7% White, 12.7% Black, 9.5% Hispanic, 8.5% Asian, and 13.3% Other. Females were more overweight than males at 13.7% and 12.2% respectively. Males were more obese than females 11.8% and 6% respectively (Table 29).

Table 29 Miami-Dade County PS Percentage of Overweight and Obese Students by Gender

Gender	%Overweight	%Obese
Female	13.7	6
Male	12.2	11.8
All	16.5	11.8

Miami-Dade County PS multinomial logistic regression was performed with normal weight adolescents being the reference category and overweight adolescents being the dependent variable. The odds ratio (OR) and p-value demonstrated an association between students who were female, White, Black, Hispanic, Asian, or other. Due to the OR being below 1.00 the adolescents who were female, White, Black, Hispanic, Asian, or other were likely to be of normal weight (Table 30).

Table 30 Miami-Dade County PS (Overweight) Multinomial Logistic Regression Results

Variable	Odds Ratio (95% CI)	Significance Level (p-value)
Green Salad	1.040 (0.933-1.158)	0.481
Vigorous Activity	0.980 (0.923-1.041)	0.518
Light Activity	1.006 (0.947-1.069)	0.840
Go without eating for 24 hrs. or more to lose weight or keep from gaining weight	0.911 (0.593-1.400)	0.671
Taken diet pills, powders, or liquids to lose weight	0.756 (0.402-1.423)	0.386
Vomit or take laxatives to lose weight	0.569 (0.295-1.099)	0.093
Gender		
Female	**0.591 (0.441-0.791)**	**<0.001***
Male	Referent	Referent
Race		
Non-Hispanic White	**0.067 (0.019-0.234)**	**<0.001***
Black	**0.210 (0.066-0.674)**	**0.009***
Hispanic	**0.083 (0.026-0.263)**	**<0.001***
Asian	**0.044 (0.006-0.321)**	**0.002***
Other	Referent	Referent
Age		
12 years old	$1.188E^{10}$ ($6.074E^{8}$-$2.32E^{11}$)	0.00
13 years old	4.004 (0.106-151.937)	0.455
14 years old	1.695 (0.952-3.020)	0.073
15 years old	1.309 (0.839-2.043)	0.235
16 years old	1.059 (0.694-1.617)	0.790
17 years old	1.247 (0.829-1.873)	0.289
18 years old or older	Referent	Referent

***Statistically significant**
Normal weight is reference

Miami-Dade County PS multinomial logistic regression was performed with normal weight adolescents being the reference category and obese adolescents being the dependent variable. The odds ratio (OR) and p-value demonstrated an association between students who were female, White, Hispanic, Asian, or other. Due to the OR being below 1.00 the adolescents who were female, White, Hispanic, Asian, or other were likely to be of normal weight. Age was significant. If one were ages 14 or 15 he/she would likely be obese. (Table 31).

Table 31 Miami-Dade County PS (Obese) Multinomial Logistic Regression Results

Variable	Odds Ratio (95% CI)	Significance Level (p-value)
Green Salad	0.983 (0.858-1.127)	0.808
Vigorous Activity	0.973 (0.902-1.049)	0.471
Light Activity	1.011 (0.937-1.091)	0.780
Go without eating for 24 hrs. or more to lose weight or keep from gaining weight	0.905 (0.533-1.538)	0.713
Taken diet pills, powders, or liquids to lose weight	0.504 (0.248-1.026)	0.059
Vomit or take laxatives to lose weight	0.695 (0.858-1.127)	0.412
Gender		
Female	**0.234 (0.161-0.340)**	**<0.001***
Male	Referent	Referent
Race		
Non-Hispanic White	**0.052 (0.019-0.234)**	**0.001***
Black	0.347 (0.066-0.674)	0.185
Hispanic	**0.116 (0.026-0.263)**	**0.007***
Asian	**0.058 (0.006-0.321)**	**0.024***
Other	Referent	Referent
Age		
12 years old	$1.200E^{11}$ ($1.200E^{11}$-	N/A
13 years old	$4.020E^{8}$ ($4.020E^{-8}$-$4.020E^{-8}$)	N/A
14 years old	**2.318 (1.125-4.775)**	**0.023***
15 years old	**1.891 (1.088-3.286)**	**0.024***
16 years old	1.196 (0.697-2.050)	0.516
17 years old	1.165 (0.680-1.996)	0.579
18 years old or older	Referent	Referent

***Statistically significant**
Normal weight is reference

Memphis Independent School District Descriptive Statistics and Multinomial Logical Regression

Descriptive statistics for Memphis ISD was 12.9% White, 81.2% African American, 3.3% Hispanic, 1.7% Asian, and 1% Other. The percentage of students who were overweight was 18.1% and 16.3% were obese. Memphis ISD students who were overweight by Race/Ethnicity was 17.8% White, 17.4% Black, 8.1% Hispanic, 3.7% Asian, and 5.2% Other. Obesity rates were 10.7% White, 16.1% Black, 8.1% Hispanic, 11.1% Asian, and 0.0% Other. Females were more overweight than males 16.6% and 14.6% respectively. Males had higher rates of being obese than females 14.3% and 13.8% respectively (Table 32).

Table 32 Memphis ISD Percentage of Overweight and Obese Students by Gender

Gender	%Overweight	%Obese
Female	16.6	13.8
Male	14.6	14.3
All	18.1%	16.3%

Memphis ISD multinomial logistic regression was performed with normal weight adolescents being the reference category and overweight adolescents being the dependent variable. The odds ratio (OR) and p-value demonstrated an association between students who took diet pills, powers, or liquids to lose weight. Due to the OR being below 1.00 the adolescents who took diet pills, powers, or liquids to lose weight were of normal weight (Table 33).

Table 33 Memphis ISD (Overweight) Multinomial Logistic Regression Results

Variable	Odds Ratio (95% CI)	Significance Level (p-value)
Green Salad	0.947 (0.802-1.117)	0.518
Vigorous Activity	1.005 (0.937-1.077)	0.964
Light Activity	0.974 (0.909-1.045)	0.463
Go without eating for 24 hrs or more to lose weight or keep from	0.938 (0.546-1.612)	0.817
Taken diet pills, powders, or liquids to lose weight	**0.305 (0.115-0.808)**	**0.017***
Vomit or take laxatives to lose	2.368 (0.722-7.768)	0.155
Gender		
Female	0.770 (0.543-1.093)	0.144
Male	Referent	Referent
Race		
Non-Hispanic White	1.207 (0.138-10.563)	0.865
Black	1.531 (0.183-12.815)	0.695
Hispanic	0.659 (0.061-7.163)	0.732
Asian	0.563 (0.029-10.890)	0.704
Other	Referent	Referent
Age		
12 years old	$1.054E^{-6}$ ($1.054E^{-6}$-$1.054E^{-}$	
13 years old	$5.880E^{-8}$ ($5.880E^{-8}$-$5.880E^{-}$	
14 years old	0.915 (0.410-2.045)	0.829
15 years old	1.208 (0.653-2.236)	0.546
16 years old	1.150 (0.639-2.068)	0.642
17 years old	0.844 (0.436-1.632)	0.614
18 years old or older	Referent	Referent

***Statistically significant**
Normal weight is reference

Memphis ISD multinomial logistic regression was performed with normal weight adolescents being the reference category and obese adolescents being the dependent variable. The odds ratio (OR) and p-value demonstrated an association between students who took diet pills, powders, or liquids to lose weight and female. Due to the OR being below 1.00 the adolescents who took diet pills, powders, or liquids to lose weight and female were likely to be of normal weight (Table 34).

Table 34 Memphis ISD (Obese) Multinomial Logistic Regression Results

Variable	Odds Ratio (95% CI)	Significance Level (p-value)
Green Salad	0.923 (0.761-1.118)	0.412
Vigorous Activity	1.039 (0.342-1.039)	0.342
Light Activity	1.033 (0.443-1.033)	0.443
Go without eating for 24 hrs or more to lose weight or keep from gaining weight	1.019 (0.556-1.868)	0.951
Taken diet pills, powders, or liquids to lose weight	**0.131 (0.048-0.357)**	**<0.001***
Vomit or take laxatives to lose weight	1.975 (0.541-7.212)	0.303
Gender		
Female	**0.498 (0.318-0.756)**	**0.001***
Male	Referent	Referent
Race		
Non-Hispanic White	4753906(0.000-4753906)	0.997
Black	$1.099E^{7}$ (0.000-$1.099E^{7)}$	0.996
Hispanic	4714470 (0.0004714470)	0.997
Asian	$1.558E^{7}$ (0.000-$1.558E^{7)}$	0.996
Other	Referent	Referent
Age		
12 years old	1.015E-5 ($1.015E^{-5}$-$1.015E^{-5}$)	
13 years old	$2.036E^{-7}$ ($2.036E^{-7}$-$2.036E^{-7}$)	
14 years old	0.831 (0.336-2.055)	0.689
15 years old	0.853 (0.463-1.889)	0.936
16 years old	0.629 (0.318-1.242)	0.182
17 years old	1.231 (0.605-2.501)	0.566
18 years old or older	Referent	Referent

***Statistically significant**
Normal weight is reference

Variance Test to Examine Nutritional Environments

Nutritional Environments across School Districts

The methodology to identify variances in school districts based on restaurants and supermarkets was discussed in Chapter 3. Table 35 lists the frequencies to test if the data was not evenly distributed. The test revealed the data was skewed to the left, verifying the data was not evenly distributed and kurtosis was very high.

Table 35 Frequency Results of Nutritional Environments

	400m Restaurants	800m Restaurants	All Restaurants	400 m Supermarkets	800 m Supermarkets	All Supermarkets
N	145	145	145	145	145	145
Mean	2.57	6.70	7.59	0.04	0.19	0.23
Median	0.000	3.00	2.00	0	0	0.00
Mode	0	0	0	0	0	0.00
Skewness	5.934	4.932	6.455	4.654	2.339	2.359
Std. Error of Skewness	0.201	0.201	0.201	0.201	0.201	0.201
Kurtosis	49.121	37.041	57.695	19.932	4.961	4.436
Std. Error of Kurtosis	0.400	0.400	0.400	0.400	0.400	0.400

Table 36 describes the statistics of nutritional environments across five school districts. Boston PS stands out among all the districts. It has the highest average number of restaurants within 400 m of school (5.9) and the highest average number of restaurants at 800 m (15.9) with the third highest percentages of overweight students and the second highest in obese students. Supermarkets within 400 m and 800 m of a school was very low within each district. Boston PS and San Diego USD had no supermarkets within 400 m and 800 m of school. Boston PS does have the highest percentage of students who are overweight and the third highest who are obese. On the contrary, San

Diego USD has the lowest rate of students who are overweight and second lowest who are obese.

Table 36 Statistics on Nutritional Environments across the Five School Districts

School District	Number of Campuses	Average Number of Restaurants		Average Number of Supermarkets		Percentage of BMI obese	Percentage of BMI over-weight
		400m buffer	800m buffer	400m buffer	800m buffer		
Boston PS	20	5.90	15.90	0	0	13	18.7
Dallas ISD	27	1.85	5.85	0.07	0.07	20.7	16.7
Memphis ISD	28	0.82	2.86	0.07	0.07	16.3	18.1
Miami-Dade County PS	38	1.47	4.21	0.05	0.21	11.8	16.5
San Diego USD	34	1.97	3.79	0	0	12.6	13.6

Table 37 lists the results of the Kruskall-Wallis test on restaurants and supermarkets. These results reveal a significant p-value for restaurants at 400 m, 800 m, and overall restaurants between districts. These results reject the null hypothesis, all districts have same distribution of restaurants at 400m, 800 m, and overall. Supermarkets on the other hand, did not have a significant p-value between districts retaining the null hypothesis all districts have the same distribution of supermarkets at all distances. Therefore, the Mann-Whitney test will not be performed on supermarkets.

Table 37 Kruskall-Wallis across Five School Districts by Restaurants and Supermarkets

Null Hypothesis	Significance	Decision	Median	Median Test Statistic	Distribution Test Statistics
The concentration of restaurants within 400 m of schools is the same across the five school districts.	<0.001	Reject Null Hypothesis	0.000	21.457	25.376
The concentration of restaurants within 800 m of schools is the same across the five school districts.	<0.001	Reject Null Hypothesis	3.000	39.671	42.062
The concentration of all restaurants are the same across the five school districts	0.020	Reject Null Hypothesis	2.000	16.575	21.661
The concentration of supermarkets within 400 m of schools is the same across the five school districts.	0.402	Retain Null Hypothesis	0.000	4.030	4.002
The concentration of supermarkets within 800 m of schools is the same across the five school districts	0.219	Retain Null Hypothesis	0.000	5.751	5.767
The concentration of all supermarkets is the same across the five school districts	0.219	Retain Null Hypothesis	0.000	5.751	4.785

Boston Public Schools

Table 38 displays the results of the Mann-Whitney test comparing Boston PS restaurants with the other districts. It shows no significant p-value in restaurants between Boston PS and Dallas ISD at the 400 m distance. However, all other districts at the 400 m, 800, and overall restaurant distance was had a significant p-value of less than 0.05 rejected the null hypothesis. Boston PS had a much higher mean rank compared to the other districts suggesting they had more restaurants within 400 m, 800 m, and overall than any other districts. Figures 20 through 22 shows maps of nutritional environments (Appendix B).

Table 38 Mann-Whitney Test Comparing Boston PS Restaurants with Dallas ISD, Memphis ISD, Miami-Dade County PS, and San Diego USD

Null Hypothesis	Significance	Decision	Mean Rank Boston	Mean Rank	Mann-Whitney U
The concentration of restaurants within 400 m of schools is the same between Boston PS and Dallas ISD.	0.123	Retain Null Hypothesis	26.32	20.34	183.50
The concentration of restaurants within 400 m of schools is the same between Boston PS and Memphis ISD.	**<0.001***	**Reject Null Hypothesis**	**33.55**	**18.04**	**99.00**
The concentration of restaurants within 400 m of schools is the same between Boston PS and Miami-Dade County PS.	**<0.001***	**Reject Null Hypothesis**	**40.35**	**23.79**	**163.00**
The concentration of restaurants within 400 m of schools is the same between Boston PS and San Diego USD.	**0.002***	**Reject Null Hypothesis**	**35.50**	**22.79**	**180.00**
The concentration of restaurants within 800 m of schools is the same between Boston PS and Dallas ISD.	**0.009***	**Reject Null Hypothesis**	**28.68**	**18.46**	**136.50**
The concentration of restaurants within 800 m of schools is the same between Boston PS and Dallas ISD Memphis ISD.	**<0.001***	**Reject Null Hypothesis**	**36.70**	**15.79**	**36.00**

Table 38. Continued					
Null Hypothesis	**Significance**	**Decision**	**Mean Rank Boston**	**Mean Rank**	**Mann-Whitney U**
The concentration of restaurants within 800 m of schools is the same between Boston PS and Miami-Dade County PS.	**<0.001***	**Reject Null Hypothesis**	**43.50**	**22.13**	**100.00**
The concentration of restaurants within 800 m of schools is the same between Boston PS and San Diego USD.	**<0.001***	**Reject Null Hypothesis**	**40.50**	**19.85**	**80.00**
The overall concentration of restaurants is the same between Boston PS and Dallas ISD.	**<0.001***	**Reject Null Hypothesis**	**30.25**	**17.20**	**105.00**
The overall concentration of restaurants is the same between Boston PS and Memphis ISD.	**<0.001***	**Reject Null Hypothesis**	**34.58**	**17.30**	**78.50**
The overall concentration of restaurants is the same between Boston PS and Miami-Dade County PS	**<0.001***	**Reject Null Hypothesis**	**40.22**	**23.86**	**165.50**
The overall concentration of restaurants is the same between Boston PS and San Diego USD	**<0.001***	**Reject Null Hypothesis**	**37.50**	**21.62**	**140.00**

Dallas Independent School District

Table 39 displays the results of the Mann-Whitney comparing Dallas ISD restaurants at the 400m and 800 m distances and overall restaurants, and all districts. As previously stated above, there is no significant variance between Dallas ISD and Boston PS at the 400 m distance. This is also no significant variance between the overall restaurants between Boston PS and Memphis ISD, and Boston PS and Miami-Dade County PS. All others show a significant p-value below 0.05, rejecting the null hypothesis. Dallas ISD has a significantly higher mean rank for both 400 m and 800 m than Memphis ISD, Miami-Dade County PS, and San Diego USD suggesting Dallas ISD has a higher number of restaurants within 400 m and 800 m than the aforementioned districts. Boston PS on the other hand, has a high mean rank at 400 m, 800 m and overall restaurants than Dallas ISD as reported in Table 38. Figures 23-25 show maps of nutritional environments (Appendix B).

Table 39 Mann-Whitney Test Comparing Dallas ISD Restaurants with Boston PS, Memphis ISD, Miami-Dade County PS, and San Diego USD

Null Hypothesis	Significance	Decision	Mean Rank Dallas	Mean Rank	Mann-Whitney U
The concentration of restaurants within 400 m of schools is the same between Dallas ISD and Boston PS.	0.123	Retain Null Hypothesis	20.34	26.32	183.500
The concentration of restaurants within 400 m of schools is the same between Dallas ISD Memphis ISD.	**0.002***	**Reject Null Hypothesis**	**33.42**	**21.27**	**189.50**
The concentration of restaurants within 400 m of schools is the same between Dallas ISD and Miami-Dade County PS.	**0.006***	**Reject Null Hypothesis**	**39.32**	**27.18**	**292.00**
The concentration of restaurants within 400 m of schools is the same between Dallas ISD and San Diego USD.	**0.045***	**Reject Null Hypothesis**	**34.82**	**26.46**	**304.50**
The concentration of restaurants within 800 m of schools is the same between Dallas ISD and Boston PS	**0.009***	**Reject Null Hypothesis**	**18.46**	**28.68**	**136.50**
The concentration of restaurants within 800 m of schools is the same between Dallas ISD and Memphis ISD.	**<0.001***	**Reject Null Hypothesis**	**34.78**	**20.05**	**155.50**
The concentration of restaurants within 800 m of schools is the same between Dallas ISD and Miami-Dade County PS.	**0.008***	**Reject Null Hypothesis**	**39.34**	**27.17**	**291.50**
The concentration of restaurants within 800 m of schools is the same between Dallas ISD and San Diego USD.	**<0.001***	**Reject Null Hypothesis**	**38.32**	**23.88**	**217.00**
The overall concentration of restaurants is the same between Dallas ISD and Boston PS.	**<0.001***	**Reject Null Hypothesis**	**17.20**	**30.25**	**105.00**
The overall concentration of restaurants is the same between Dallas ISD and Memphis ISD.	0.756	Retain the Null Hypothesis	27.66	26.41	333.50

Table 39. Continued					
Null Hypothesis	**Significance**	**Decision**	**Mean Rank Dallas**	**Mean Rank**	**Mann-Whitney U**
The overall concentration of restaurants is the same between Dallas ISD and Miami-Dade County PS	0.051	Retain the Null Hypothesis	37.46	28.84	338.50
The overall concentration of restaurants is the same between Dallas ISD and San Diego USD	**0.014***	**Reject Null Hypothesis**	**36.20**	**25.44**	**270.00**

Memphis Independent School District

Table 40 compares Memphis ISD restaurants with all other districts using the Mann-Whitney test. At the 400 m and 800 m distances there are variances between Memphis ISD and Boston PS, and Memphis ISD and Dallas ISD with p-values below 0.05, rejecting the null hypothesis. In addition, there is a significant variance between all Memphis ISD restaurants and all Boston PS restaurants with Boston PS having the highest mean rank suggesting Boston PS has a higher number of restaurants than Memphis ISD. This was also stated in Table 38. Therefore, rejecting the null hypothesis, there is a variance in restaurants. The mean rank at 400 m and 800 m is highest among Boston PS and Dallas ISD. Suggesting Boson PS and Dallas ISD have more restaurants within 400 m and 800 m than Memphis PS. This was also stated in Table 38 and 39. There is no significant variance at the 400 m and 800 m distance between Memphis PS and Miami-Dade County PS and San Diego USD. Also, there is no significant variance between the overall restaurants between Memphis ISD and Dallas ISD Miami-Dade County PS, and San Diego USD. Retaining the null hypothesis there is no variance in restaurants. Figures 27 through 30 show maps of the nutritional environments (Appendix B).

Table 40 Mann-Whitney Test Comparing Memphis ISD Restaurants with Boston PS, Dallas, Miami-Dade County PS, and San Diego USD

Null Hypothesis	Significance	Decision	Mean Rank Memphis	Mean Rank	Mann-Whitney U
The concentration of restaurants within 400 m of schools is the same between Memphis ISD and Boston PS	**<0.001***	**Reject Null Hypothesis**	**18.04**	**33.55**	**99.00**
The concentration of restaurants within 400 m of schools is the same between Memphis ISD and Dallas ISD	**0.002***	**Reject Null Hypothesis**	**21.27**	**33.42**	**189.50**
The concentration of restaurants within 400 m of schools is the same between Memphis ISD and Miami-Dade County PS	0.429	Retain Null Hypothesis	31.68	34.84	583.00
The concentration of restaurants within 400 m of schools is the same between Memphis ISD and San Diego USD.	0.461	Retain Null Hypothesis	29.98	32.75	518.50
The concentration of restaurants within 800 m of schools is the same between Memphis ISD and Boston PS.	**<0.001***	**Reject Null Hypothesis**	**15.79**	**36.70**	**36.00**
The concentration of restaurants within 800 m of schools is the same between Memphis ISD and Dallas ISD.	**<0.001***	**Reject Null Hypothesis**	**20.05**	**34.78**	**155.50**
The concentration of restaurants within 800 m of schools is the same between Memphis ISD and Miami-Dade County PS.	0.394	Retain Null Hypothesis	31.32	35.11	593.00
The concentration of restaurants within 800 m of schools is the same between Memphis ISD and San Diego USD.	0.857	Retain Null Hypothesis	31.09	31.84	487.50
The overall concentration of restaurants is the same between Memphis ISD and Boston PS.	**<0.001***	**Reject Null Hypothesis**	**17.30**	**34.58**	**78.50**
The overall concentration of restaurants is the same between Memphis ISD and Dallas ISD	0.756	Retain the Null Hypothesis	26.41	27.66	333.50
The overall concentration of restaurants is the same between Memphis ISD and Miami-Dade County PS.	0.319	Retain the Null Hypothesis	30.86	35.45	606.00

Table 40. Continued					
Null Hypothesis	**Significance**	**Decision**	**Mean Rank Memphis**	**Mean Rank**	**Mann-Whitney U**
The overall concentration of restaurants is the same between Memphis ISD and San Diego USD	0.803	Retain the Null Hypothesis	30.91	31.99	492.50

Miami-Dade County Public Schools

As stated previously above, within Boston PS and Dallas ISD, there is a significant variance between Miami-Dade County PS versus Boston PS and Dallas ISD at the 400 m and 800 m distances, rejecting the null hypothesis. Also shown in Table 41. This is also true for the overall restaurants between Miami-Dade County PS and Boston PS. The mean rank of the overall restaurants between Miami-Dade County PS and Dallas ISD was just above 0.05 at 0.051, which is considered not significant. The mean rank at the 400 m and 800 m distances is greater for Boston PS and Dallas ISD than Miami-Dade County PS. The mean rank is higher overall for Boston PS than Miami-Dade County PS. This suggests Boston PS has a higher number of the restaurants within 400 m and 800 m than Dallas ISD as well as overall with Miami-Dade County PS. This is also stated in the previous Table 39 and 40. Figures 31 through 34 show maps of nutritional environments (Appendix B).

Table 41 Mann-Whitney Test Comparing Miami-Dade County PS Restaurants with Boston PS, Dallas ISD, Memphis ISD, and San Diego USD

Null Hypothesis	Significance	Decision	Mean Rank Miami-Dade	Mean Rank	Mann-Whitney U
The concentration of restaurants within 400 m of schools is the same between Miami-Dade County PS and Boston PS.	**<0.001***	**Reject Null Hypothesis**	**23.79**	**40.35**	**163.00**

Table 41. Continued					
Null Hypothesis	**Significance**	**Decision**	**Mean Rank Miami-Dade**	**Mean Rank**	**Mann-Whitney U**
The concentration of restaurants within 400 m of schools is the same between Miami-Dade County PS and Dallas ISD.	**0.006***	**Reject Null Hypothesis**	**27.18**	**39.32**	**292.00**
The concentration of restaurants within 400 m of schools is the same between Miami-Dade County PS and Memphis ISD.	0.429	Retain Null Hypothesis	34.84	31.68	583.00
The concentration of restaurants within 400 m of schools is the same between Miami-Dade County PS and San Diego USD.	0.989	Retain Null Hypothesis	36.47	36.53	647.00
The concentration of restaurants within 800 m of schools is the same between Miami-Dade County PS and Boston PS.	**<0.001***	**Reject Null Hypothesis**	**22.13**	**43.50**	**100.00**
The concentration of restaurants within 800 m of schools is the same between Miami-Dade County PS and Dallas ISD.	**0.008***	**Reject Null Hypothesis**	**27.17**	**39.34**	**291.50**
The concentration of restaurants within 800 m of schools is the same between Miami-Dade County PS and Memphis ISD.	0.394	Retain Null Hypothesis	35.11	31.32	593.00
The concentration of restaurants within 800 m of schools is the same between Miami-Dade County PS and San Diego USD.	0.518	Retain Null Hypothesis	37.88	34.96	593.50
The overall concentration of restaurants is the same between Miami-Dade County PS and Boston PS.	**<0.001***	**Reject Null Hypothesis**	**23.86**	**40.22**	**165.50**
The overall concentration of restaurants is the same between Miami-Dade County PS and Dallas ISD.	0.051	Retain the Null Hypothesis	28.84	37.46	338.50

Table 41. Continued					
Null Hypothesis	**Significance**	**Decision**	**Mean Rank Miami-Dade**	**Mean Rank**	**Mann-Whitney U**
The overall concentration of restaurants is the same between Miami-Dade County PS and Memphis ISD	0.319	Retain the Null Hypothesis	35.45	30.86	606.00
The overall concentration of restaurants is the same between Miami-Dade County PS and San Diego USD	0.499	Retain the Null Hypothesis	38.17	34.63	582.50

San Diego Unified School District

Table 42 compares San Diego USD restaurants with all school districts. The results are displayed in Tables 38 thru 41, but have been combined below for easy comparison. A significance of variance is evident between San Diego USD vs Boston PS and Dallas ISD at the 400 m and 800 m distances as well as overall restaurants. The null hypothesis can be rejected. The mean rank is higher in Boston PS and Dallas ISD at the 400 m and 800 m distances and overall than San Diego USD**.** Figures 35 through 37 show maps of nutritional environments (Appendix B).

Table 42 Mann-Whitney Test Comparing San Diego USD Restaurants with Boston PS, Dallas ISD, Memphis ISD, and Miami-Dade County PS

Null Hypothesis	Significance	Decision	Mean Rank San Diego	Mean Rank	Mann-Whitney U
The concentration of restaurants within 400 m of schools is the same between San Diego USD and Boston PS.	**0.002***	**Reject Null Hypothesis**	**22.79**	**35.50**	**180.00**
The concentration of restaurants within 400 m of schools is the same between San Diego USD and Dallas school ISD.	**0.045***	**Reject Null Hypothesis**	**26.46**	**34.82**	**304.50**

Table 42. Continued					
Null Hypothesis	**Significance**	**Decision**	**Mean Rank San Diego**	**Mean Rank**	**Mann-Whitney U**
The concentration of restaurants within 400 m of schools is the same between San Diego USD and Memphis ISD.	0.461	Retain Null Hypothesis	32.75	29.98	518.50
The concentration of restaurants within 400 m of schools is the same between San Diego USD and Miami Dade County PS.	0.989	Retain Null Hypothesis	36.53	36.47	647.00
The concentration of restaurants within 800 m of schools is the same between San Diego USD and Boston PS.	**0.009***	**Reject Null Hypothesis**	**18.46**	**28.68**	**136.50**
The concentration of restaurants within 800 m of schools is the same between San Diego USD and Dallas ISD.	**0.001***	**Reject Null Hypothesis**	**23.88**	**38.32**	**217.00**
The concentration of restaurants within 800 m of schools is the same between San Diego USD and Memphis ISD.	0.857	Retain Null Hypothesis	31.09	31.84	487.50
The concentration of restaurants within 800 m of schools is the same between San Diego USD and Miami-Dade County PS	0.518	Retain Null Hypothesis	34.96	37.88	593.50
The overall concentration of restaurants is the same between San Diego USD and Boston PS	**<0.001***	**Reject Null Hypothesis**	**21.62**	**37.50**	**140.00**
The overall concentration of restaurants is the same between San Diego USD and Dallas ISD	**0.014***	**Reject Null Hypothesis**	**25.44**	**36.20**	**270.00**
The overall concentration of restaurants is the same between San Diego USD and Memphis ISD	0.803	Retain the Null Hypothesis	31.99	30.91	492.50
The overall concentration of restaurants is the same between San Diego USD and Miami-Dade County PS	0.499	Retain the Null Hypothesis	34.63	38.17	582.50

I wanted to see if BMI varied across school districts. Table 43 identifies the results of the Kruskall-Wallis test done on BMI. The Kruskall-Wallis test revealed BMI did not vary across school districts thus retain the null hypothesis, the distribution of BMI is the same across school districts.

Table 43 Kruskall-Wallis of BMI across School Districts

Null Hypothesis	Significance	Decision	Test Statistic
The distribution of BMI is the same across each school district	0.879	Retain the Null Hypothesis	1.196

Trend Analysis across School Districts

Figures 3 through 6 were created to visualize possible trends in the data by examining the percentage of students who are overweight/obese verses the percentage of schools with restaurants. At 400 m Boston PS and Memphis ISD have the highest percentage of students who are overweight. Boston PS also had the highest percentage of schools with restaurants within 400 m and 800 m. Memphis ISD, however, has the lowest percentage of schools with restaurants within 400 m. San Diego USD has the lowest percentage of students who overweight. They also have the lowest percentage of schools with restaurants within 400 m.

There is no significant trend noted for the percentage of students who are obese. Dallas ISD has the highest percentage of students who are obese, but a low percentage of schools with restaurants within 400 m as well as 800 m. Boston PS has the highest percentage of schools with restaurants within 400 m and 800 m, but has the third highest percentage of students who are obese.

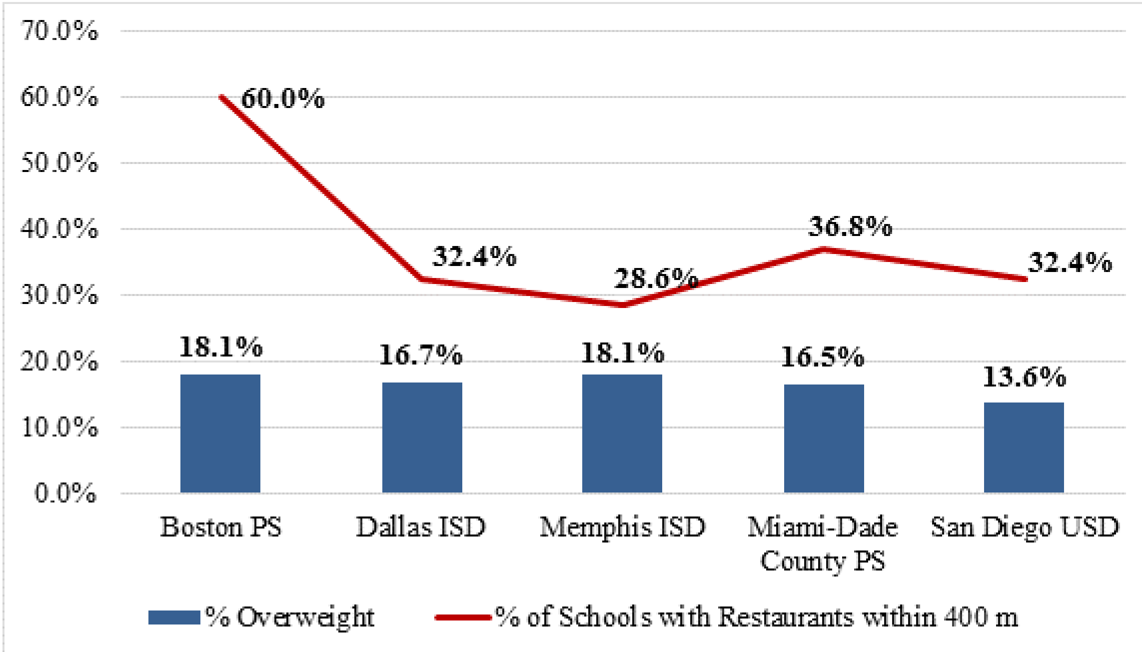

Figure 3 Percent of Students Overweight versus Percent of Schools with Restaurants within 400 m for each School District

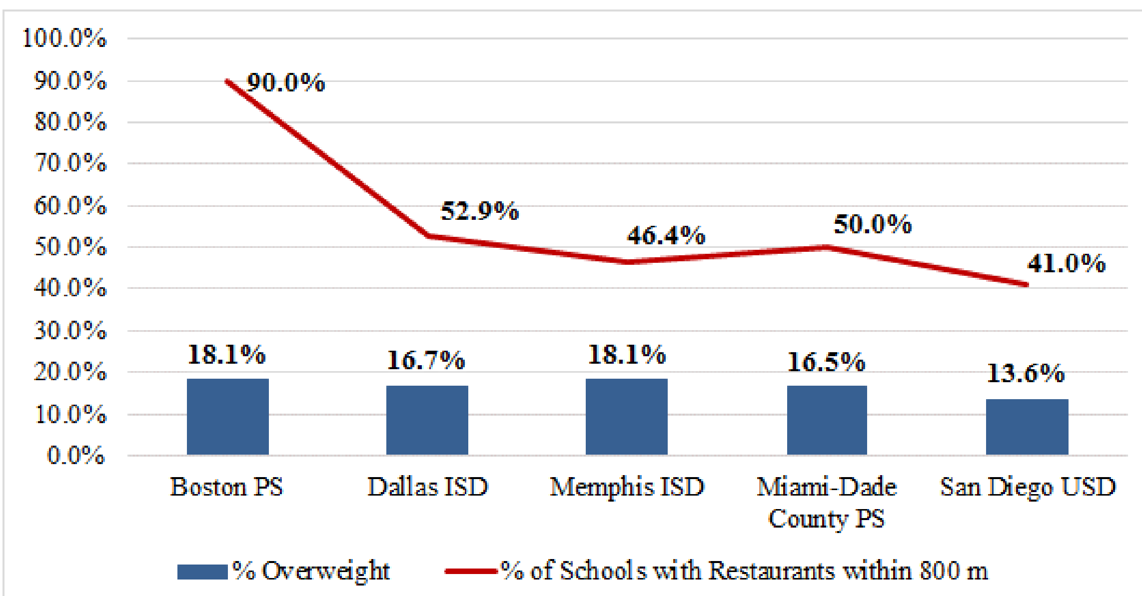

Figure 4 Percent Students Overweight versus Percent of Schools with Restaurants within 800 m for each School District

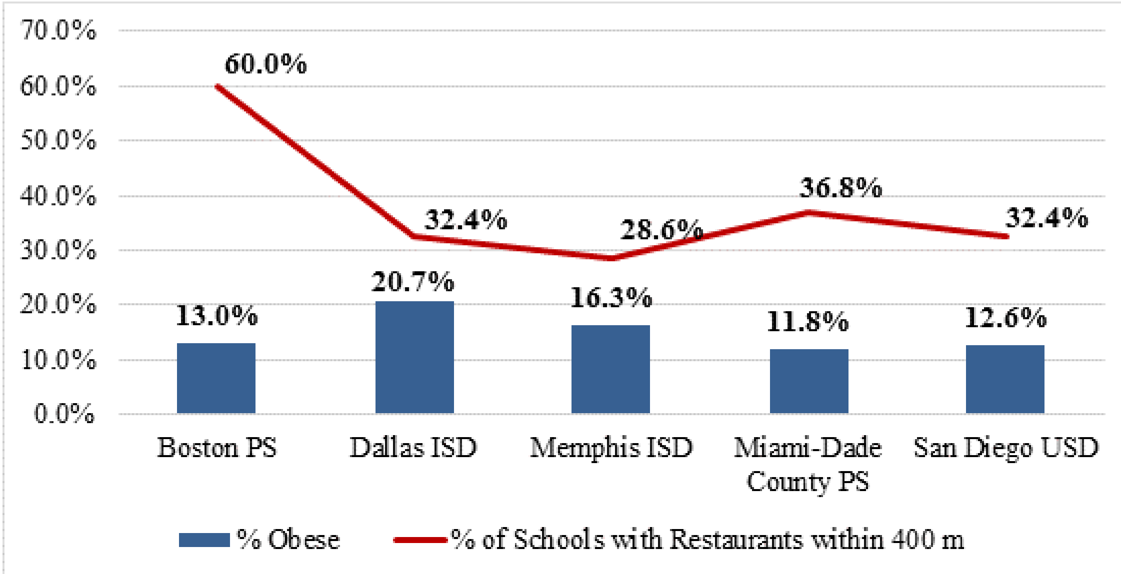

Figure 5 Percent Students Obese versus Percent of Schools with Restaurants within 400 m for each School District

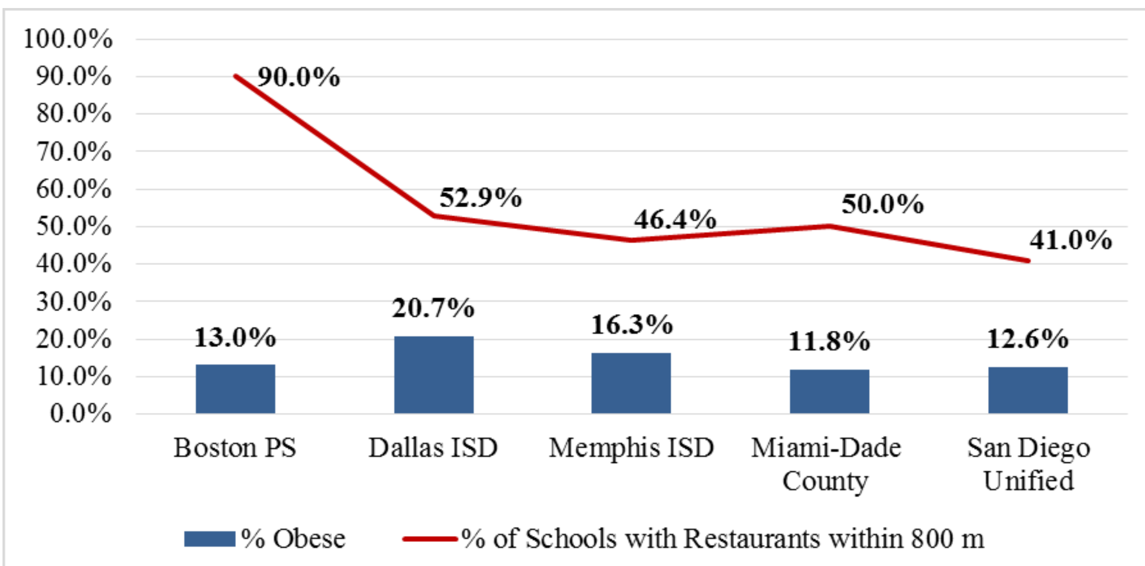

Figure 6 Percent Students Obese versus Percent of Schools with Restaurants within 800 m for each School District

Figures 7 through 10 examined the percentage of students who are overweight/obese verses the percentage of schools with supermarkets within 400 m and 800 m for each school district. The percentage of schools with supermarkets within 400 m of schools is nonexistent for Boston PS and San Diego USD. Boston PS is tied with Memphis ISD for the highest percentage of students who are overweight and San Diego USD is lowest. Memphis ISD, however, has the highest percentage of schools with supermarkets within 400 m of a school. The percentage of supermarkets within 800 m of a school is highest the San Diego USD which also has the lowest percentage of students who are overweight.

No significant trend is noted at the 800 m distance. San Diego USD has the highest percentage of supermarkets within 800 m of a school and the lowest percentage of students who are obese. Dallas ISD has the highest percentage of students who are obese and the lowest percentage of schools with a supermarket within 800 m of a school.

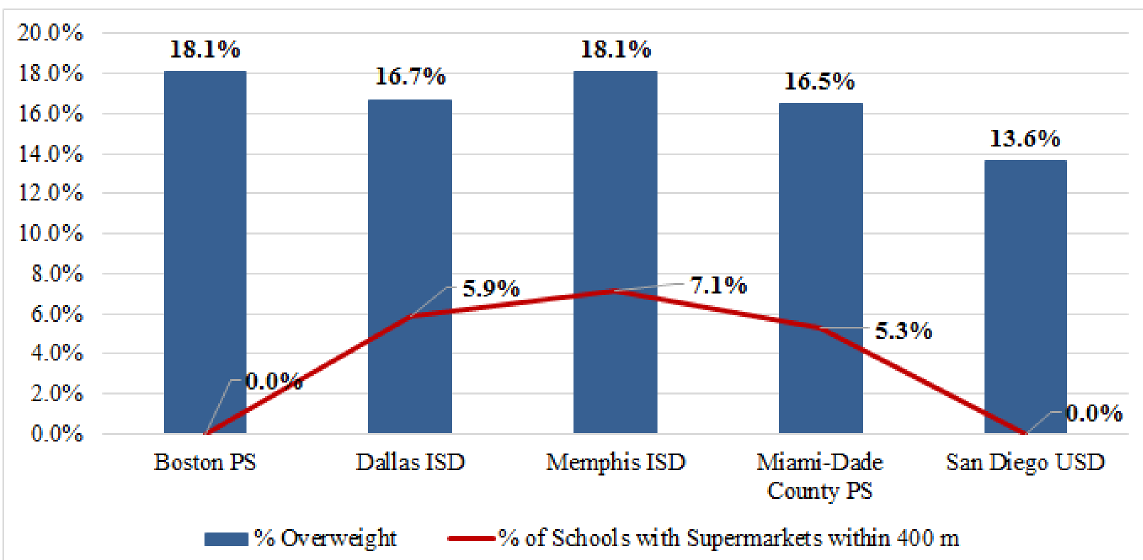

Figure 7 Percent of Students Overweight versus Percent of Schools with Supermarkets within 400 m for each School Districts

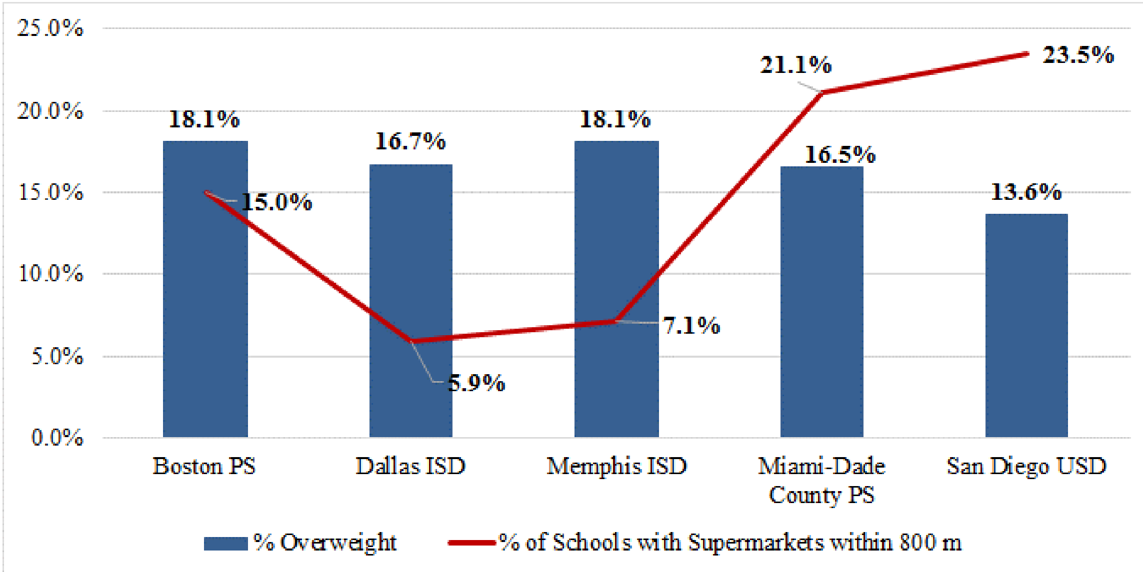

Figure 8 Percent Students Overweight versus Percent of Schools with Supermarkets within 800 m for each School Districts

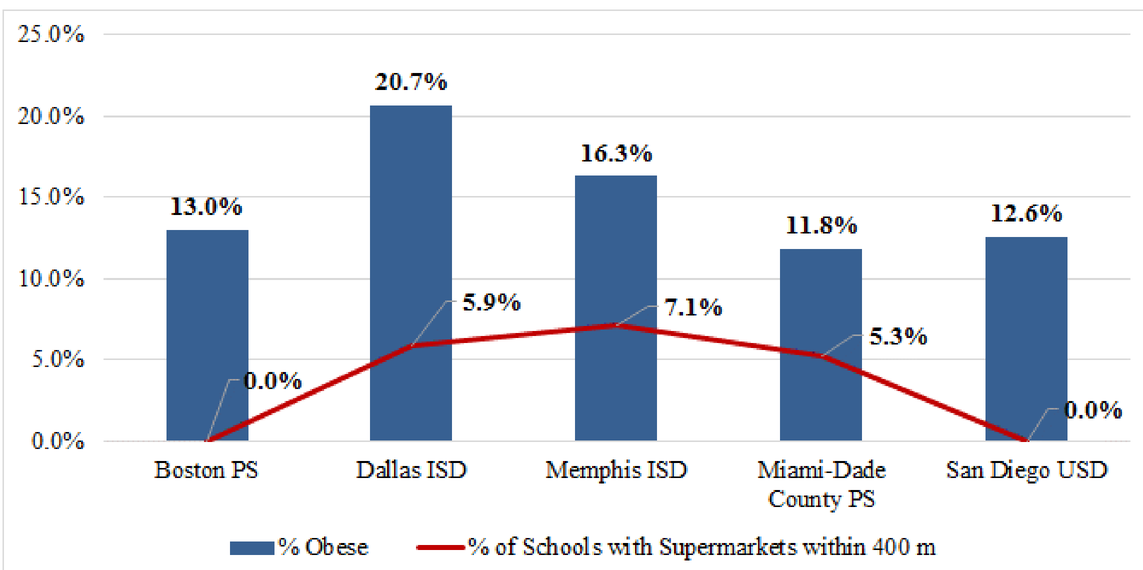

Figure 9 Percent of Students Obese versus Percent of Schools with Supermarkets within 400 m for each School Districts

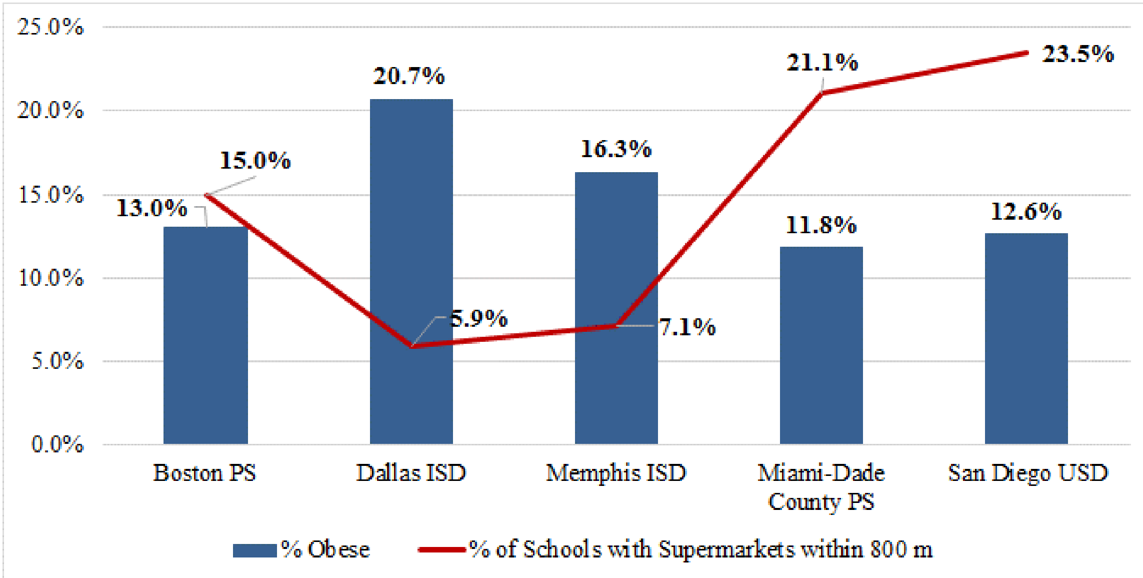

Figure 10 Percent of Students Obese versus Percent of Schools with Supermarkets within 800 m for each School Districts

Variance Test to Examine Bike Routes and Park Environments

Bike Route and Park Environments across School Districts

The methodology to identify variances in schools districts based on bike routes and parks is discussed in Chapter III. Table 44 lists the frequencies to rest if the bike routes and parks were not evenly distributed. The test revealed a slight skewness to the left and slightly high kurtosis with the exception of parks and all bike routes. This test is necessary to perform a Kruskall-Wallis test and Mann-Whitney test. Table 46 identifies the results of the Kruskall-Wallis test across school districts based on bike routes and parks. The test revealed a significant variance of 400 m and 800 m bike routes and parks as well as combined bike routes and parks. These results reject the null hypothesis of there are no difference between school districts. Tables 45 through 53 display the results of the Mann-Whitney test on either bike routes or parks comparing two districts at a time.

Table 44 Frequencies of Bike Routes and Parks

	400m Bike Routes	800m Bike Routes	All Bike Routes	400 m Parks	800 m Parks	All Parks
N	145	145	145	145	145	145
Mean	0.230	0.300	0.440	0.460	0.60	1.34
Median	0	0	0	0	0	1.00
Mode	0	0	0	0	0	0
Skewness	2.359	1.884	1.278	1.262	3.483	2.294
Std. Error of Skewness	0.201	0.201	0.201	0.201	0.201	0.201
Kurtosis	4.436	4.106	1.388	1.040	16.197	5.744
Std. Error of Kurtosis	0.400	0.400	0.400	0.400	0.400	0.400

Table 45 describes the statistics on physical activity environments across the five school districts. San Diego USD has the highest average number of bike routes within 400 m and 800 m. Furthermore, San Diego USD has the lowest percentage of students who are overweight and the second lowest percentage who are obese. Memphis ISD has the highest percentage of students who are overweight and the lowest average of bike routes at 400 m. Boston PS has the same average of bike routes within 400 m as Memphis ISD and has the highest percentage of students who are overweight. Boston ISD has the highest average of parks within 400 m and 800 m of a school, but has one of the highest percentage of students who are overweight.

Table 45 Statistics on Physical Activity Environments across the Five School Districts

School District	Number of Campus	Average Number of Bike Routes		Average Number of Parks		Percentage of BMI obese	Percentage of BMI over-weight
		400m buffer	800m buffer	400m buffer	800m buffer		
Boston PS	20	0.10	0.25	1.95	5	13	18.1
Dallas ISD	27	0.33	0.52	0.26	1.33	20.7	16.7
Memphis ISD	28	0.10	0.21	0.25	0.79	16.3	18.1
Miami-Dade County PS	38	0.11	0.24	0.42	1.05	11.8	16.5
San Diego USD	34	0.62	1.24	0.18	0.59	12.6	13.6

Table 46 Kruskall-Wallis across School Districts by Bike Routes and Parks

Null Hypothesis	Significance	Decision	Median	Median Test Statistic	Distribution Test Statistic
The concentration of bike routes within 400 m of schools is the same across the five school districts.	**<0.001***	**Reject Null Hypothesis**	**0.000**	**25.946**	**26.391**
The concentration of bike routes within 800 m of schools is the same across the five school districts.	**<0.001***	**Reject Null Hypothesis**	**0.000**	**29.884**	**28.029**
The concentration of all bike routes is the same across the five school districts	**<0.001***	**Reject Null Hypothesis**	**0.000**	**29.884**	**28.412**
The concentration of parks within 400 m of schools is the same across the five school districts.	**<0.001***	**Reject Null Hypothesis**	**0.000**	**25.512**	**34.473**

Table 46. Continued					
Null Hypothesis	**Significance**	**Decision**	**Median**	**Median Test Statistic**	**Distribution Test Statistic**
The concentration of parks within 800 m of schools is the same across the five school districts.	**<0.001***	**Reject Null Hypothesis**	**1.000**	**64.342**	**52.044**
The concentration of all parks is the same across the five school districts	**<0.001***	**Reject Null Hypothesis**	**1.000**	**58.530**	**51.500**

<u>Boston Public Schools</u>

Table 47 reveals there is a significant variance at the 400 m distance between Boston PS and Dallas ISD. In addition, at the 800 m distance there is a variance between Boston PS versus Memphis ISD and Miami-Dade County PS as well as all bike routes. The significance values were below 0.05 therefore rejecting the null hypothesis there were no variances among Boston PS versus Miami-Dade County PS and Memphis ISD at the 800 m and all bike routes as well as at the 400 m distance for Boston PS versus Dallas ISD. Boston PS mean rank was higher than Miami-Dade County PS and Memphis ISD suggesting Boston has more bike routes at the 800 m distance and overall. Dallas ISD on the other hand, had a higher mean rank for bike routes at the 400 m distance than Boston PS.

Table 48 reveals there a significant variance in parks between Boston PS and all districts at all distances and overall. The significance level was below 0.05. This rejects the null hypothesis, there is no variance in the distribution of parks between Boston PS and all school districts. The mean rank for Boston PS was much higher than all of the districts suggesting they have more access to parks. Figures 38 through 41 show maps of nutritional environments (Appendix B).

Table 47 Mann-Whitney Test Comparing Boston PS Bike Routes with Dallas ISD, Memphis ISD, Miami-Dade County PS, and San Diego USD

Null Hypothesis	Significance	Decision	Mean Rank Boston	Mean Rank	Mann-Whitney U
The concentration of bike routes within 400 m of schools is the same between Boston PS and Dallas ISD.	**0.003***	**Reject Null Hypothesis**	**17.30**	**27.56**	**364.00**
The concentration of bike routes within 400 m of schools is the same between Boston PS and Memphis ISD.	0.604	Retain Null Hypothesis	25.30	23.93	264.00
The concentration of bike routes within 400 m of schools is the same between Boston PS and Miami-Dade County PS.	0.324	Retain Null Hypothesis	31.30	28.55	344.00
The concentration of bike routes within 400 m of schools is the same between Boston PS and San Diego USD.	0.291	Retain Null Hypothesis	25.20	28.85	386.00
The concentration of bike routes within 800 m of schools is the same between Boston PS and Dallas ISD.	0.222	Retain Null Hypothesis	20.70	24.84	296.00
The concentration of bike routes within 800 m of schools is the same between Boston PS and Memphis ISD.	**0.014***	**Reject Null Hypothesis**	**29.25**	**21.11**	**185.00**
The concentration of bike routes within 800 m of schools is the same between Boston PS and Miami-Dade County PS.	**0.004***	**Reject Null Hypothesis**	**36.30**	**25.92**	**244.00**
The concentration of bike routes within 800 m of schools is the same between Boston PS and San Diego USD.	0.937	Retain Null Hypothesis	27.70	27.38	336.00
The concentration of all bike routes near schools is the same between Boston PS and Dallas ISD.	0.284	Retain Null Hypothesis	20.92	24.66	291.50
The concentration of all bike routes near schools is the same between Boston PS and Memphis ISD.	**0.012***	**Reject Null Hypothesis**	**29.38**	**21.02**	**182.50**

Table 47. Continued					
Null Hypothesis	**Significance**	**Decision**	**Mean Rank Boston**	**Mean Rank**	**Mann-Whitney U**
The concentration of all bike routes near schools is the same between Boston PS and Miami-Dade ISD.	**0.004***	**Reject Null Hypothesis**	**36.45**	**25.84**	**241.00**
The concentration of all bike routes near schools is the same between Boston PS and San Diego USD	0.905	Retain Null Hypothesis	27.80	27.32	334.00

Table 48 reveals there is a significant variance in parks between Boston PS and all districts at all distances and overall. The significance level is below 0.05. This rejects the null hypothesis, there is no variance in the distribution of parks between Boston PS and all school districts. The mean rank for Boston PS is much higher than all of the districts suggesting they have more access to parks. Figures 38 through 41 show maps of nutritional environments (Appendix B).

Table 48 Mann-Whitney Test Comparing Boston PS Parks with Dallas ISD, Memphis ISD, Miami-Dade County PS, and San Diego USD

Null Hypothesis	**Significance**	**Decision**	**Mean Rank Boston**	**Mean Rank**	**Mann-Whitney U**
The concentration of parks within 400 m of schools is the same between Boston PS and Dallas ISD	**<0.001***	**Reject Null Hypothesis**	**31.25**	**16.40**	**85.00**
The concentration of parks within 400 m of schools is the same between Boston PS and Memphis ISD.	**0.001**	**Reject Null Hypothesis**	**31.72**	**19.34**	**135.50**
The concentration of parks within 400 m of schools is the same between Boston PS and Miami-Dade County PS.	**<0.001***	**Reject Null Hypothesis**	**41.62**	**23.12**	**137.50**
The concentration of parks within 400 m of schools is the same between Boston PS and San Diego USD.	**<0.001***	**Reject Null Hypothesis**	**39.35**	**20.53**	**103.00**

Table 48. Continued					
Null Hypothesis	**Significance**	**Decision**	**Mean Rank Boston**	**Mean Rank**	**Mann-Whitney U**
The concentration of parks within 800 m of schools is the same between Boston PS and Dallas ISD	**<0.001***	**Reject Null Hypothesis**	**33.18**	**14.86**	**46.50**
The concentration of parks within 800 m of schools is the same between Boston PS and Memphis ISD.	**<0.001***	**Reject Null Hypothesis**	**37.88**	**14.95**	**12.50**
The concentration of parks within 800 m of schools is the same between Boston PS and Miami-Dade County PS.	**<0.001***	**Reject Null Hypothesis**	**46.05**	**20.79**	**49.00**
The concentration of parks within 800 m of schools is the same between Boston PS and San Diego USD.	**<0.001***	**Reject Null Hypothesis**	**43.70**	**17.97**	**16.00**
The concentration of all parks near schools is the same between Boston PS and Dallas ISD	**<0.001***	**Reject Null Hypothesis**	**32.92**	**15.06**	**51.50**
The concentration of all parks near schools is the same between Boston PS and Memphis ISD	**<0.001***	**Reject Null Hypothesis**	**37.38**	**15.30**	**22.50**
The concentration of all parks near schools is the same between Boston PS and Miami-Dade County PS	**<0.001***	**Reject Null Hypothesis**	**45.82**	**20.91**	**53.50**
The concentration of all parks near schools is the same between Boston PS and San Diego USD.	**<0.001***	**Reject Null Hypothesis**	**43.35**	**18.18**	**23.00**

Dallas Independent School District

Table 49 reveals there is no significant variance among bike routes at the 800 m distance between Dallas ISD versus Boston PS and San Diego USD. In addition, there is no significant difference in bike routes overall between Dallas ISD versus Boston PS and San Diego USD. The significance level is well above 0.050. All others show a significant difference in bike route access at the 400 m, 800 m distance and overall.

Dallas ISD has a higher mean rank than Boston PS, Memphis ISD, and Miami-Dade County PS at all levels suggesting they have more accessible bike routes.

Table 49 Mann-Whitney Test Comparing Dallas ISD Bike Routes with Boston PS, Memphis ISD, Miami-Dade County PS, and San Diego USD

Null Hypothesis	Significance	Decision	Mean Rank Dallas	Mean Rank	Mann-Whitney U
The concentration of bike routes within 400 m of schools is the same between Dallas ISD and Boston PS.	**0.003***	**Reject Null Hypothesis**	**27.56**	**17.30**	**364.00**
The concentration of bike routes within 400 m of schools is the same between Dallas ISD and Memphis ISD.	**<0.001***	**Reject Null Hypothesis**	**34.12**	**20.64**	**172.00**
The concentration of bike routes within 400 m of schools is the same between Dallas ISD and Miami-Dade County PS.	**<0.001***	**Reject Null Hypothesis**	**42.32**	**25.21**	**217.00**
The concentration of bike routes within 400 m of schools is the same between Dallas ISD and San Diego USD.	**0.026***	**Reject Null Hypothesis**	**35.14**	**26.22**	**296.00**
The concentration of bike routes within 800 m of schools is the same between Dallas ISD and Boston PS.	0.222	Retain Null Hypothesis	20.70	24.84	296.00
The concentration of bike routes within 800 m of schools is the same between Dallas ISD and Memphis ISD.	**<0.001***	**Reject Null Hypothesis**	**35.14**	**19.73**	**146.00**
The concentration of bike routes within 800 m of schools is the same between Dallas ISD and Miami-Dade County PS	**<0.001***	**Reject Null Hypothesis**	**43.44**	**24.47**	**189.00**
The concentration of bike routes within 800 m of schools is the same between Dallas ISD and San Diego USD.	0.183	Retain Null Hypothesis	33.14	27.69	346.50
The concentration of all bike routes near schools is the same between Dallas ISD and Boston PS.	0.284	Retain Null Hypothesis	24.66	20.92	51.50
The concentration of all bike routes near schools is the same between Dallas ISD and Memphis ISD.	**<0.001***	**Reject Null Hypothesis**	**35.24**	**19.94**	**144.00**

Table 49. Continued					
Null Hypothesis	**Significance**	**Decision**	**Mean Rank Dallas**	**Mean Rank**	**Mann-Whitney U**
The concentration of all bike routes near schools is the same between Dallas ISD and Miami-Dade County PS.	**<0.001***	**Reject Null Hypothesis**	**43.56**	**24.39**	**186.00**
The concentration of all bike routes near schools is the same between Dallas ISD and San Diego USD.	0.203	Retain Null Hypothesis	33.04	27.76	349.00

Table 50 lists the results of the Mann-Whitney test comparing Dallas ISD parks with other school districts. There is a significant variance at the 400 m distance between Dallas ISD and Boston PS, as previous stated above. Due to the mean rank being higher for Boston PS this suggests Boston PS has better access to bike routes at 400 m than Dallas ISD. There is also a significant difference at the 800 m distance between Dallas ISD versus Boston PS and San Diego USD. Again, Boston PS having the higher mean rank than Dallas ISD suggesting Boston PS having greater access to parks than Dallas ISD. Surprisingly, Dallas ISD's mean rank is higher than San Diego USD's suggesting Dallas ISD having greater access to parks at the 800 m distance than San Diego USD. In addition, there is a significant difference overall between Dallas ISD versus Boston PS, Miami-Dade County PS, and San Diego USD. Figures 42 through 45 show maps of physical activity environments (Appendix B)

Table 50 Mann-Whitney Test Comparing Dallas ISD Parks with Memphis ISD, Miami-Dade County PS, and San Diego USD

Null Hypothesis	**Significance**	**Decision**	**Mean Rank Dallas**	**Mean Rank**	**Mann-Whitney U**
The concentration of parks within 400 m of schools is the same between Dallas ISD and Boston PS.	**<0.001***	**Reject Null Hypothesis**	**16.40**	**31.25**	**85.00**

Table 50. Continued					
Null Hypothesis	**Significance**	**Decision**	**Mean Rank Dallas**	**Mean Rank**	**Mann-Whitney U**
The concentration of parks within 400 m of schools is the same between Dallas ISD and Memphis ISD.	0.054	Retain Null Hypothesis	23.28	30.32	443.00
The concentration of parks within 400 m of schools is the same between Dallas ISD and Miami-Dade County PS	0.985	Retain Null Hypothesis	32.04	31.97	474.00
The concentration of parks within 400 m of schools is the same between Dallas ISD and San Diego USD.	0.512	Retain Null Hypothesis	31.26	29.07	393.50
The concentration of parks within 800 m of schools is the same between Dallas ISD and Boston PS.	**<0.001***	**Reject Null Hypothesis**	**14.86**	**33.18**	**46.50**
The concentration of parks within 800 m of schools is the same between Dallas ISD and Memphis ISD.	0.297	Retain Null Hypothesis	29.18	25.05	295.50
The concentration of parks within 800 m of schools is the same between Dallas ISD and Miami-Dade County PS.	0.064	Retain Null Hypothesis	36.78	28.86	355.00
The concentration of parks within 800 m of schools is the same between Dallas ISD and San Diego USD.	**0.035***	**Reject Null Hypothesis**	**35.06**	**26.28**	**298.50**
The concentration of all parks near schools is the same between Dallas ISD and Boston PS.	**<0.001***	**Reject Null Hypothesis**	**15.06**	**33.18**	**51.50**
The concentration of all parks near schools is the same between Dallas ISD and Memphis ISD.	0.164	Retain Null Hypothesis	29.86	24.45	278.50
The concentration of all parks near schools is the same between Dallas ISD and Miami-Dade County PS.	**0.027***	**Reject Null Hypothesis**	**37.80**	**28.18**	**330.00**
The concentration of all parks near schools is the same between Dallas ISD and San Diego USD.	**0.012***	**Reject Null Hypothesis**	**36.06**	**25.54**	**273.50**

Memphis Independent School District

Table 51 reveals there is a significant variance among bike routes at the 400 m distance between Memphis ISD and Dallas ISD school districts. The mean rank is higher for Dallas ISD than Memphis ISD. This is also illustrated in Table 46. At the 800 m distance there is a significant difference between Memphis ISD versus Boston PS, Dallas ISD and San Diego USD. Boston PS, Dallas ISD, and San Diego USD have higher mean ranks than Memphis ISD. This suggests Boston PS, Dallas ISD and San Diego USD have better access to bike routes at the 800 m distance. In addition, there is a significant difference between overall bike routes among Memphis ISD versus Boston PS, Dallas ISD, and San Diego USD. Again Boston PS, Dallas ISD, and San Diego USD having higher mean rank than Memphis ISD.

Table 51 Mann-Whitney Test Comparing Memphis ISD Bike Routes with Boston PS, Dallas ISD, Miami-Dade County PS, and San Diego USD

Null Hypothesis	Significance	Decision	Mean Rank Memphis	Mean Rank	Mann-Whitney U
The concentration of bike routes within 400 m of schools is the same between Memphis ISD and Boston PS	0.604	Retain Null Hypothesis	23.93	25.30	264.00
The concentration of bike routes within 400 m of schools is the same between Memphis ISD and Dallas ISD	**<0.001***	**Reject Null Hypothesis**	**20.64**	**34.12**	**172.00**
The concentration of bike routes within 400 m of schools is the same between Memphis ISD and Miami-Dade County PS	0.646	Retain Null Hypothesis	34.21	32.97	512.00
The concentration of bike routes within 400 m of schools is the same between Memphis ISD and San Diego USD	0.088	Retain Null Hypothesis	28.29	34.15	566.00

Table 51. Continued					
Null Hypothesis	**Significance**	**Decision**	**Mean Rank Memphis**	**Mean Rank**	**Mann-Whitney U**
The concentration of bike routes within 800 m of schools is the same between Memphis ISD and Boston PS	**0.014***	**Reject Null Hypothesis**	**21.11**	**29.25**	**264.00**
The concentration of bike routes within 800 m of schools is the same between Memphis ISD and Dallas ISD	**<0.001***	**Reject Null Hypothesis**	**19.73**	**35.14**	**146.00**
The concentration of bike routes within 800 m of schools is the same between Memphis ISD and Miami-Dade County PS	0.825	Retain Null Hypothesis	33.89	33.21	521.00
The concentration of bike routes within 800 m of schools is the same between Memphis ISD and San Diego USD	**0.016***	**Reject Null Hypothesis**	**26.50**	**35.62**	**616.00**
The concentration of all bike routes near schools is the same between Memphis ISD and Boston PS	**0.012***	**Reject Null Hypothesis**	**21.02**	**29.38**	**182.50**
The concentration of all bike routes near schools is the same between Memphis ISD and Dallas ISD	**<0.001***	**Reject Null Hypothesis**	**19.94**	**35.24**	**144.00**
The concentration of all bike routes near schools is the same between Memphis ISD and Miami-Dade County PS	0.826	Retain Null Hypothesis	33.89	33.21	521.00
The concentration of all bike routes near schools is the same between Memphis ISD and San Diego USD	**0.014***	**Reject Null Hypothesis**	**26.41**	**35.69**	**618.50**

Table 52 reveals significant differences at the 400 m distance between Memphis ISD versus Boston PS, Miami-Dade County PS, and San Diego USD. As stated previously, Boston PS has a higher mean rank suggesting increased access to parks within 400 m of school. Memphis ISD has a higher mean rank than Miami-Dade County

PS or San Diego USD within 400 m of school. This suggests Memphis ISD possibly has increased access to parks within 400 m of a school than Miami-Dade County PS or San Diego USD. The overall park access is significant between Memphis ISD and Boston PS as stated previously above. All others did not show a difference in park access. Figures 46 through 49 show maps of physical activity environments (Appendix B).

Table 52 Mann-Whitney Test Comparing Memphis ISD Parks with Boston PS, Dallas ISD, Miami-Dade County PS, and San Diego USD

Null Hypothesis	Significance	Decision	Mean Rank Memphis	Mean Rank	Mann-Whitney U
The concentration of parks within 400 m of schools is the same between Memphis ISD and Boston PS	**0.001***	**Reject Null Hypothesis**	**19.34**	**31.72**	**135.50**
The concentration of parks within 400 m of schools is the same between Memphis ISD and Dallas ISD	0.054	Retain Null Hypothesis	30.32	23.28	443.00
The concentration of parks within 400 m of schools is the same between Memphis ISD and Miami-Dade County PS	**0.040***	**Reject Null Hypothesis**	**38.30**	**29.96**	**397.50**
The concentration of parks within 400 m of schools is the same between Memphis ISD and San Diego USD	**0.006***	**Reject Null Hypothesis**	**37.23**	**26.78**	**315.50**
The concentration of parks within 800 m of schools is the same between Memphis ISD and Boston PS	**<0.001***	**Reject Null Hypothesis**	**14.95**	**37.88**	**12.50**
The concentration of parks within 800 m of schools is the same between Memphis ISD and Dallas ISD	0.297	Retain Null Hypothesis	29.18	25.05	295.50
The concentration of parks within 800 m of schools is the same between Memphis ISD and Miami-Dade County PS	0.080	Retain Null Hypothesis	37.88	30.28	409.50

Table 52. Continued					
Null Hypothesis	**Significance**	**Decision**	**Mean Rank Memphis**	**Mean Rank**	**Mann-Whitney U**
The concentration of parks within 800 m of schools is the same between Memphis ISD and San Diego USD	0.061	Retain Null Hypothesis	35.68	28.06	359.00
The concentration of all parks near schools is the same between Memphis ISD and Boston PS	**<0.001***	**Reject Null Hypothesis**	**15.30**	**37.38**	**22.50**
The concentration of all parks near schools is the same between Memphis ISD and Dallas ISD	0.164	Retain Null Hypothesis	29.86	24.45	278.50
The concentration of all parks near schools is the same between Memphis ISD and Miami-Dade County PS	0.080	Retain Null Hypothesis	37.88	30.28	409.50
The concentration of all parks near schools is the same between Memphis ISD and San Diego USD	0.061	Retain Null Hypothesis	35.68	28.06	359.50

Miami-Dade County Public Schools

Table 53 lists the results of the Mann-Whitney test between Miami-Dade County PS bike routes with all other districts. The test discovered there is a significant variance at the 400 m distance between Miami-Dade County PS versus Dallas ISD and San Diego USD. Dallas ISD having the higher mean rank than Miami-Dade County PS as well as San Diego USD having a higher mean rank. This suggests Miami-Dade County PS has less access to bike routes than Dallas ISD or San Diego USD. At the 800 m distance and overall, there is a significant difference between Miami-Dade County PS versus Boston PS, Dallas ISD, and San Diego USD. Boston PS, Dallas ISD, and San Diego USD has a higher rank means than Miami-Dade County PS suggesting they have greater access to bike routes at the 800 m distance and overall than Miami-Dade County PS.

Table 53 Mann-Whitney Test Comparing Miami-Dade County PS Bike Routes with Boston PS, Dallas ISD, Memphis ISD, and San Diego USD

Null Hypothesis	Significance	Decision	Mean Rank Miami-Dade	Mean Rank	Mann-Whitney U
The concentration of bike routes within 400 m of schools is the same between Miami-Dade County PS and Boston PS	0.324	Retain Null Hypothesis	28.55	31.30	344.00
The concentration of bike routes within 400 m of schools is the same between Miami-Dade County PS and Dallas ISD	**<0.001***	**Reject Null Hypothesis**	**25.21**	**42.32**	**217.00**
The concentration of bike routes within 400 m of schools is the same between Miami-Dade County PS and Memphis ISD	0.646	Retain Null Hypothesis	32.97	34.21	512.00
The concentration of bike routes within 400 m of schools is the same between Miami-Dade County PS and San Diego USD	**0.020***	**Reject Null Hypothesis**	**32.68**	**49.76**	**40.76**
The concentration of bike routes within 800 m of schools is the same between Miami-Dade County PS and Boston PS	**0.004***	**Reject Null Hypothesis**	**36.30**	**25.92**	**244.00**
The concentration of bike routes within 800 m of schools is the same between Miami-Dade County PS and Dallas ISD	**<0.001***	**Reject Null Hypothesis**	**24.47**	**43.44**	**189.00**
The concentration of bike routes within 800 m of schools is the same between Miami-Dade County PS and Memphis ISD	0.825	Retain Null Hypothesis	33.21	33.89	521.00
The concentration of bike routes within 800 m of schools is the same between Miami-Dade County PS and San Diego USD	**0.004***	**Reject Null Hypothesis**	**31.21**	**42.41**	**847.00**
The concentration of all bike routes near schools is the same between Miami-Dade County PS and Boston PS	**<0.001***	**Reject Null Hypothesis**	**15.30**	**37.38**	**22.50**
The concentration of all bike routes near schools is the same between Miami-Dade County PS and Dallas ISD	**<0.001***	**Reject Null Hypothesis**	**24.39**	**43.56**	**186.00**

Table 53. Continued					
Null Hypothesis	**Significance**	**Decision**	**Mean Rank Miami-Dade**	**Mean Rank**	**Mann-Whitney U**
The concentration of all bike routes near schools is the same between Miami-Dade County PS and Memphis ISD	0.826	Retain Null Hypothesis	33.21	33.89	521.00
The concentration of all bike routes near schools is the same between Miami-Dade County PS and San Diego USD	**0.004***	**Reject Null Hypothesis**	**31.13**	**42.50**	**850.00**

Table 54 revealed parks are significant at the 400 m distance between Miami-Dade County PS versus Boston PS and Memphis ISD. The rank mean for Boston PS is higher than Miami-Dade County PS. Memphis ISD also has a higher rank mean than Miami-Dade County PS. This suggests they both have greater access to parks than Miami-Dade County PS at the 400 m distance. There is a significant variance at the 800 m distance and overall between Miami-Dade County PS versus Boston PS and Dallas ISD. The mean rank for Boston PS and Dallas ISD is greater than Miami-Dade County PS at the 800 m and overall suggesting both Boston PS and Dallas ISD have increased access to parks than Miami-Dade County PS. Figures 50 through 53 show maps of physical activity environments (Appendix B).

Table 54 Mann-Whitney Test Comparing Miami-Dade County PS Parks with Boston PS, Dallas ISD, Memphis ISD, and San Diego USD

Null Hypothesis	Significance	Decision	Mean Rank Miami-Dade	Mean Rank	Mann-Whitney U
The concentration of parks within 400 m of schools is the same between Miami-Dade County PS and Boston PS	**<0.001***	**Reject Null Hypothesis**	**23.12**	**41.62**	**137.50**

Table 54. Continued					
Null Hypothesis	**Significance**	**Decision**	**Mean Rank Miami-Dade**	**Mean Rank**	**Mann-Whitney U**
The concentration of parks within 400 m of schools is the same between Miami-Dade County PS and Dallas ISD	0.985	Retain Null Hypothesis	31.97	32.04	474.00
The concentration of parks within 400 m of schools is the same between Miami-Dade County PS and Memphis ISD	**0.040***	**Reject Null Hypothesis**	**29.96**	**38.30**	**397.50**
The concentration of parks within 400 m of schools is the same between Miami-Dade County PS and San Diego USD	0.502	Retain Null Hypothesis	37.66	35.21	602.00
The concentration of parks within 800 m of schools is the same between Miami-Dade County PS and Boston PS	**<0.001***	**Reject Null Hypothesis**	**14.86**	**33.18**	**49.00**
The concentration of parks within 800 m of schools is the same between Miami-Dade County PS and Dallas ISD	**<0.001***	**Reject Null Hypothesis**	**20.79**	**46.05**	**49.00**
The concentration of parks within 800 m of schools is the same between Miami-Dade County PS and Memphis ISD	0.080	Retain Null Hypothesis	30.28	37.88	409.50
The concentration of parks within 800 m of schools is the same between Miami-Dade County PS and San Diego USD	0.836	Retain Null Hypothesis	36.08	36.97	662.00
The concentration of all parks near schools is the same between Miami-Dade County PS and Boston PS	**<0.001***	**Reject Null Hypothesis**	**20.91**	**45.82**	**53.50**
The concentration of all parks near schools is the same between Miami-Dade County PS and Dallas ISD	**0.027***	**Reject Null Hypothesis**	**28.18**	**37.80**	**330.00**
The concentration of all parks near schools is the same between Miami-Dade County PS and Memphis ISD	0.080	Retain Null Hypothesis	30.28	37.88	409.50

Table 54. Continued					
Null Hypothesis	**Significance**	**Decision**	**Mean Rank Miami-Dade**	**Mean Rank**	**Mann-Whitney U**
The concentration of all parks near schools is the same between Miami-Dade County PS and San Diego USD	0.836	Retain Null Hypothesis	36.08	36.97	662.00

<u>San Diego Unified School District</u>

The analysis between San Diego USD and all other districts for bike routes and parks has been presented previously in Tables 47 through 54. Tables 55 and 56 have reemphasize that information into two tables. The results will be reiterated here. There is a significant variance at the 400 m distance between San Diego USD versus Dallas ISD and Miami-Dade County PS. The mean rank is higher for both Dallas ISD and Miami-Dade County PS than San Diego USD. At the 800 m distance there is a significance between San Diego USD versus Boston PS, Memphis ISD, and Miami-Dade County PS. The mean rank is higher for Boston PS than San Diego USD as well as San Diego USD having a higher mean rank than Memphis ISD or Miami-Dade County PS. Overall bike routes saw a significance between San Diego USD and Miami-Dade County PS with San Diego USD having a higher mean rank.

Table 55 Mann-Whitney Test Comparing San Diego USD Bike Routes with Boston PS, Dallas ISD, Memphis ISD, and Miami-Dade County PS

Null Hypothesis	**Significance**	**Decision**	**Mean Rank San Diego**	**Mean Rank**	**Mann-Whitney U**
The concentration of bike routes within 400 m of schools is the same between San Diego USD and Boston PS	0.291	Retain Null Hypothesis	28.85	25.20	386.00

Table 55. Continued					
Null Hypothesis	**Significance**	**Decision**	**Mean Rank San Diego**	**Mean Rank**	**Mann-Whitney U**
The concentration of bike routes within 400 m of schools is the same between San Diego USD and Dallas ISD	**0.026***	**Reject Null Hypothesis**	**26.22**	**35.14**	**296.00**
The concentration of bike routes within 400 m of schools is the same between San Diego USD and Memphis ISD	0.088	Retain Null Hypothesis	34.15	28.29	566.00
The concentration of bike routes within 400 m of schools is the same between San Diego USD and Miami-Dade County PS	**0.020***	**Reject Null Hypothesis**	**49.76**	**32.68**	**791.00**
The concentration of bike routes within 800 m of schools is the same between San Diego USD and Boston PS	**<0.001***	**Reject Null Hypothesis**	**17.97**	**43.70**	**16.00**
The concentration of bike routes within 800 m of schools is the same between San Diego USD and Dallas ISD	0.183	Retain Null Hypothesis	27.69	33.14	346.50
The concentration of bike routes within 800 m of schools is the same between San Diego USD and Memphis ISD	**0.016***	**Reject Null Hypothesis**	**35.62**	**26.50**	**616.00**
The concentration of bike routes within 800 m of schools is the same between San Diego USD and Miami-Dade County PS	**0.004***	**Reject Null Hypothesis**	**42.41**	**31.21**	**847.00**
The concentration of all bike routes near schools is the same between San Diego USD and Boston PS	0.905	Retain Null Hypothesis	27.32	27.80	334.00
The concentration of all bike routes near schools is the same between San Diego USD and Dallas ISD	0.203	Retain Null Hypothesis	27.76	33.04	349.00
The concentration of all bike routes near schools is the same between San Diego USD and Memphis ISD	0.014*	Reject Null Hypothesis	35.69	26.41	618.50

Table 55. Continued					
Null Hypothesis	**Significance**	**Decision**	**Mean Rank San Diego**	**Mean Rank**	**Mann-Whitney U**
The concentration of all bike routes near schools is the same between San Diego USD and Miami-Dade County PS	**0.004***	**Reject Null Hypothesis**	**42.50**	**31.13**	**850.00**

Table 55 reveals an increased significance between San Diego USD versus Boston PS and Memphis USD at the 400 m distance. The mean rank is higher for both Boston PS and Memphis USD suggesting they have better access to parks at the 400 m distance than San Diego USD. At the 800 m distance as well as overall, there is significance between San Diego USD versus Boston PS and Dallas ISD. Both Boston PS and Dallas ISD have higher mean ranks than San Diego USD indicating a possible increased access to parks at the 800 m distance as well as overall. Figures 54 through 57 show maps of physical activity environments (Appendix B).

Table 56 Mann-Whitney Test Comparing San Diego Parks with Boston PS, Dallas ISD, Memphis ISD, and Miami-Dade County PS

Null Hypothesis	**Significance**	**Decision**	**Mean Rank San Diego**	**Mean Rank**	**Mann-Whitney U**
The concentration of parks within 400 m of schools is the same between San Diego USD and Boston PS	**<0.001***	**Reject Null Hypothesis**	**20.53**	**39.35**	**103.00**
The concentration of parks within 400 m of schools is the same between San Diego USD and Dallas ISD	0.512	Retain Null Hypothesis	29.07	31.26	393.50
The concentration of parks within 400 m of schools is the same between San Diego USD and Memphis ISD	**0.006***	**Reject Null Hypothesis**	**26.78**	**37.23**	**315.50**

Table 56. Continued					
Null Hypothesis	**Significance**	**Decision**	**Mean Rank San Diego**	**Mean Rank**	**Mann-Whitney U**
The concentration of parks within 400 m of schools is the same between San Diego USD and Miami-Dade County PS	0.502	Retain Null Hypothesis	35.21	37.66	602.00
The concentration of parks within 800 m of schools is the same between San Diego USD and Boston PS	**<0.001***	**Reject Null Hypothesis**	**17.97**	**43.70**	**16.00**
The concentration of parks within 800 m of schools is the same between San Diego USD and Dallas ISD	**0.035***	**Reject Null Hypothesis**	**26.28**	**35.06**	**298.50**
The concentration of parks within 800 m of schools is the same between San Diego USD and Memphis ISD	0.061	Retain Null Hypothesis	28.06	35.68	359.00
The concentration of parks within 800 m of schools is the same between San Diego USD and Miami-Dade PS	0.836	Retain Null Hypothesis	36.97	36.08	662.00
The concentration of all parks near schools is the same between San Diego USD and Boston PS	**<0.001***	**Reject Null Hypothesis**	**18.18**	**43.35**	**23.00**
The concentration of all parks near schools is the same between San Diego USD and Dallas ISD	**0.012***	**Reject Null Hypothesis**	**25.54**	**36.06**	**273.50**
The concentration of all parks near schools is the same between San Diego USD and Memphis ISD	0.061	Retain Null Hypothesis	28.06	35.68	359.50
The concentration of all parks near schools is the same between San Diego USD and Miami-Dade County PS	0.836	Retain Null Hypothesis	36.97	36.08	662.00

Trend Analysis across School Districts

Figures 11 through 13 visualize possible trends in the data by examining the percentage of students who were overweight/obese verses the percentage of schools with bicycle routes. San Diego USD has the lowest percentage of students and has the second highest percentage of schools with bicycle routes within 400 m and third highest at 800 m. Miami-Dade County PS has the lowest percentage of students who are obese, but also has the lowest percentage of schools with access to bicycle routes at 400 m. Dallas ISD has the highest percentage of students who are obese, but have the highest percentage of schools with access to bicycle routes at 400 m and 800 m.

Boston PS has the highest percentage of students who are overweight. They also have the highest percentage of schools with access to parks at both 400 m and 800 m. San Diego USD has the lowest percentage of schools with parks within 400 m and 800 m. In addition, they have the lowest percentage of students who are overweight and the second lowest who are obese.

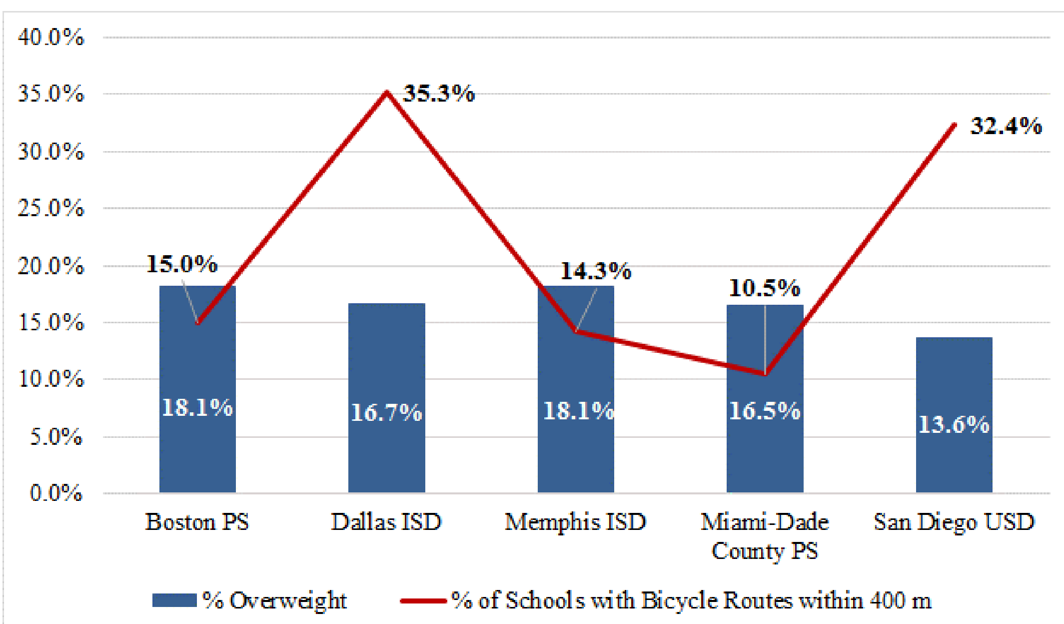

Figure 11 Percent of Students Overweight versus Percent of Schools with Bicycle Routes within 400 m for each School District

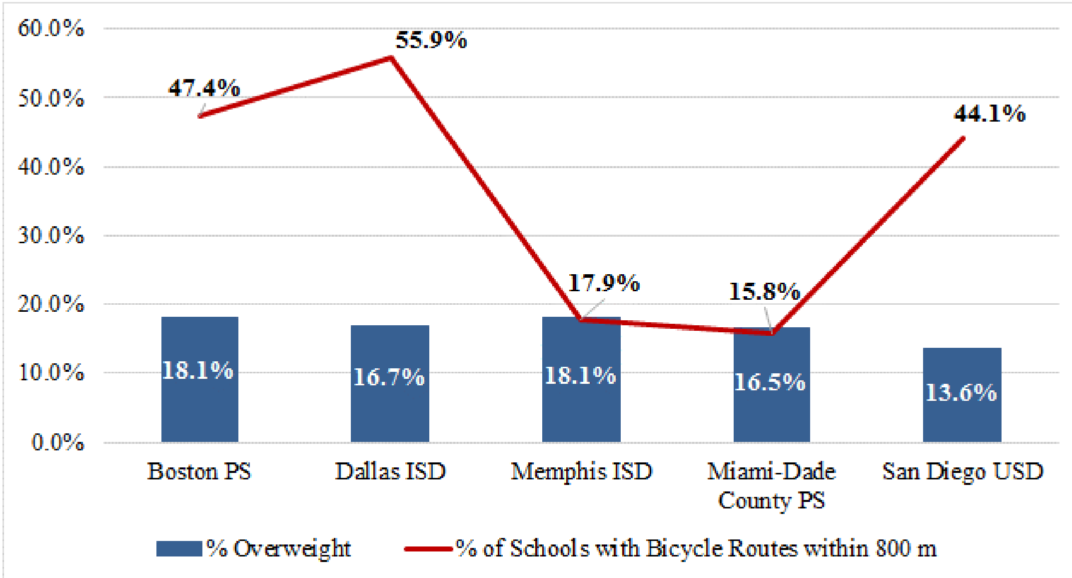

Figure 12 Percent of Students Overweight versus Percent of Schools with Bicycle Routes within 800 m for each School District

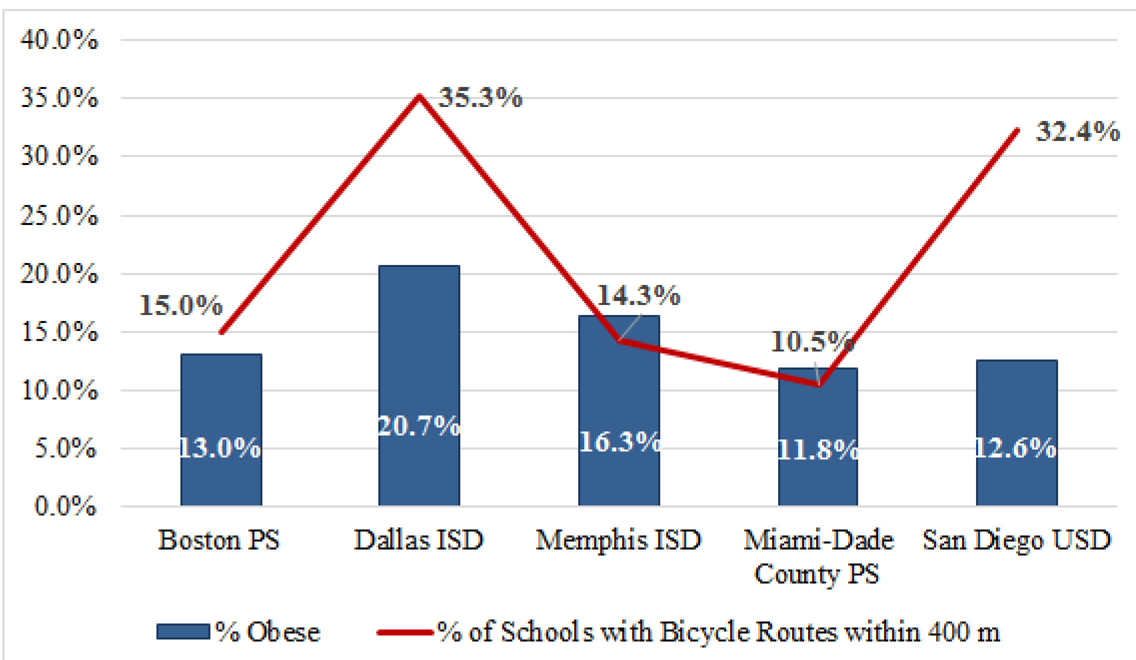

Figure 13 Percent of Students Obese versus Percent of Schools with Bicycle Routes within 400 m of a School District

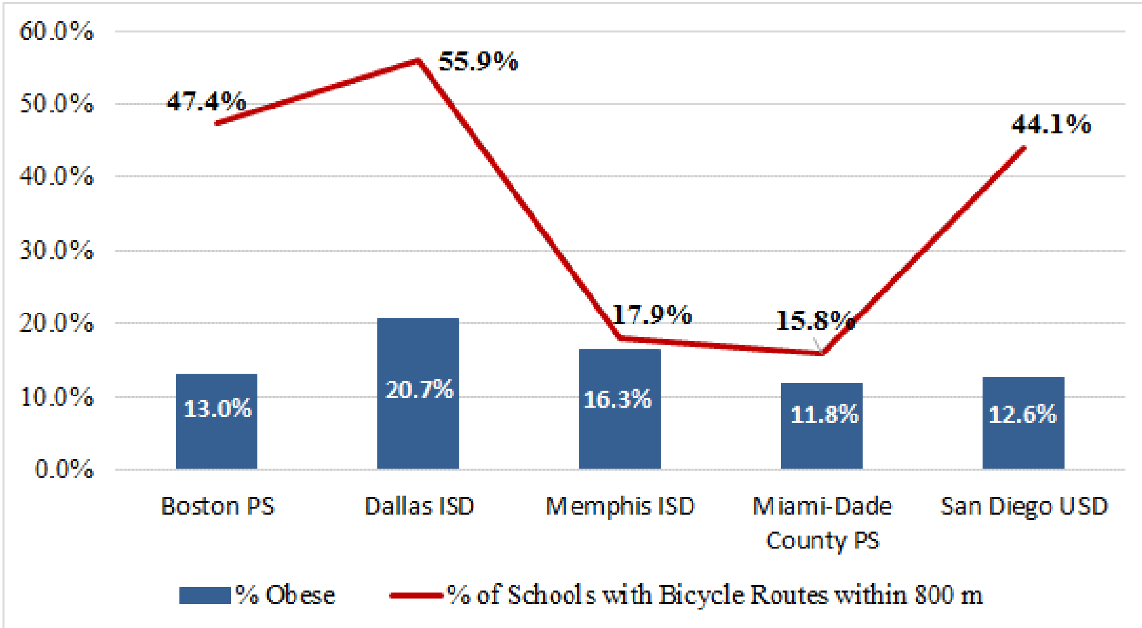

Figure 14 Percent of Students Obese versus Percent of Schools with Bicycle Routes within 800 m for each School District

Figures 15 through 19 visualize possible trends in the data by examining the percentage of students who were overweight/obese verses the percentage of schools with parks. Boston PS has the highest average number of parks within 400 m and 800 m of school as well as the highest percentage of students who are overweight. San Diego USD has the lowest percentage of students who are overweight, but has one of the lowest percentages of parks within 400 m and second lowest at 800 m. Dallas ISD has the highest percentage of students who are obese and has the lowest percentage of parks within 400 m and 800 m.

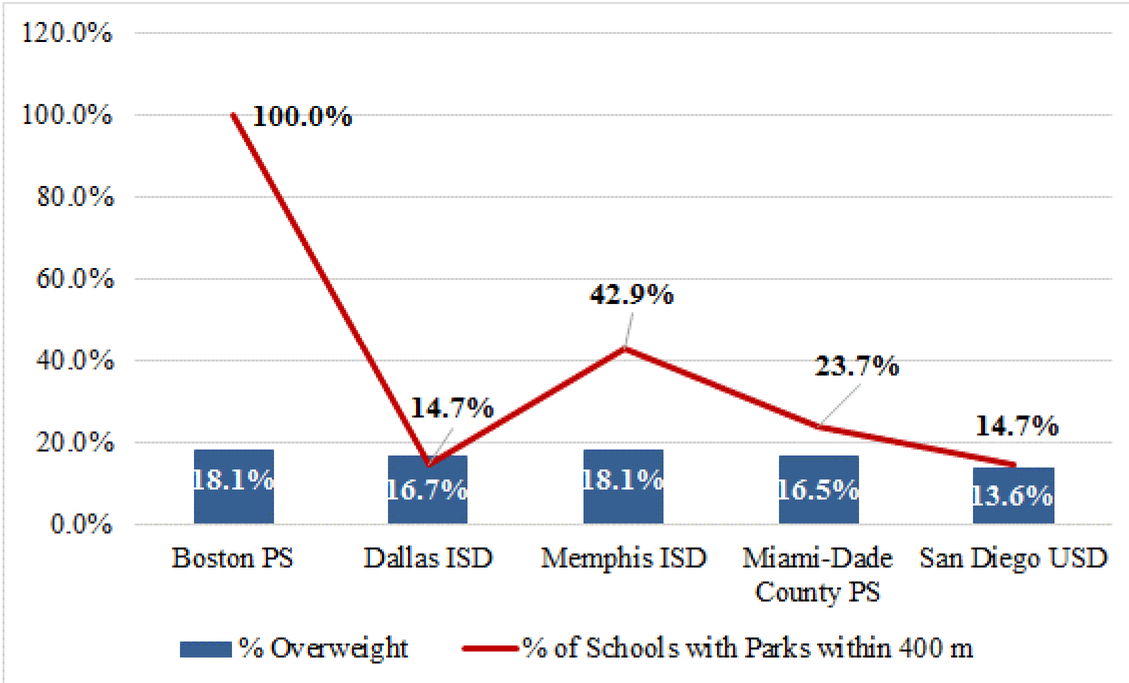

Figure 15 Percent of Students Overweight versus Percent of Schools with Parks within 400 m for each School Districts

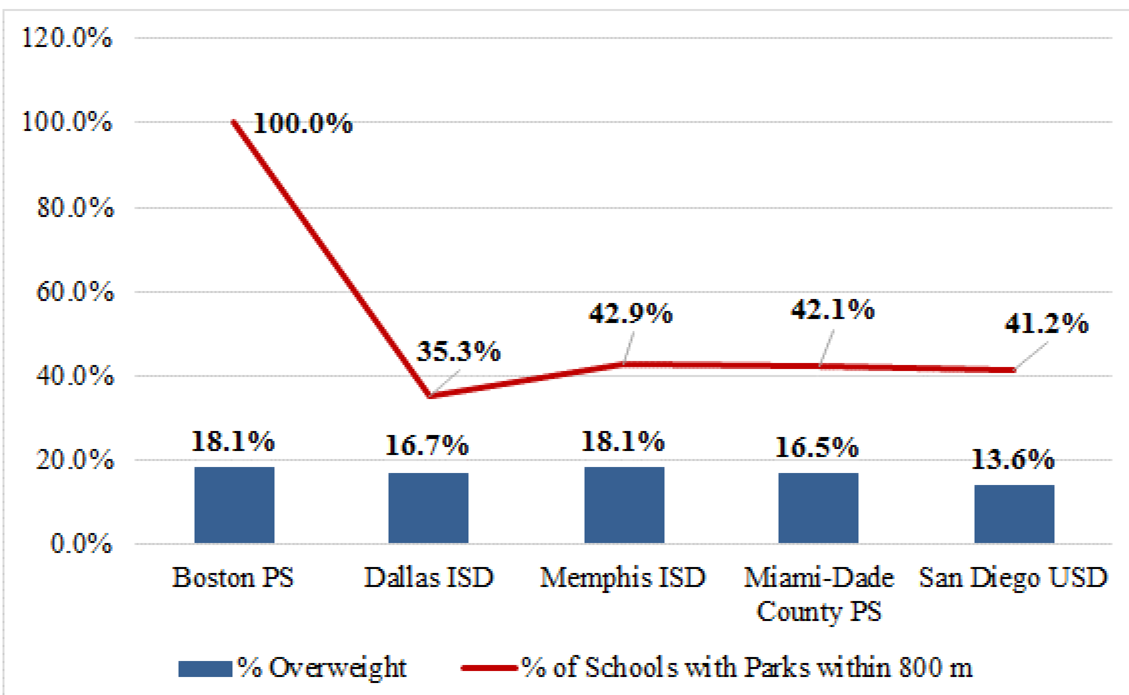

Figure 16 Percent of Students Overweight versus Percent of Schools with Parks within 800 m for each School Districts

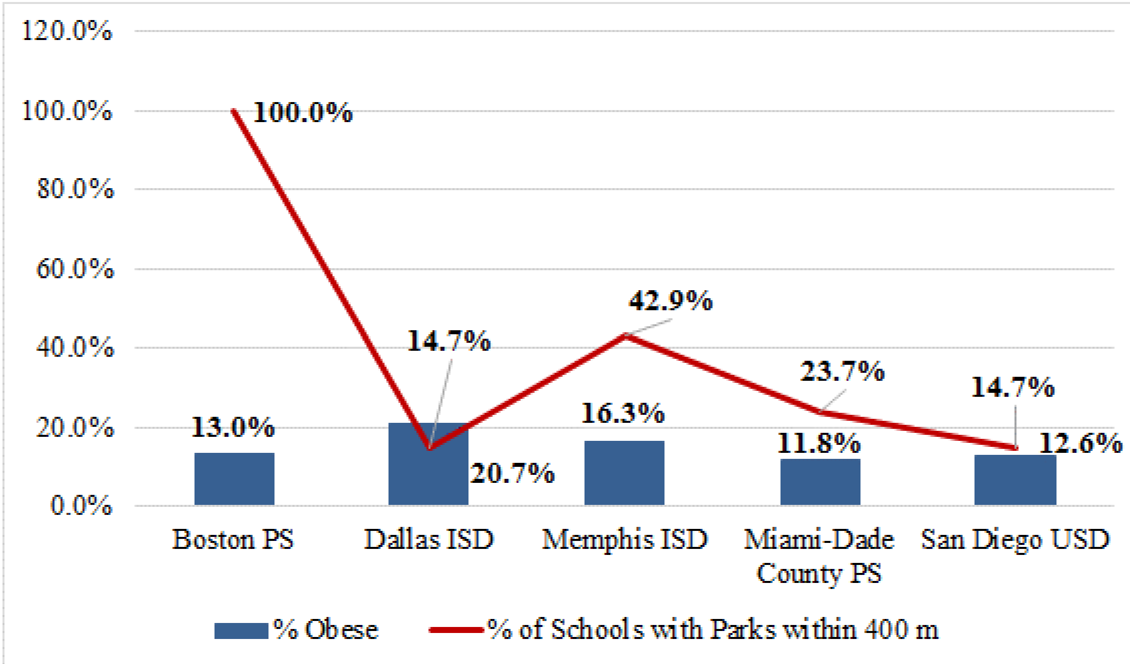

Figure 17 Percent of Students Obese versus Percent of Schools with Parks within 400 m for each School Districts

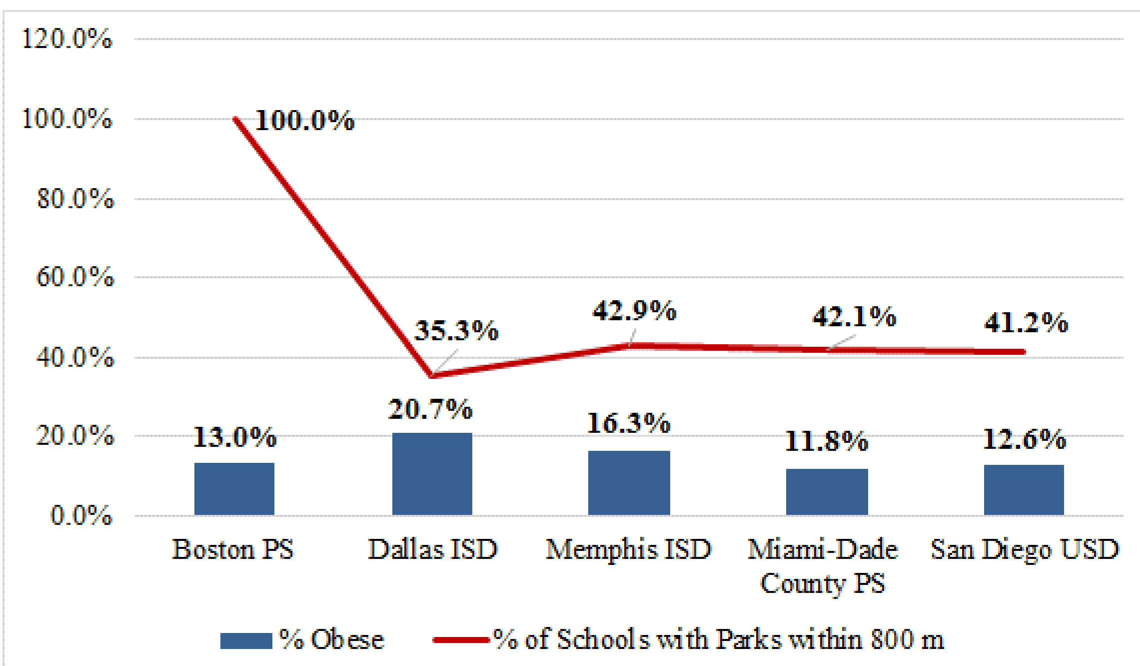

Figure 18 Percent of Students Obese versus Percent of Schools with Parks within 800 m for each School Districts

Summary

The following information is a summary of the results and how they relate to the research questions listed in Chapter 2. To answer research questions one, "Does BMI status change in adolescents based on dietary, physical activity and method of weight loss behaviors?" weight loss behavior was most significant. According the results of the multinomial logistic regression analysis, all five districts revealed adolescents engaged in weight loss activity they would be of normal weight. Surprisingly dietary intake is not significant in this study which has played significant roles in previous studies. Taking diet pills, vomiting and taking laxatives was significant in the overweight and obese sample for Dallas ISD, Boston PS, and Memphis ISD. Age was not a factor in Dallas ISD. However, in San Diego USD adolescents aged 14 or 15 were likely to be obese or overweight respectively. Female high school students tended to be normal weight than overweight or obese. Being obese is less likely a health problem for Whites in Dallas ISD. Asian's and Non-Hispanic White adolescents in San Diego USD, Miami-Dade County PS, and Boston PS are likely to be normal weight than overweight. Non-Hispanic White, African–American and Asian adolescents in San Diego USD, are likely to be normal weight than obese. Non-Hispanic White, African-American, Hispanic, and Asian adolescents in Miami-Dade County PS are likely to be of normal weight than overweight. Non-Hispanic White, Hispanic, and Asian adolescents in Miami-Dade County PS, are likely to be of normal weight than obese.

Descriptive statistics from the multinomial logistic regression show females tend to be more overweight than males across districts, but males tend to be more obese than females. Comparing the descriptive statistics with the multinomial logistic regression showed two abnormalities. Boston PS had a very high percentage of Asian's (22%) who are considered overweight, but multinomial logistic regression showed Asian's are more likely to be normal weight. Also, Miami-Dade County PS had very high rates of students being overweight among Black and Other adolescents when the regression analysis displaced all ethnicities were likely to be of normal weight.

The results for questions two, "Do nutritional environments vary across school districts? If so, is there a relationship between access to restaurants and fresh foods outlets, and BMI status?" Variation is seen between districts in regards to access restaurants. This was accomplished using the Kruskall-Wallis test as well as the Mann-Whitney test. The Kruskall-Wallis test revealed no significant differences between school districts in regards to supermarkets. However, there is significant variance between school districts and restaurants. The Mann-Whitney test revealed Boston PS had the highest mean rank of restaurants within 400 m and 800 m of a school between all districts. The basic statistics table also shows the highest average number of restaurants within 400 m. Boston PS shows the highest percentage of students who are obese and third highest who are overweight. Figures 3 through 6 show a similar trend for Boston PS with percentage of schools with restaurants within 400 m and 800 m. Dallas ISD had the highest mean rank of restaurants at 400 m and 800 m between Memphis ISD, Miami-Dade County PS, and San Diego USD. There are no significant variances between Memphis ISD and Miami-Dade County PS, and San Diego USD.

Figure 3 shows San Diego USD with the lowest percentage of students who are overweight and the second lowest percentage of restaurants within 400 m. They also have the lowest percentage of restaurants within 800 m. San Diego USD has the second lowest percentage of students who are obese and have the second lowest percentage of schools with restaurants within 400 m. They also have the lowest percentage of restaurants at 800 m.

Figure 5 shows Boston PS and San Diego USD had no supermarkets within 400 m and 800 m of school. Boston PS does have the highest percentage of students who are overweight and the third highest who are obese. On the contrary, San Diego USD has the lowest rate of students who are overweight and second lowest who are obese.

The results for question three, “Does access to bike routes and parks vary across school districts? Is there a relationship among school districts between availability of bike routes and parks, and BMI status?” The Kruskall-Wallis test revealed variances in bike routes as well as parks between all school districts. The Mann-Whitney test revealed a variance between Boston PS and Dallas ISD at the 400 m distance from a school. Dallas ISD had a higher mean rank than Boston PS. At the 800 m distance Boston PS has a higher mean rank than Memphis ISD and Miami-Dade County PS. This is also true for overall bike routes.

Statistics on bike routes revealed San Diego USD within the highest average of bike routes within 400 m and 800 m of a school with the second lowest percentage of students who are overweight. Figure 11 shows San Diego USD with the second highest percentage of schools with bike routes within 400 m and third highest at 800 m. Memphis ISD has the highest percentage of obese students and the lowest average of bike routes within 400 m. Figure 11 shows Memphis ISD having the second lowest percentage of schools with bike routes within 400 m and 800 m. Boston PS has the same average of bike routes as Memphis ISD and has a high percentage of students who are obese.

Boston PS has a higher mean rank for parks between all schools school districts at 400 m, 800 m and overall. Dallas ISD has the highest mean rank for parks with San Diego USD at 800 m as well as overall with Miami-Dade County PS and San Diego Unified. Memphis ISD has the highest mean rank for parks at 400 m with Miami-Dade County PS and San Diego USD.

Statistics of parks revealed Boston PS has the highest average number of parks within 400 m and 800 m of school. Boston PS has highest percentage of students who are overweight. This is also found in Figure 15 showing the percentage of students who are overweight and the percentage of schools with parks within 400 m and 800 m of a school. Figure 15 also revealed San Diego USD has the lowest percentage of students who are overweight, but has one of the lowest percentages of parks within 400 m and second lowest at 800 m. Dallas ISD has the highest percentage of students who are obese and has the lowest percentage of parks within 400 m and 800 m according to Figures 17 and 18.

V. CONCLUSION

The first section of this dissertation research found that BMI status is more related to weight loss methods, taking diet pills, powders, or liquids to lose weight, than physical activity or dietary intake. Research is limited on weight loss methods and BMI status in adolescents even though the question is still asked on the YRBSS. Older research from French et al. (1995) found a weak relationship between adolescent being overweight and normal weight and unhealthy weight control methods. The current YRBSS results have indicated there has only been a slight decrease in the usage of diet pills, powders, or liquids to lose weight (Kann et al 2013).

My analysis also found if a student was 14 or 15 years of age, they had a higher odds of being overweight or obese. Research studies in adolescent obesity do not report age specific results only age ranges, such as 12 to 17 years age, so no studies could be found to concur with my results. High BMIs in the age range of 12 to 17 years have been found in adolescent obesity research (Ogden et al. 2016). Females also had a higher odds of being overweight or obese. This is consistent with the trends in obesity in the United States (Skinner and Skelton 2014)

A significance in variance is found among districts in regards to restaurants access. The Kruskall-Wallis test, as well as, the Mann-Whitney test are used to assess significant variances between districts and restaurant counts around schools at the 400 m and 800 m distances. Boston PS has the highest average number of restaurants within 400 m of a school and the highest percentage of students who are obese, and the third highest who are overweight. Boston PS also has the highest percentage of schools with restaurants with 400 m and 800 m. Austin et al. (2005) found fast food restaurants that are clustered around schools had higher BMIs. Alviola IV and colleagues (2014) calculated the counts of fast food and sit down restaurants near schools. Although their scale was different, they found the more fast food restaurants within one mile of a school, the higher the obesity rates. Figure 3 shows San Diego USD has the lowest percentage of students who are overweight and the second lowest percentage of restaurants within 400 m. They also have the lowest percentage of restaurants within 800 m of a school. Figure 5 shows San Diego USD with the second lowest percentage of students who are obese and have the second lowest percentage of schools with restaurants within 400 m. They also have the lowest percentage of restaurants within 800 m.

There is no significant variance in supermarket access across the five school districts. The Kruskall-Wallis test revealed there was no significant difference in supermarket concentration across the school districts. Although, Figure 37 showed Boston PS and San Diego USD have no supermarkets within 400 m and 800 m of school. Boston PS does have the highest percentage of students who are overweight and the third highest who are obese. On the contrary, San Diego USD has the lowest rate of students who are overweight and second lowest who are obese. Though studies have found an increased access to supermarkets with fresh food has been linked to lower BMI statuses within adults (Morland and Evenson 2009) and children (Fiechtner et al. 2016).

A significant variance is found between school districts and bicycle routes. Statistics on bicycle routes revealed San Diego USD within the highest average of bicycle routes within 400 m and 800 m of a school with the second lowest percentage of students who are overweight. Memphis ISD has the highest percentage of obese students and the lowest average of bike routes within 400 m of a school. Research has shown lower BMI status has been linked to active transport, riding a bicycle or walked, to school

(Sun, Liu, and Tao 2015; Ostergaard et al. 20012). Bere and colleagues (2011) also found lower rates of adolescents being overweight, if they rode their bicycles to school than not. They found the greatest percentage of schools with access to bicycle route has the highest rate of obesity out of the five districts.

Access to parks also has a significant variance across the five school districts. Dallas ISD has the highest percentage of students who are obese and has the lowest percentage of parks within 400 m and 800 m of a school. Gordon-Larsen and colleagues (2006) found there is decreased access to parks which led to less physical activity and higher BMIs. Floyd et al. (2011) found more children and adolescents active in a park the more their peers were apt to join them and had increased physical activity. Increased physical activity has also been noted in adolescent girls who live near parks (Cohen et al. 2006).

Implications

The findings from the analysis of the YRBSS suggest Boston PS, Dallas ISD, and Memphis ISD have a high usage of diet pills, powders, and/or liquids to lose weight. These districts should offer prevention and intervention programs targeting these types of behaviors. This study also found Boston PS as well as Dallas ISD had significant weight loss behavior of vomiting and/or using laxatives. These behaviors also warrant prevention and intervention programs within these districts.

There were significant variances between access to restaurants, bike routes, and park among school districts. This was to be expected. Even though I was not able to make a connection linking BMI status and a student's access to restaurants, bike routes, or parks, there were unexpected findings in this study. Memphis ISD has one of the highest rates of overweight students and the second highest in obese students, but they have the least amount of restaurants within 400 m and 800 m. In addition, Dallas ISD has the highest rate of obese students, but only has one of the lowest percentages of restaurants within 400 m. Further research into this finding could explore student travel through this environment and their food purchasing behavior.

Additionally, unexpected findings encountered while analyzing bicycle route access. Boston PS has one of the highest percentages of students who are overweight, but have the second highest access to bicycle routes within 800 of a school and the third lowest within 400 m.   Furthermore, Dallas ISD has the highest access to bike routes within 400 m and 800 m of a school, but has the highest rates of students who are obese. Further research into the above findings could investigate why students are not participating in active commuting to school.

Lastly, there were a few surprising results in regards to park access. Boston PS students have the greatest access to parks at both the 400 m and 800 m distances, but have the highest rates of being overweight. Further investigation could assess the park environments and explore the student's behavior in park usage.

Limitations

The YRBS survey is self-reported information. Self-reported studies can lead to discrepancies within the data recorded. BMI is based on height and weight of a person. In this study, BMI was calculated from self-reported height and weight, which has been linked to a person's perception of their height and weight and not their actual height and weight. (Brener et al. 2004). Questions within the YRBS survey may be removed by a school district as they district see fit. The YRBS survey is voluntary and permission must be granted by the student's parents. Therefore, the survey is not a true representation of the student body as a whole. The survey does not reveal which school the student took the survey, limiting the assessment of specifically linking BMI with access to nutritional environments as well as bike routes and parks.

Data on supermarket and restaurants locations, as well as bicycle routes and parks are all secondary data and subjected to inaccuracies. Drewnowski and colleagues (2014) suggests geographic measures of nutritional environments do not reflect the actual nutritional environment. This data did not reveal where the adolescent participants shopped for food or ate food.

The size of each district varied which could have created a disadvantage of smaller districts when compared to larger districts. Socioeconomic status was not analyzed in this study, which may be able to explain BMI status within districts (Frederick, Snellman, and Putnam 2014). Restaurants included all type of restaurants, fast food to sit down as well as all price ranges. Physical activity policies among districts were not taken into consideration in this analysis as well as state nutrition programs

Future Work

Future research should investigate the social and cultural (education attainment and income) aspects of the conceptual model within the study area and its relationship to obese and overweight adolescents. In addition, further examine the spatial disparities or differences between education attainment, income, and BMI. Local Entropy Map (LEM) is one technique that should be utilized to analyze the variation in the relationship between BMI and socioeconomic status (Jin and Lu 2016). This method is a nonparametric technique used at a local scale to find multivariate relationships (Jin and

Lu 2016, Guo 2010). Geographically weighted Regression (GWR) is another technique that should be applied to examine the spatial variation in the relationships between BMI and educational attainment and income (Jin and Lu In Press). Research into school district nutrition programs as well as state nutrition programs and their possible effect on BMI status should be conducted.

APPENDIX SECTION

TEXAS STATE UNIVERSITY
SAN MARCOS
The rising STAR of Texas

In future correspondence please refer to EXP2009H2691

July 7, 2016

Tamara Biegas
c/o Yongmai Lu
Assistant Professor
Department of Geography
Texas State University
601 University Drive.
San Marcos, TX 78666

Dear Tamara:

Your IRB application EXP2009H2691 was reviewed by the Texas State University IRB and approved 04/18/09. It has been determined that risks to subjects are: (1) minimized and reasonable; and that (2) research procedures are consistent with a sound research design and do not expose the subjects to unnecessary risk. Reviewers determined that: (1) benefits to subjects are considered along with the importance of the topic and that outcomes are reasonable; (2) selection of subjects is equitable; and (3) the purposes of the research and the research setting is amenable to subjects' welfare and producing desired outcomes; that indications of coercion or prejudice are absent, and that participation is clearly voluntary.

1. In addition, the IRB found that you need to orient participants as follows: (1) signed informed consent is waived; (2) Provision is made for collecting, using and storing data in a manner that protects the safety and privacy of the subjects and the confidentiality of the data; (3) Appropriate safeguards are included to protect the rights and welfare of the subjects.

This project is therefore approved at the Exempt Review Level

2. Please note that the institution is not responsible for any actions regarding this protocol before approval. If you expand the project at a later date to use other instruments please re-apply. Copies of your request for human subjects review, your application, and this approval, are maintained in the Office of Research Integrity and Compliance. Please report any changes to this approved protocol to this office.

Sincerely,

Monica Gonzales

Monica Gonzales
IRB Regulatory Manager
Office of Research and Integrity
Texas State University

OFFICE OF THE ASSOCIATE VICE PRESIDENT FOR RESEARCH
601 University Drive | JCK #489 | San Marcos, Texas 78666-4616
Phone: 512.245.2314 | *fax:* 512.245.3847 | WWW.TXSTATE.EDU

This letter is an electronic communication from Texas State University-San Marcos, a member of The Texas State University System.

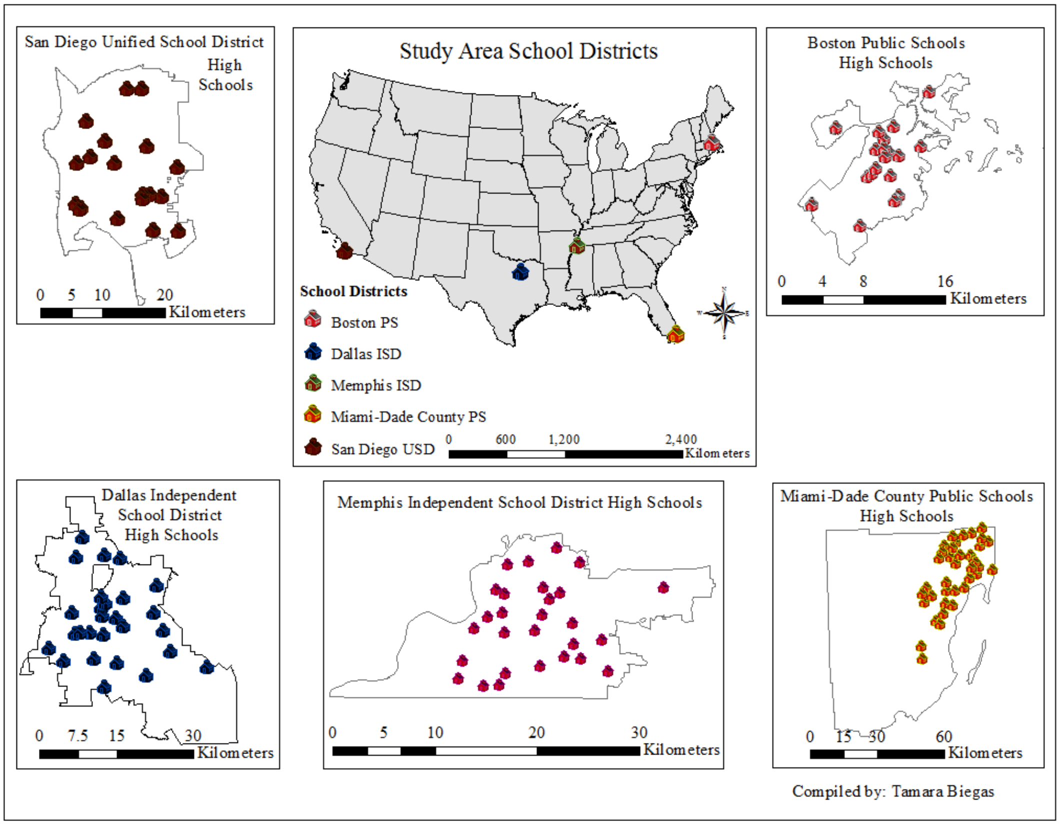

Figure 19 Study Area School Districts

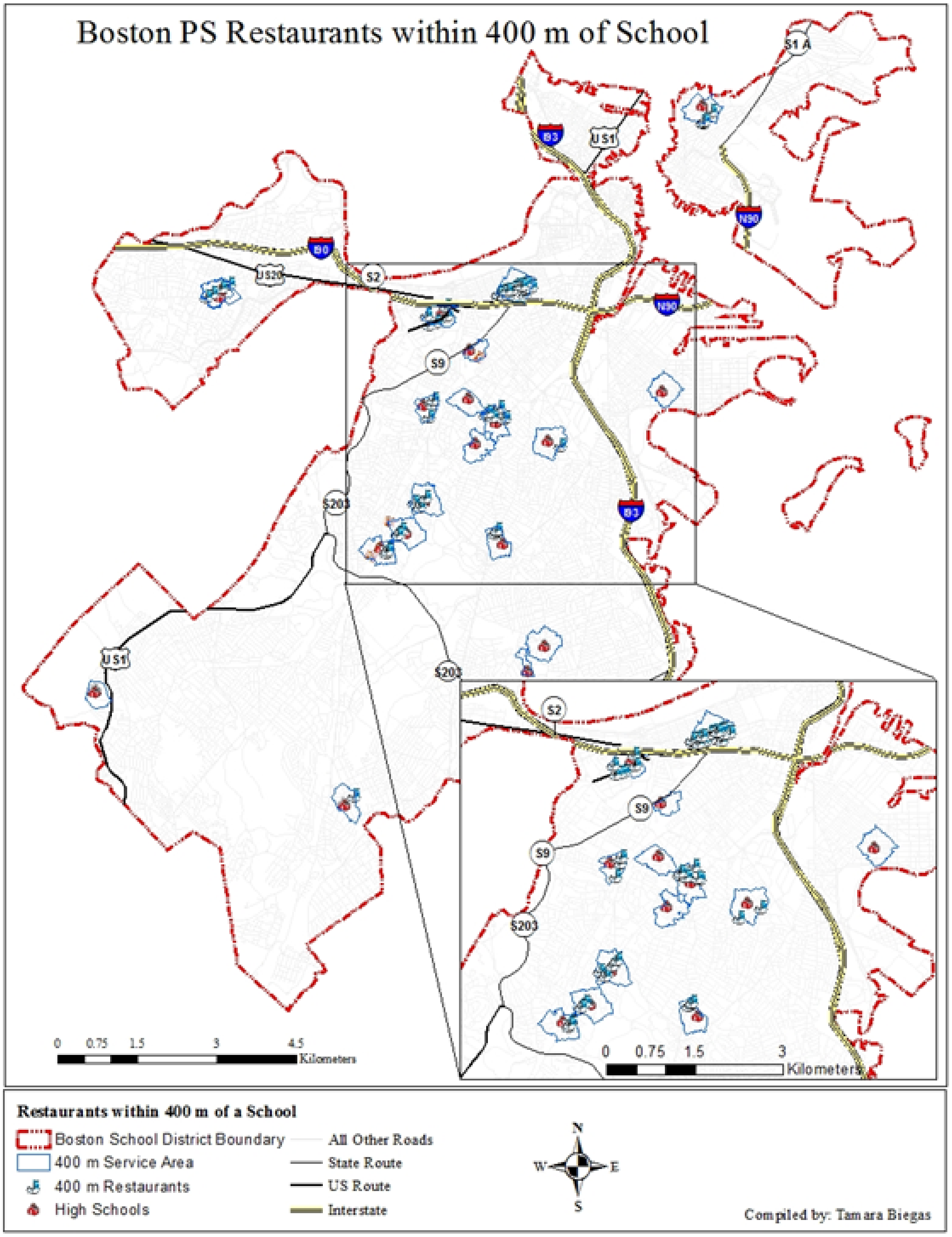

Figure 20 Restaurants within a 400 m Service Area (Buffer) of a School in the Boston Public Schools

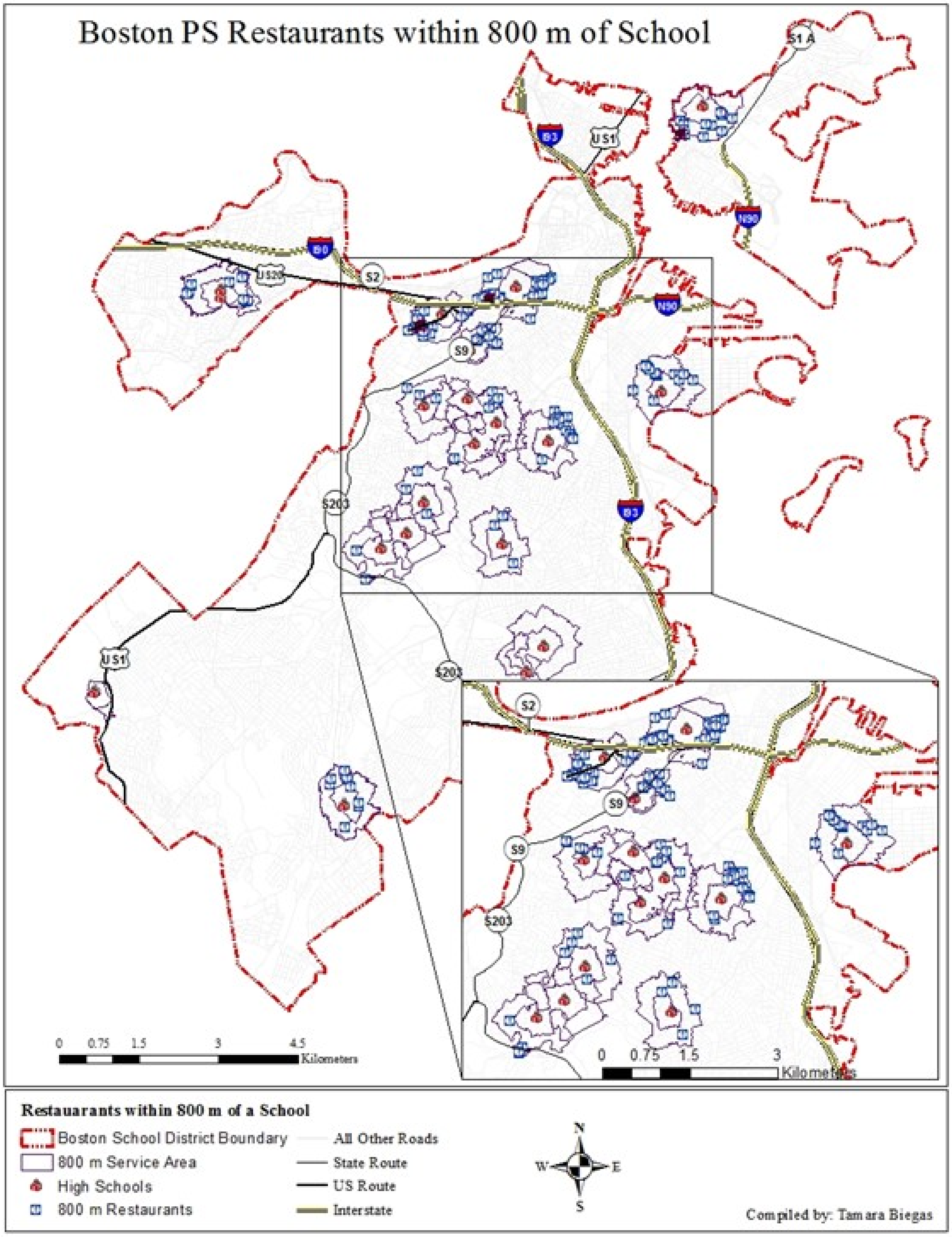

Figure 21 Restaurants within an 800 m Service Area (Buffer) of a School in the Boston Public Schools

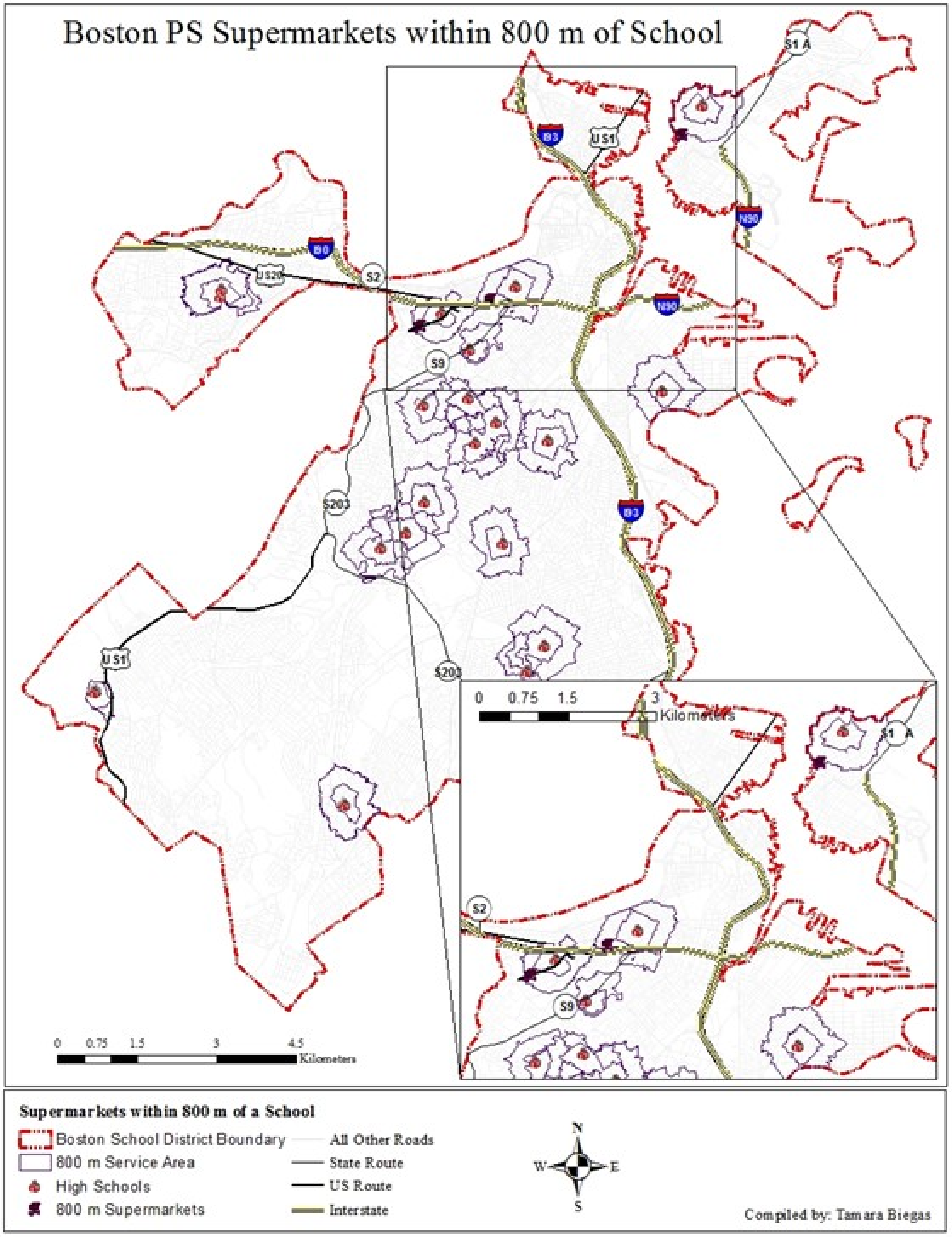

Figure 22 Supermarkets within an 800 m Service Area (Buffer) of a School in the Boston Public Schools

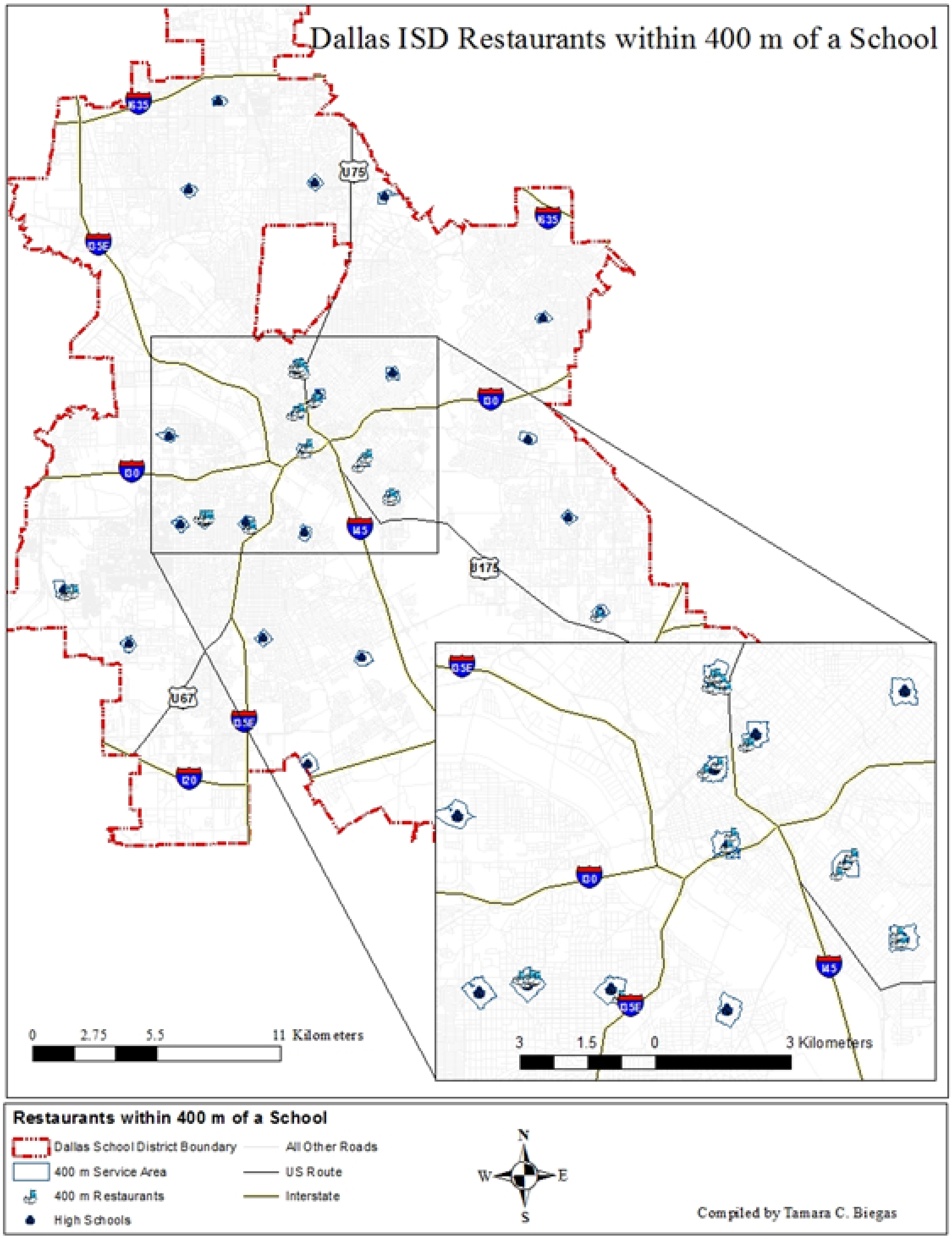

Figure 23 Restaurants within a 400 m Service Area (Buffer) of a School in the Dallas Independent School District

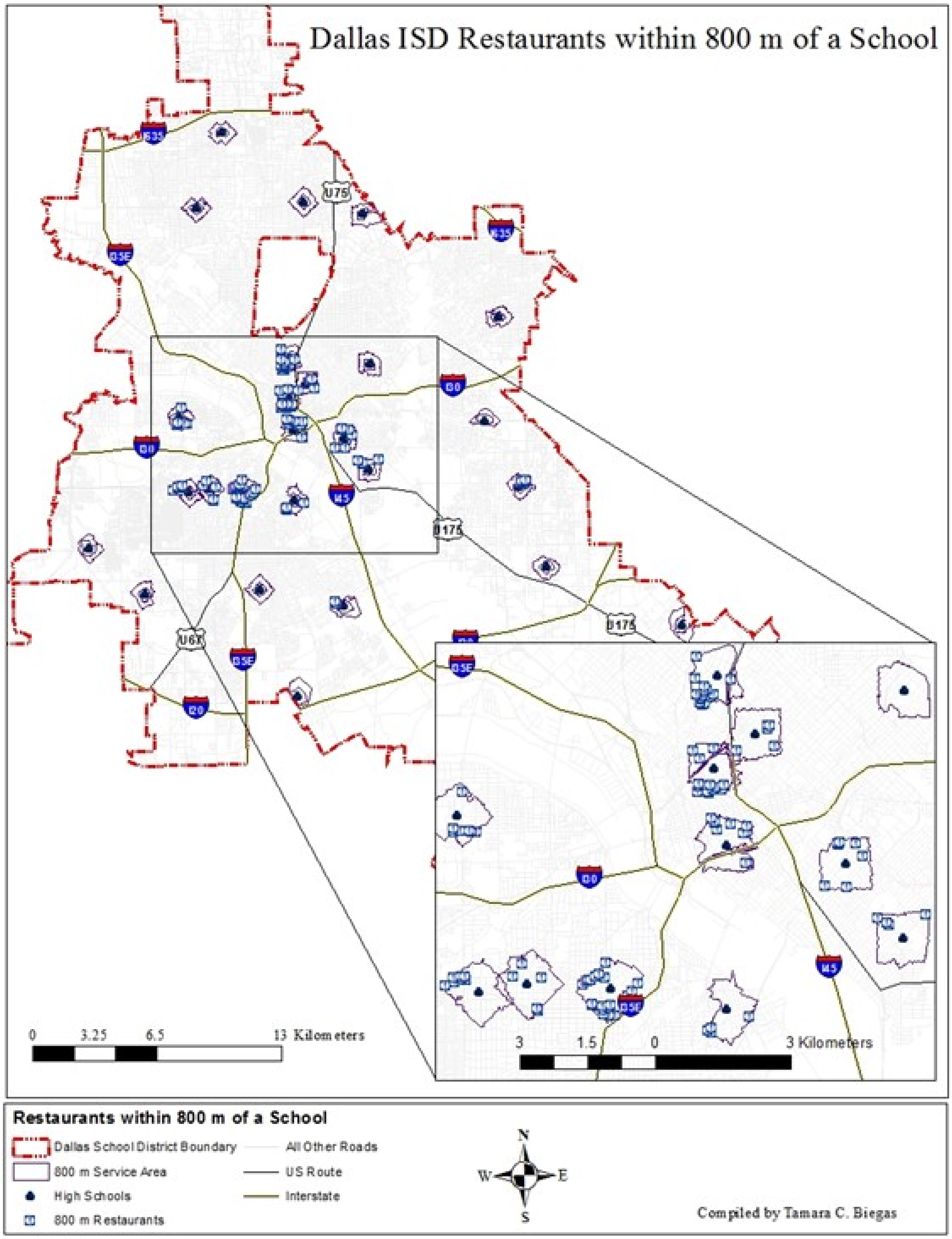

Figure 24 Restaurants within an 800 m Service Area (Buffer) of a School in the Dallas Independent School District

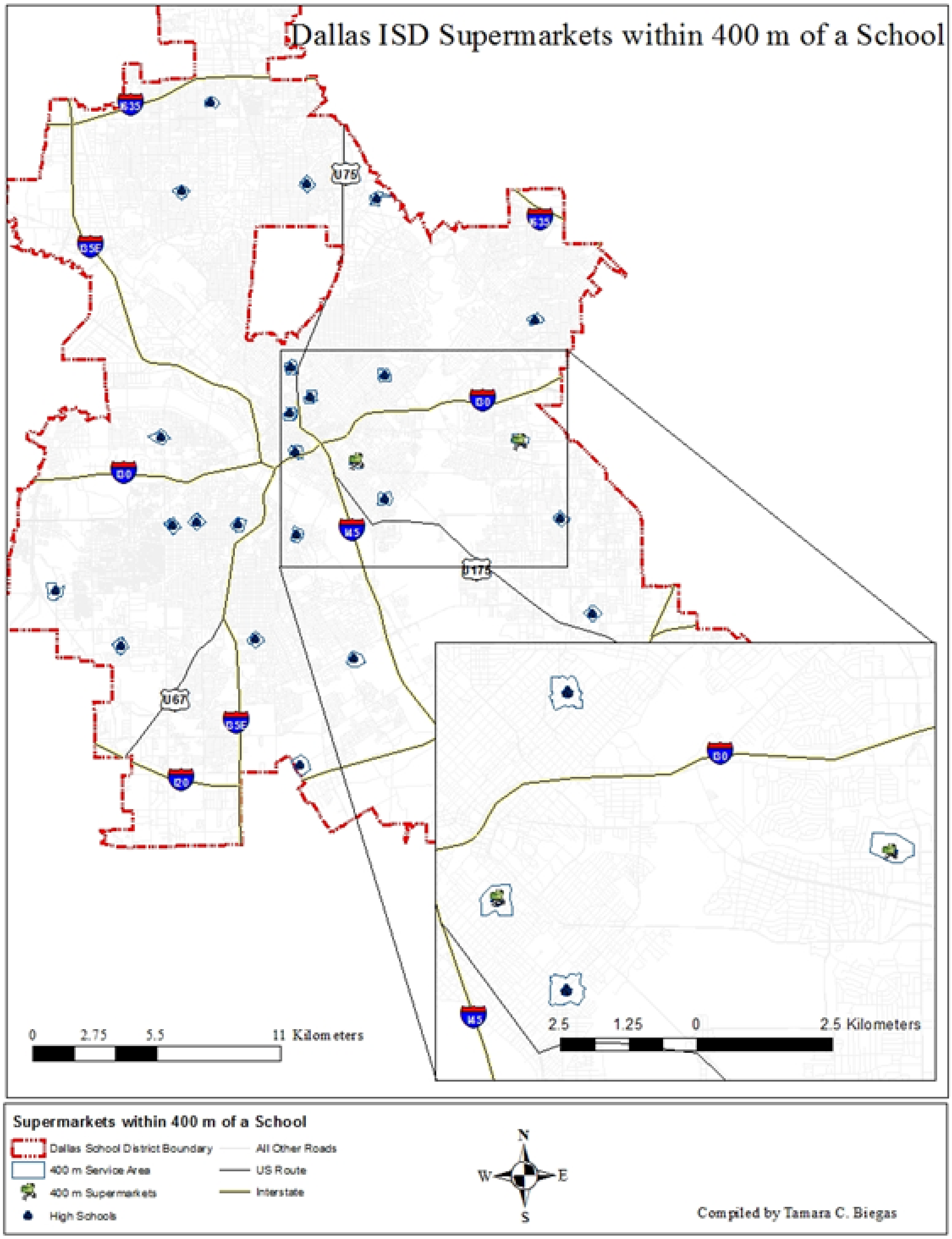

Figure 25 Supermarkets within a 400 m Service Area (Buffer) of a School in the Dallas Independent School District

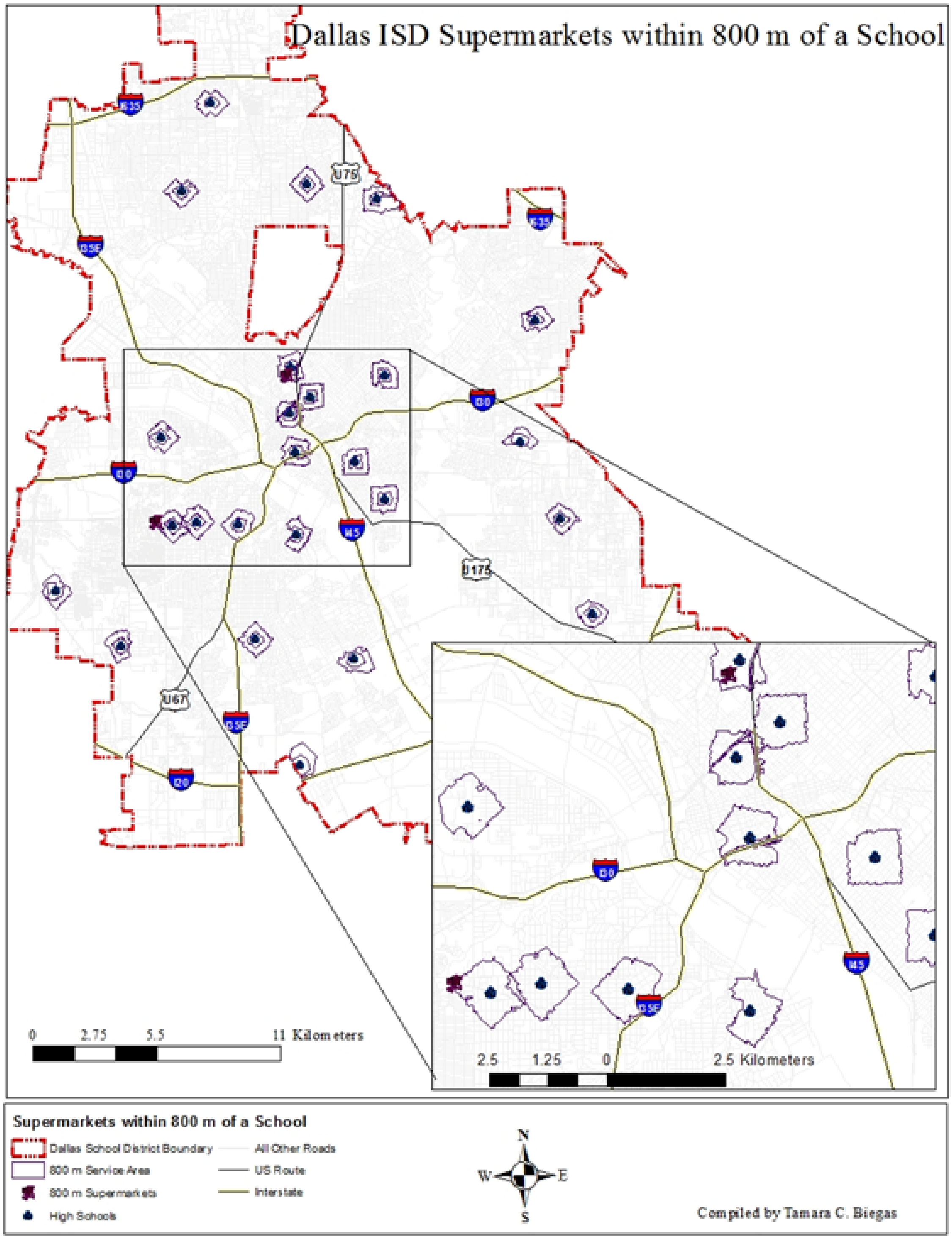

Figure 26 Supermarkets within an 800 m Service Area (Buffer) of a School in the Dallas Independent School District

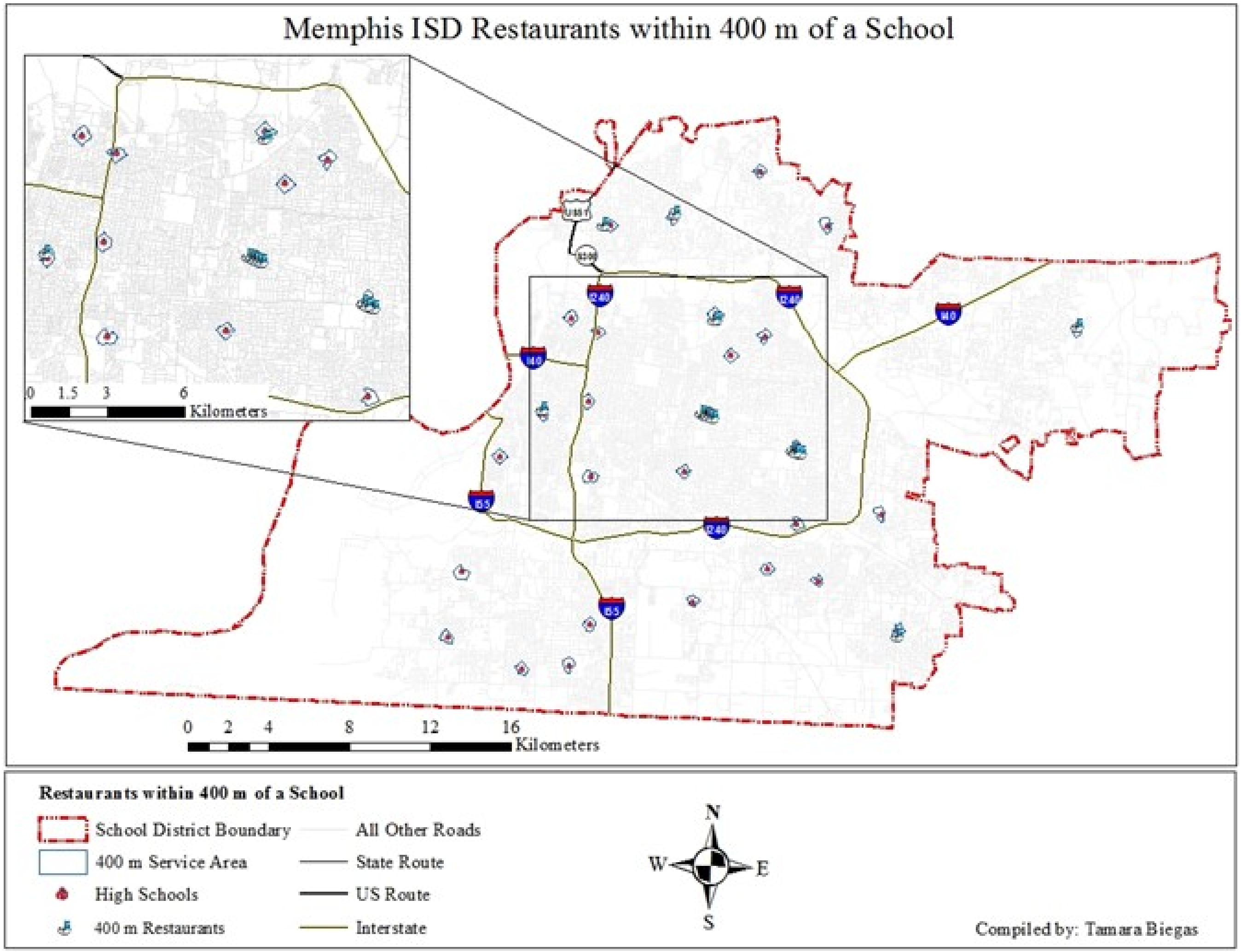

Figure 27 Restaurants within a 400 m Service Area (Buffer) of a School in the Memphis Independent School District

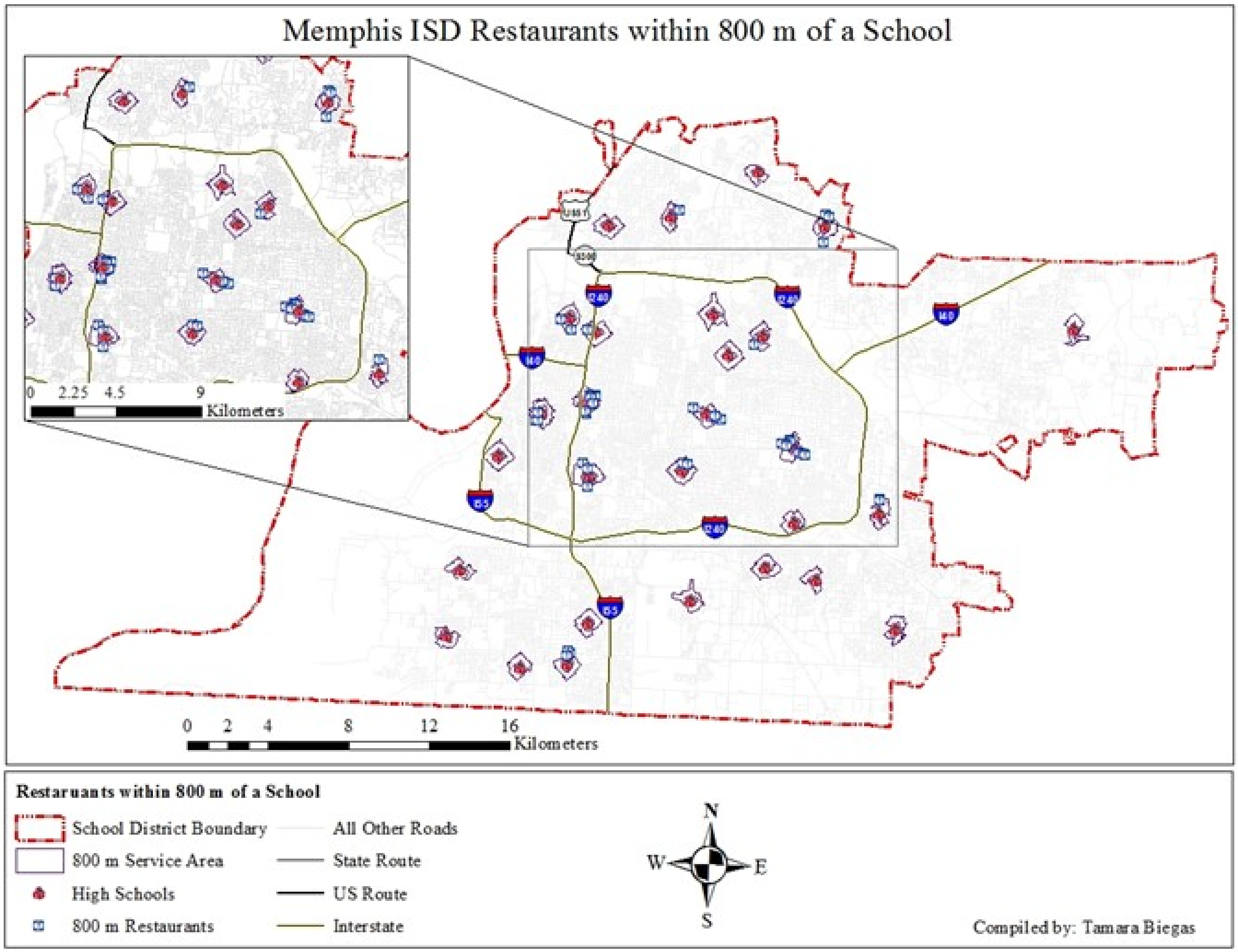

Figure 28 Restaurants within an 800 m Service Area (Buffer) of a School in the Memphis Independent School District

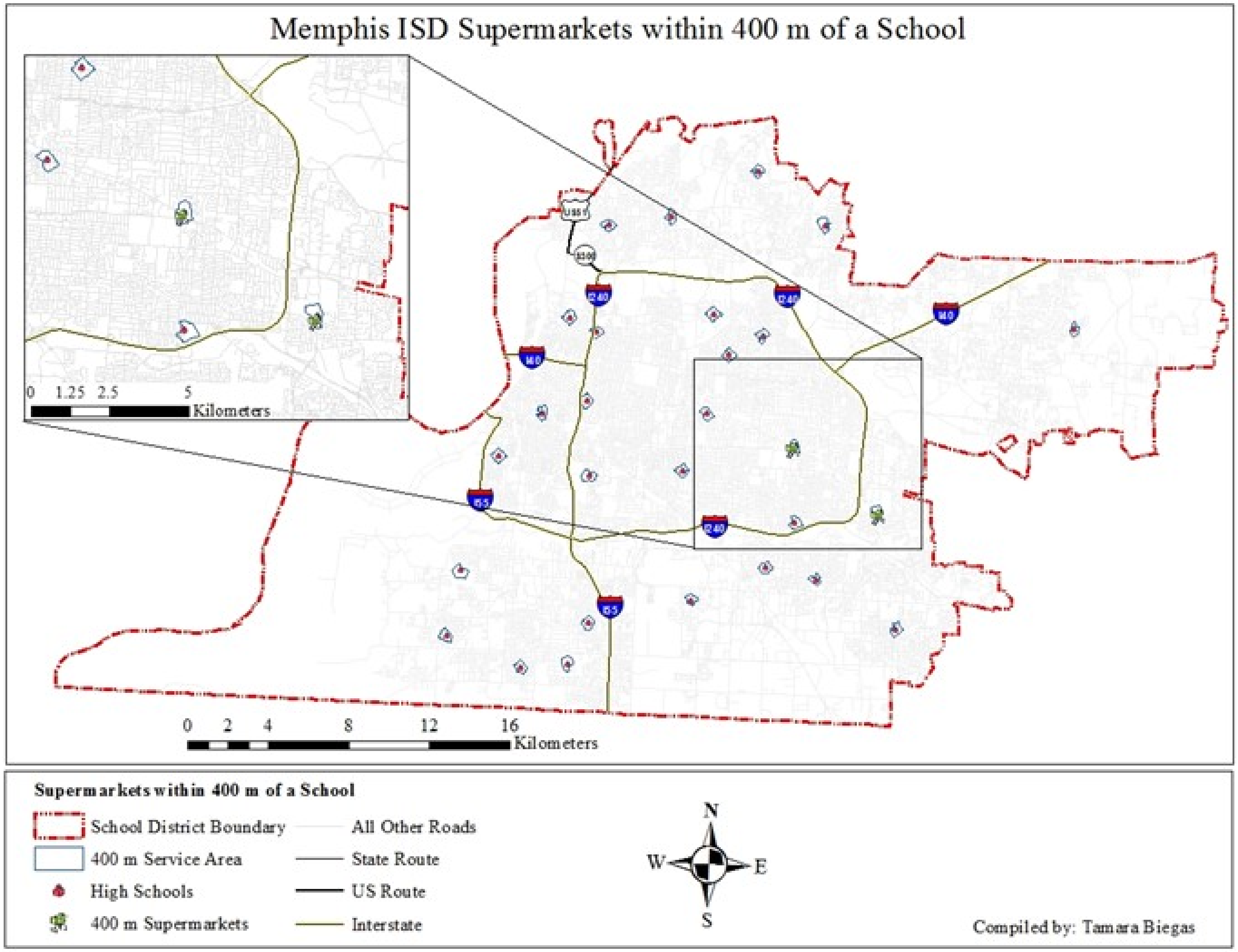

Figure 29 Supermarkets within a 400 m Service Area (Buffer) of a School in the Memphis Independent School District

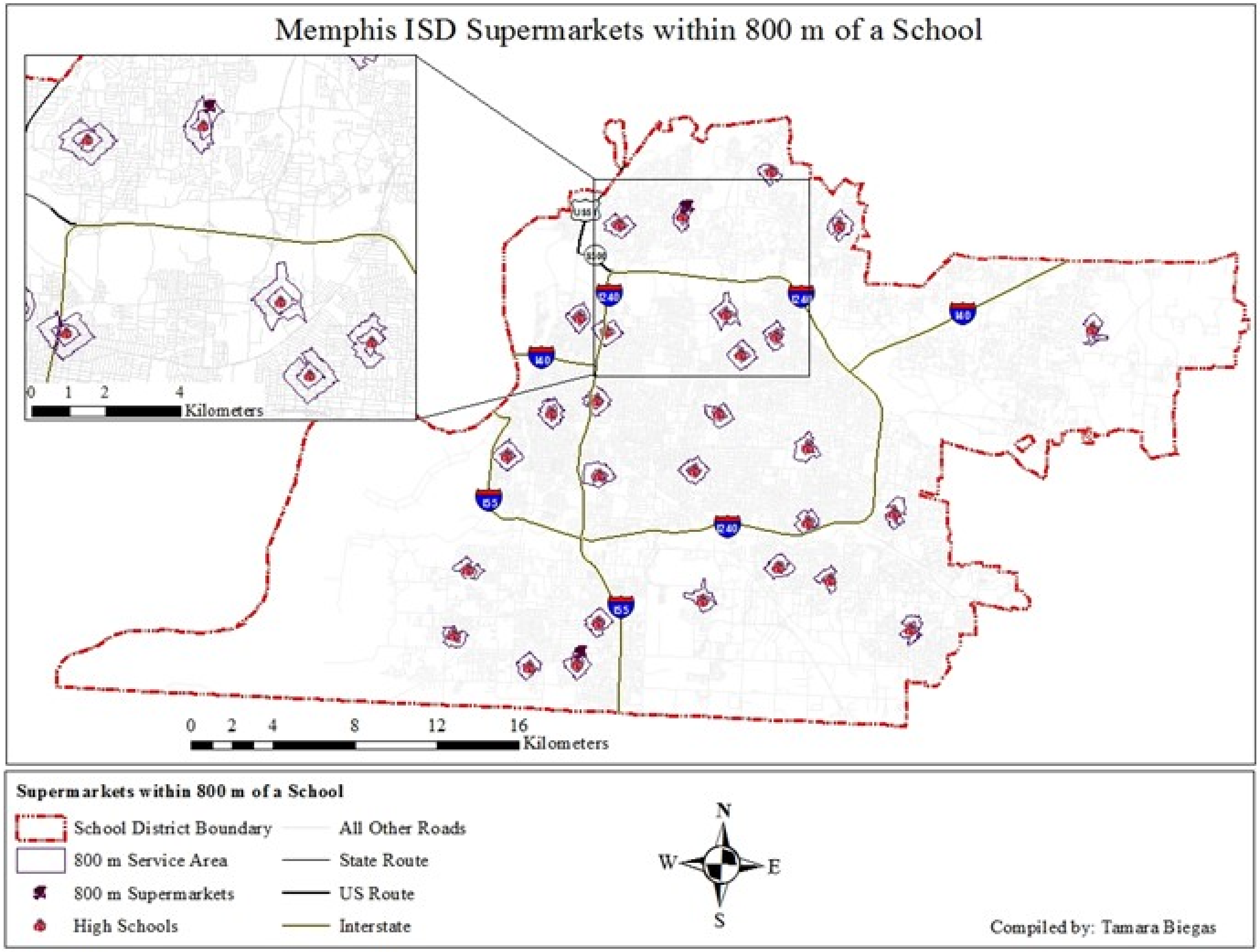

Figure 30 Supermarkets within an 800 m Service Area (Buffer) of a School in the Memphis Independent School District

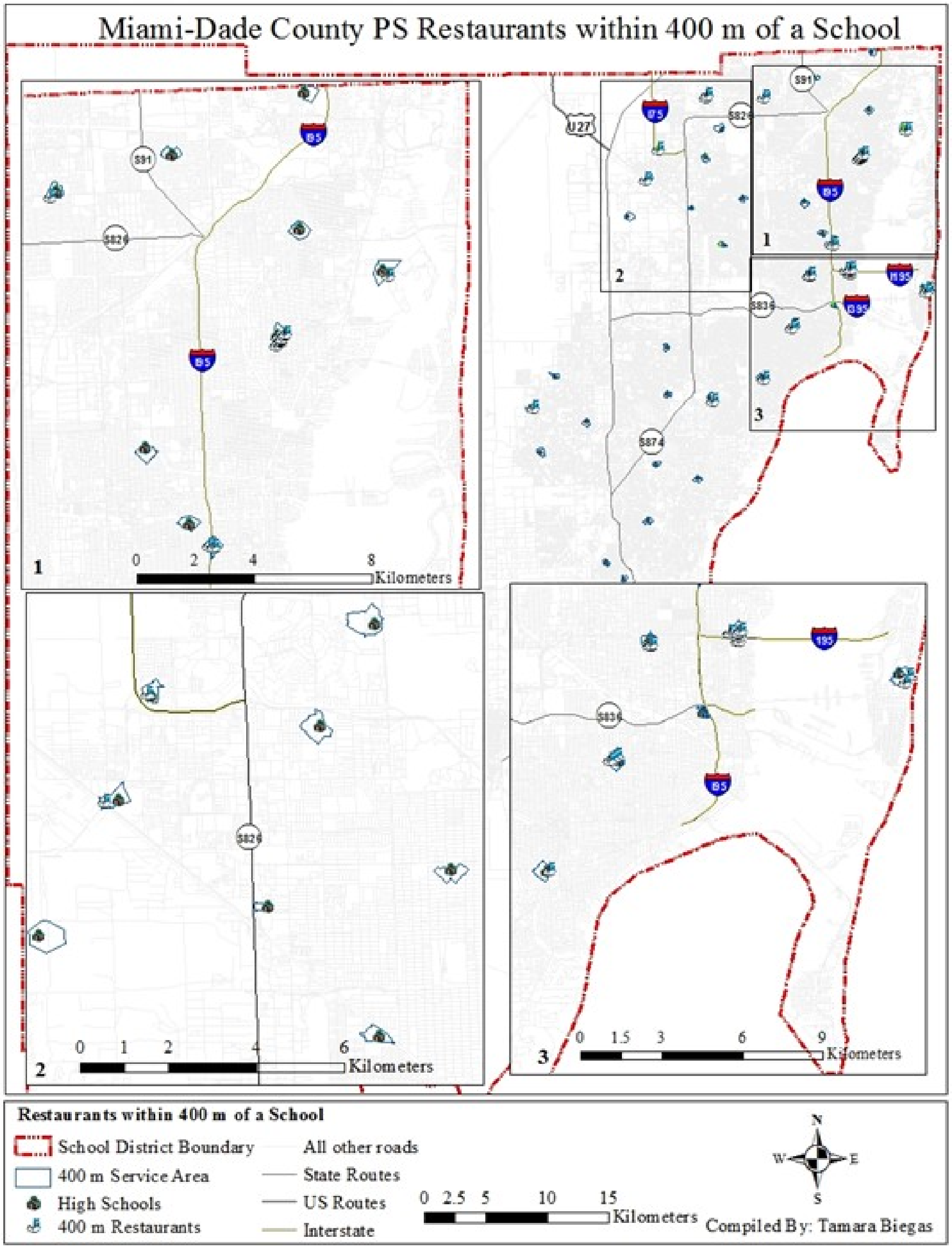

Figure 31 Restaurants within a 400 m Service Area (Buffer) of a School in the Miami-Dade County Public Schools

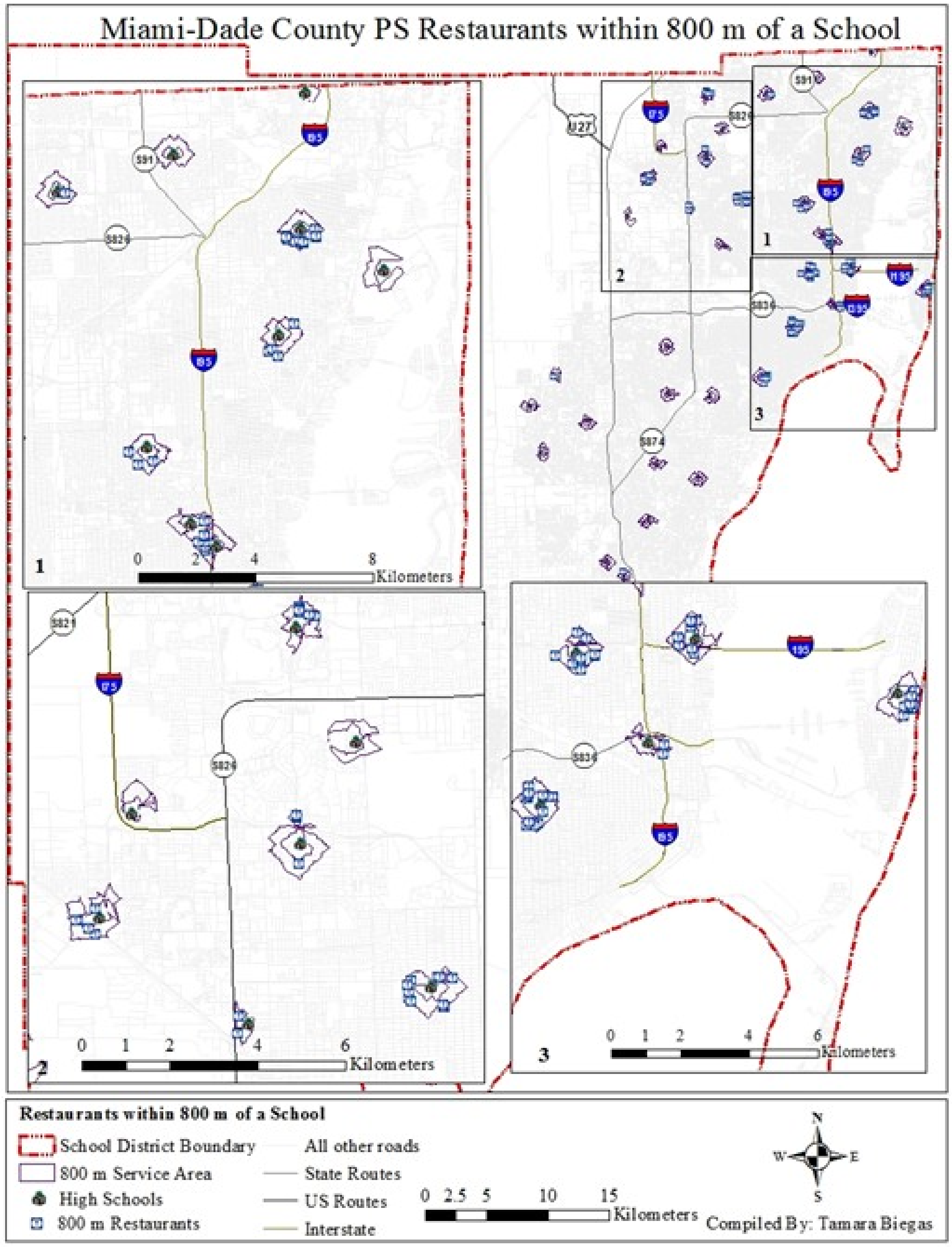

Figure 32 Restaurants within an 800 m Service Area (Buffer) of a School in the Miami-Dade County Public Schools

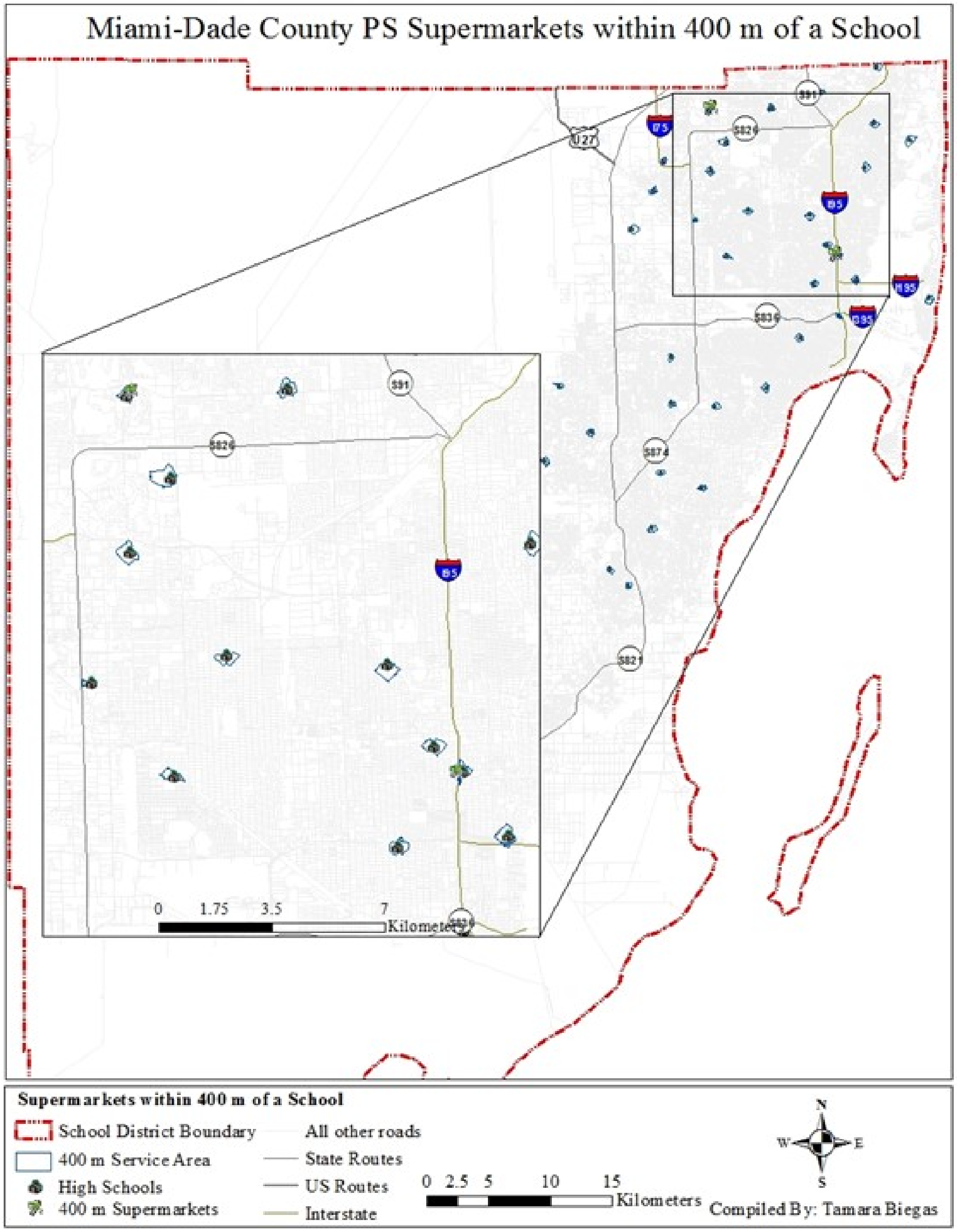

Figure 33 Supermarkets within a 400 m Service Area (Buffer) of a School in the Miami-Dade County Schools

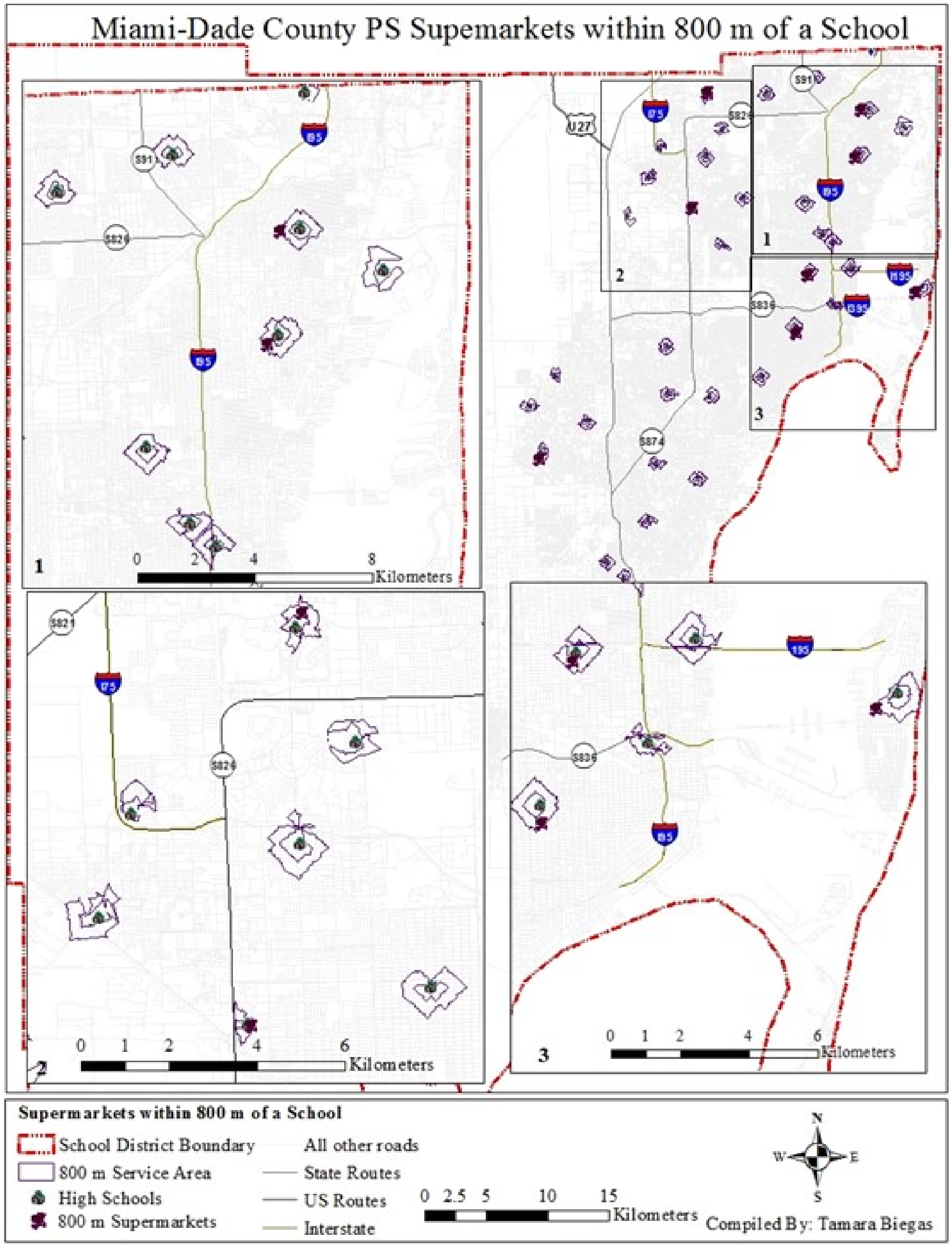

Figure 34 Supermarkets within an 800 m Service Area (Buffer) of a School in the Miami-Dade County Public Schools

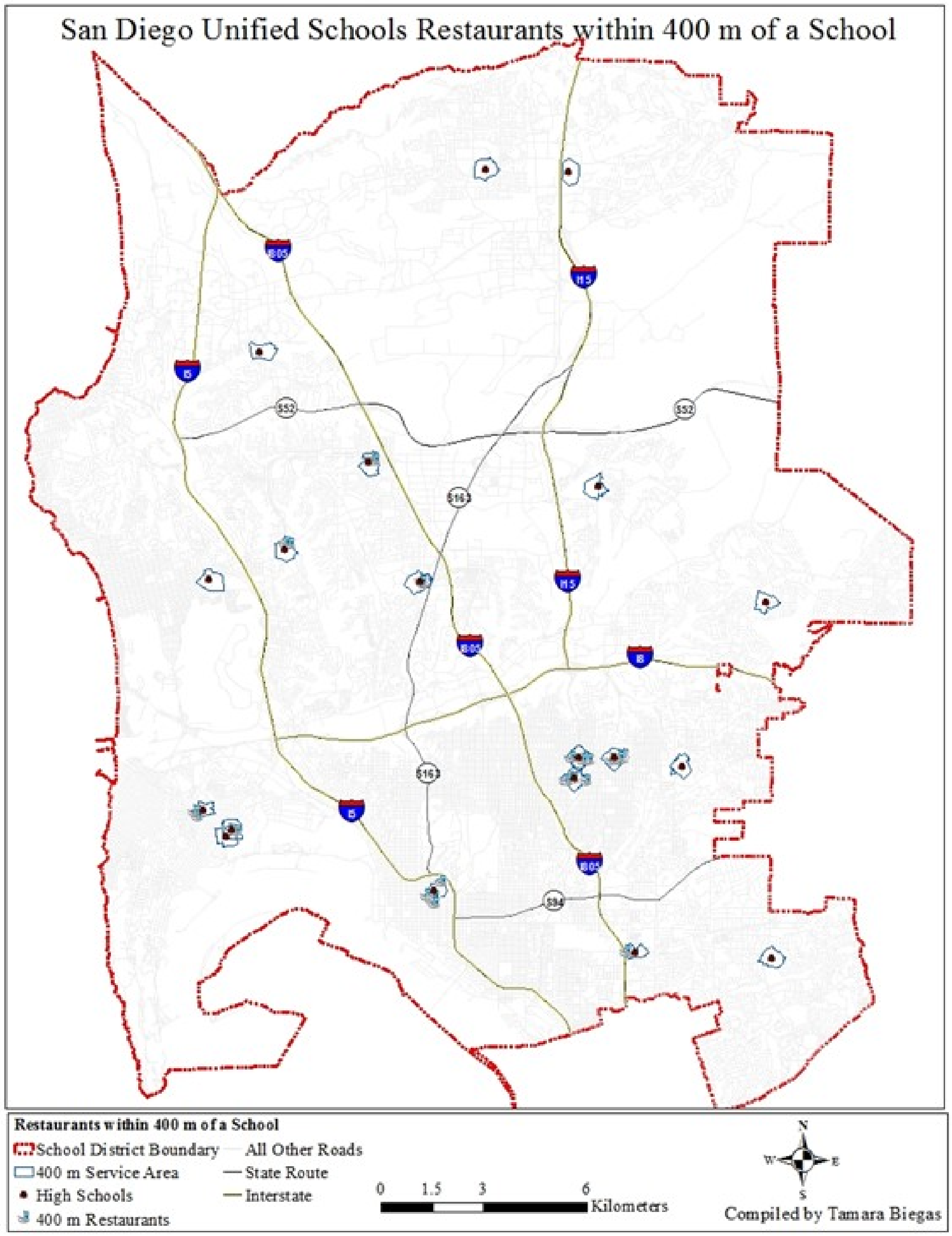

Figure 35 Restaurants within a 400 m Service Area (Buffer) of a School in the San Diego Unified School District

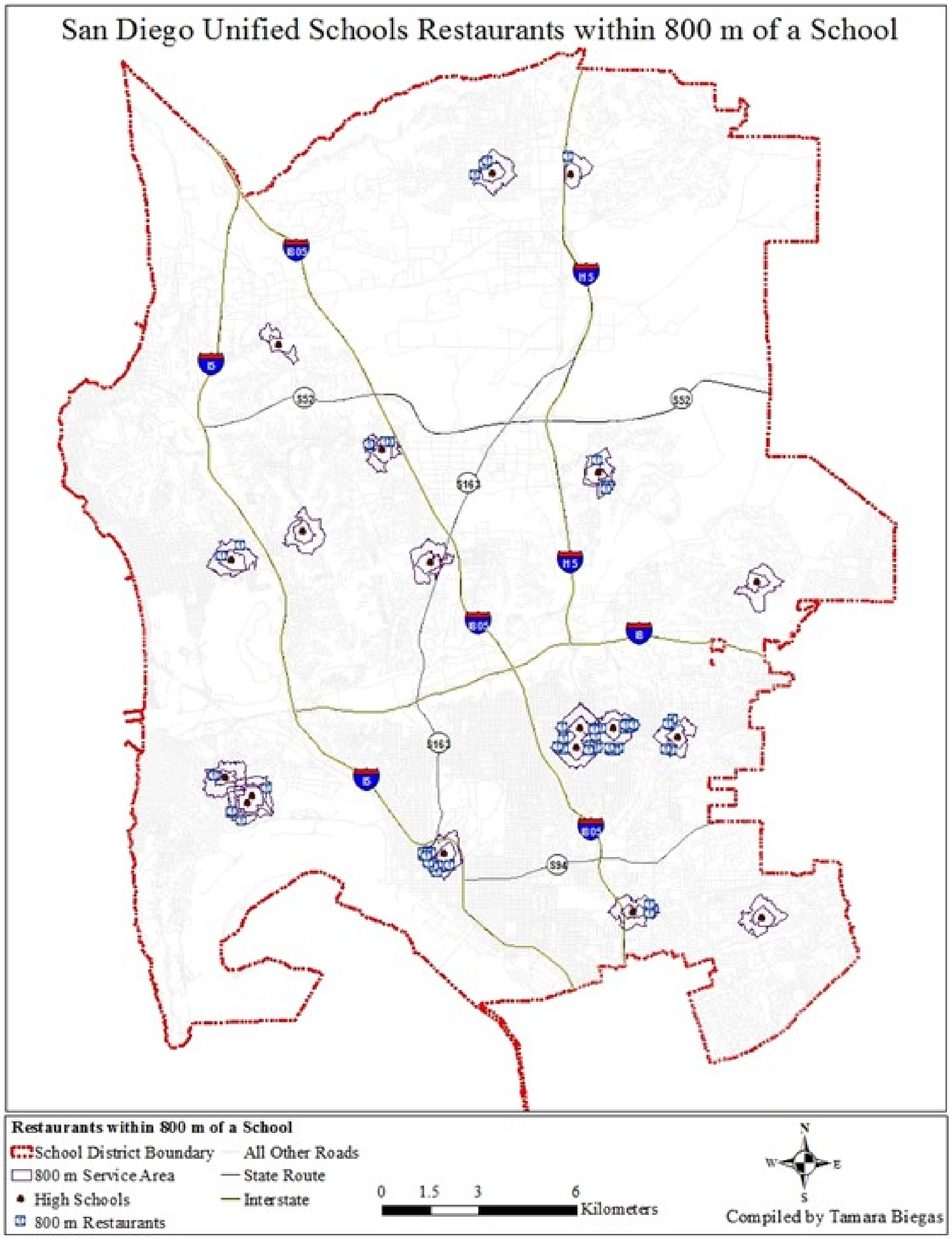

Figure 36 Restaurants within an 800 m Service Area (Buffer) of a School in the San Diego Unified School District

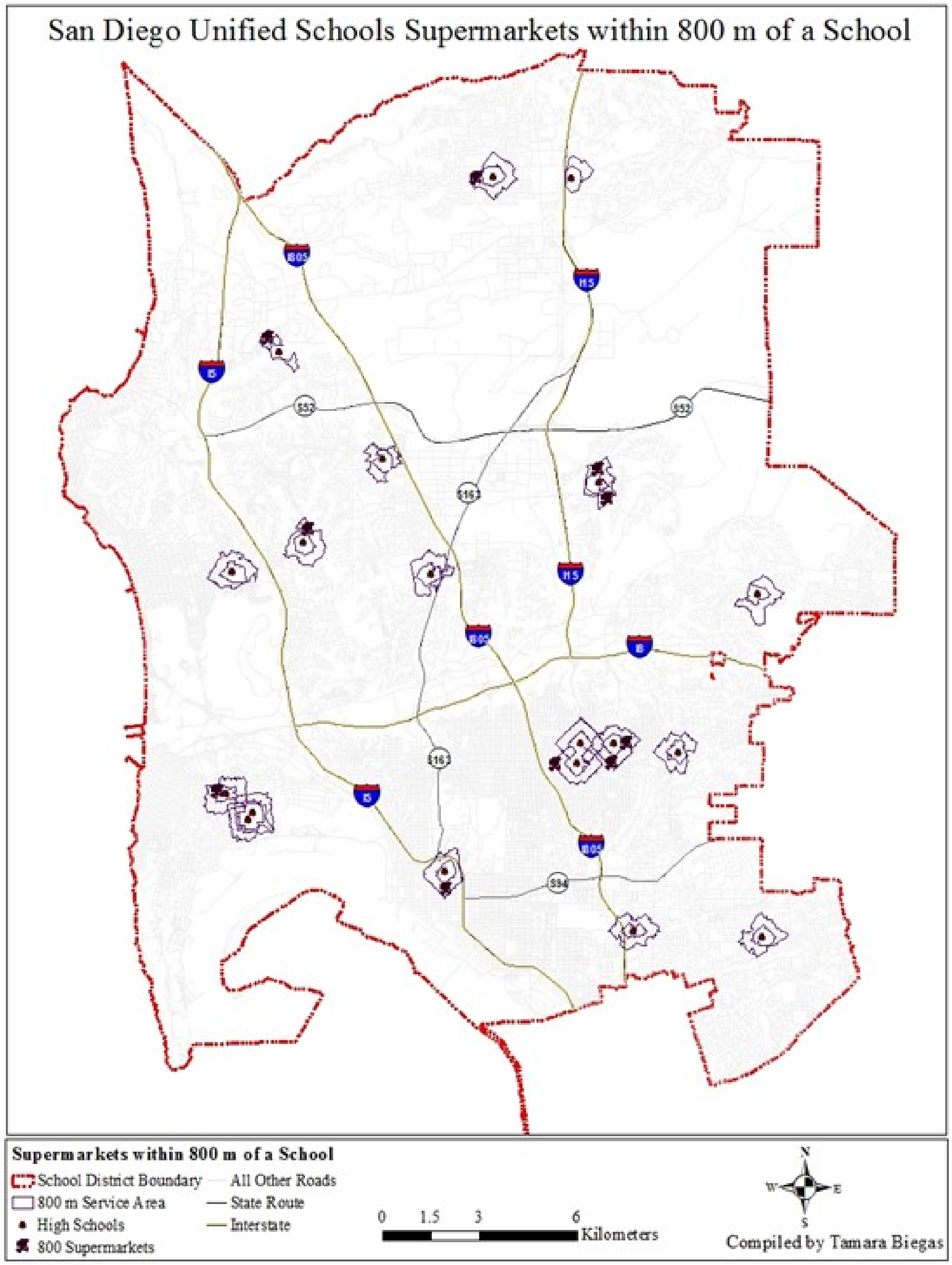

Figure 37 Supermarkets within an 800 m Service Area (Buffer) of a School in the San Diego Unified School District

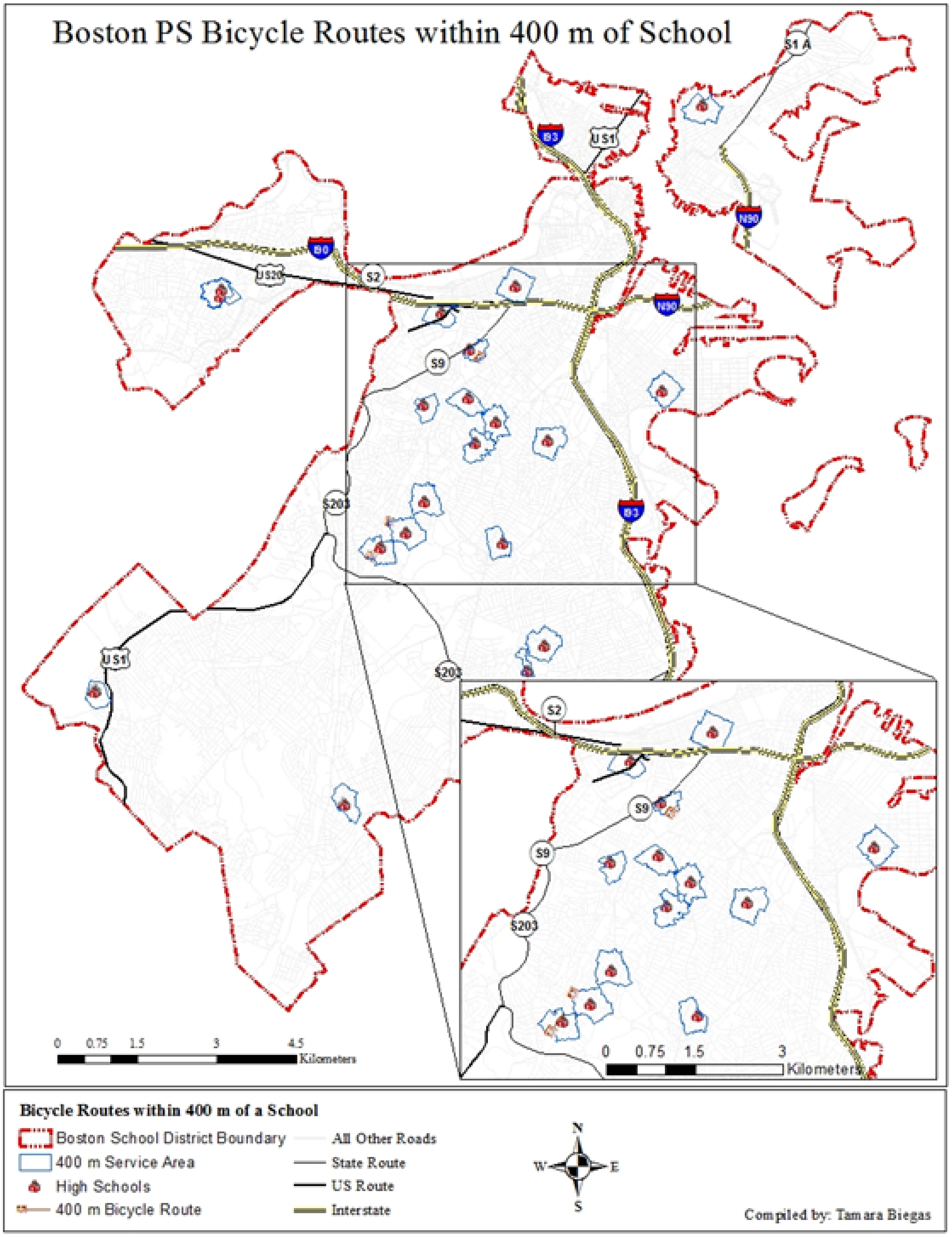

Figure 38 Bicycle Routes within a 400 m Service Area (Buffer) of a School in the Boston Public Schools

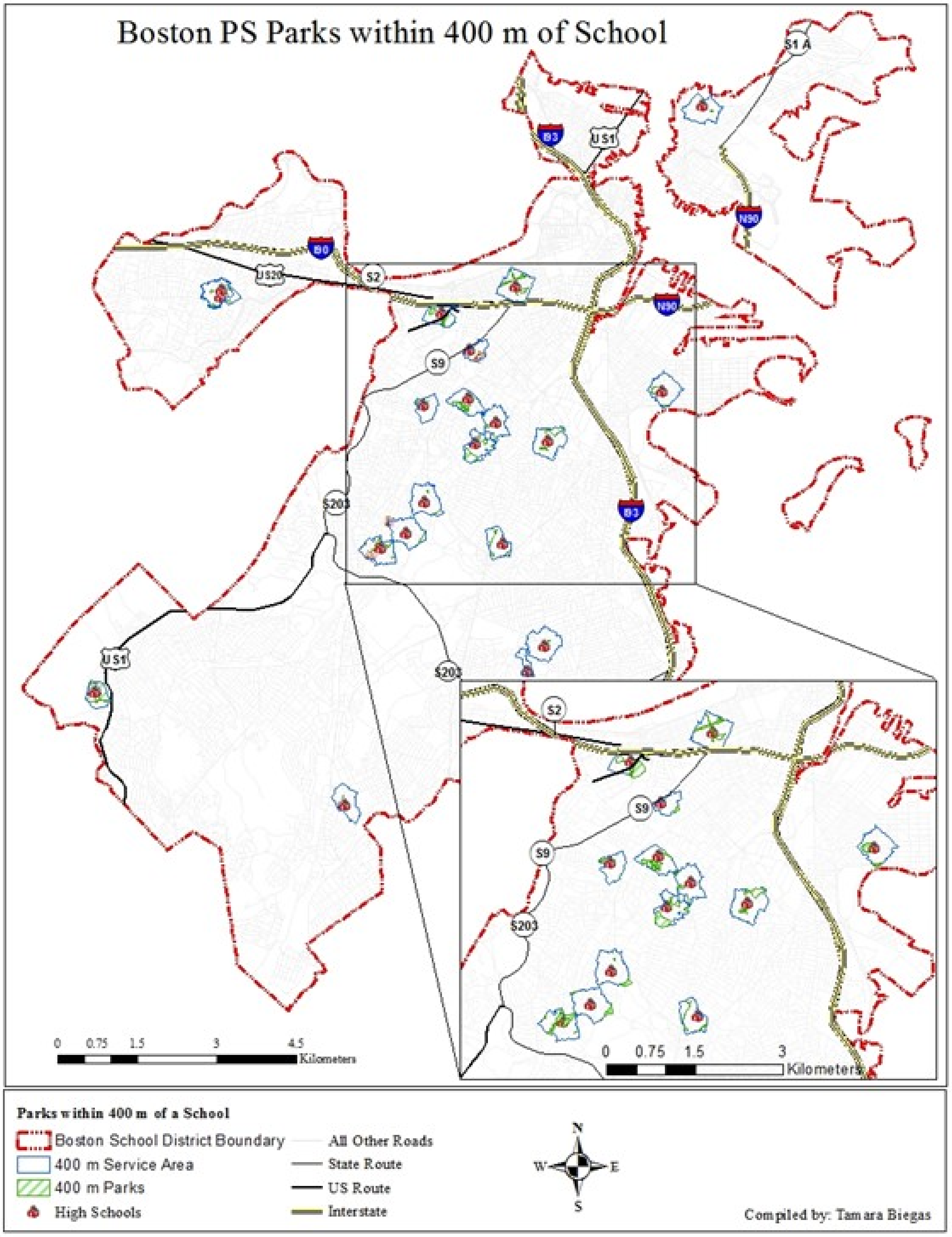

Figure 39 Parks within a 400 m Service Area (Buffer) of a School in the Boston Public Schools

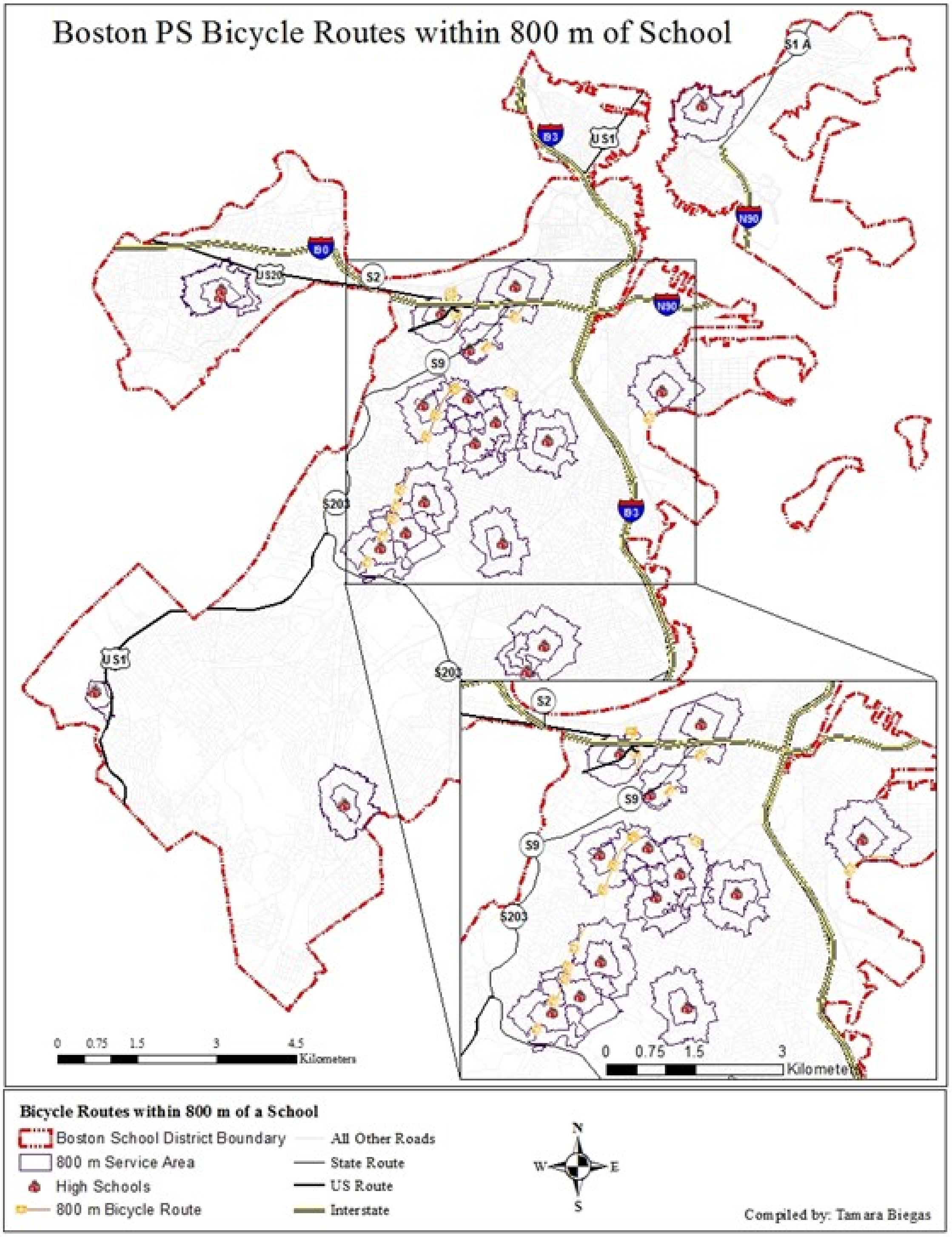

Figure 40 Bicycle Routes within an 800 m Service Area (Buffer) of a School in the Boston Public Schools

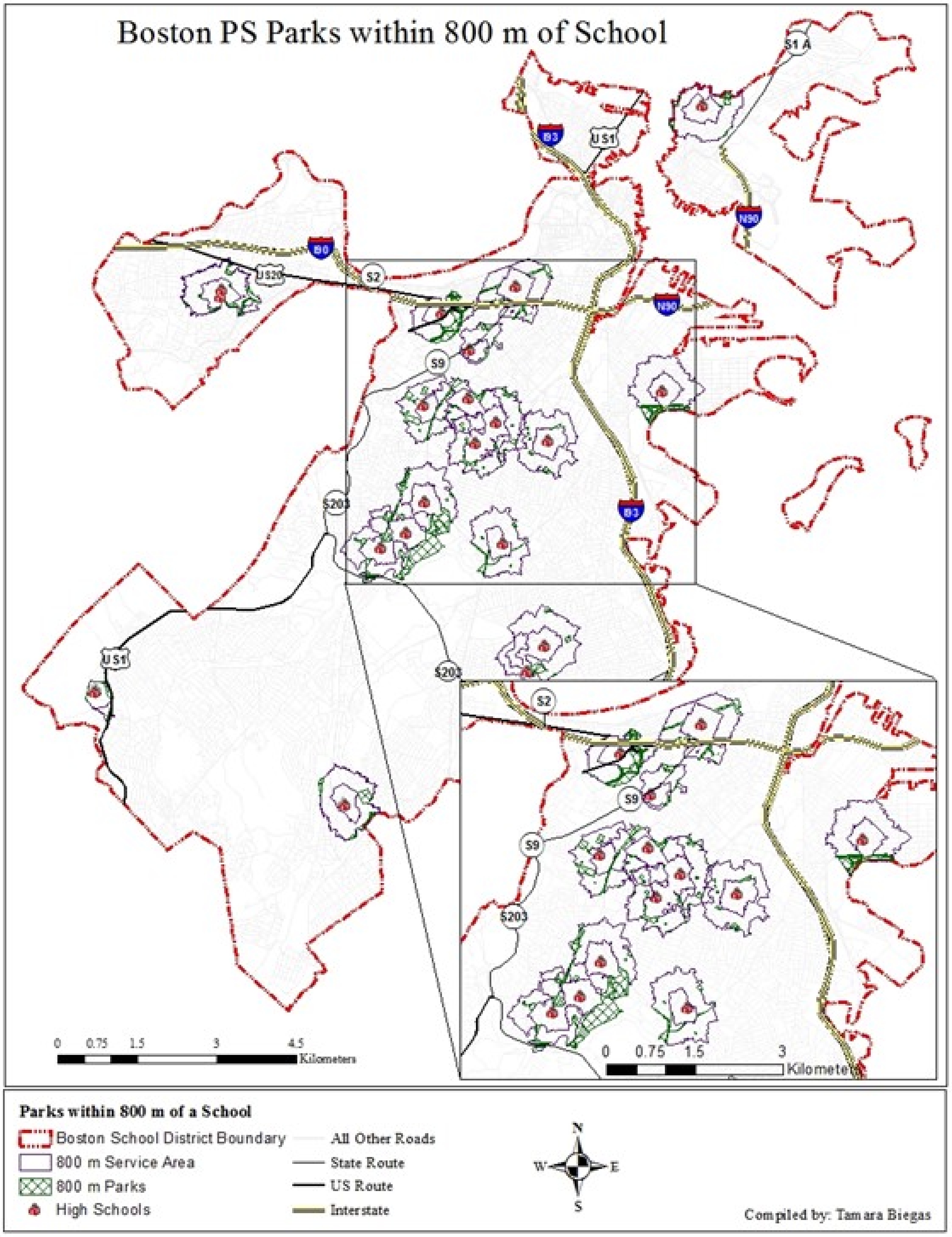

Figure 41 Parks within an 800 m Service Area (Buffer) of a School in the Boston Public Schools

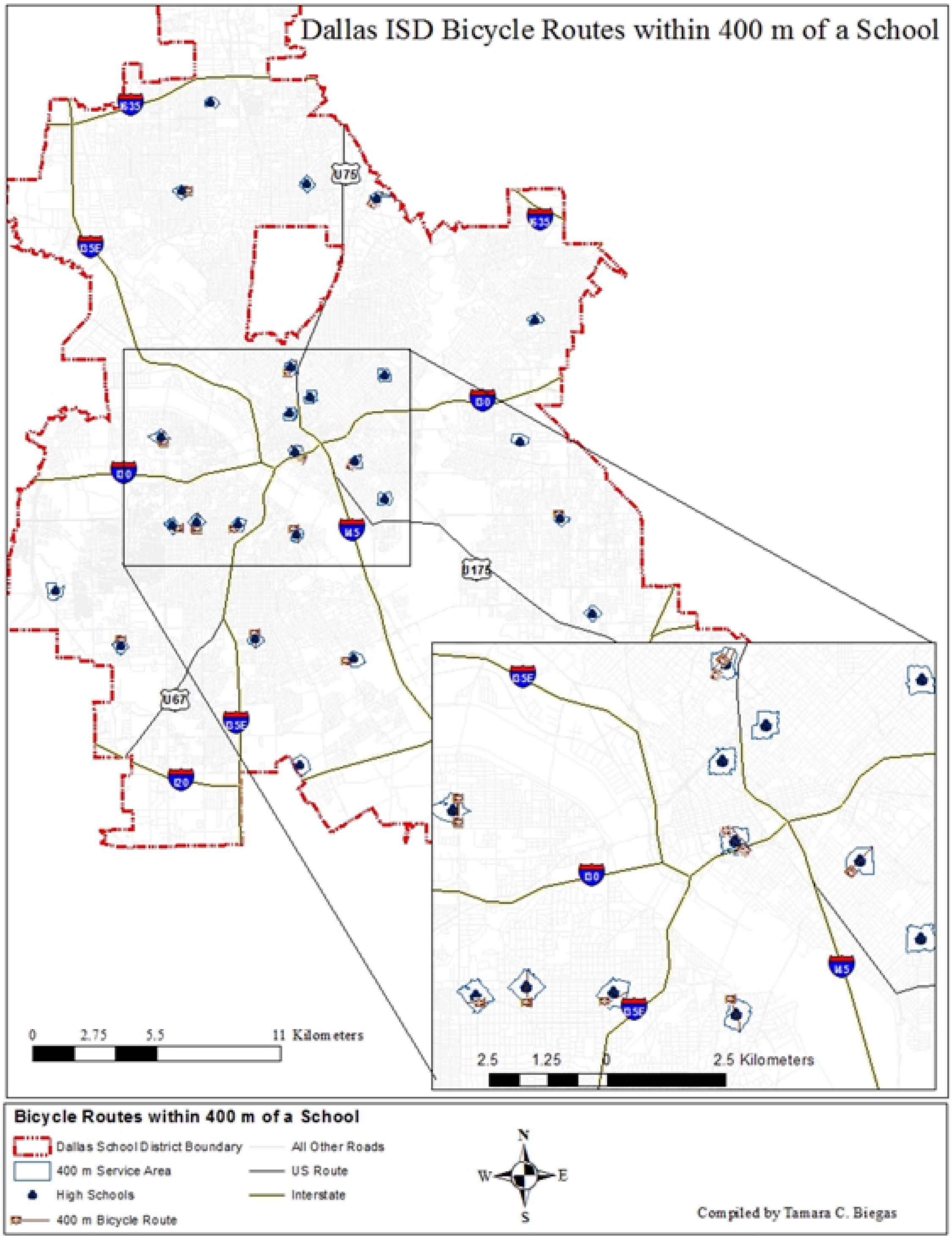

Figure 42 Bicycle Routes within a 400 m Service Area (Buffer) of a School in the Dallas Independent School District

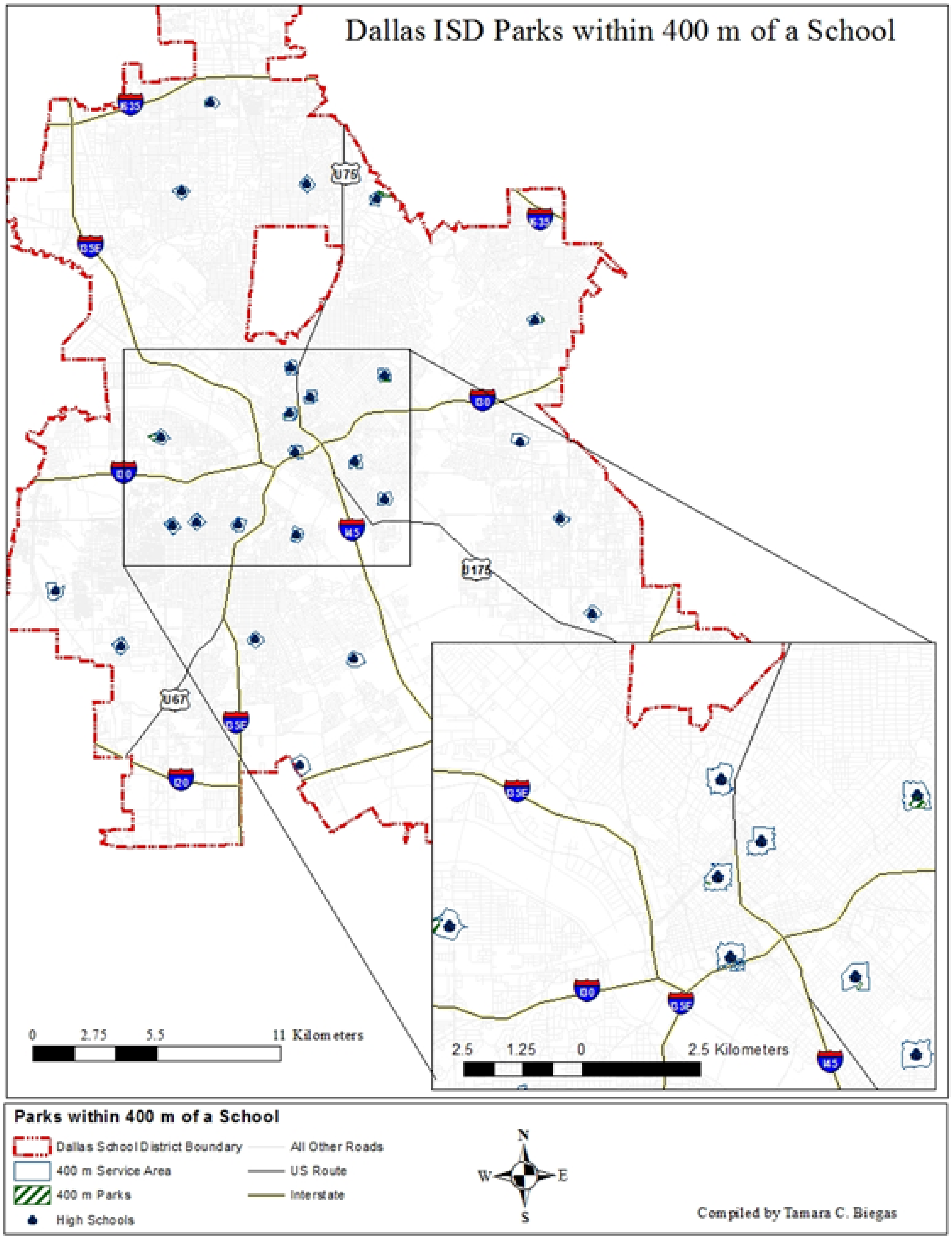

Figure 43 Parks within a 400 m Service Area (Buffer) of a School in the Dallas Independent School District

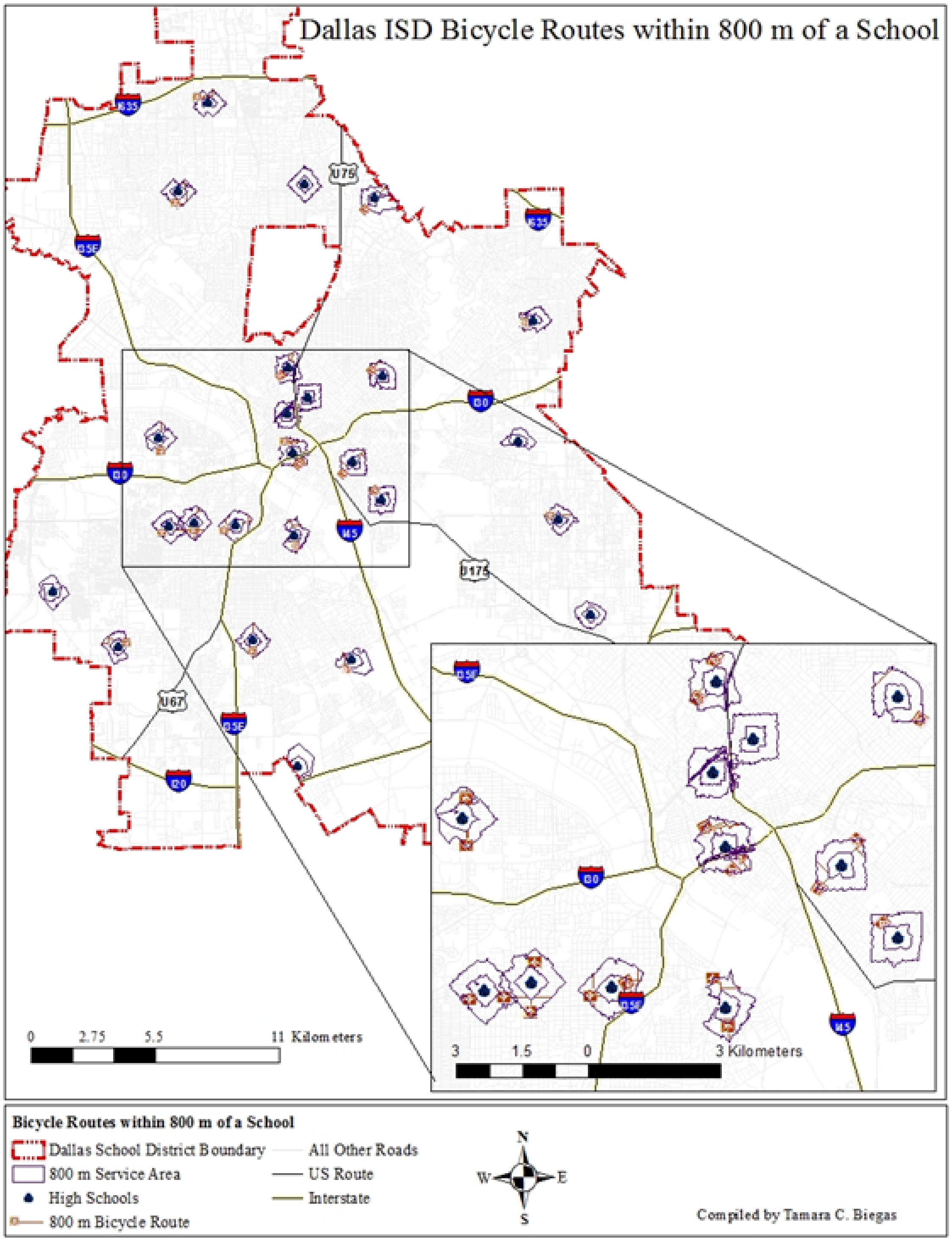

Figure 44 Bicycle Routes within an 800 m Service Area (Buffer) of a School in the Dallas Independent School District

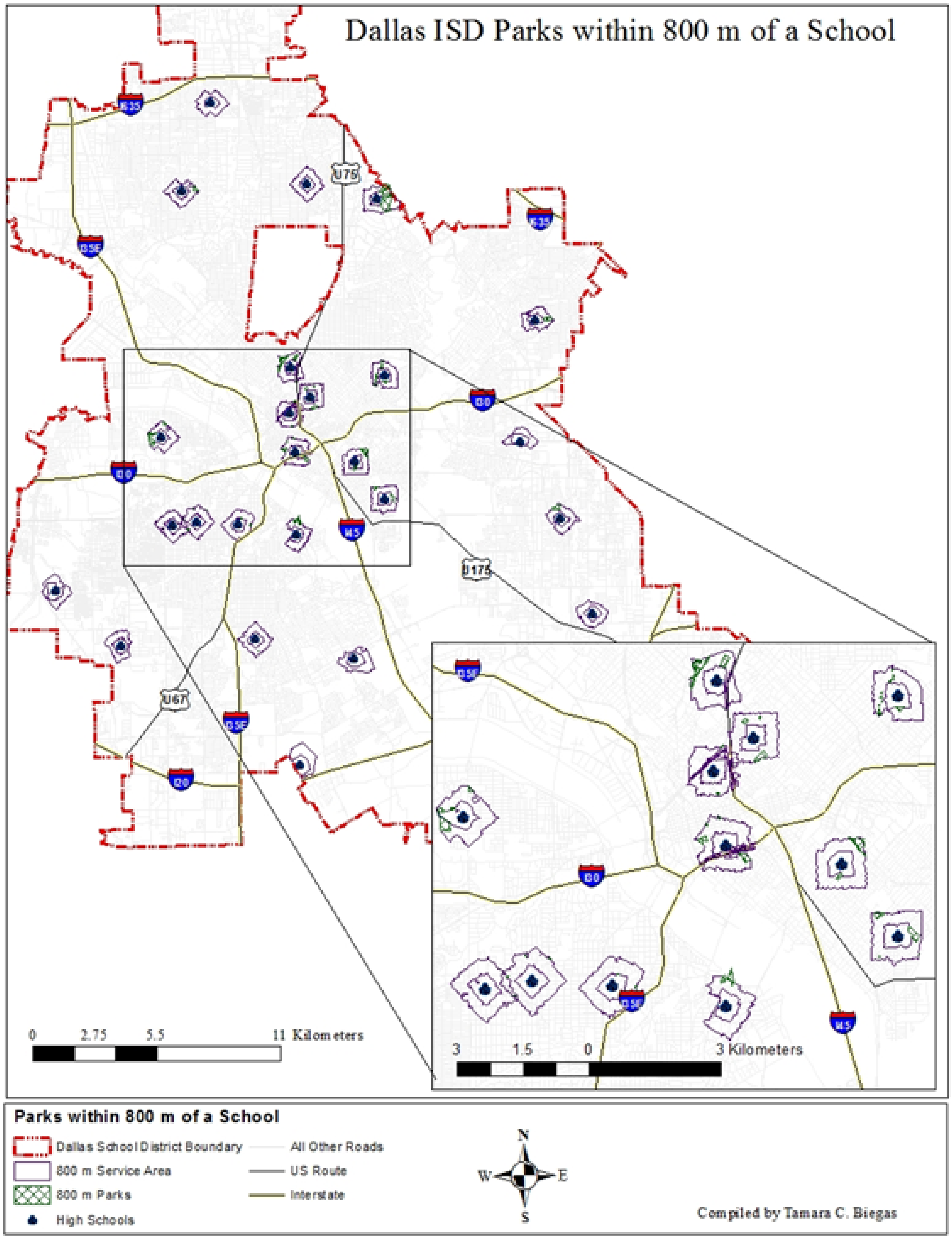

Figure 45 Parks within an 800 m Service Area (Buffer) of a School in the Dallas Independent School District

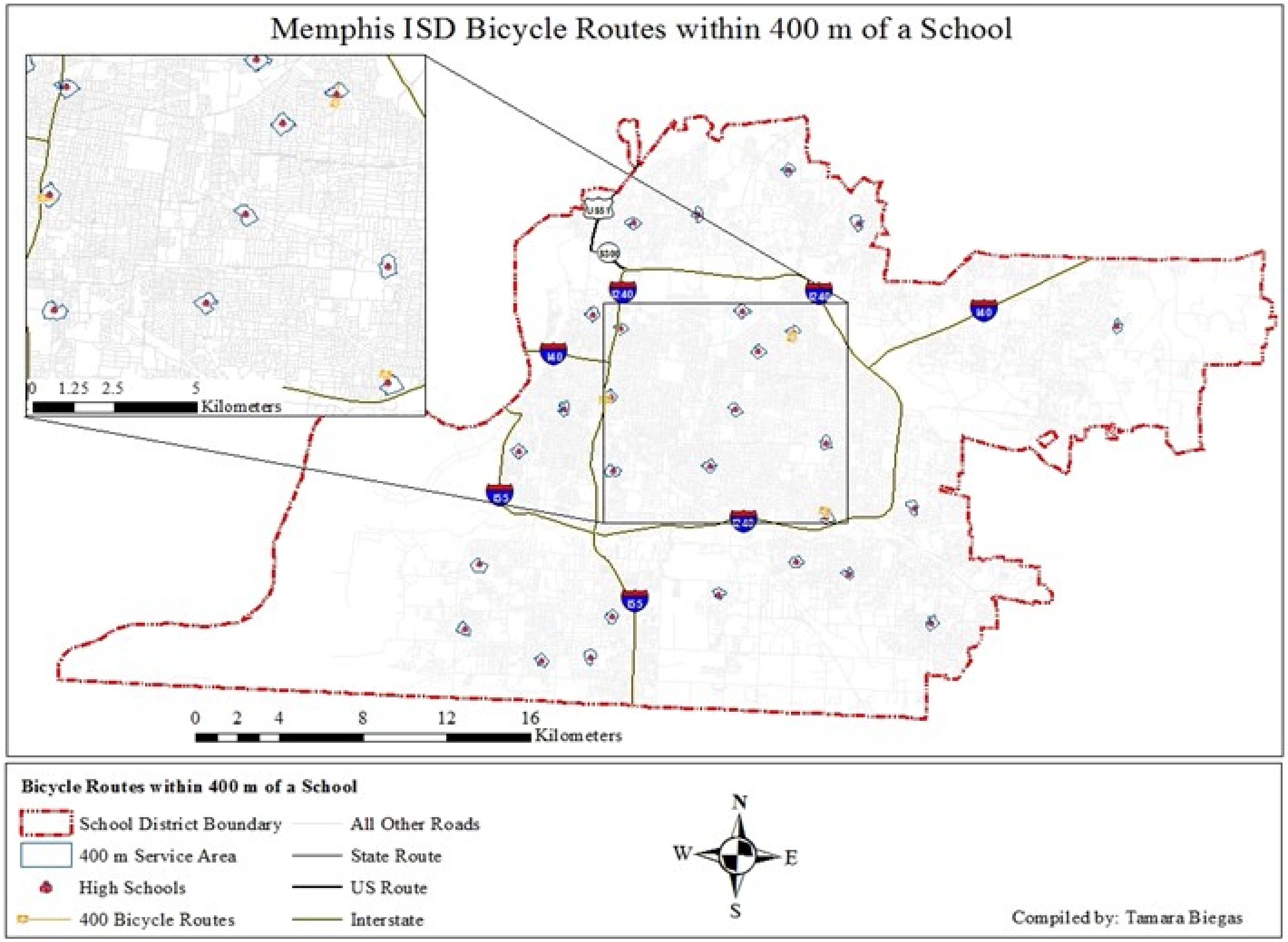

Figure 46 Bicycle Routes within a 400 m Service Area (Buffer) of a School in the Memphis Independent School District

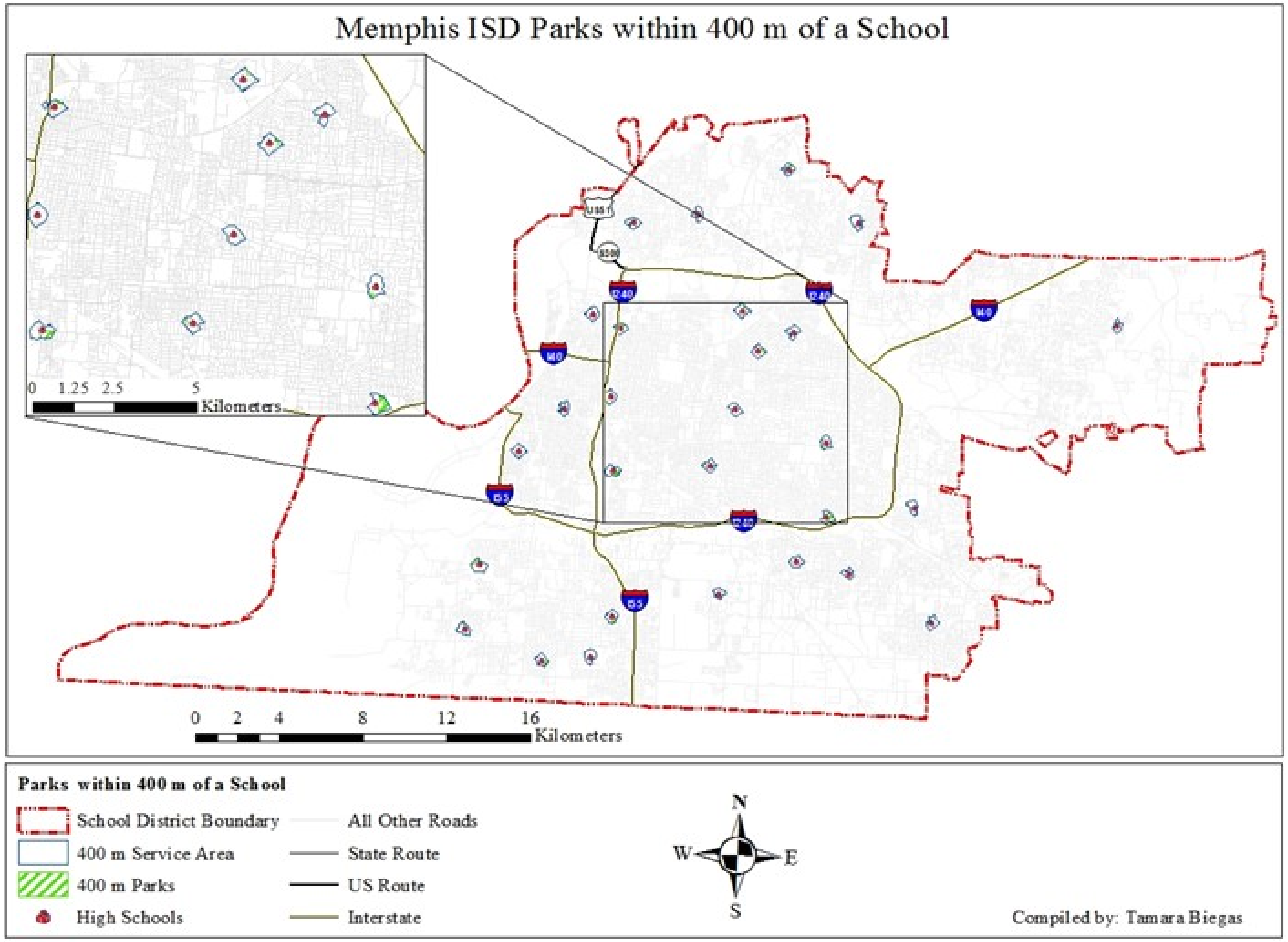

Figure 47 Parks within a 400 m Service Area (Buffer) of a School in the Memphis Independent School District

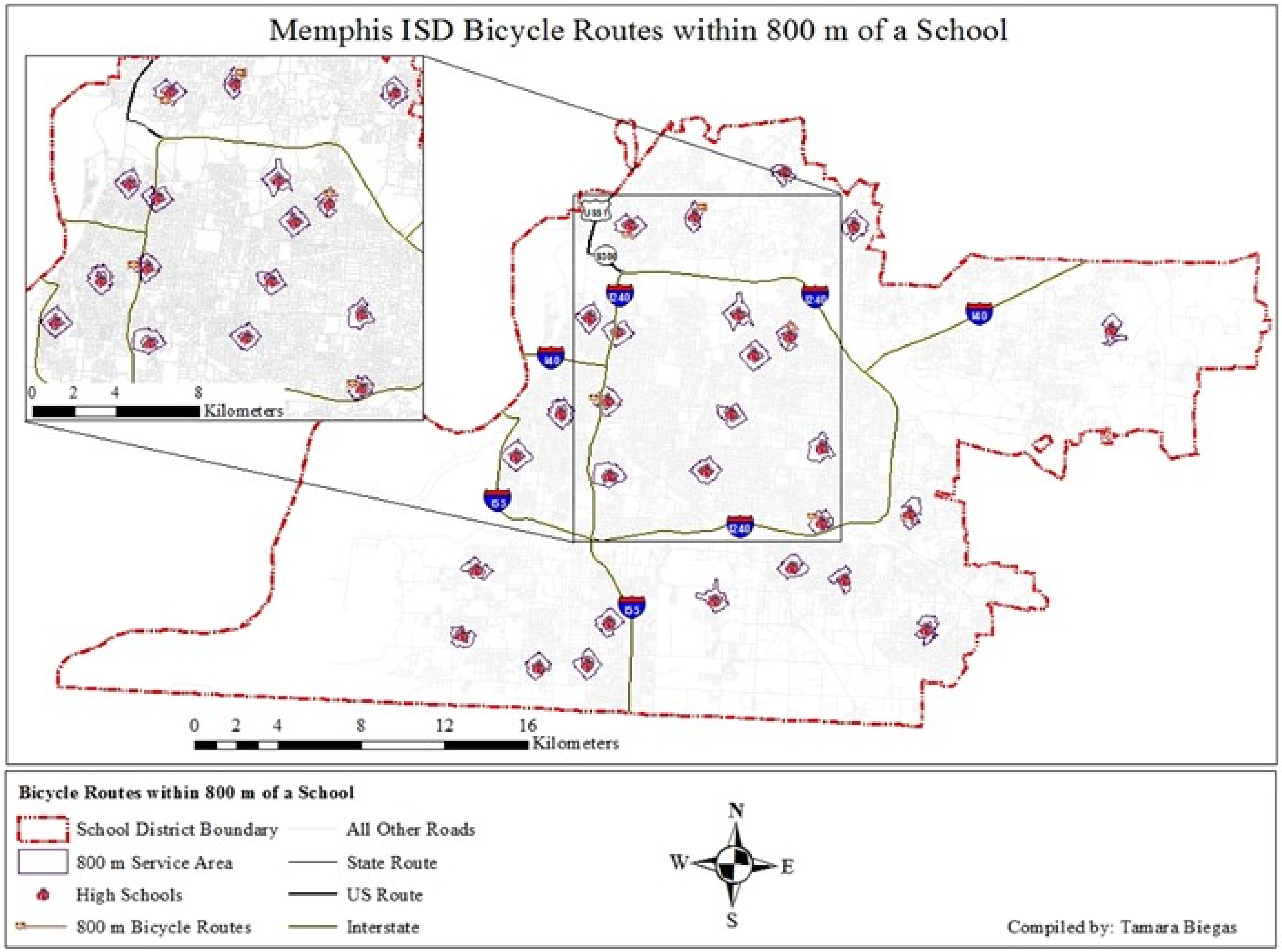

Figure 48 Bicycle Routes within an 800 m Service Area (Buffer) of a School in the Memphis Independent School District

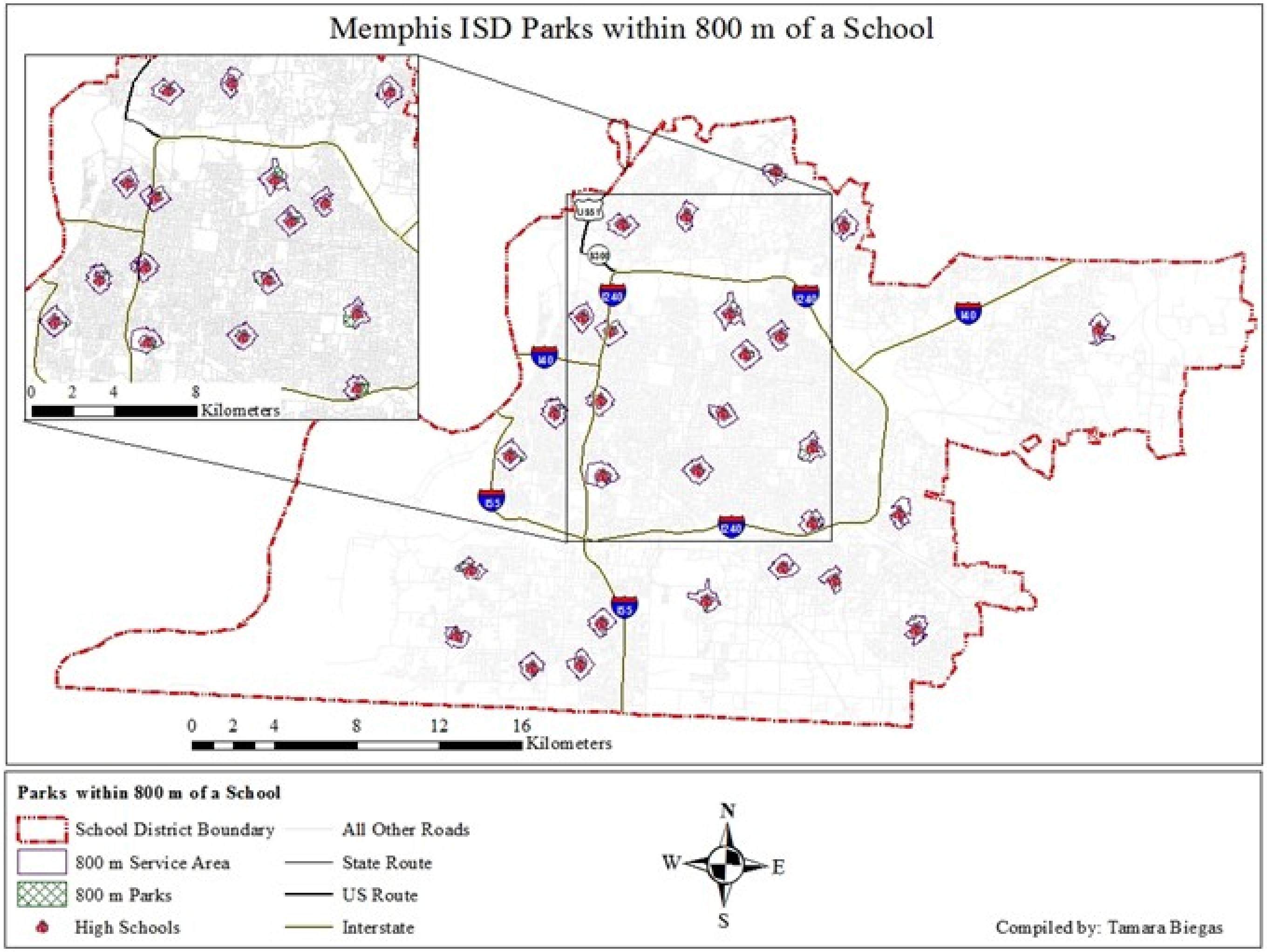

Figure 49 Parks within an 800 m Service Area (Buffer) of a School in the Memphis Independent School District

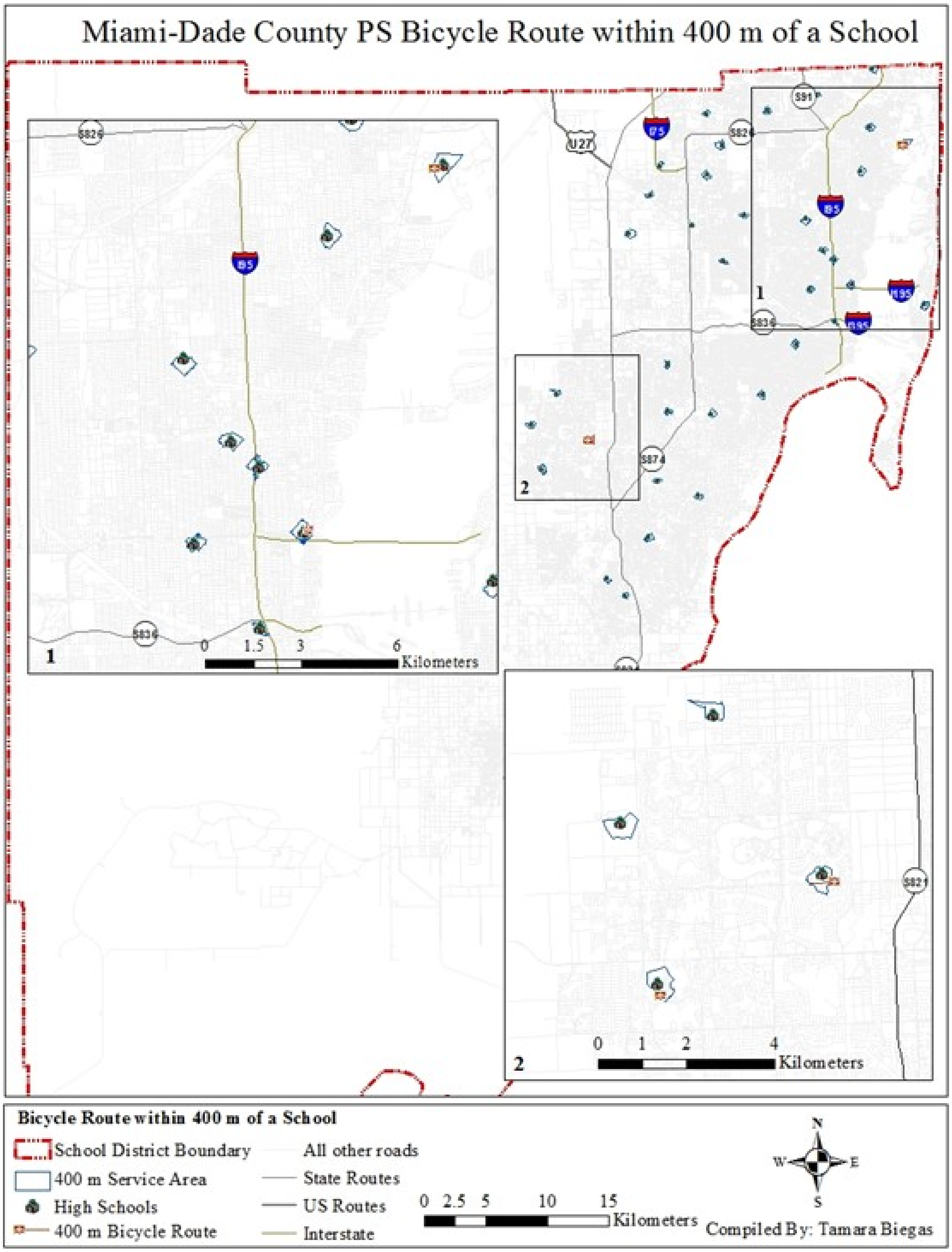

Figure 50 Bicycle Routes within a 400 m Service Area (Buffer) of a School in the Miami-Dade County Public Schools

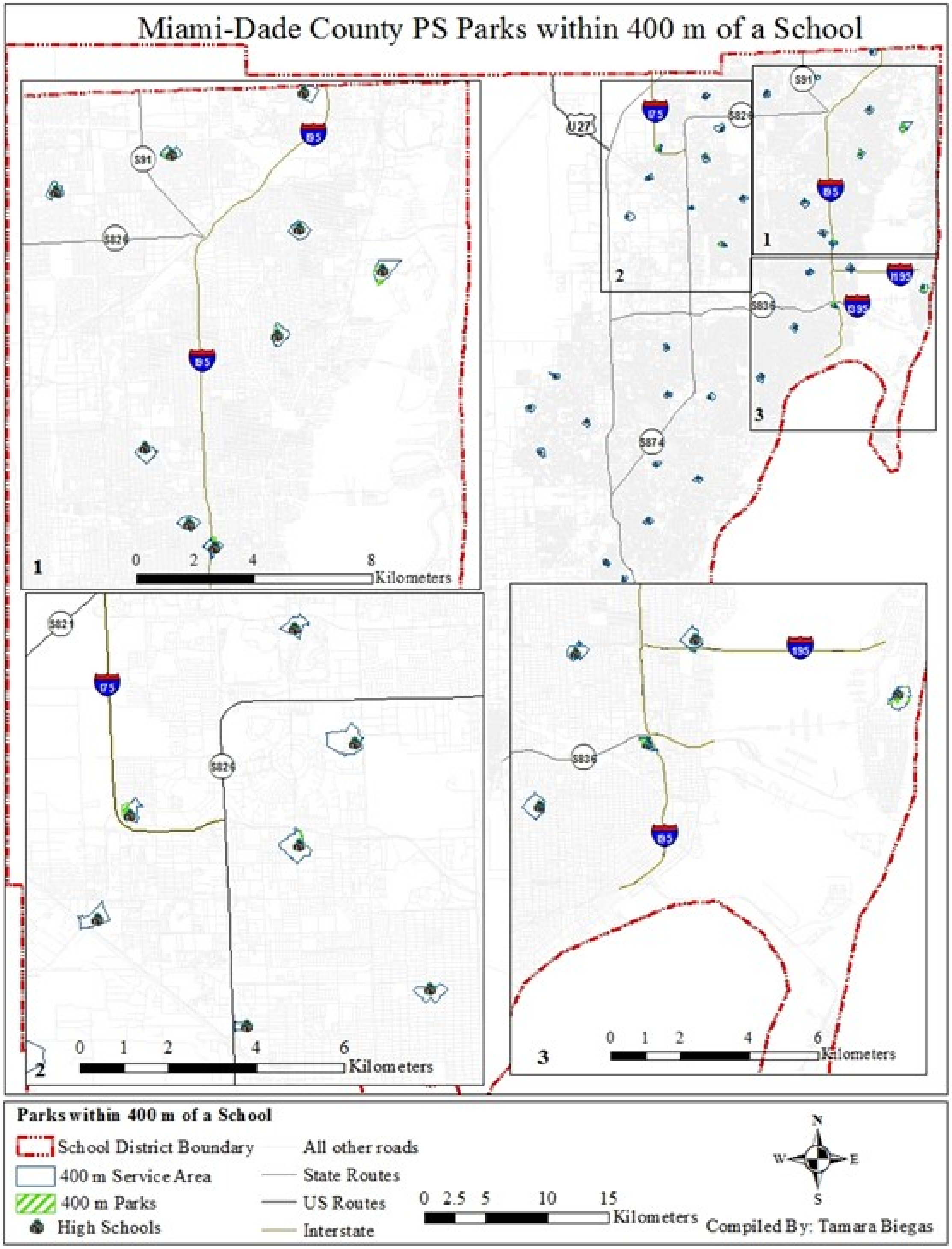

Figure 51 Parks within a 400 m Service Area (Buffer) of a School in the Miami-Dade County Public Schools

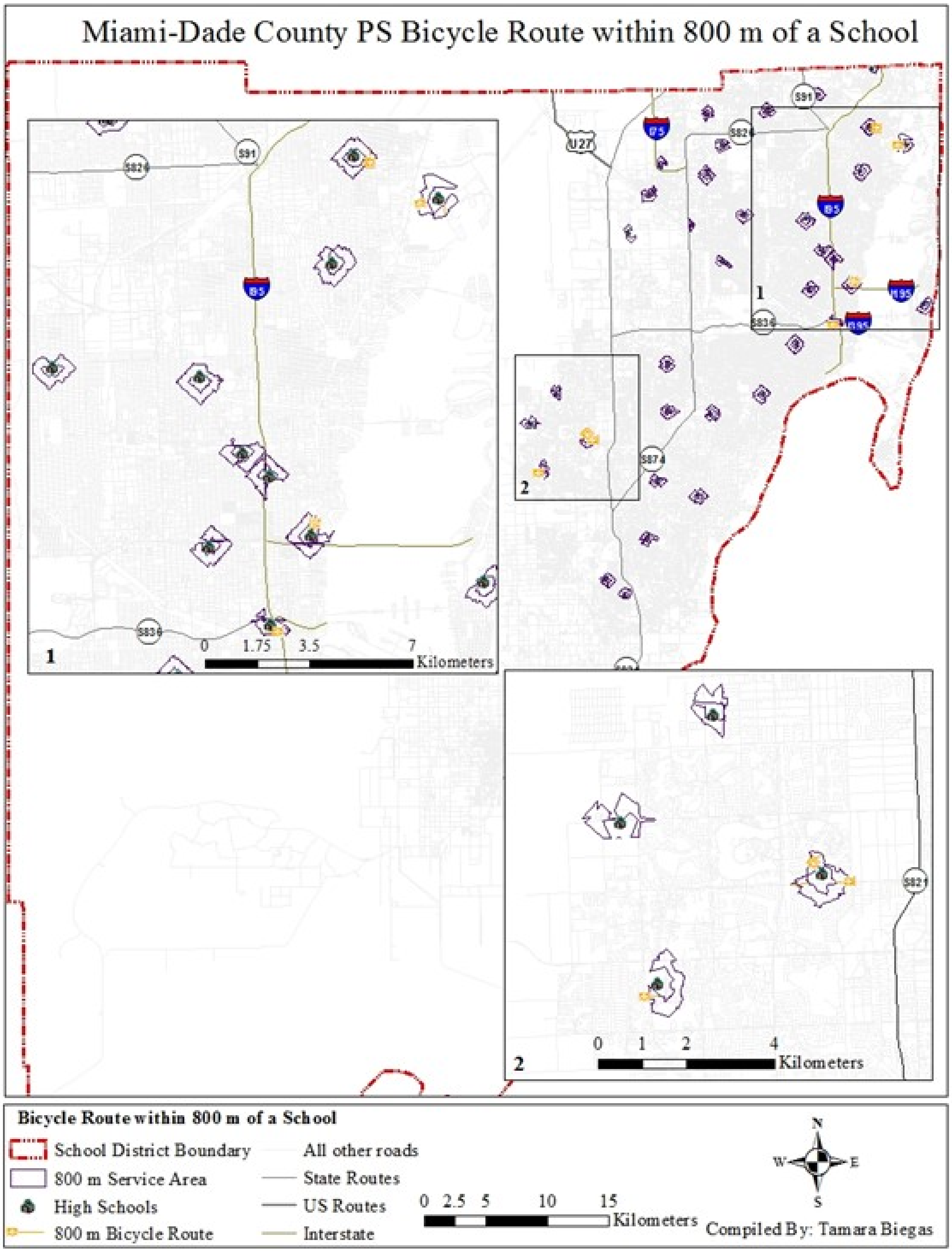

Figure 52 Bicycle Routes within an 800 m Service Area (Buffer) of a School in the Miami-Dade County Public Schools

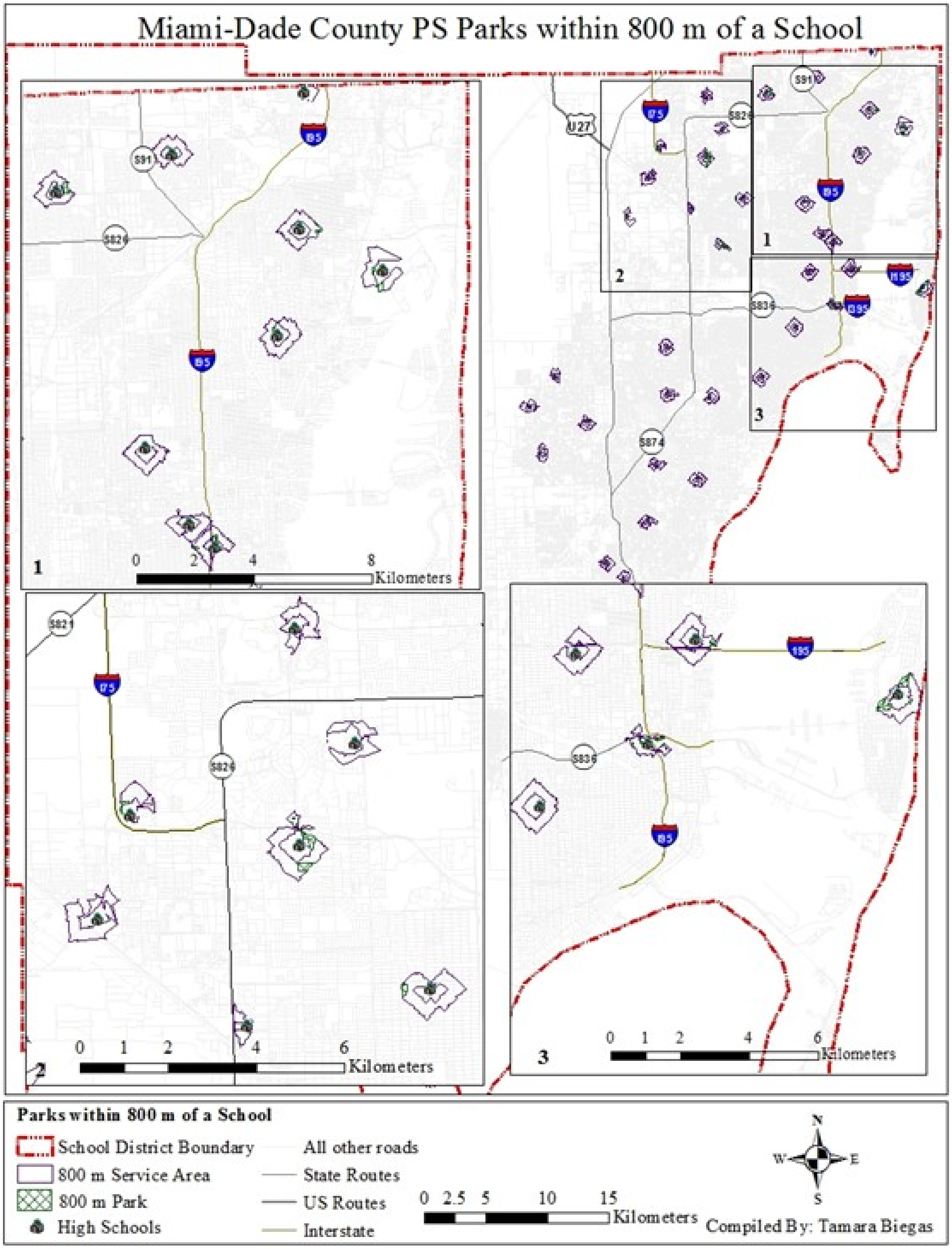

Figure 53 Parks within an 800 m Service Area (Buffer) of a School in the Miami-Dade County Public Schools

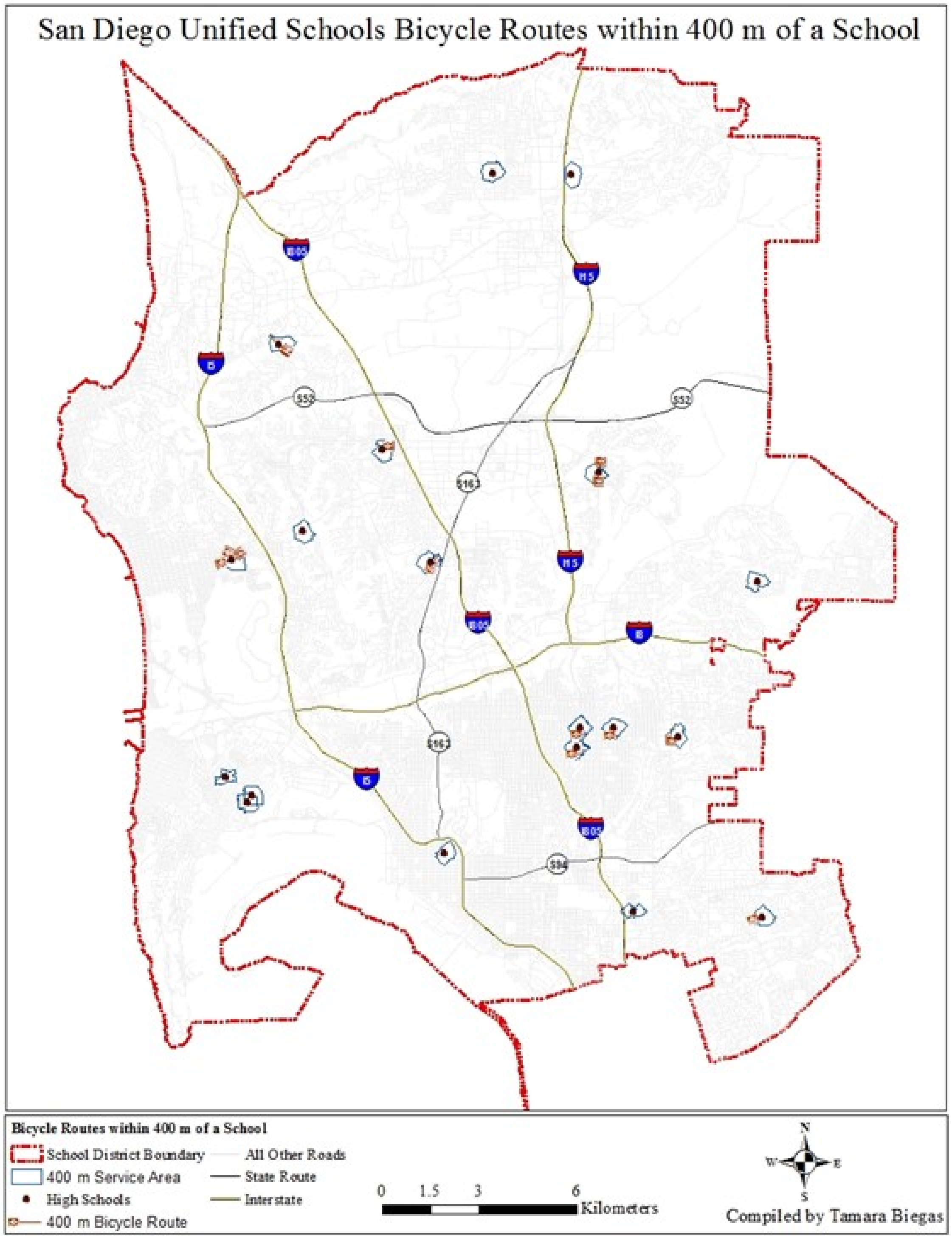

Figure 54 Bicycle Routes within a 400 m Service Area (Buffer) of a School in the San Diego Unified School District

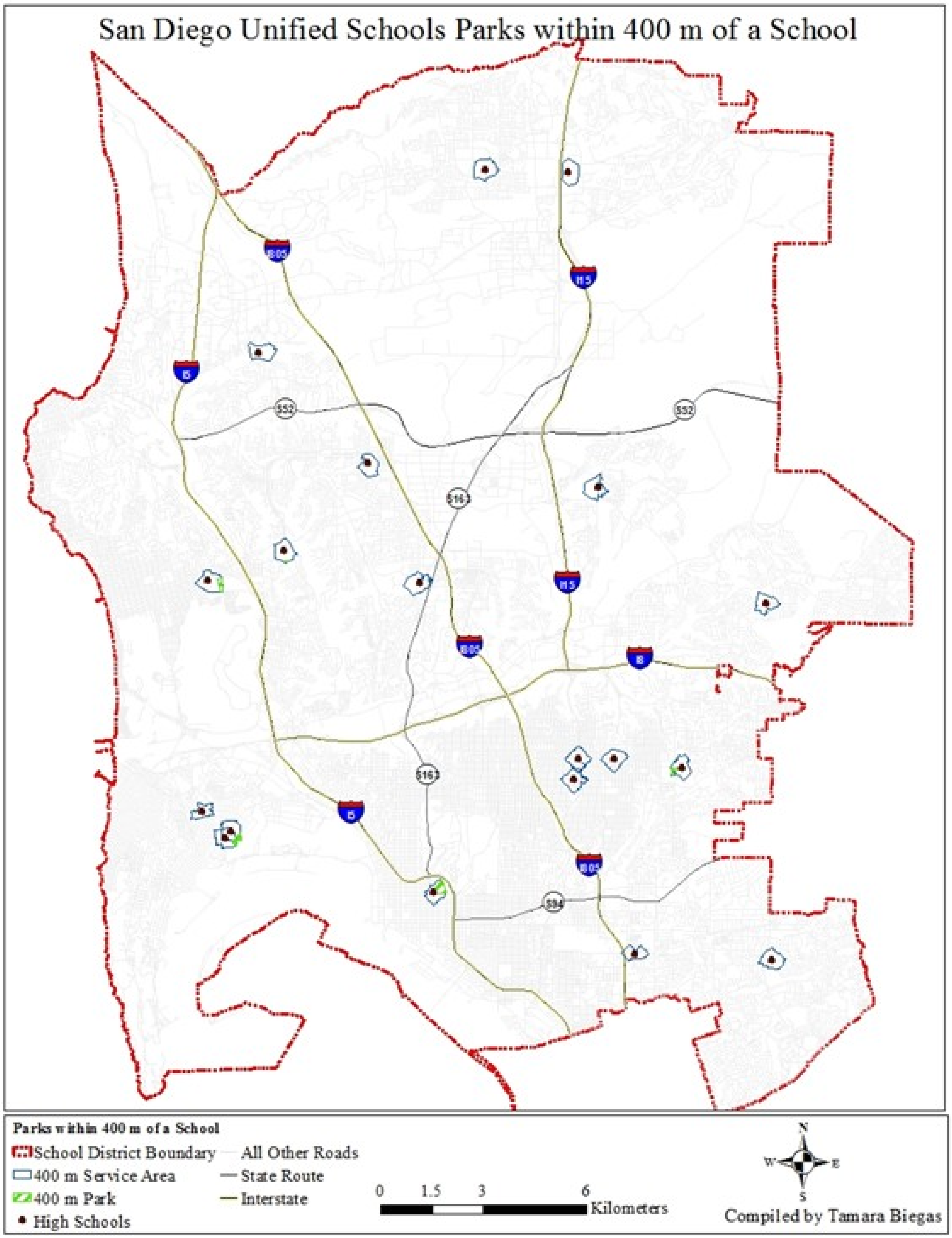

Figure 55 Parks within a 400 m Service Area (Buffer) of a School in the San Diego Unified School District

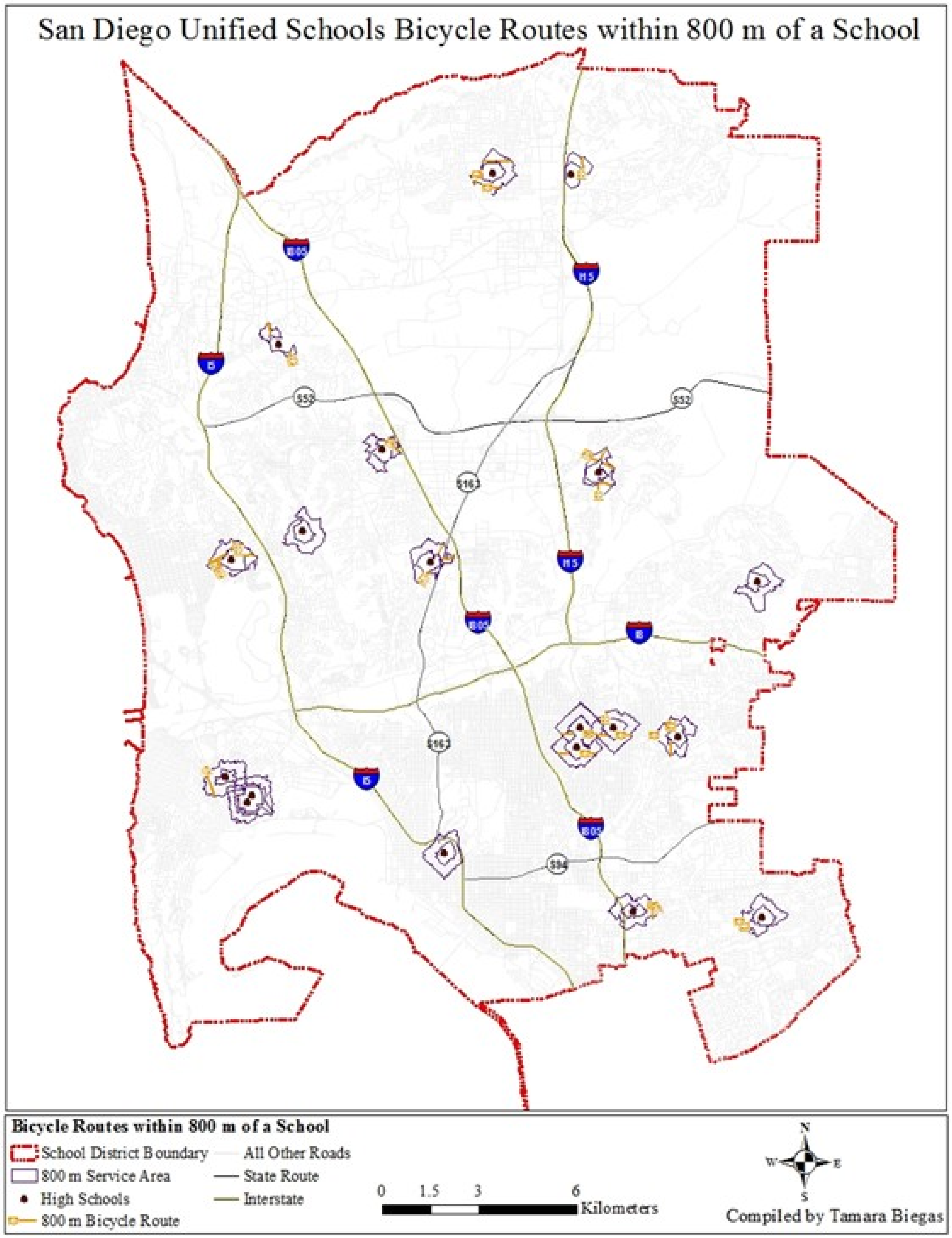

Figure 56 Bicycle Routes within an 800 m Service Area (Buffer) of a School in the San Diego Unified School District

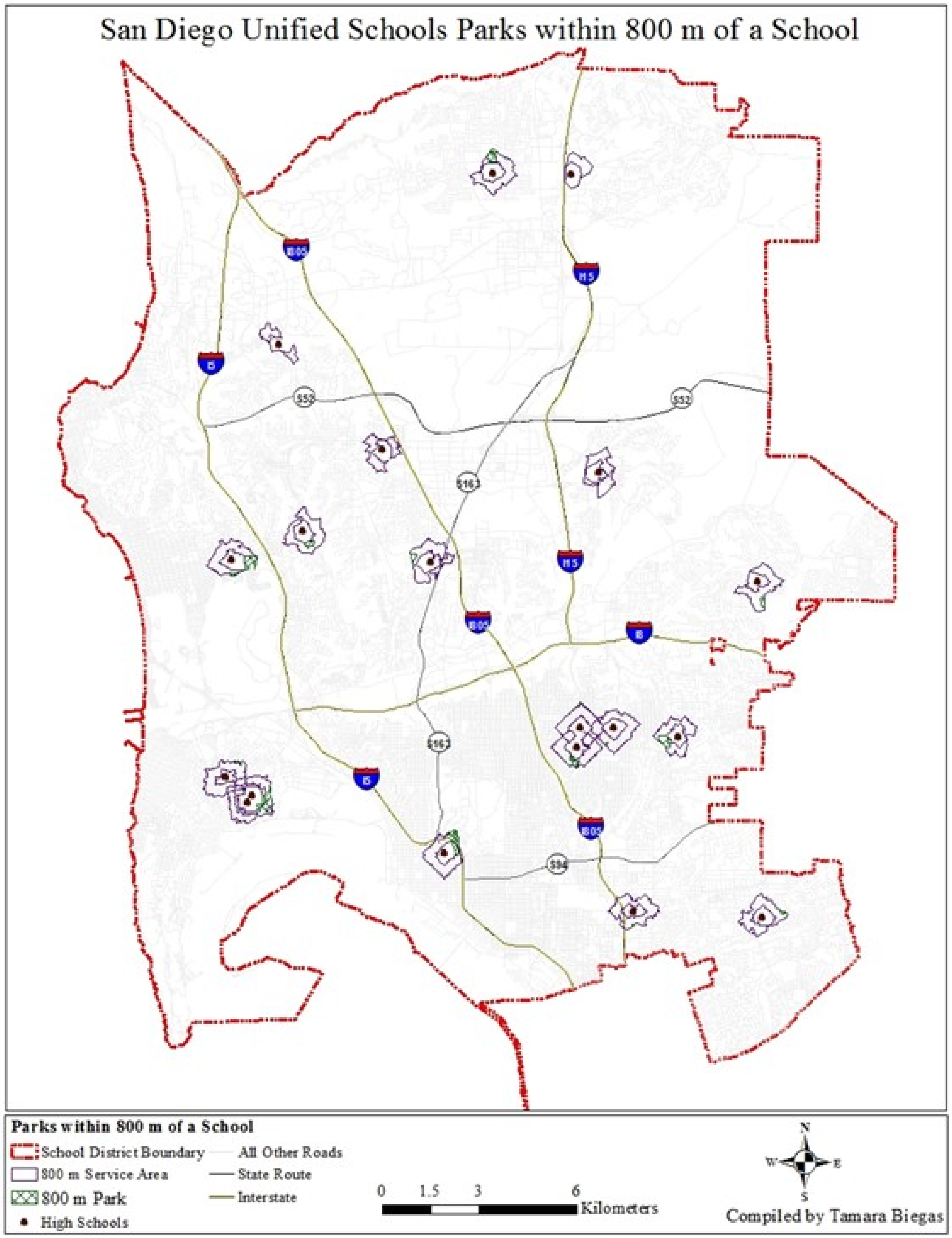

Figure 57 Parks within an 800 m Service Area (Buffer) of a School in the San Diego Unified School District

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