NEIGHBORHOOD-LEVEL INFLUENCE OF THE FAST-FOOD ENVIRONMENT AND ADULT OBESITY IN NYC: A CROSS-SECTIONAL ANALYSIS

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TABLE OF CONTENTS

Page

ABSTRACT

For adults, age 20 and older, obesity definition is based on body mass index (BMI). BMI is a ratio that shows an individual height to weight and an adult with a BMI ≥30 is considered to be obese. The rapid increase in the rates of obesity has contributed to various related diseases, for example, heart disease, stroke and ultimately death. The association of fast-food restaurant and obesity is not quite understood and is very much understudy. Thus, the purpose of this study was to investigate the influence of the neighborhood-level fast-food restaurants to determine whether there's an association with adult obesity in NYC after controlling for socioeconomic status (SES) levels of the geographic region. Fast-food restaurants (limited) were the main focus of this study, but other restaurants (full-service) were included in the analysis in order to capture food consumed outside of home. Pearson correlations were conducted in order to assess the bivariate correlations between the study variables BMI, SES, number of fast-food restaurants, and number of restaurants. The results conclude that there were strong negative correlations between BMI and SES (r = -.421, p = .013), fast-food (r = -.417, p = .014), and number of restaurants (r = -.396, p = .021). Multiple linear regression model using the three predictors explained 16.7% of variation in predicting BMI (Adjusted R2 = 0.167). The overall model was found to be significant, F (3, 30) = 3.206, p = .037. However, none of the predictors were found to be significant: SES (B = -.365, p = .109), fast-food (B = -.640, p = .213), and restaurants (B = 0.449, p = .427). Multicollinearity may explain this paradoxical finding. Due to multicollinearity, the independent variables were assessed separately by conducting three

separate linear regressions. Results of the study were that there were negative associations of SES, number of fast-food establishments, and number of restaurants, with BMI. They supported the assertion that an increased in the density of fast-food restaurants in neighborhoods does not lead to higher obesity prevalence in NYC with socioeconomic status serving as a control variable. It is recommended, however, for future studies to consider looking at the restaurant mix as well as other influential factors of the fast-food environment that may play a role in differences in weight outcome.

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DEDICATION

I would like to dedicate my doctoral degree journey to my parents, Valrose Graham and late father Lambert Graham. They created the path so that I could be able to pursue my dreams. It was because of their love, prayers and support that contributed to my will power to persevere and accomplished my goal. My drive and resilience to conquer the many obstacles faced with this project stem from my desire to excel and to make my parents proud. There is a quote that resonates with me throughout this entire journey, which states:

> "Believe in yourself and all that you are. Know that there is something inside you that is greater than any obstacle." – Christian D. Larson

LIST OF FIGURES

Page

LIST OF TABLES

Page

CHAPTER 1

INTRODUCTION

1.1 Statement of the problem

In recent years, adult obesity has been an ever-growing problem in the United States (US). The prevalence of obesity in the US has acquired much attention and has become a serious concern for public health. Over the past three (3) decades the rates of obesity have been rapidly increasing. According to the most recent NHANES data 2015-2016, almost 40 percent of adults 20 years and over living in the US are obese [1]. Over the past year, there has not been any great improvement in obesity rates. The increase in rate of obesity in the US has become noticeable since the mid-1970s [2-4]. Over this same time period, the rise in fast-food restaurants have been more than doubled whereas the number for other restaurants grew at a slower rate based on Census of Retail Trade [5] . It is often assumed in public debate that the extensive availability of fast-food restaurants is a significant determinant of the rapid increase of obesity rates.

The US is included among other developed countries with the highest obesity rates. Today, sub-Saharan Africa is the only place where obesity is rare [6]. The spatiotemporal change relating to the trends of obesity in the US is shown in Figure 1. It can be easily inferred that there is an increasing obesity epidemic from 1999-2000 through 2015-2016 for adults. In Figure 2, when compared to other race, Non Hispanic Asian adults (12.7 percent),

for both men and women had the lowest obesity prevalence. On the other hand, a higher prevalence of obesity was evident in non Hispanic black (46.8 percent) and Hispanic (47.0 percent) adults when compared to non Hispanic white adults (37.9 percent). Moreover, there was not much difference in obesity prevalence between men and women who are non Hispanic. However, there was a higher obesity ocurrence in non-Hispanic Black and Hispanic women than men.

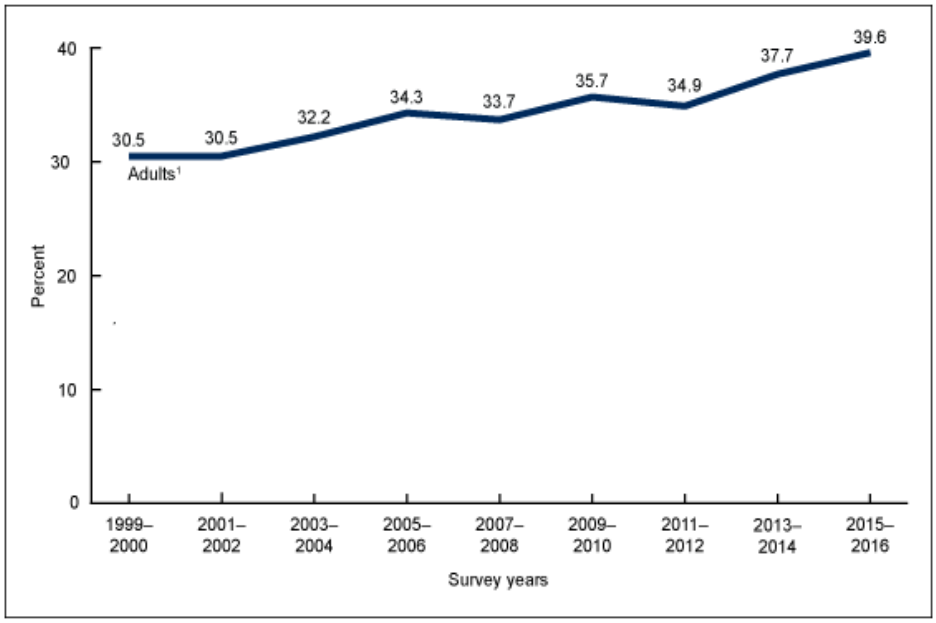


Figure 1 Trends in Adult Obesity in the US
Source: National Health and Nutrition Examination Survey

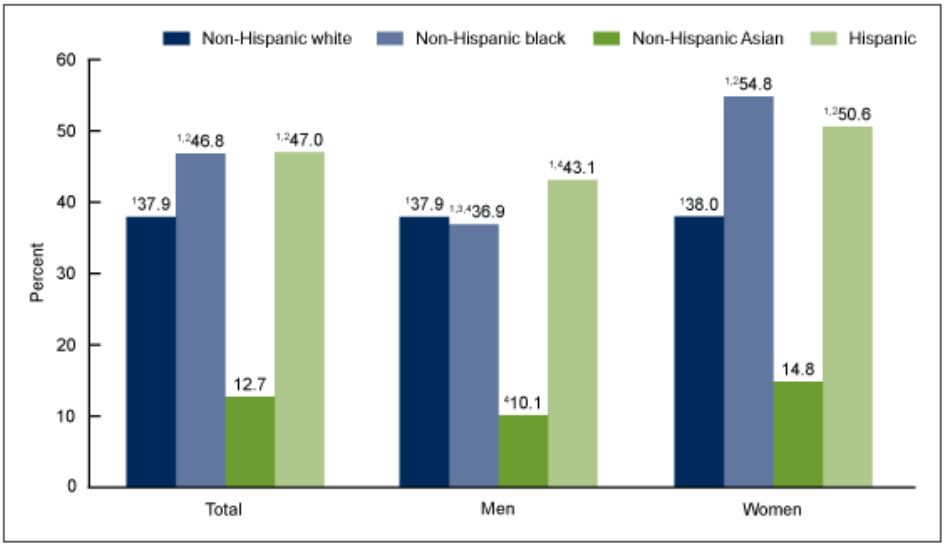


Figure 2 Age-adjusted prevalence of obesity among adults aged 20 and over, by sex and race and Hispanic origin: United States, 2015–2016
Source: National Health and Nutrition Examination Survey, 2015-2016

1.1.1 Health impact of obesity

On a consistent basis studies have shown the association of obesity to increased risk of mortality and morbidity [7]. One particular study revealed that the mortality impact caused by obesity is very significant as cigarette smoking [8]. Overall, obesity increase the likelihood of other health disorders such as type 2 diabetes, heart diseases, high blood pressure and stroke. Actually, the risk of comorbidities has to do with obesity severity and duration. Even though obese adults' mortality rate may not be much different from adults with normal rate, the risk is greater for non-communicable diseases resulting from obesity which ultimately adds to health burden and decrease life expectancy [9].

1.1.2 Obesity economic consequences

A number of studies have tried to assess obesity economic consequences. Nevertheless, estimating obesity total cost is very challenging and the cost approximations varies among studies, due to the data and methods used. Majority of studies speak about the medical cost (direct cost) attributable to obesity while others consider the productivity loss (indirect cost). Even though in the US, the total cost for productivity loss is difficult to estimate, it is presumed to be more than $66 billion per year [10]. Additionally, the direct medical cost is estimated to be approximately $147 billion annually [11]. Hence, the total cost attributable to obesity might be about $215 billion.

1.2 Defining the issue

1.2.1 Scope

Over the past several decades, there have been great changes with regards to the food environment, which have been widely connected to obesity [12]. Greater emphasis has been placed on environmental factors which may potentially play a role in the development of obesity. One particular environmental factor of interest is the presence of fast-food restaurant. An increase in fast-food consumption has been linked to poorer diet and obesity on the individual level [5]. As a result, significant attention has been given to neighborhood food environments in the latest local and state initiative for obesity prevention, with specific focus on areas lacking access to healthy food [13,14]. There have been restrictions by policy makers regarding the availability of fast-food or its content. Restrictions include displaying caloric content of all meals as well as zoning to limit fast-food outlets [15]. The evidence associating fast-food and obesity is limited. In addition, most cross-sectional studies differ in

terms of geographic coverage, methods, and statistical modeling which makes comparing studies a challenging one. Moreover, heterogeneity is apparent in the relationship between the exposures to the environment and health outcomes when it comes to gender, neighborhoods and ethnicity, which also pose difficulty in elucidation of the findings.

1.2.2 Severity

The access to high energy density food affects individual health all over the world [16] . The costs of healthy food, for example, fruits and vegetables is significantly higher than unhealthy foods (refined grains, sugar) prices which provide easy access to different kinds of processed food for individuals of various income levels [16]. However, low income individuals are mostly affected by the unhealthy food price structure [17]. Generally speaking, access to fast-food has become very easy, inexpensive and convenient.

1.2.3 Characteristics of people affected

Even though fast-food environment to some extent may affect all residents, vulnerable residents are mostly at risk [18-20] due to the observed variances in food establishments' access [21,22]. However, the inconsistencies in the findings suggest a nuanced relationship between neighborhood level food environment and obesity [20,23]. The variances in cost and availability for healthy food, in addition to other factors maybe a barrier to eating healthy for many individuals who are less wealthy. For instance, due to cost individuals of low income maybe more vulnerable, they may be used as marketing strategy for the locations of fast-food restaurants [24]. Thus, store options, perceived quality of food items, and the buying pattern of customers play a central role in food availability in poor neighborhoods [25]. In addition, differences exist in rural and urban areas in accessing healthy foods [26], even

though this area is somewhat understudied. These limited studies [27-29] suggest that deprived areas are very much underserved.

1.3 Background of the problem

Obesity is a word used to describe people who weigh above what is normally considered healthy in relation to a given height or in simple terms it can be referred to as having excess fat. For adults, age 20 and older, obesity definition is based on body mass index (BMI). BMI is a ratio that shows an individual height to weight and an adult with a BMI ≥30 is considered to be obese. At its simplest, obesity is gained through a positive balance between the input of energy of food and drink and the energy that is produced by the metabolic processes and physical activity, with body fat that is caused by excess calories [30]. The magnitude of obesity has led to various related diseases, for example, heart disease, stroke [31] and ultimately death [32]. As a result, obesity has accounted for approximately 12 percent of the overall U.S healthcare spending, over the past decade [33]. In 2020, obesity annual related healthcare spending in the US was estimated to be $343 billion, which is approximately 21 percent of the overall healthcare spending [33].

Given the magnitude of obesity in the United States, it is very crucial to decipher and understand the influential factors that increase the likelihood of adult obesity. A report done by the National Center for Environmental Health acknowledges that neighborhood factors can possibly play crucial roles in the health of individuals- including obesity. In other words, the neighborhoods in which people live play a great role in obesity risk and their overall health. Moreover, the risk of obesity is not randomly dispersed across different population groups. This means that particular groups are more likely than others of

becoming obese. What is the cause of this inequity? The reasons are yet to be known. The risk factors on the individual level do not fully explain this or the dramatic increase over the years in obesity prevalence [34]. One explanation that is often mentioned about the significant increase in obesity is sedentary lifestyle and diet; it is often stated that the cause of this shift in lifestyle has to do with neighborhood environment changes that are not in support of a healthy lifestyle.

Furthermore, one of the proposed explanations for obesity risk on the neighborhood level is the availability of healthy food [35]. There has been extensive evidence that living in neighborhoods with access to fast-food outlets may result in high fat diet which will further leads to higher obesity risk [20,36]. Although the importance of recognizing neighborhood-level characteristics in research is not new, the popularity of such research, in recent years is growing and the limitations of only focusing on determinants on the individual-level have been recognized. Specifically, recent research in industrialized countries has investigated the possible links between features of the neighborhood and obesity. Even though the attention from scholars on the neighborhood aspects is relatively new and the accumulation of evidence is ongoing, the importance of looking at neighborhood factors as obesity determinants is becoming highly apparent.

Despite the efforts of public health in trying to curb obesity through the usual exercise and diet interventions the rates of obesity remain high. In recent years, scholars and researchers have focused mostly on individual level risk factors such as physical activity, diet, education, income, [37] age, sex and ethnicity [38] that are associated with obesity. The interventions focused on these individual factors attempting to reduce obesity have proven limited success [39]. Moreover, the over-emphasis and focused that is placed on obesity

individual risk factors tends to cause influential factors in the environmental context to be ignored or overlooked [40]. Nonetheless, recognition has been increased regarding the influences of fast-food environment on BMI.

Studies have looked at the role restaurants play on diet because food consumed at these outlets is normally less healthy than food prepared at home [5]. To be specific, fast-food restaurants are related to higher fat consumption and sodas [41] and less fruits and vegetables consumption [42]. By utilizing different database and empirical strategies, prior researches have established positive association density of restaurant and adult obesity [5,43]. The zoning laws that have been proposed by policy makers in certain areas to limit access to fast-food, put mandatory labels displaying calories on restaurant menus were all proven to have limited effect [44].

Most studies have largely overlooked causality issues, as well as fail to account for factors which could cause bias regarding the influence of certain food establishments on diet (consumption of fruits and vegetables) and rates of obesity. Such bias could specifically be seen in fast-food restaurant cases, as they might be located in neighborhoods where people are more likely to part take in food choices and eating behaviors of an unhealthy nature. At the county level Dun 2008 [45] used the number of highway exits as measurements for density of fast-food restaurants. According to this study, a 10 percent growth in fast-food outlets surges BMI by 0.33 points. In another study by Anderson et al 2011 [46] in rural areas, interstate highways were used as instruments for density of restaurants. There were no causal association found between the consumption of food from fast-food/full-service restaurants and obesity, showing that people who eat regularly at restaurants may balance calories by consuming less in other instances. At the aggregate level, there are similar mixed

findings: even though there's a positive association between fast-food restaurants and obesity in adults at the state-level [47] there has been doubt on whether there is a causal relationship [48].

Despite the growing body of research, concerning the food environment and obesity rates among varied populations, the association of fast-food restaurant and obesity is not quite understood and is very much understudy. In addition, prior empirical findings evaluating the association of neighborhood fast-food and increased BMI have been inconsistent and as a result direction for guiding policy appears uncertain. Although there are numerous factors in a neighborhood that may contribute to gaining weight or increased BMI, it is with no doubt that food plays a great role. Hence, the fast-food environment aspect of the neighborhood which is very much understudy will be the focus of this study.

Food that is usually eaten outside or away from home, specifically fast-food, is related to gaining weight and the widespread of obesity [49,50]. According to a study, the more availability of fast-food restaurants will result in more fast-food consumption [51]. It is also known that people receive less energy intake from their food prepared at home and more from fast-food restaurants [52]. Considering the fact that fast-food is inexpensive compared to other healthier foods, it is quite normal for poor people to spend more on fast-food. Actually, the costs for fast-food, fruits and vegetable relationship vary with dietary quality among US population [53]. Therefore, fast-food restaurant locations in deprived neighborhoods may be a contributing factor to an obesogenic environment [54].

One major limitation in the literature regarding existing food environment on the neighborhood level has been the lack of adequate discussion on the association of fast-food outlets and SES with obesity. Thus, this study addresses this gap in our knowledge by

examining the importance of neighborhood-level fast-food establishments and the extent to which they influence "obesogenic" neighborhoods in NYC after controlling for socioeconomic levels of the geographic regions. An estimation regarding the impact of neighborhood-level features on obesity seems to be a challenge due to the fact that people living in the same neighborhood are most likely to be the same when compared with people living in other neighborhoods [55]. Thus, NYC which includes the five boroughs (Bronx, Brooklyn, Manhattan, Queens, and Staten Island) is an interesting locale to examine the associations among neighborhood fast-food environment and obesity and will be used as the study area.

1.3.1 Etiology of obesity

The origins of obesity are not fully understood. Regardless of the many years of research, the uncertainty regarding obesity etiology still remains one of the key barriers to designing treatment and prevention strategies that are effective. It can be developed by influences, both modifiable and non-modifiable. Obesity is a multifaceted health condition that results from the interaction between the environment and genetics [56] and is characterized by inactive lifestyle and over consumption of foods with high calorie. Obesity is known to be prone to genetics. However, genetics influences are not adequate enough to rationalize the rapid increase in obesity rates observed in varied neighborhoods and the US on a whole[57] and studies are ongoing to understand how other influences such as environmental could play a role.

1.3.2 Obesity and genetic influences

Even though the genetic factor is linked to the development of obesity, the mechanism is still uncertain. The influences of genetics are challenging to explain and to identify the genes is not easy in studies such as familial or pedigree. Moreover, whatever effect the genotype may have on obesity etiology, it is usually exacerbated by non-genetic elements. It has been known that gaining weight tends to run in the family. However, it is important to note that family does not only a share gene, but they also share habits pertaining to diet and lifestyle that may add to obesity. Separating genetics and lifestyle factors has been a challenge. Also, obesity seems to be dominant among certain families and ethnic groups.

1.3.3 Obesity and environmental influences

Since most times genetic influences account for about a third of variance in BMI, it simply means that influences of the environment account for the rest. Most environmental influences that include energy intake/output contribute to body weight. The influences of the environment on obesity are primarily associated with behaviors pertaining to food intake and physical activity. Evidence suggests that the key reason for increasing rate is the combination of not eating healthy and having less active lifestyle.

1.4 Study aims

The purpose of this study was to investigate the influence of the neighborhood-level fast-food restaurants to determine whether there's an association with adult obesity in NYC after controlling for socioeconomic status levels of the geographic region. This association

will be examined on the basis of local fast-food outlets in NYC neighborhoods, in which their influence of will be studied. Specific aims included:

Aim 1: Systematic review of scientific literature investigating the relationship between the neighborhood-level fast-food environment and obesity

Aim 2: A sample consisted of about 10,000 adults, aged 18 and above were randomly selected from NYC five boroughs (Manhattan, Brooklyn, Queens, Bronx, and Staten Island) characterize the relationship between the fast-food environment within the neighborhoods and BMI score trajectory.

Research Question: To what extent, if any, do the density of restaurants in a geographic region, and the SES level within that region, are associated with BMI?

$H0_1$: Density of restaurants in a geographic region, and SES level within that region, are not significantly associated with BMI.

$H1_1$: Density of restaurants in a geographic region, and SES level within that region, are significantly associated with BMI.

In order to test the relationship, cross-sectional data on adults was used. The New York City Community Health Survey (CHS) 2017 provides estimates on various health measures which in this case, BMI as well as borough variables were combined with SES level data based on geographic region from 2010 Census in addition to restaurants data from NYC Department of Health and Mental Hygiene (DOHMH) restaurant inspection online directory.

1.5 Significance of the study

Obesity in New York City has spiraled into an epidemic. The city is undergoing an obesity crisis. Over half of adult New Yorkers are obese. According to NYC.GOV obesity prevalence for adults in New York is presently 25.0 percent, a huge increase from 17.1 percent in 2000 and 9.3 percent in 1990 [58]. Overall, 57 percent of adults, which is equivalent to 3,437,000 people, in addition to 70 percent who live in areas of high-need in NYC are either overweight or obese [59,60]. NYC spatial distribution of obesity is shown in Figure 3. Evidently, obesity rates in Manhattan are fairly low but very high in the Bronx. Obesity has become a norm in the city. This obesity crisis strikes the hardest in neighborhoods that are already burdened with health disparities especially our low income neighborhoods where obesity/overweight reaches 70 percent rate [60].

This rise in obesity rate has contributed to increase healthcare cost, and associated conditions including type 2 diabetes, heart disease and some types of cancer [3], preventable deaths and has killed approximately 5,800 NYC residents on a yearly basis. It is estimated that the health care system of New York needs approximately $7.6 billion each year for treatment of illnesses related to obesity [60]. The cost to treat illnesses related to obesity is projected to be about $136.3 billion over a period of ten years from 2011 to 2019 [61].

This study is an investigation of whether neighborhood-level fast-food environment is associated with adult obesity in NYC using the 2017 Community Health Survey (CHS). The CHS is a cross-sectional telephone survey comprises of approximately 10,000 adults aged 18 and above who were randomly selected from the five (5) boroughs of NYC (Manhattan, Brooklyn, Queens, Bronx, and Staten Island) [62]. Identifying the relationships and impact of neighborhood fast-food environment on obesity will help shed some light on

the major influences within the community and possibly inform policies/programs for obesity prevention.

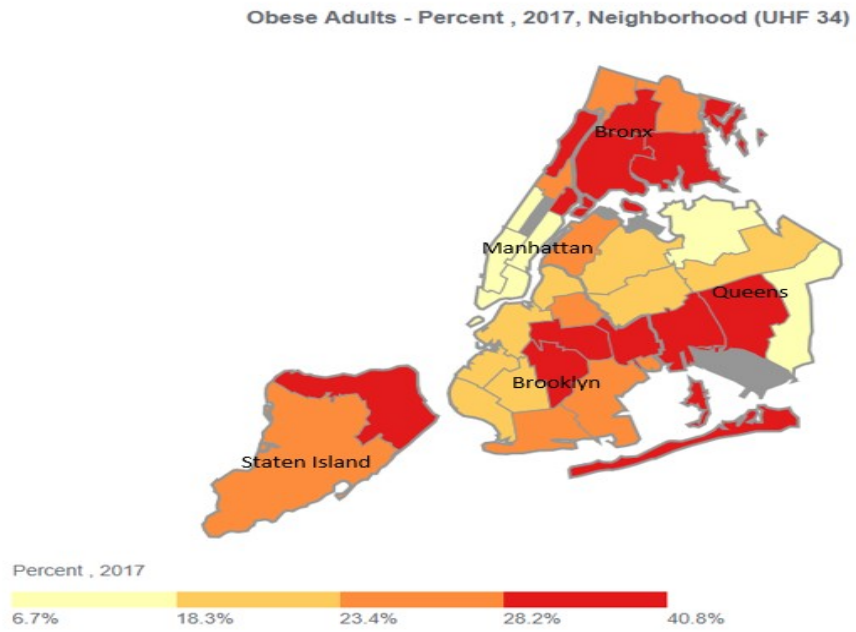


Figure 3 Map showing spatial distribution of obesity in NYC
Source: NYC Community Health Survey

1.6 What is known currently about the subject?

- Evidence of whether the density of fast-food restaurants is related to obesity is not conclusive
- The measures of fast-food restaurants vary widely across studies
- The current studies that examined the relationship regarding fast-food restaurant environment and obesity is very limited

1.7 What will this study add?

- The analysis will show new evidence of the relationship between the density of fast-food restaurant and obesity among adults
- The focus will be on measures that look on fast-food restaurant

1.8 Chapter summary

This chapter discusses the obesity trends including the spatiotemporal change relating to obesity in the US. It shows that over the past three (3) decades the rates of obesity have been rapidly increasing. Obesity has both health impact and economic consequences. It increases the likelihood of other health disorders such as type 2 diabetes, heart diseases, high blood pressure and stroke. Also, the total cost attributable to obesity might be about $215 billion annually. The neighborhoods in which people live play a great role in obesity risk and their overall health. Moreover, the risk of obesity is not randomly dispersed across different population groups. This means that particular groups are more likely than others of becoming obese. A higher prevalence of obesity was evident in non-Hispanic black and Hispanic adults when compared to non-Hispanic white adults.

It is often assumed in public debate that the extensive availability of fast-food restaurants is a significant determinant of the rapid increase of obesity rates. Studies have looked at the role restaurants play on diet because food consumed at these outlets is normally less healthy than food prepared at home. One particular study stated that the more availability of fast-food restaurants will result in more fast-food consumption. However, evidence of whether the density of fast-food restaurants is related to obesity is not conclusive. The analysis of this study will show new evidence of the relationship between

the density of fast-food restaurant and obesity among adults. Following in the next Chapter, is an overview of the study area, New York City.

CHAPTER II

STUDY AREA

2.1 New York City

New York City (NYC) is known to be the most compact populated region in the USA. It is populated by approximately 8.4 billion ethnically diverse residents of which 35 percent White, 27 percent Hispanic, 24 percent Black and 36 percent Foreign-born; 21 percent of NYC's population is living in poverty and 1.8 million on Supplemental Nutrition Assistance Program (SNAP) [59]. NYC has five boroughs, Bronx, Queens, Manhattan, Brooklyn and Staten Island. It has great influence on areas such as commerce, fashion, technology and education. Perhaps it is the world's central financial center. NYC has quite a number of schools/colleges for example, Columbia University, Rockefeller University, in addition to various parks (e.g. Central Park, Forest Park Prospect Park)

Obesity is an epidemic in NYC: over half of adult living in New York are overweight (34 percent) or obese (22 percent) [58]. In 2011, the prevalence of obesity in NYC was 2-fold higher among Hispanic Black and adult Hispanics when compared with non-Hispanic Whites [63]. Within the city the features and characteristics vary, and it is important to look at these factors to get a deeper understanding of how they might contribute to obesity. According to the NYC Community Health Survey 2017 which was conducted by NYC Department of Health and Mental Hygiene (DOHMH), one out of every four persons living

in NYC is obese, and more than half of NYC population is either overweight or obese, Figure 4.

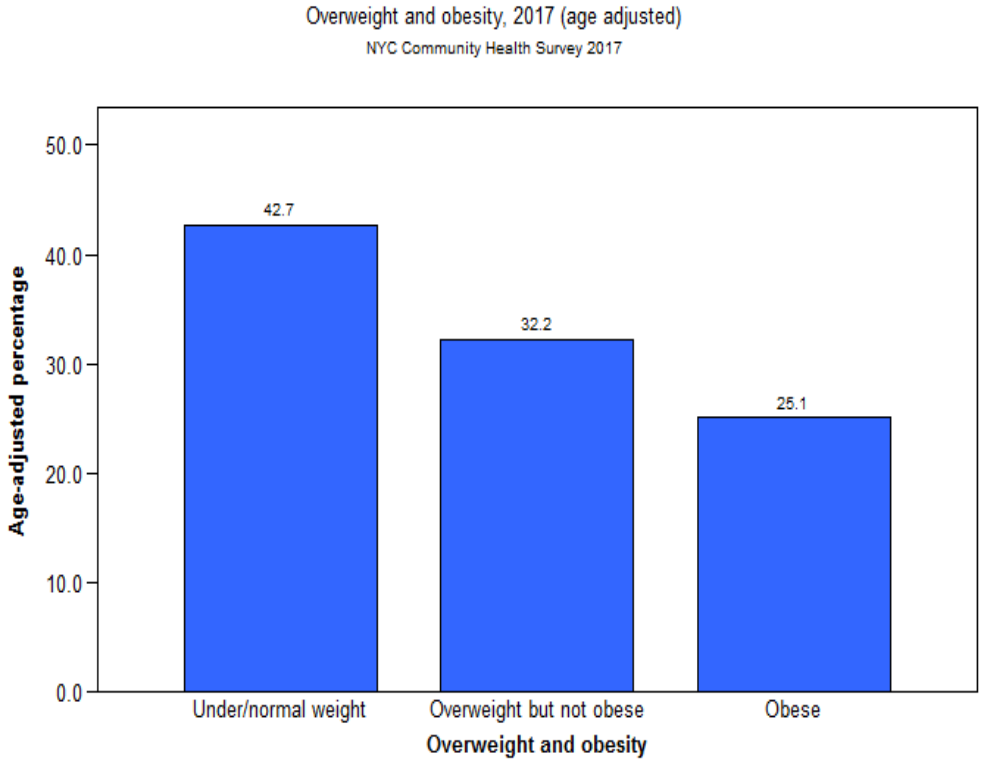


Figure 4 Percentage of obese/overweight adults by neighborhood of NYC
Source: NYC Community Health Survey, 2017

NYC DOHMH started doing community health survey since 2002. Since that time, NYC obesity rates have steadily increased, as shown in Figure 5. The obesity rate in 2002 was 18.2 percent, but the current rate in 2017 is 25.1 percent.

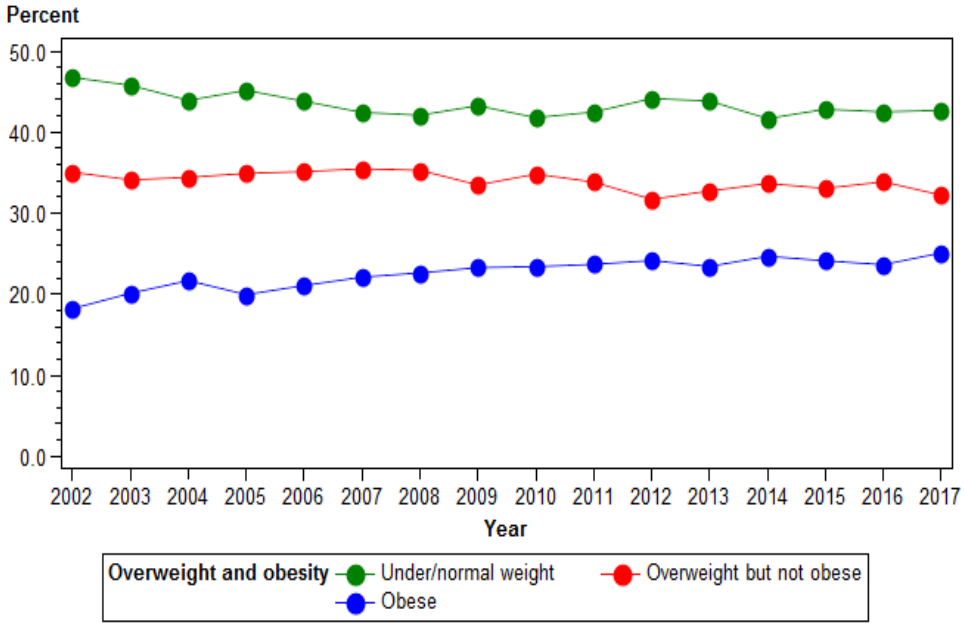


Figure 5 Overweight and obesity trend in NYC by year
Source: NYC Community Healthy Survey, 2017

2.1.1 Bronx

In Figure 6, obesity prevalence in the Bronx is highest when compared to all the other boroughs, with approximately 34.4 percent of adults obese versus nearly 25.1 percent in NYC. The rates of obesity vary across the borough with Fordham-Bronx Park (36.5 percent) to the South Bronx (39.1 percent) having the highest rates. Also, Pelham-Throgs Neck (32 percent) has very high rates.[1] The obesity trend over a certain period of time shows Bronx in the lead for the highest rate of obesity when compared to the other boroughs and NYC, Figure 7. It was reported that 6 percent of adults in the Bronx eat on a daily basis fruits or vegetable compared to nearly 9 percent in NYC [64]. Around 70 percent of adults reported, in the last 30 days, taking part in leisure time physical activity compared to a

[1] Rates are according to UHF neighborhood; rates by zip code are not available. Thus, variation could exist in these UHF neighborhoods which are not covered here.

72 percent rate in NYC [65]. According to a focus group report conducted in the Bronx, participants attributed obesity to various factors, such as limited access and costly healthy food [65]. In general, the challenge to change dietary behavior and weight loss was described, regardless of the health consequences. Also acknowledge was the preferences for fried food as well as food with high calories.

2.1.2 Brooklyn

Brooklyn has a population of approximately 2.5 million, which is about one-third of the overall population of NYC and about 13 percent of NYS population [66]. In 2017, the NYC Department of Health and Mental Hygiene estimated a total of 514,000 obese adults in Brooklyn, Table 1. Approximately one out of four adults living in Brooklyn is likely to be obese and at risks for comorbidies such as diabetes and cardiac events [66]. As for diabetes rates, at-risk neighborhoods have higher numbers. In Figure 6, obesity prevalence for adults in Brooklyn (26.4 percent) is higher when compared to NYC (25.1 percent). Within Brooklyn the prevalence of obesity varies widely with Bedford Stuyvesant-Crown Heights (36.1 percent) having the highest rate. There are also high rates of obesity in East New York (31.7 percent), East Flatbush – Flatbush (33.9 percent), Coney Island- Sheepshead Bay (26.4 percent), Williamsburg-Bushwick (27.5 percent). Bensonhurst-Bay Ridge (19.5 percent) has the lowest obesity rates in the borough.

According to a Flatbush focus group report [67], the members of the community and key participants recognized obesity high rates in the borough and a major health concern: "*Obesity. Obesity. Obesity. That is the number one." [focus group in Flatbush]* They said obesity is as a result of dietary behavior, which were attributed to the availability of food, in addition to

lack of money, time, knowledge etc. Across lower income communities, participants described the lack of access to fruits and vegetables. Even though farmer's market were present in these neighborhoods, they were open to the public once per week or regular business hours which makes it difficult for the working class to access. Another concern was price especially in neighborhoods that were experiencing gentrification as well as for informants who believed that organic produce was the better and healthier choice. On the other hand, there were a lot of fast-food and bodegas according to multiple participants.

Participants of the focus group seemed to know the difference between the healthy and the unhealthy foods and the importance of having access to fresh fruits and vegetables was consistently emphasized. There were concerns, in general, regarding the cost of fresh food in comparison with other foods. Additionally, parents who worked had little time and energy to do shopping and cook, so they offered their family fast-food, as it is consider being very inexpensive and easy to prepare alternative. For individuals who are at a disadvantaged and living in poverty – especially if they have dietary restrictions that are health related – access to food was considered to be very problematic.

2.1.3 Queens

When compared to NYC, the obesity rate in Queens is slightly lower. Of all the adults living in Queens, 23.9 percent reported a BMI $\geq$ 30 versus NYC (25.1 percent), Figure 6. Within Queens, the prevalence of obesity varies widely with Rockaways (33.7 percent) having the highest rate, followed by Jamaica (33.5 percent) and Southwest Queens (30.6 percent). The populations within these areas have high prevalence of Medicaid. According to NYAM community survey, in Jamaica obesity was considered very problematic

especially among the African-American and Caribbean populations [68]. Also, in most neighborhoods, having access to healthy food was not described to be an issue. However, in Jamaica limitations were described.

2.1.4 Manhattan

Manhattan is populated by approximately 1.6 million people. It has the lowest rate of obesity (17.3 percent) when compared to the other boroughs, Figure 6. Within Manhattan the prevalence of obesity varies widely with Washington Heights (29 percent) having the highest rate, followed by East Harlem (28.6 percent) and Central Harlem-Morningside Heights (24.8 percent), Table 1.

2.1.5 Staten Island

Staten Island has a population of 474, 893 people. It has the third highest obesity rate (26 percent) when compared to the other boroughs, Figure 6. Almost two-thirds of adults living in Staten Island are overweight or obese. It is one of the city's greenest boroughs. However, there are more people with cars than walkers and bicyclists as shown in the Department of Health and mental Hygiene report, based on the data of 2012.

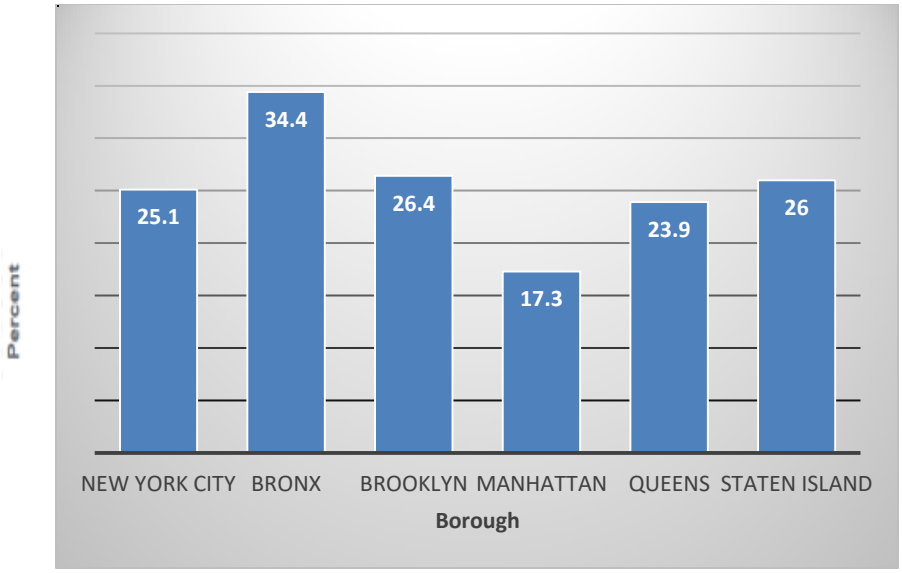


Figure 6 Adult Obesity by Borough (Age-Adjusted)
Source: NYC Community Health Survey, 2017

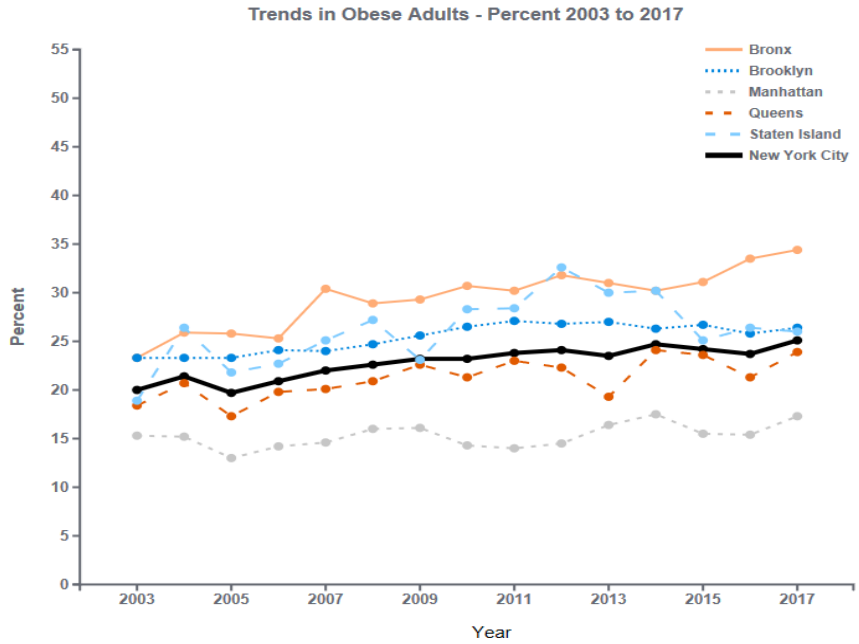


Figure 7 Trends in Obese Adults in NYC
Source: NYC Community Health Survey, 2017

Table 1 Obese Adults Citywide, by Borough, and by Neighborhood (2017)

Year	Geo Type Name	Borough	Geography	Number	Percent
2017	Citywide	New York City	New York City	1,617,000	25.1
2017	Borough	Bronx	Bronx	357,000	34.4
2017	Borough	Brooklyn	Brooklyn	514,000	26.4
2017	Borough	Manhattan	Manhattan	226,000	17.3
2017	Borough	Queens	Queens	426,000	23.9
2017	Borough	Staten Island	Staten Island	94,000	26
2017	Neighborhood (UHF 34)	Queens	Bayside Little Neck-Fresh Meadows	34,000	22.7
2017	Neighborhood (UHF 34)	Brooklyn	Bedford Stuyvesant - Crown Heights	88,000	36.1
2017	Neighborhood (UHF 34)	Brooklyn	Bensonhurst - Bay Ridge	32,000	19.5
2017	Neighborhood (UHF 34)	Brooklyn	Borough Park	47,000	19.7
2017	Neighborhood (UHF 34)	Brooklyn	Canarsie - Flatlands	36,000	23.5
2017	Neighborhood (UHF 34)	Manhattan	Central Harlem - Morningside Heights	30,000	24.8
2017	Neighborhood (UHF 34)	Manhattan	Chelsea-Village	18,000	9
2017	Neighborhood (UHF 34)	Brooklyn	Coney Island - Sheepshead Bay	62,000	26.4
2017	Neighborhood (UHF 34)	Brooklyn	Downtown - Heights - Slope	39,000	21.8
2017	Neighborhood (UHF 34)	Brooklyn	East Flatbush - Flatbush	79,000	33.9
2017	Neighborhood (UHF 34)	Manhattan	East Harlem	23,000	28.6*
2017	Neighborhood (UHF 34)	Brooklyn	East New York	42,000	31.7
2017	Neighborhood (UHF 34)	Queens	Flushing - Clearview	38,000	17.9
2017	Neighborhood (UHF 34)	Bronx	Fordham - Bronx Pk	69,000	36.5
2017	Neighborhood (UHF 34)	Brooklyn	Greenpoint	22,000	21.1
2017	Neighborhood (UHF 34)	Queens	Jamaica	75,000	33.5
2017	Neighborhood (UHF 34)	Bronx	Kingsbridge - Riverdale	17,000	23.7*
2017	Neighborhood (UHF 34)	Queens	Long Island City - Astoria	41,000	24
2017	Neighborhood (UHF 34)	Bronx	Northeast Bronx	41,000	27.9
2017	Neighborhood (UHF 34)	Staten Island	Northern SI	43,000	30.2
2017	Neighborhood (UHF 34)	Bronx	Pelham - Throgs Neck	74,000	32
2017	Neighborhood (UHF 34)	Queens	Ridgewood - Forest Hills	46,000	22.7
2017	Neighborhood (UHF 34)	Queens	Rockaways	27,000	33.7
2017	Neighborhood (UHF 34)	Bronx	South Bronx	153,000	39.1
2017	Neighborhood (UHF 34)	Queens	Southeast Queens	26,000	17.1
2017	Neighborhood (UHF 34)	Staten Island	Southern SI	51,000	23.4
2017	Neighborhood (UHF 34)	Queens	Southwest Queens	64,000	30.6
2017	Neighborhood (UHF 34)	Brooklyn	Sunset Park	22,000	22.5
2017	Neighborhood (UHF 34)	Manhattan	Union Square-Lower Manhattan	32,000	15.2
2017	Neighborhood (UHF 34)	Manhattan	Upper East Side-Gramercy	40,000	12.9

2017	Neighborhood (UHF 34)	Manhattan	Upper West Side	25,000	13.4
2017	Neighborhood (UHF 34)	Manhattan	Washington Heights	57,000	29
2017	Neighborhood (UHF 34)	Queens	West Queens	74,000	19.7
2017	Neighborhood (UHF 34)	Brooklyn	Williamsburg - Bushwick	44,000	27.5

**Interpret with caution, the numbers for this estimate is small*

How Calculated: Estimated number of adults classified as obese; based on the Body Mass Index (BMI) calculated from self-reported weight and height, rounded to the nearest 1,000. A BMI of 30 or more is categorized as obese.

Source(s): New York City Community Health Survey (CHS) 2017

2.2 Chapter summary

Obesity is an epidemic in NYC: over half of adult living in New York is overweight or obese. NYC has five boroughs, Bronx, Queens, Manhattan, Brooklyn and Staten Island. Within the city the features and characteristics vary. One out of every four persons living in NYC is obese. The Bronx has the highest rate of obesity followed by Brooklyn, Staten Island, Queens and Manhattan. NYC DOHMH started doing community health survey since 2002. Since that time, NYC obesity rates have steadily increased. In Chapter III, a thorough review of the literature related to the fast-food environment and obesity was conducted.

CHAPTER III

REVIEW OF THE LITERATURE

3.1 Neighborhood Influences

It is often said, where you live affects how you live. The features of a neighborhood can contribute to an individual overall health and lifestyle. Research on how exactly neighborhood influences obesity is growing with limited data from prior study [69].

Generally speaking, residing in poor neighborhoods has been linked to poorer health outcomes. Particularly, several studies have shown that people living in poor urban neighborhoods have increased odds of obesity [70,71] but little consensus have been made with regards to how and which types of neighborhood characteristics influence BMI. Research has shown that low-income neighborhood experience higher obesity rates particularly for women and certain ethnicity [72]. African Americans are known to have the highest rate of obesity in the US when compared to the other ethnicities; and they are likely to live in segregated neighborhoods. Approximately 48.4 percent of US non-Hispanic black adults are obese, which is almost half of the population. [2]

Also, studies have shown that Black neighborhoods have greater access to unhealthy food. It is shown that accessibility to fast-food restaurants is an issue for African Americans [73-76]. The consumption of fast-food has been established to be a great contributor to weight

[2] National Health and Nutrition Examination Survey (NHANES) 2013-2014

gain among African American women [77] and between the years 2000-2001 more Blacks visit fast-food restaurants than Whites [50]. These levels of fast-food consumption come from more accessibility to fast-food in neighborhoods. With that being said, socioeconomically disadvantaged neighborhoods are more likely to be obesogenic, have less stores with healthful foods but more restaurant that sell fast-food [20,21].

3.1.1 Literature search

The online database PubMed was searched for various combinations of medical subject headings such as "obesity" or "BMI" and "fast-food environment" "neighborhood" "food environment" "restaurant". The search was limited to English Language articles with publication dates between the years 2007 to 2017. Studies were excluded if they did not measure the outcome obesity or BMI and the exposure neighborhood food environment specifically restaurant/fast-food restaurant. A total of nine (9) relevant articles were identified. A summary table indicating the exposure and outcome variables and relevant results are shown in Table 2.

Table 2. Studies examining the relations between fast-food restaurants (FFRs) and obesity/BMI

Author	Outcome	Dependent Variable	Independent Variable	Population
Reitzel et al. 2014	FFR density was not associated with BMI in the main analyses. However, FFR density at 0.5, 1, and 2 miles was positively associated with BMI among participants with lower incomes	BMI	Density & Proximity of fast-food restaurants	Adults
Mehta and Chang 2008	Fast-food restaurant density was associated with higher BMI and a higher density of full-service restaurants was associated with lower weight status.	BMI	Fast-food density	Adults
Zick et al. 2009	People living in non-low-income areas, with one or more convenience stores, full-service restaurants, or fast-food restaurants is related to lower BMI/obesity risk, compared to areas with no food outlets	Obesity	Fast-food restaurant, full-service restaurant, convenience stores	Adults
Dunn et al. 2012	Greater availability of fast-food is positively associated with both the number of meals consumed for non-white rural residents and their obesity.	Obesity	Fast-food availability	Adults
Hollands et al. 2014	Fast-food density had a positive association whereas full-service and non-chain restaurant density had a negative association with BMI	BMI	Fast-food & full-service restaurant density	Adults
Li et al. 2009	Increased density of neighborhood fast-food outlets was associated with unhealthy lifestyles, poorer psychosocial profiles, and increased risk of obesity among older adults.	Obesity	Density of neighborhood fast-food outlets	Adults
Stark et al. 2013	There is an inverse relationship between BMI and density of food outlets; a positive relationship exists between BMI and the amount of unhealthy food stores and the greater proportion of unhealthy food outlets were dominant in lower poverty zip code than those in higher poverty zip code	BMI	Neighborhood food environment	Adults
Mazidi et al. 2017	Obesity prevalence was highly significantly negatively related to the densities of both FFRs and FSRs	Obesity	Density of fast-food restaurants and full-service restaurants	Adults
Lopez 2007	A negative relationship exists between the availability of fast-food restaurants and risk of obesity	Obesity	Neighborhood risk factors	Adults

3.2 Fast-food restaurants (FFRs)

Studies[78,79] have indicated that dietary patterns and the rates of obesity is different between neighborhoods; with residing in low-income or deprived neighborhood independently related to obesity rate and poor quality food consumption. As a result, being exposed to an environment of poor food quality increases the risks factors for obesity. This may be due to what is known as "deprivation amplification" [23]. The influences in the neighborhood regarding food availability are powerful in governing eating habits and health [80]. In neighborhoods that are poor, there are more fast-foods restaurants or easy access to foods that are not healthful when compared to fluent neighborhoods. The problem of buying healthy food is not solely due limited to income, but mostly, people residing in neighborhoods with low income do not have much access to healthy foods due to the fact that it may be inconvenient to reach the location to access these food items.

In studies focusing on increased obesity rate, fast-food is a growing concern. Fast-food is linked to having higher intakes of fat, sodium, sugar and less fruits and vegetable [81]. The consumption of fast-food, on a regular basis, is connected to increased obesity rates [82] because fast-foods are cheap and easily available. In addition, they contain high-calorie and less alimentary value [83]. Fast-foods are overly marketed in ethnic minority neighborhoods [84] which make people in these neighborhoods prone to increased BMI.

In the US, buying food from fast-food restaurants or eating out has increasingly become a part of people's diet [52]. This is an issue given that the quality of home prepared foods is higher than the food consumed at restaurants [85]. Fast-food restaurants are popular food sources away from home. However, the energy density of the foods that are available constitutes a great risk factor for obesity [86]. In addition, possible mechanisms include large

portion size [87], excessive starch and sugar [88] have associate eating of fast-food to obesity risk. Studies in the US have shown positive relationship between eating fast-food and poorer dietary practices, which include higher energy intake and fat energy but little evidence for reduced fruits and vegetable consumption and obesity [89-91]. Thus, it is hypothesized that through this mediating pathway, increased fast-food availability at the neighborhood level is related to the risk of obesity. It has also been well recognized that excess caloric intake is a contributing factor to weight gain [86,92].

The consumption of certain nutrients is much lower in people who consume more restaurant food [93] and they tend to have a heavier body type compare to those who do not, after controlling for certain variables, including income [50,90,94]. Also, the portion sizes for food consumed out-of-home are usually bigger than meals prepared at home [95]. According to a study 80 fast-food restaurants and outlets are more dominant in low income and ethnic minority neighborhoods, making a knowingly impact on obesity prevalence among these groups [20]. Thus, this might be of help in explaining the higher obesity rates in these areas. Similarly, impoverished neighborhoods in the Los Angeles area are populated with higher proportions of African American with less accessibility to healthy options in restaurants and other outlets, plus promotional activities and advertising prompts residents in consuming alternatives that are unhealthy [75] .

Fundamentally speaking, food-service outlets (food consumed away from home) can offer full or limited services. Full-service restaurants are normally categorized based on wait service, alcohol licenses and much longer food wait time. The current literature places more emphasis on limited service restaurants which are categorized as fast-food [96]. Full-service restaurants will be included in this study in order to capture food consumed outside of

home. However, the main focus is fast-food availability. It is not clear what constitute the definition of fast-food-it is necessary for methodological work to define types of fast-food store and establish strategies for appropriate categorization. The direction of the association may appear to be uncontroversial. It is not very clear whether fast-food restaurants location affects how the interpretation is drawn pertaining to fast-food–obesity association. In a fast-food access systematic review study, about half of the studies had their own definitions in classifying fast-food restaurants [97]. Some of the features would normally include over the counter service only, short wait time for food order based and food types. Another common way to identify restaurants with limited service is through using Standard Industrial Classification (SIC). Also, other studies relied on putting popular food chains restaurants in groups, for example, McDonald's, Burger King, Subway and Wendy's [97].

Evidently the consumption of fast-food in America is a reality for many; with disadvantaged groups, it may be a functional strategy because they benefit from foods that are highly palatable, widely available and cheap regardless of the energy density. However, the strategies of public health are now shifting, and they are recommending individuals to buy fast-foods that are more healthful. Today, the options of healthful fast-food are becoming more and more available in restaurants. The negative health impact associated with the consumption of fast-food has received a lot of public attention. Actually, the increase in the rates of obesity has parallel a huge increase in the fast-food business. For instance, in the US between 1970 and 2004, the number of fast-food restaurants has increased by approximately 750% [49]. At the same time, the expenses for food consumed outside of home have almost doubled. According to an estimate, the average American eats

at least three (3) burgers and four (4) large French fries weekly [98]. On average, 42% of Americans food budget is spent on food consumed outside of home.

Table 2 summarizes the results of studies that examined the connection regarding the neighborhood fast-food environment and obesity. So far, no consensus has been reached regarding how to measure neighborhood fast-food environment, so as a result geographic scales measures vary across studies. For instance, Maddock 2004 [47] used data from the Behavioral Risk Factor Surveillance System (BRFSS) and looked at the aggregated means at the state-level per square miles for fast-food restaurants and the number of people per fast-food outlets and used them for food environment measures. A correlation was revealed between the measures with obesity rate at the state-level. Another study by Mehta et al 2008 [99] used five-year data from BRFSS. On the county level, the numbers of fast-food restaurants for every 10,000 people were calculated. The result showed a significant fast-food density was associated with higher BMI and higher density of full-service restaurant was associated with lower BMI.

Lopez 2007 [100] also did a study using BRFSS sample by incorporating in the analysis zip code level variables and found that a negative relationship exist between the availability of fast-food restaurants and risk of obesity. In another study by Zick et al 2009 [101], census block groups were used. The authors combined city walkability measures and found that people living in high income neighborhoods, with at least one or more grocery stores, restaurants (full-service/fast-food) has a negative association with obesity risk; and having at least one healthful grocery selection for low income areas also linked to obesity risk reduction. Similarly, Mazidi et al[102] result indicates that the prevalence of obesity was

significantly negative associated with fast-food restaurants (FFRs) and full-service restaurants (FSRs) at the county level across the mainland in US.

Obviously, the reviewed studies used different methods. The contradictory findings related to the relationship between access to food outlets and obesity may arise from differences in the methodological approach between studies, especially when it comes to measures of the food environment. Limiting analyses to one type of food establishment prevents the assessment of food environment on a broader scale and all the choices that are available to people. A person's decision to go to a fast-food restaurant maybe initiated by not only their personal choice but by food store accessibility (density) and food options (diversity) in the neighborhood. This is considered a limitation in most of the studies reviewed. For instance, Rundle et al [103] classify food outlets in three categories, healthy, unhealthy, and intermediate in relation to BMI and found an inverse relationship between BMI and the availability of healthy outlets. They did not look into the possible diversity of healthy or not so healthy food outlets that people encounter when deciding to buy food in their neighborhood. Also, other studies[104,105] used similar classification (healthy and unhealthy) food stores to predict purchases for fruits, vegetables and fast-food and found evidence suggesting that the more availability of healthy food options influences the purchasing of healthy and unhealthy food in a neighborhood.

Given that consumers' choice influences their behavior, it is very important to study the options as they relate to diversity and density which will further inform research on the food environment and its influence on obesity [106]. For instance, diversity as it relates to environmental measures – refers to the kinds of food outlets or restaurants and density within a particular area. For example, a definition of a specific area can be within a spatial

area, buffer area or population. For the purpose of this research the focus will be on density, which is, the simple counts per area.

3.2.1 Fast-food availability

Prior studies have found a strong positive relationship between fast-food availability and the intake of fast-food [107,108] and between the intake of fast-food and risk of obesity [94,109]. However, studies related to fast-food availability and obesity has produced different results. While some investigators [5,99,110,111] have shown strong positive association others have identified the relationship to be statistically insignificant [91,112] but these studies had some limitations. For instance, they seemed to have used samples that are mostly non-Hispanic white. In the study of Anderson et al [113], 93 percent of individuals for the zip codes considered are white. As stated previously, obesity is high among minority groups living in poor areas.

3.3 Spatial clustering of obesity in the US

Numerous studies in the US conveyed spatial clustering regarding obesity rates. The Michimi et al. [114] study investigated spatial obesity pattern by using data from Behavioral Risk Factor Surveillance System. In the US, the study showed higher obesity prevalence in areas of the south and lower occurrence in the west and northeast regions. Also, spatial analyses regarding different risk factors suggested that factors in the environment for example, land use, density of the population could be the driving force behind special patterns observed for obesity. One study, by Mobley et al. [115] used data from the 45 states on 30, 000 women. At the county level median BMI was used and substantial evidence of spatial auto-association was found. For instance, clustering was found to be both negative

and positive at the local level. It was evident that high clusters of obesity were connected to disadvantaged neighborhoods. In addition, at the county level, Schlundt et al. [116] showed evidence of clustering using Pearson's correlation coefficient for their analysis.

3.4 Chapter summary

Being exposed to an environment of poor food quality increases the risks factors for obesity. Numerous studies have examined the connection regarding the neighborhood fast-food environment and obesity. So far, no consensus has been reached regarding how to measure neighborhood fast-food environment, so as a result geographic scales measures vary across studies. Obviously, the reviewed studies used different methods, which make the findings not consistent across studies. The contradictory findings related to the relationship between access to food outlets and obesity may arise from differences in the methodological approach between studies, especially when it comes to measures of the food environment. Prior studies have found a strong positive relationship between fast-food availability and the intake of fast-food and between the intake of fast-food and risk of obesity, while some investigators have shown negative association between densities of fast-food and BMI. Chapter IV discusses how the factors within the theoretical framework can influence individuals' behavior. In addition, the overall methods of the study are also outlined.

CHAPTER IV

METHODS

4.1 Theoretical and conceptual framework, data sources and measures

In the prior chapter, empirical evidence was used to show the effects of fast-food environment on obesity. This chapter will discuss the theoretical and conceptual framework which includes behavioral theory and food choice model. In addition, the data sources of the variables used as well as the measures will be outlined.

4.1.1 Conceptual framework

From the sociological perspective, obesity covers factors at numerous levels that can influence individuals' behavior leading to energy imbalance and health problems related weight [117]. This study is informed by contributions to the literature [118,119]. The conceptual model for this dissertation is shown in Figure 8. This model was adapted from Black et al[35] which look on important factors to behavioral antecedents of obesity. The model shows how factors such as social and political policies, access and quality of food, culture and genetics can contribute to an individual dietary intake and physically active behavior resulting in weight or weight related morbidity.

4.1.2 Social- ecological model

This research study is guided on the empirical evidence and theoretical contributions from scientific literature [118,119] as well as a conceptual framework that focused on obesity determinants based on three (3) inter-connected levels [35]. The model in Figure 8 recognizes numerous realms of influences on individuals' behavior – from the predisposition of genetics to cultural norms. For instance, at the meso level health behaviors are shape directly or indirectly by the living conditions or factors within an area such as food quality and availability, food stores, exercise facilities; environment physical features, example, walkability and land use for commercial purpose; reputation of the neighborhood, e.g. crime; the artistic taste of the neighborhood and local community social organizations which lead to various levels of social support and trust [118]. The macro level has to do with the distribution of social and economic resources at the group level, (for example, community income and demographics) and the law and legislative impact that form the characteristics of the neighborhood overtime. Quality of life and amenities availability are affected by these factors. The micro level otherwise known as the individual level include obesity determinants such as cultural aspects, genetic factors, income, age, gender etc. In the end, obesity can be the result of a combination of being predisposed to physical features of the environment as well as individual behaviors that impact dietary intake and physical activity.

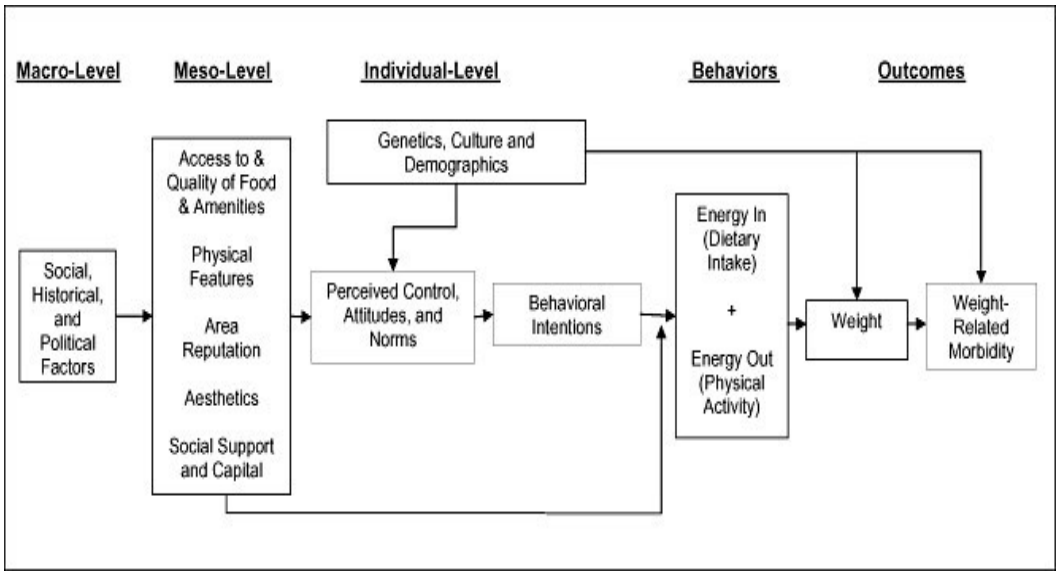


Figure 8 Proposed framework for understanding how neighborhoods influence body weight and obesity
Adapted from Black et al. (2008)

4.1.3 Food choice model

It is evident that there's a large difference in dietary patterns for individuals in the US. Over the years researchers and food marketers focused their effort in understanding food choices determinants [120]. It's no one choice to be obese, so it is practical to think of obesity as a by-product of person preferences. The framework in Figure 9 can be used to study these preferences. This food choice models framework is built on social-psychological theories of behavior pertaining to decision making [120]. Value expectancy enables methodical evaluation of preferences an individual may think of when pursuing a course of action. This facilitates the understanding of how individuals assess the components of the decision-making process, regarding particular behavior and preferences. Another theory which is a

division of the value expectancy theory is the Multi-attribute utility (MAU) theory which is specifically important in studying food choice determinants.

MAU suggests that various factors are taken into consideration for a particular behavior; each has their own importance [120]. The model developed by Glanz et al [120] was created on the basis of the MAU theory; describe contributing factors to food choice. Some of these components in the framework help to comprehend fast-food consumption in the perspective of this dissertation. The model that is graphically displayed in Figure 9 shows how various factors may influence food choice.

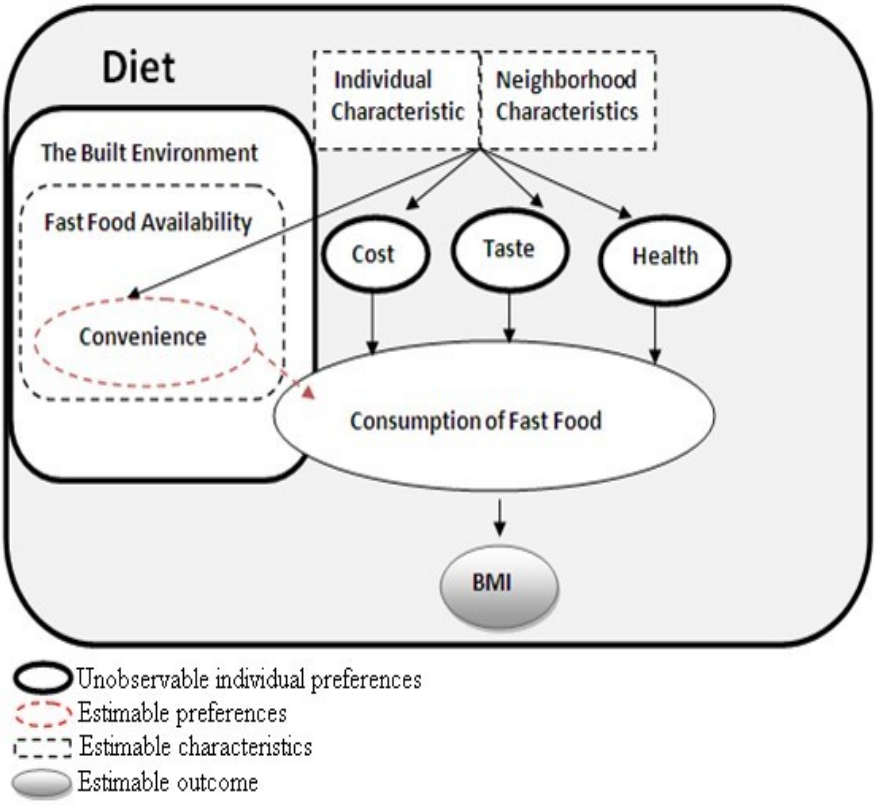


Figure 9 Food Choice Model on the individual level
Adapted from Holland S. (2012)

4.1.3.1 Fast-food consumption and obesity

The food choice model suggests that what a person chooses to eat will eventually boil down to personal choice regarding various factors. Moreover, convenience is a key feature on consumer food choices. This inspires the model in which differences in density of local fast- food was assessed with regards to disparity in BMI. There are two vital ways that link the availability of fast-food to BMI variances. One is the unobservable pathway as suggested by the study design, which is the association between the intake of fast-food and weight gain as shown in Figure 10. The other pathway which is of interest is the connection between the availability of fast-food and the intake of fast-food, Figure 11.

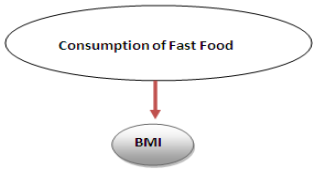


Figure 10 Pathway A

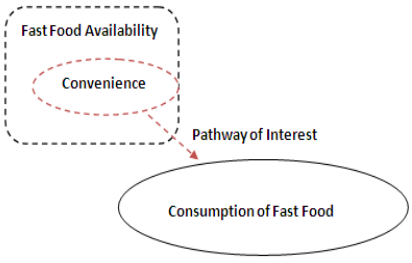


Figure 11 Pathway B

At the population level, fast-food is actually a great influence of increased energy intake. In the food environment industry, there have been efforts to diversify items on the

menu and market healthier options. Nonetheless, these healthier options in the marketplace have been below par [98]. Hence, in the US, hamburgers and fries currently have the highest sale volume [121] and are sold the most in fast-food restaurants leading in sales have the highest sales volume in the US. According to research, the frequency of dining at a fast-food restaurant was linked to more energy intake, more hamburgers, fries and soda consumption and less consumption of fruits and vegetables [121]. Therefore, it can be argued that the contextual effect relating to fast-food availability drives consumption. The framework above stipulates this underlying motivation that may influence the relationship between fast-food establishments' availability and food intake.

4.1.3.2 Convenience

It is well known by the fast-food industry that sales are significantly reliant on convenience. The industry is always seeking ways for market penetration and taking advantage of the convenience strategy. Recent highlight has been on "satellite" outlets, which is basically smaller, small volume, short menu restaurants which operate at a lower cost [122]; they are normally located in convenience stores and gas stations. The connection between convenience and food consumption which is the main pathway of interest in the model, has been previously studied. Numerous surveys indicated that individuals mentioned convenience as the main reason for fast-food consumption. According to a Michigan survey of 4,311 individuals, convenience was shown to be the major reason for buying fast-food [123]. In another survey, 17 percent of individuals who reported convenience as their preference were likely to buy fast-food [124]. According to Moore [107], for each standard deviation increase in fast-food restaurant density close to home, the likelihood of eating fast-food increased

from 11 percent to 61 percent and the chances of having a healthy diet lessened by 3 percent to 17 percent, depending on the model.

4.2 Data sources

The dataset for this study was gathered using three sources: NYC Community Health Survey (CHS) 2017, US Census 2010 and NYC Department of Health and Mental Hygiene. To examine the stated hypotheses, a cross-sectional design was used.

4.2.1 Individual-level data (Community Health Survey 2017)

For this study, secondary data was derived from the 2017 City Community Health Survey (CHS) of NYC. The CHS is a cross-sectional telephone survey comprises of approximately 10,000 non-institutionalized adults aged 18 and above who were randomly selected from the five (5) boroughs of NYC (Manhattan, Brooklyn, Queens, Bronx, and Staten Island). Since 2009, a computer-assisted telephone interviewing (CATI) system is utilized to gather the data from survey participants who are selected by telephone (landlines and cell phones). The collected data are self-reported body weight and height and interviews are done in English, Spanish, Russian, and Chinese (Mandarin and Cantonese).

CHS provides estimates on various health measures and the sampling frame surrounds the United Hospital Fund (UHF) (N=34) neighborhoods which defined by combining adjoining zip codes for the names and location of the neighborhood, Table 3. For example, "Williamsburg/Bushwick" UHF neighborhood is the combination of zip codes 11206, 11221, 11237. UHF neighborhoods are neighborhood proxies that are used to characterize areas with similar features. A limitation of the survey's methodology is the exclusion of adults living in an institutional setting, for example, college dorms. The

description of the survey design used has been stated elsewhere [125]. A cross-sectional design deals with the collection of information from respondents at a point in time. The use of CHS dataset provided access to quantitative data that have been critically analyzed.

Table 3 NYC United Hospital Fund (UHF) Neighborhoods

UHF Code	UHF Neighborhood	Zip Code	City
101	Kingsbridge and Riverdale	10463, 10471	Bronx
102	The Northeast Bronx	10466, 10469, 10470, 10475	Bronx
103	Fordham/Bronx Park	10458, 10467, 10468	Bronx
104	Pelham/Throgs Neck	10461, 10462, 10464, 10465, 10472, 10473	Bronx
105/106/107	The South Bronx	10451, 10452, 10453, 10454, 10455, 10456, 10457, 10459, 10460, 10474	Bronx
201	Greenpoint	11211, 11222	Brooklyn
202	Downtown Brooklyn/Heights/Slope	11201, 11205, 11215, 11217, 11231	Brooklyn
203	Bedford Stuyvesant/Crown Heights	11212, 11213, 11216, 11233, 11238	Brooklyn
204	East New York/New Lots	11207, 11208	Brooklyn
205	Sunset Park	11220, 11232	Brooklyn
206	Borough Park	11204, 11218, 11219, 11230	Brooklyn
207	Flatbush	11203, 11210, 11225, 11226	Brooklyn
208	Canarsie and Flatlands	11234, 11236, 11239	Brooklyn
209	Bay Ridge/Bensonhurst	11209, 11214, 11228	Brooklyn
210	Coney Island	11223, 11224, 11229, 11235	Brooklyn
211	Williamsburg/Bushwick	11206, 11221, 11237	Brooklyn
301	Washington Heights/Inwood	10031, 10032, 10033, 10034, 10040	Manhattan
302	Central Harlem	10026, 10027, 10030, 10037, 10039	Manhattan
303	East Harlem	10029, 10035	Manhattan
304	Upper West Side	10023, 10024, 10025, 10069	Manhattan
305/307	Upper East Side/Gramercy	10010, 10016, 10017, 10021, 10022, 10028, 10044, 10065, 10075, 10128, 10162,	Manhattan
		10165, 10170, 10171	
306/308	Chelsea/Greenwich Village	10001, 10011, 10012, 10013, 10014, 10018, 10019, 10020, 10036	Manhattan
309/310	Union Square/Lower Manhattan	10002, 10003, 10004, 10005, 10006, 10007, 10009, 10038, 10048, 10280, 10282	Manhattan
401	Long Island City/Astoria	11101, 11102, 11103, 11104, 11105, 11106, 11109	Queens
402	West Queens	11368, 11369, 11370, 11372, 11373, 11377, 11378	Queens
403	Flushing/Clearview	11354, 11355, 11356, 11357, 11358, 11359, 11360	Queens
404/406	Bayside/Little Neck/Fresh Meadows	11361, 11362, 11363, 11364, 11365, 11366, 11367	Queens
405	Ridgewood/Forest Hills	11374, 11375, 11379, 11385	Queens
407	Southwest Queens	11414, 11415, 11416, 11417, 11418, 11419, 11420, 11421	Queens
408	Jamaica	11412, 11423, 11430, 11432, 11433, 11434, 11435, 11436	Queens
409	Southeast Queens	11001, 11004, 11005, 11040, 11411, 11413, 11422, 11426, 11427, 11428, 11429	Queens
410	The Rockaways	11691, 11692, 11693, 11694, 11697	Queens
501/502	Northern Staten Island	10301, 10302, 10303, 10304, 10305, 10310	Staten Island
503/504	Southern Staten Island	10306, 10307, 10308, 10309, 10312, 10314	Staten Island

4.2.2 Neighborhood-level data (US Census 2010)

The magnitude of neighborhood influences comes with dealing with numerous issues regarding methods and concepts. When defining the word "neighborhood", it is looking precisely at the definition of a geographic area in which the features are deemed important to the obesity prevalence. Neighborhood is a term that is loosely defined as the direct place or region an individual resides [126]. Most studies about the built environment, for instance, focus on capturing factors (physical and social) on the neighborhood level that impact obesity rate. However, on a historical basis, neighborhood is centered on features of residents, administrative boundaries or perceptions [126].

4.2.3 Restaurant data (NYC Department of Health and Mental Hygiene)

In addition, NYC Department of Health and Mental Hygiene (DOHMH) restaurant inspections online directory was used for locating restaurants. DOHMH conducts inspections in the city for all food service outlets and the latest results are listed according to name, borough and zip code. The DOHMH directory will be searched for national chain restaurants, for example, McDonald's, Burger King, Popeye's and Wendy's. Local chains were also identified (for example, Kennedy Fried Chicken, Crown etc.) Community residents considered Chinese take-out as fast-food [127] and according to a research take-outs from Chinese and Mexicans restaurants contributed to a significant part of dietary fat in African Americans [77] . Due to the fact that Chinese take-out seems to be everywhere in NYC and the frequency at which fast-foods are being sold at these restaurants, for example, fried chicken wings, french fries etc., the Chinese restaurant will be considered fast-food as well. Even though they serve food that is less healthy, they have other healthier options, for

example, steam vegetables. In addition, restaurant locations will be obtained using databases online and it will be challenging to break down or categorize "fast-food like" Chinese restaurants and the ones that are formal waiter service with more food choices.

4.3 Measures

4.3.1 Socio economic Status (SES)

It has already been established that people who reside in poor neighborhoods are very much likely to be surrounded with more fast-food restaurants [128-130], and more likely to have higher BMI [131] then SES is a possible covariate of any relations between the neighborhood environment and obesity. Thus, it is important to include in the analysis measures of SES both on the individual and neighborhood level. Data was from the 2010 Census based on the participant's zip code as well as the SES index for the neighborhood [132] which was defined by the median income based on the previous 12 months before the 2010 census survey.

4.3.2 BMI (Outcome)

BMI is the main outcome of interest and is a ratio that shows an individual height to weight. Participants' self-reported height and weight with a body mass index (BMI) of 30 or more is classified as obese.

$$BMI = \frac{Weight\ (kg)}{Height\ (in)^2}$$

BMI	Classification
BMI < 18.5	Underweight
BMI 18.5 to 25	Healthy weight
BMI ≥ 25 to <30	Overweight
BMI ≥ 30	Obese

4.3.3 Fast-food restaurants (Exposure)

The NYC Department of Health and Mental Hygiene (DOHMH) restaurant inspections online directory was used for locating restaurants. Fast-food restaurants (limited) was defined as those with a walk-up counter service that sell mostly prepared or pre-processed foods. Also, it can be described as places where you eat and drink with >15 locations, without waiter service such as food chain restaurants (KFC, Wendy's, Popeye's, Taco Bell). Definitions for subcategories of food service outlets of interest are shown in Table 4.

Table 4 Description of neighborhood-level variables

Measures/Variables	Definition	Data Source	Justification
Fast-food restaurant (limited) Per 100,000	Places where you eat and drink without waiter service such as food chain restaurants (KFC, Wendy's) Walk-up counter service that sell mostly prepared or pre-processed foods	NYC Department of Health and Mental Hygiene (DOHMH) restaurant inspection online directory	Maddock, 2004
Restaurant (full-service) Per 100,000	A food store considered to be an "Eating Establishment" with waiter service	NYC Department of Health and Mental Hygiene (DOHMH) restaurant inspection online directory	Morland et al 2002

4.3.4 Density

This refers to different kinds of restaurants within geographic distance. There are different ways to measure restaurant density. One of the measures is to count within a geographic area, the number of fast-food restaurants. The density of individual fast-food outlet measures was, for example, simple counts, counts per population and counts per area.

4.4 Tools used for analysis

The SPSS software was used to conduct the analysis for this study. The analysis was done using various computations within the SPSS software. This statistical program was also used to modify and merge all variables used. Outlined below is a brief synopsis of the tools used in this analysis to assure validity of the analysis.

Frequency- The frequency distribution gives an overview of the categorical variables. It provides a visual picture of the highest and lowest scores. This can be shown using a frequency table, bar chart and pie chart. It is also an important function of the SPSS software which is used to show a clear visualization of the distribution of data. In addition, it denotes the mean, mode and median which are referred to as measures of central tendency.

Skewness and Kurtosis – This refers to estimates validity by utilizing the standard normal curve which relies on the closeness within which a sample equals the normal distribution. The SPSS program can compute the skewness and kurtosis of a sample. When a value is close to zero it shows a distribution is normal. On the other hand, if the value is increasingly positive or negative, it shows that the data are skewed. Skewness should be stated in order to help us to understand the distribution shape and to assess the appropriate use of statistical method [133].

Pearson Correlation- This is one of the most frequent used statistical tests. The symbol "*r*" used in this statistic represents sample data and "*ρ*" (rho) represents population parameter. This statistic is used when X and Y are continuous variables with normal distributions within the interval.

Scatterplot- A scatterplot diagram is often used to examine statistical relationship. A point (dot) in a scatterplot represents an intersection of a related pair of observations. With enough data points a scatterplot can show the strength and shape of an association. In a case in which Y values increase in exact proportion to X values, it is considered to be a perfect positive relationship. On the other hand, a perfect negative relationship is considered when lower Y values are associated with higher X values.

ANOVA- The analysis of variance (ANOVA) is a statistical tool used when comparing three (3) or more groups. It is used to determine whether observed differences among group means are greater than what would be expected if it was by chance alone. The ANOVA is built on the *F* statistic. It is the same as the t which is a ratio of between-groups treatment effects to within-groups variability[134].

Linear Regression- Simply put, linear regression has to do with the exploration of two variables (X and Y) that are linearly correlated, X is referred to as the independent or predictor variable and Y is referred to as the dependent or criterion variable. A linear regression model was used to examine the influence of fast-food restaurant (independent variable) on obesity (dependent) after controlling for SES. This model has been used by other studies [108,135-137] examining fast-food influences on obesity. Thus, BMI was used as a function of the density of fast-food restaurants on both individual and neighborhood levels, Figure 12**.** Linear regression model was used to show the magnitude, direction as well as the significance of the association between the dependent and independent variables.

$$BMI = a + \beta_0 Density + \beta_1 Individual + \beta_2 Neighborhood + \epsilon$$

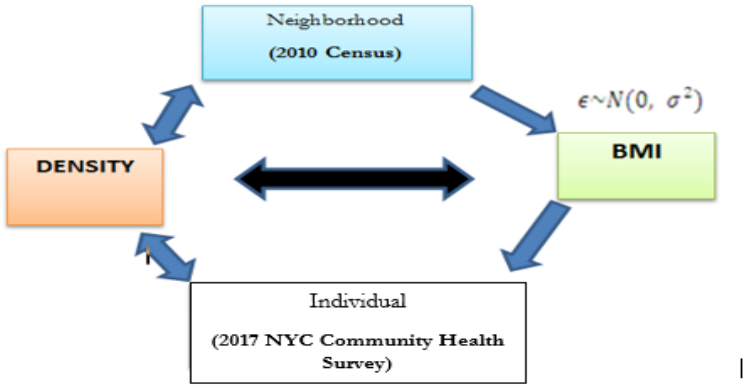


Figure 12 Linear Regression Model

The two-model used were:

- BMI from CHS for individual zip code level = a + B_0* density of restaurant in individual zip code level + B_1*SES level of individual zip code level
- BMI from CHS for neighborhood (cluster of zip codes) level = a + B_0* density of restaurant for neighborhood level + B_1*SES level of neighborhood level

In this case, we will be able to see how restaurant and socioeconomic level will be used within the regression model to estimate the BMI within both individual and neighborhood level by separating the model.

4.5 Analytical approach

Descriptive statistics and multiple regression were used to address the research question and hypotheses. The analytical approach utilized multiple regression in order to predict a continuous dependent variable based on multiple independent variables. As such, it extends simple linear regression, which is used with one continuous independent variable. Multiple regression also allows a researcher to determine the overall fit (variance explained) of the model and the relative contribution of each of the predictors to the total variance explained. Since the aim of this study was to investigate the relationships between a continuous variable and multiple independent variables, multiple regression was the best fit.

Sample sizes presented were unweighted, but all other estimates (proportions, standard errors [SE], PRs and their 95% confidence intervals [CIs]) were weighted, in order to make the results representative of NYC. In the next chapter, we started with the descriptive analysis for the general contents about the core factors. We went further and used the current measure section and provide distribution of restaurants within NYC, population demographics of NYC, demographics for the obesity population within NYC, etc. with tables and figures so that the descriptive analysis provide a clear analysis and visualization of the data set. After which, we focus on the variables that are going to be used to evaluate the linear regression model.

4.6 Chapter summary

This research study is guided on the empirical evidence and theoretical contributions from scientific literature as well as a conceptual framework. The food choice model suggests that what a person chooses to eat will eventually account to personal choice regarding various factors. Moreover, convenience is a key feature on consumer food choices. This inspires the model in which differences in density of local fast-food was assessed with regards to disparity in BMI. There are two vital ways that link the availability of fast-food to BMI variances. One is the unobservable pathway as suggested by the study design, which is the association between the intake of fast-food and weight gain and the other pathway which is of interest is the connection between the availability of fast-food and the intake of fast-food.

Although fast-food restaurants (limited) were the main focus of this study, other restaurants (full service) which were defined as "eating establishment" with waiter service, was included in the analysis in order to capture food consumed outside of home. NYC Department of Health and Mental Hygiene (DOHMH) restaurant inspections online directory was used for locating restaurants. DOHMH conducts inspections in the city for all food service outlets and the latest results are listed according to name, borough and zip code. A BMI of 30 or more was considered obese and this was obtained from the 2017 Community Health Survey. Density was the number of restaurants within an area or counts per area and SES was defined by the median income based on the previous 12 months and was obtained from the 2010 US Census. The SPSS software was used to conduct the analysis for this study. This statistical program was also used to modify and merge all variables used. The results based on the analysis using SPSS are discussed in Chapter V.

CHAPTER V

RESULTS

The following is a discussion of the study's population and sample as well as a demographic description of the sample. Demographic descriptions included frequencies and percentages for categorical (nominal) variables and descriptive statistics of minimum, maximum, mean, and standard deviation for variables measured at the interval level of measurement. Also presented are the testing of parametric assumptions for the statistical analysis and results of hypothesis testing. This chapter concludes with a discussion of the results of this study.

5.1 Overall data

The dataset for this study was gathered using three sources: NYC Community Health Survey (CHS) 2017, US Census 2010 and NYC Department of Health and Mental Hygiene. The CHS is a cross-sectional telephone survey comprises of approximately 10,000 non-institutionalized adults aged 18 and above who were randomly selected from the five (5) boroughs of NYC (Manhattan, Brooklyn, Queens, Bronx, and Staten Island). The variables in the CHS pertinent to this study were the BMI, and borough variables. BMI, or Body Mass Index, served as the dependent variable in this study. The borough variable was needed, as it represented the individual's geographic location (Manhattan, Brooklyn, Queens, Bronx, and Staten Island). The US Census 2010 survey provided information on SES level information

based on geographic region. This was measured by the median earnings in the past 12 months. Finally, the NYC Department of Health and Mental Hygiene (DOHMH) restaurant inspections online directory was used for locating restaurants. DOHMH conducts inspections in the city for all food service outlets and the latest results are listed according to name, borough and zip code.

5.1.1 Distribution of Neighborhoods in NYC

The complete dataset consists of $N = 34$ neighborhoods in NYC which are depicted in Table 5 below together with the corresponding city.

Table 5 NYC geographic locations

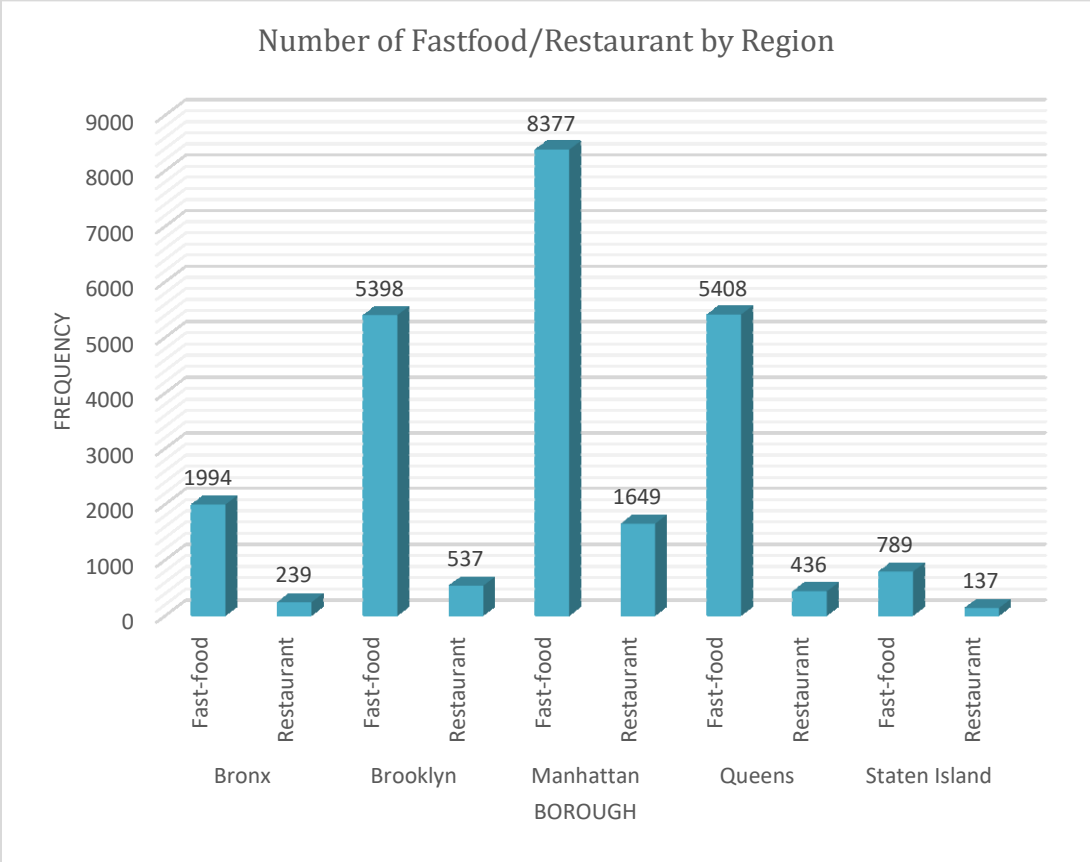
City	Neighborhood
Bronx	Fordham/Bronx Park
	Kingsbridge and Riverdale
	Pelham/Throgs Neck
	The Northeast Bronx
	The South Bronx
Brooklyn	Bay Ridge/Bensonhurst
	Bedford Stuyvesant/Crown Heights
	Borough Park
	Canarsie and Flatlands
	Coney Island
	Downtown Brooklyn/Heights/Slop
	East New York/New Lots
	Flatbush
	Greenpoint
	Sunset Park
	Williamsburg/Bushwick

City	Neighborhood
Manhattan	Central Harlem
	Chelsea/Greenwich Village
	East Harlem
	Union Square/Lower Manhattan
	Upper East Side/Gramercy
	Upper West Side
	Washington Heights/Inwood
Queens	Bayside/Little Neck/Fresh Mead
	Flushing/Clearview
	Jamaica
	Long Island City/Astoria
	Ridgewood/Forest Hills
	Southeast Queens
	Southwest Queens
	The Rockaways
	West Queens
	Northern Staten Island
	Southern Staten Island

5.1.2 Distribution of fast-food restaurants and restaurants in NYC

Manhattan has the largest number of fast-food restaurants and restaurants, 8377 and 1649 respectively. This was followed by Queens (Fast-food: 5408, restaurants: 436); Brooklyn (Fast-food: 5398, restaurants: 537); Bronx (Fast-food: 1994, restaurants: 239); and Staten Island (Fast-food: 789, restaurants 137). Table 6 depicts this information.

Table 6 Number of Fast-food/Restaurant by Region



5.1.3 Distribution of SES level by Region

Socioeconomic (SES) level was measured by the median income based on the previous 12 months before the 2010 census survey. Manhattan had the largest median income ranging from $26, 881.40 to $92, 907.86 (M = $59, 429.16, SD = $27, 958.11). Brooklyn had the least median income ranging from $23, 660.50 to $53, 694.20 (M = $34, 724.52, SD = $8069.10). The Bronx had a similar median income ranging from $22, 332.44 to $49, 693.50 (M = $35, 821.09, SD = $11,199.07). Table 7 below provides this information below.

Table 7 SES by Region*

City	Min	Max	*M*	*SD*
Bronx	22332.44	49693.50	35821.09	11199.07
Brooklyn	23660.50	53694.20	34724.52	8069.10
Manhattan	26881.40	92907.86	59429.16	27958.11
Queens	30026.57	46759.00	40339.64	6096.67
Staten Island	41947.00	52972.60	47459.80	7796.28

* SES measured as median income (in USD) based on previous 12 months.

Skewness and kurtosis index were used to identify the normality of the SES data. The results suggested the deviation of data from normality was not severe as the value of skewness and kurtosis index were below 3 and 10 respectively [138]. Table 8 provides these results.

Table 8 SES Skewness and Kurtosis Values

Skewness	Kurtosis
1.689	2.808

Additionally, there were no standardized SES values that exceeded -3/+3, thus no extreme outliers to be concerned about, Table 9.

Table 9 Range of Standardized SES Values

City	Min	Max
Bronx	-1.2	.4
Brooklyn	-1.1	.7
Manhattan	-.9	3.0
Queens	-.7	.3
Staten Island	.0	.6

5.1.4 Descriptive statistics of BMI

BMI data was obtained from the 2017 CHS survey, which ranged from 6.30 to 27.38 (M = 27.38, SD = 6.30). Skewness and kurtosis index were used to identify the normality of the data. The results suggested the deviation of data from normality was not severe as the value of skewness and kurtosis index were below 3 and 10 respectively [138]. Table 10 provides this information.

Table 10 BMI Descriptive Statistics

	M	*SD*	Skewness	Kurtosis
Body Mass Index (kg / sq in)	27.38	6.30	1.704	7.150

5.1.5 Distribution of BMI by borough

The BMI descriptive statistics by borough is shown below in Table 11. Bronx had the greatest mean BMI (M = 28.68, SD = 6.55). This was followed by Staten Island (M = 27.76, SD = 6.19); Brooklyn (M = 27.34, SD = 6.37); Queens (M = 27.21, SD = 6.05); and Manhattan which had the lowest mean BMI (M = 26.20, SD = 6.03).

Table 11 BMI by Borough

Borough	***M***	***SD***
Bronx	28.68	6.55
Brooklyn	27.34	6.37
Manhattan	26.20	6.03
Queens	27.21	6.05
Staten Island	27.76	6.19

5.2 Pearson Correlations between variables

Pearson correlations were conducted in order to assess the bivariate correlations between the study variables BMI, SES, number of fast-food restaurants, and number of restaurants, Table 12. There were strong negative correlations between BMI and SES (r = -.421, p = .013), fast-food (r = -.417, p = .014), and number of restaurants (r = -.396, p =

.021). Increases in SES, fast-food, and number of restaurants are significantly associated with lower BMI. Scatter plots in Figures 13 through 15 depict this negative association.

Table 12 Pearson Correlations between Study Variables

		BMI	**SES**	**Fast-food**	**Restaurants**
BMI	*r*	1			
SES	*r*	-.421	1		
	p	.013			
Fast-food	*r*	-.417	.551	1	
	p	.014	.001		
Restaurants	*r*	-.396	.661	.944	1
	p	.021	.000	.000	

5.3 Scatterplots depicting the association between variables

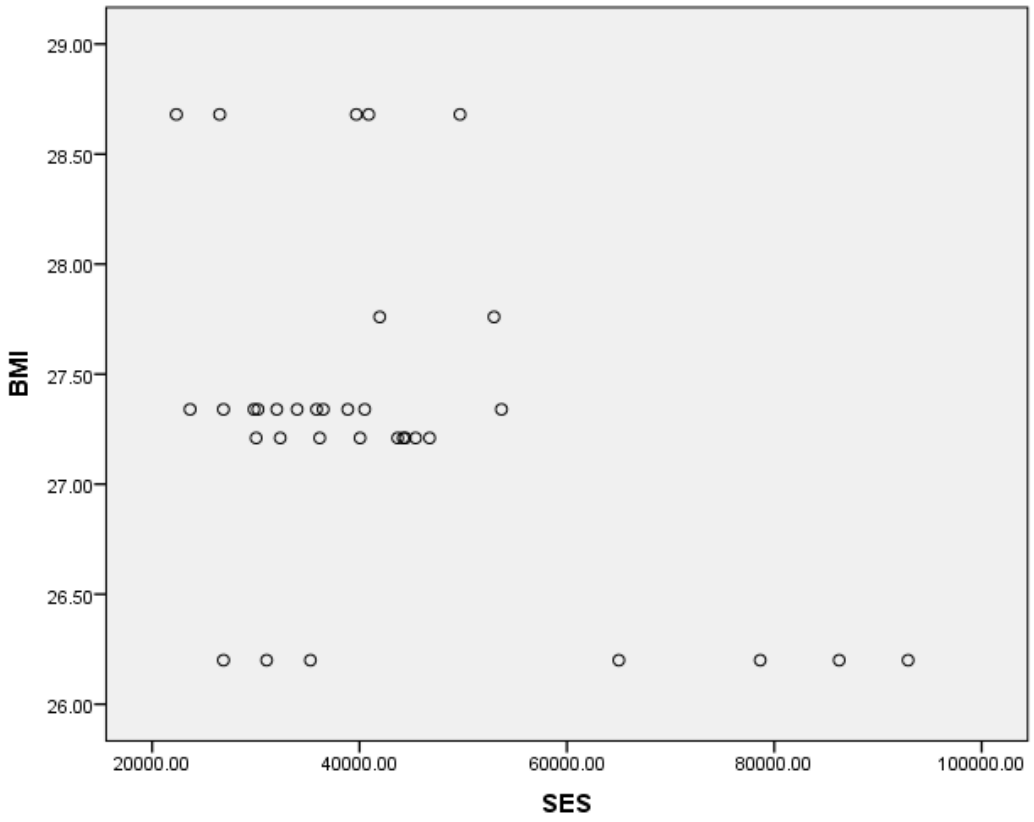


Figure 13 Scatter plot of BMI versus SES

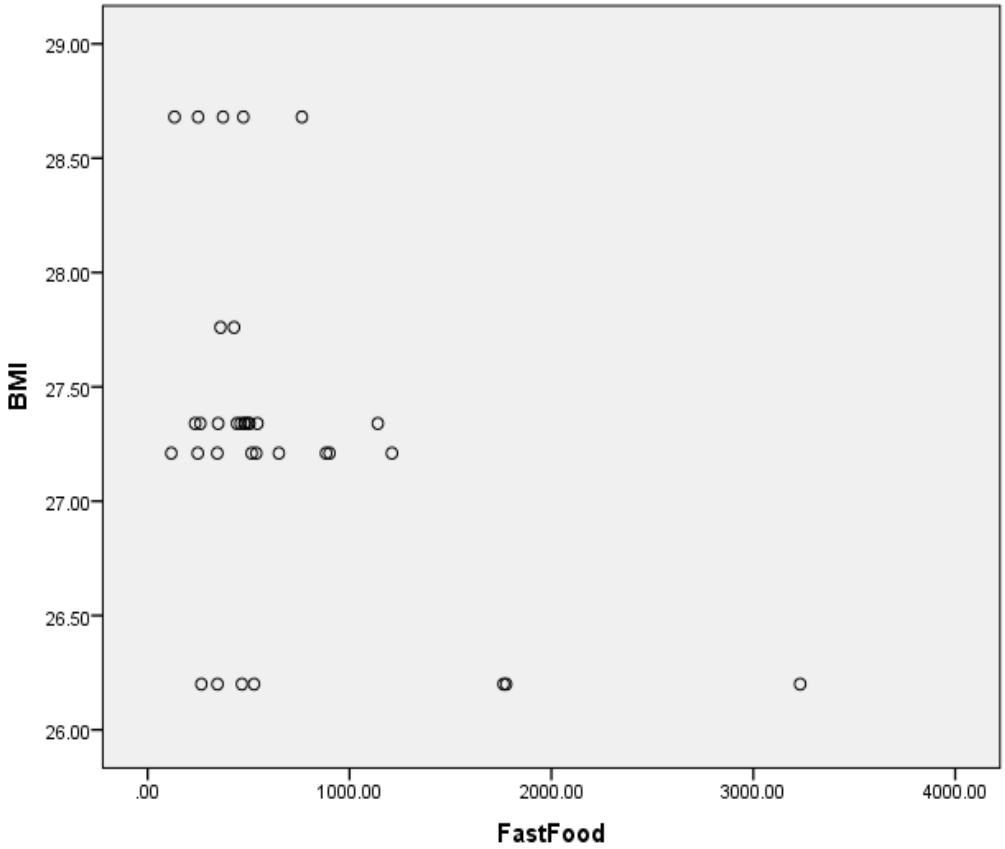


Figure 14 Scatter plot of BMI versus number of fast-food restaurants.

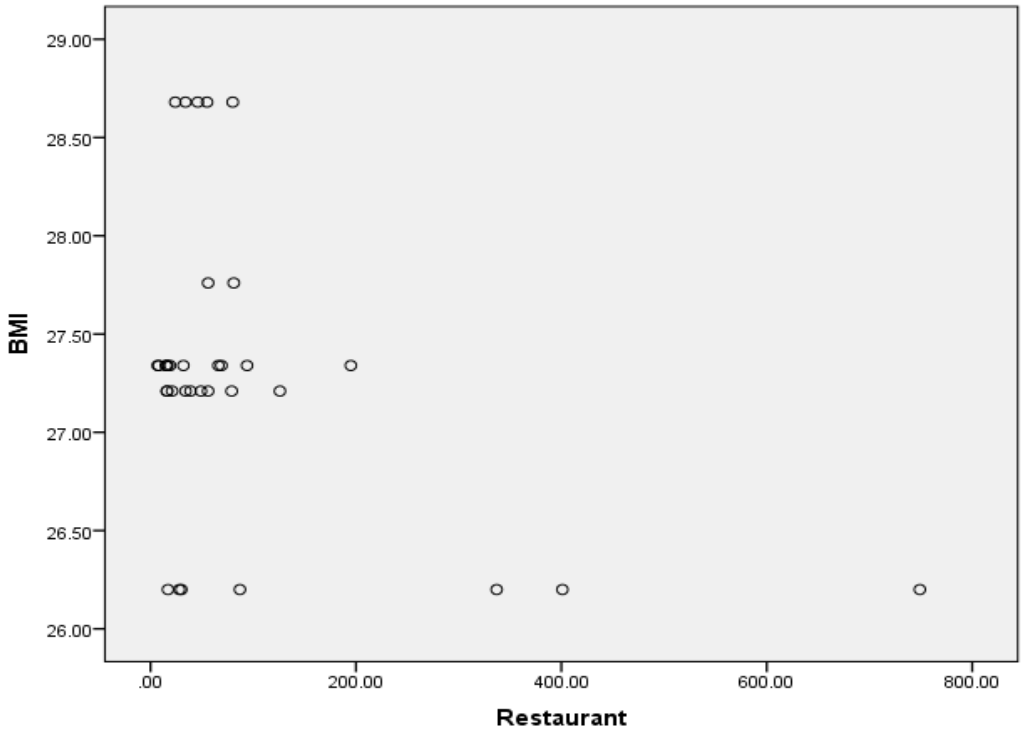


Figure 15 Scatter plot of BMI versus number of restaurants

5.4 Multiple linear regression analysis

Multiple regression was conducted in order to address the following research question and corresponding hypotheses:

Research question: To what extent, if any, do density of restaurants in a geographic region, and SES level within that region, are associated with BMI?

$H0_1$: Density of restaurants in a geographic region, and SES level within that region, are not significantly associated with BMI.

$H1_1$: Density of restaurants in a geographic region, and SES level within that region, are significantly associated with BMI.

Due to the nature of the research question posed, multiple linear regression was the best fit for data analysis for this study. Multiple linear regression analysis is used to predict a continuous dependent variable based on multiple independent variables[139]. Additionally, multiple regression analysis also determines the overall fit and the relative contribution of each of the predictors to the total variance explained[139]. The study's approach includes multiple regression analyses to test for the effects of the independent variable on the dependent variables using one dependent variable, BMI, and the independent variables, SES, number of fast-food restaurants, and number restaurants.

The following model was tested in SPSS:

$$BMI = b_0 + b_1 SES + b_2 FastFood + b_3 Restaurants$$

Prior to conducting multiple linear regression, some assumptions that must be tested. These include normality of residuals, linearity, homoscedasticity, absence of outliers, and absence of multicollinearity. If any of these assumptions are violated, then the predictions, confidence intervals, and p-values yielded by a regression model may be inefficient or severely biased, or misleading[140]. It is imperative that these assumptions are not severely violated [140].

Standardized residuals were generated with SPSS which revealed that the residuals were approximately normally distributed with skewness of 0.866 and kurtosis of 1.991. Hair et al. (2010)[141] and Byrne (2010)[142] argued that data is considered to be normal if skewness is between -2 to +2 and kurtosis is between -7 to +7. Linearity and homoscedasticity were

assessed by visual inspection of a scatter plot which revealed no curvilinear pattern, Figure 16. This suggests that there is no violation of the linearity and homoscedasticity assumptions.

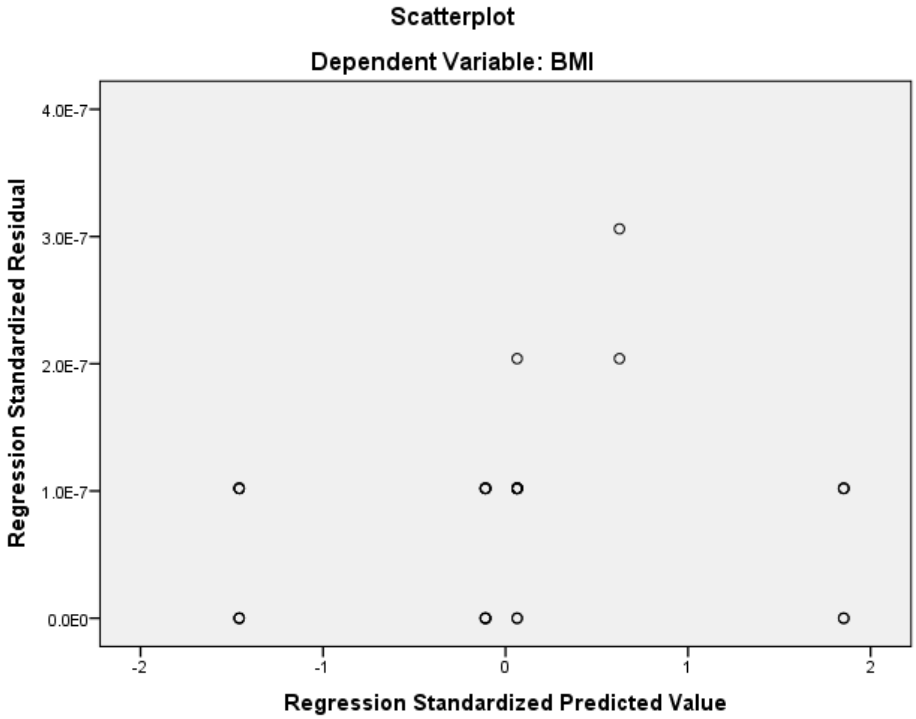


Figure 16 Scatter plot of regression standadrized predcited values versus regression residuals

There were no univariate outliers as assessed by standardized residuals within the -3 to +3 threshold. There was, however, an issue with multicollinearity, as assessed by variance inflation factors (VIFs) exceeding 10. As a result, this multiple regression was followed up with three simple regressions to further assess the relationships of the three independent variables SES, fast-food, and restaurants with BMI separately.

The model using the three predictors explained 16.7% of variation in predicting BMI (Adjusted R2 = 0.167). The overall model was found to be significant, $F(3, 30) = 3.206$, $p =$

.037. However, none of the predictors were found to be significant: SES (*B* = -.365, p = .109), fast-food (*B* = -.640, p = .213), and restaurants (*B* = 0.449*, p* = .427*)*. Multicollinearity may explain this paradoxical finding. Violating multicollinearity does not affect prediction but may have an effect on inference. For example, for strongly correlated covariates, p-values usually get larger, which may cause statistically significant variables to lack significance. Tables 13, 14 and 15 depict this information.

Table 13 Model Summary[b]

R	R Square	Adjusted R Square	Std. Error of the Estimate
.493[a]	*.243*	*.167*	.68341

a. Predictors: (Constant), SES, Fast-food, Restaurant

b. Dependent Variable: BMI

Table 14 ANOVA[a]

		Sum of Squares	*df*	Mean Square	*F*	*p*
	Regression	4.492	3	1.497	3.206	.037[b]
	Residual	14.012	30	.467		
	Total	18.504	33			

a. Dependent Variable: BMI

b. Predictors: (Constant), SES, Fast-food, Restaurant

Table 15 Coefficients[a]

	Unstandardized Coefficients		Standardized Coefficients	*t*	*p*	Collinearity Statistics	
	B	Std. Error	*B*			Tolerance	VIF
(Constant)	28.294	.465		60.788	.000		
Fast-food	-.001	.001	-.640	-1.273	.213	.100	10.000
Restaurant	.002	.003	.449	.805	.427	.081	12.349
SES	-1.641E-005	.000	-.365	-1.652	.109	.516	1.938

a. Dependent Variable: BMI

Simple linear regression

Due to multicollinearity, the independent variables were assessed separately by conducting three separate linear regressions. The first regression tested is the relationship between BMI and SES:

$$BMI = b_o + b_1 SES$$

The results of the regression were significant with increasing levels of SES resulting in a mean decrease in BMI (B = -.421, p = .013). Table 16 shows this information.

Table 16 Coefficients[a]

	Unstandardized Coefficients		Standardized Coefficients	*t*	*p*	Collinearity Statistics	
	B	Std. Error	*B*			Tolerance	VIF
(Constant)	28.091	.326		86.172	.000		
SES	-1.891E-005	.000	-.421	-2.627	.013	1.000	1.000

a. Dependent Variable: BMI

The second regression tested is the relationship between BMI and fast-food:

$$BMI = b_o + b_1 Fast\text{-}food$$

The results of regression were significant with increasing levels of fast-food restaurants resulting in a mean decrease in BMI (B = -.417, p = .014). Table 17 shows this information.

Table 17 Coefficients[a]

	Unstandardized Coefficients		Standardized Coefficients	*t*	*p*	Collinearity Statistics	
	B	Std. Error	*B*			Tolerance	VIF
(Constant)	27.627	.175		157.717	.000		
Fast-food	-.001	.000	-.417	-2.595	.014	1.000	1.000

a. Dependent Variable: BMI

The third regression tested is the relationship between BMI and number of restaurants:

$$BMI = b_o + b_1 Restaurants$$

The results of regression were significant with increasing levels of restaurants resulting in a mean decrease in BMI (B = -.396, p = .021). Table 18 shows this information.

Table 18 Coefficients[a]

	Unstandardized Coefficients		Standardized Coefficients	*t*	*p*	Collinearity Statistics	
	B	Std. Error	*B*			Tolerance	VIF
(Constant)	27.473	.141		195.158	.000		
Restaurant	-.002	.001	-.396	-2.437	.021	1.000	1.000

a. Dependent Variable: BMI

5.5 Chapter summary

The purpose of this study was to investigate the influence of the neighborhood-level fast-food restaurants to determine whether there's an association with adult obesity in NYC after controlling for socioeconomic levels of the geographic region. Specifically, the following research question was addressed:

Research question: To what extent, if any, do the density of restaurants in a geographic region, and SES level within that region, are associated with BMI?

$H0_1$: Density of restaurants in a geographic region, and SES level within that region, are not significantly associated with BMI.

$H1_1$: Density of restaurants in a geographic region, and SES level within that region, are significantly associated with BMI.

Results of the study were that there were negative associations of SES, the number of fast-food establishments, and the number of restaurants, with BMI. A reduction in BMI was associated with increasing levels of SES, fast-food restaurants, and number of restaurants. In Chapter VI, we discussed how the study's results are interpreted in the context of the theoretical framework. The limitations of the results of the study are provided. Additionally, recommendations for future research are also discussed.

CHAPTER VI

DISCUSSION

The purpose of this cross-sectional quantitative study was to investigate the influence of the neighborhood-level fast-food restaurants to determine whether there's an association with adult obesity in NYC after controlling for socioeconomic levels of the geographic region. Understanding these influences provides insights that are useful to the scientific community in developing ways to reduce increased risks of mortality and morbidity as has been witnessed to be associated with obesity. During the last decades, obesity has become a global epidemic, and its prevalence has nearly tripled between 1975 and 2016. Despite being a global problem, economically developed countries seem to face the most significant burden. During 2015-2016 in the U.S. alone, obesity, defined as body mass index (BMI) over 30kg/m2, affected about 93.3 million adults. Therefore, given the magnitude of obesity in the United States, it is crucial to understand the influential factors that may likely increase adult obesity. It is believed that the neighborhoods in which people live play a great role in obesity risk and their overall health.

Moreover, the risk of obesity is not randomly dispersed across different population groups. This means that particular groups are more likely than others to become obese. One explanation that is often mentioned about the significant increase in obesity is sedentary lifestyle and diet; it is often stated that the cause of this shift in lifestyle has to do with neighborhood environment changes that are not in support of a healthy lifestyle. Furthermore, one of the proposed explanations for obesity risk on the neighborhood level is

the availability of healthy food [35]. There has been extensive evidence that living in neighborhoods with access to fast-food outlets may result in a high-fat diet, leading to higher obesity risk [20,36].

New York City (NYC) was chosen as the study area since it is known to be the most compact populated region in the USA. New York City has a population of approximately 8.4 billion ethnically diverse residents, of which 35 percent White, 27 percent Hispanic, 24 percent Black, and 36 percent Foreign-born. The 21 percent of NYC's population lives in poverty, and 1.8 million on Supplemental Nutrition Assistance Program (SNAP) [59] hence most suitable for this analysis. With obesity being an epidemic in NYC: over half of adults living in New York are overweight (34 percent) or obese (22 percent) [58]. The analysis was conducted in NYC's five boroughs: Bronx, Queens, Manhattan, Brooklyn, and Staten Island. To be specific, this study aimed to better understand the potential impact of neighborhood-level fast-food restaurants and their effect on adulthood obesity, with socioeconomic status (SES) being the control. Multivariate linear regression was used to determine the relationship between neighborhood-level fast-food restaurants and obesity among adults living in NYC. The rationale of conducting this study was to examine whether neighborhood-level predictors such as geographic factors such as proximity of distance and socioeconomic status could influence adult's BMI and their risk of developing obesity.

In this chapter, we discussed the data analysis as presented in Chapter V and make connections between the findings of this study and those of previous research, reviewed in Chapter III. This chapter is divided into six main sections: a summary of key findings, interpretations of the findings, limitations of the study, recommendations for action, implications for social change, and conclusions.

To achieve the purpose and goal of this cross-sectional analysis research study, which was to investigate the influence of the neighborhood-level fast-food restaurants to determine whether there's an association with adult obesity in NYC after controlling for socioeconomic levels of the geographic region; the study attempted to answer the following research question?

Research question: To what extent, if any, do the density of restaurants in a geographic region, and SES level within that region are associated with BMI?

$H0_1$: Density of restaurants in a geographic region, and SES level within that region, are not significantly associated with BMI.

$H1_1$: Density of restaurants in a geographic region, and SES level within that region, are significantly associated with BMI.

6.1 Summary of key findings

The analysis with the simple linear regression model disclosed significance with increasing fast-food restaurants' levels, resulting in a mean decrease in BMI (B = -.417, p = .014). The regression results were significant, with increasing SES levels resulting in a mean reduction in BMI (B = -.421, p = .013). In summary, the study results revealed negative associations of SES, the number of fast-food establishments, and the number of restaurants with BMI. A reduction in BMI was associated with increasing SES, fast-food restaurants, and the number of restaurants.

6.2 Interpretation of findings

Contrary to expectations, the study suggests a negative association between fast-food restaurants, SES and number of restaurants. If the fast-food environment is indeed a contributor to the obesity crisis and studies have suggested that having more access to these outlets promotes more consumption, then one would predict a higher density of fast-food restaurants would be linked to greater obesity prevalence. Actually, one study has shown such association exists between the prevalence of obesity and the density of two restaurant outlets at the state level [47]. Although the prevalence of obesity among the poor has often blamed for the high consumption of fast-food, other studies have suggested that people of higher income status eat the most calories from fast-food restaurants and restaurants compared with people of low income status [143,144]. While this may be the case, Power[145] indicated that individuals of high SES tend to eat healthier by having more fruits and vegetables, lower fat consumption and partake in more physical activity[146].

Furthermore, there are other factors that may play a role in this negative association such as having greater access to gyms and other recreational facilities. In a study conducted by Smith[147] in the District of Columbia, high income and predominantly white neighborhoods tend to have more gyms and recreational facilities than lower income and minority neighborhoods. Moreover, even in a situation where there are gym facilities available and accessible in all neighborhoods, the cost might not be affordable to all residents. According to Blackwell Publishing Ltd[148]., the characteristics of a neighborhood, which include the area's income level contributes to the obesity prevalence. The authors found that neighborhoods with less economic as well as social resources have higher obesity prevalence. They also reported that people living in low-income urban neighborhoods are

more likely to encounter more neighborhood physical activity barriers, for example, limited opportunities for daily walks or physical activity, in addition to stores that sell healthy foods.

Similar to our findings, Mazidi and Speakman[102] reported that obesity was significantly negatively associated with the density of fast-food restaurants and restaurants. This means, people living in areas with many fast-food restaurants tended to have lower BMI than those who did not[102]. According to the authors, this was mainly because majority of both fast-foods and restaurants were located in neighborhoods in which people on average were affluent and educated. In addition, fast-food consumptions have been linked to higher incomes in both Australia and the US[149-151]. Thus, it makes real sense commercially for restaurateurs to locate their businesses in neighborhoods with more affluent people that also have on average lower obesity prevalence, resulting in the negative association that was observed. Also, in another study that used census tract, middle income neighborhoods had the most restaurants and fast-food restaurants and both were less prevalent in neighborhoods with high African American people[152] . This negative association between the availability of restaurants and BMI was also evident in another study of county level data that used household income, population size, and adults with high school diploma as covariates[99]. In our study, SES was used as a covariate and we believe the negative association was due in part to the confounding effects income has on the relationship between fast-food and restaurant density and the prevalence of obesity.

In many of the studies reviewed concerning socioeconomic status, SES measures served as controls to accurately study the fast-food environment and its relationship to obesity/overweight rates without confounding variables. However, about 21 (62%) studies further examined the relationship between SES measures and the fast-food environment.

These studies demonstrated similar findings: lower SES was associated with a higher density of fast-food restaurants and convenience stores, an unfavorable retail climate, more impoverished food environments, higher consumption of junk foods, and higher obesity rates. Higher SES was associated with a "healthier" food environment and lower obesity rates. Also, when a significant positive association was found between the fast-food environment and obesity/overweight rates, the association was often strongest in low SES areas (persistent poverty, higher levels of deprivation, etc.) [24,54,57]. Interestingly, the SES findings were consistent across studies that found no significant relationship between the fast-food environment and obesity/overweight rates and studies that saw at least one significant association between the fast-food environment and higher rates of obesity/overweight. For example, although Laxy et al.[153] found no direct associations between the fast-food environment and obesity; this study found that neighborhood economic hardship was associated with an unfavorable retail environment.

Through the analysis of the spatial accessibility of healthy food outlets in New York City highlights racial disparities[154], predominantly black neighborhoods have lower access to healthy food outlets, and more than half of the city's predominantly black neighborhoods have bus-only access to supermarkets and restaurants. Although densely settled areas of concentrated poverty have received justifiable policy attention, lower-density neighborhoods may also be underserved, particularly where low incomes, limited mobility, and limited public transit service are impediments. The analysis also highlighted the critical role of smaller retailers and farmers' markets (food stores) in providing fresh produce, especially in low-income and minority neighborhoods (low socioeconomic status).

By contrast, Chou et al.[5] reported a positive relationship between the availability of fast-food restaurants and full service restaurants with BMI. This discrepancy in the results may be due to the data used. The restaurant data used in Chou et al.[5] was between 1984 and 1999 whereas the fast-food restaurants in current study are measured in 2018. Additionally, over this period, eating behaviors and the landscape of restaurant have been rapidly changing, and the relationship between fast-food density and BMI may have shifted. Maddock et al.[47] also found a significantly positive association between the density of fast-food restaurants and BMI. This study utilized aggregated data at the state level and adjusted for age, ethnicity, consumption of fruits and vegetables, and physical inactivity. The differences between the studies could be because of spatial scale at which the analyses were done. Another difference could be the data source for the numbers of fast-food restaurants. In our study, the restaurant data was obtained from DOHMH restaurant inspection online directory and included all fast-food restaurants and restaurants using the 2012 NAICS defined criteria. The prior study, however, focused only on the numbers of the two (2) top fast-food chain restaurants which were sourced from the yellow pages. This was definitely a small percentage of the overall fast-food establishments, including other local chains and establishments that are not chain affiliated. Thus, due to the restricted numbers of fast-food restaurants in the previous study, the association may not be reflective of the general pattern of all fast-food establishments are incorporated.

The negative association for our study might have come about due to various reasons. First, the analysis of this study matches fast-food restaurant densities in a given borough with people obesity rate that are living in the same borough. However, individuals may eat food at fast-food restaurants and restaurants in the vicinity of their workplace as

well as the neighborhood in which they live[102]. Through the lens of economic theory, adults with shorter distances between their residence and areas of work, such as those who attend a neighborhood office or work, typically have less access to fast-food alternatives on their route[155]. These residents would incur higher travel costs when seeking to purchase food outside their neighborhood. Alternatively, residents with longer distances to and from work have more access to fast-food alternatives along their routes to work/residence, without significantly increasing travel costs. Also, if individuals often work or travel outside of the boroughs in which they live then they would more likely consumed fast-food outside of their neighborhood. This could have on obscurity on the trends between fast-food restaurant densities and obesity prevalence[102].

A second potential reason is that these establishments only represent a small fraction of the obesity problem. According to Mazidi and Speakman[102] across the US, food eaten at fast-food restaurants and other restaurants account for a mean of 15 percent of the total calories consumed. This estimate was consistent to Bowman and Vinyard[41] study which reported that when fast-food was eaten or not, fast-food accounts for only 8 percent of calories consumed over all days. This provide an understanding as to why density of fast-food restaurants do not increase obesity prevalence and suggests the driving force maybe calories consumed away from these outlets, which by far represents a larger proportion of the total calories consumed[102].

This study suggests that the density of fast-food outlets in neighborhoods where residents live may not increase the likelihood of being obese apart from other factors such as lifestyles and psychological factors that are also believed to contribute to increased weight and obesity risk. However, it is by no means suggesting that fast-foods are healthy; but is of

the view that people living in neighborhoods with more fast-foods and of high SES are less likely to be obese than people of low SES. This could also indicate that high income neighborhoods have a more advantageous eating environment with different set of food options[102]. Let's take for instance, Manhattan; this neighborhood has the lowest rate of obesity, highest number of fast-food restaurants and highest mean income. Thus, it should be understood that a person's decision to go to a fast-food restaurant within their neighborhood is influenced by different factors such as nutrition, cost, and convenience[120].

Lastly, different aspects of the restaurant environment will show differential associations with BMI. The multilevel influences of the geographical location (environment) and individual characteristics on the obesity problem have not been reported in part because, methodologically, most studies lack a multilevel design and level-specific measures defined the level of the data hierarchy. With that being said, these results point out the need for further research to understand the influential factors of the fast-food environment as well as the neighborhood-level restaurant mix (different types of restaurant) which are important in determining weight status. The different types of eating establishments away from home may accurately capture the food choices that are available to individuals which maybe prominent in determining BMI.

6.3 Limitations of the study

Amongst the studies conducted in the review, some reported at least one significant association between fast-food restaurants and higher rates of obesity/overweight or excessive weight gain. In contrast, about 41% of all the reviewed literature found no significant association or only indirect associations between fast-food restaurants and rates of obesity/overweight. Of the included studies conducted, 40% found at least one significant association between the fast-food environment and higher rates of obesity/overweight. In comparison, 60% saw no significant association or only indirect associations between the fast-food environment and rates of obesity/overweight.

The studies performed in the U.S. and countries outside the U.S. both demonstrated largely mixed results regarding the relationship between the fast-food environment and obesity. In both the U.S. and non-US studies, when associations were present between the fast-food environment and obesity/overweight rates, the associations were strongest in urban areas and populations with lower SES. Thus, the fast-food environment may be associated with higher rates of obesity in areas with lower SES and higher concentrations of ethnic minorities in both the U.S. and countries other than the U.S. However, as a whole, similar to a review performed by Fleischhacker et al.[97], we find no consistent associations between the fast-food environment and measures of obesity/overweight.

The primary data sources for this study's analysis were all from well-established government departments in the US, including Department of Health and Mental Hygiene, US Census and Community Health Survey. Thus, the strengths of this analysis include the use of a nationally representative sample. In addition, reliable geographic data was accessed

for all fast-food restaurants locations in NYC. Moreover, socio economic status which is a control variable used in most studies was included to minimize residual bias.

The findings of this study should be looked at in the context of a few limitations. Firstly, limiting analyses to one type of food establishment prevents the assessment of the food environment on a broader scale and all the available choices. A person's decision to go to a fast-food restaurant may be initiated by not only their personal choice but by food store accessibility (density) and food options (diversity) in the neighborhood. This is considered a limitation in most of the studies reviewed. For instance, Rundle et al [103] classify food outlets in three categories, healthy, unhealthy, and intermediate in relation to BMI and found an inverse relationship between BMI and healthy outlets' availability. They did not look into the possible diversity of healthy or not so healthy food outlets that people encounter when deciding to buy food in their neighborhood. Other studies[104,105] used similar classification (healthy and unhealthy) food stores to predict purchases for fruits, vegetables, and fast-food and found evidence suggesting that the more availability of healthy food options influences the purchasing of healthy and unhealthy food in a neighborhood.

Secondly, the vast majority (89%) of the reviewed studies, both from the U.S. and non-US, were cross-sectional in design. The cross-sectional nature of the included studies in both the U.S. and non-US categories dramatically limits our ability to draw definitive conclusions about the relationship between the fast-food environment and rates of obesity/overweight. It is not possible to draw casual inferences when associations are observed. A longitudinal study could be more useful for tracking both BMI and neighborhood-level restaurant density in order to ascertain causal associations. Besides, there was a significant amount of heterogeneity in various essential components of the included

studies, such as the study population, scale of the study, methods of measuring the fast-food environment (density, proximity, availability), assessment of other food outlets (Examples: convenience stores, supermarkets), and assessment of BMIs in the study population (self-reported *vs.* standardized exams). The majority of included studies were performed in metropolitan areas; more studies must be performed in rural areas, in both the U.S. and outside the U.S., to understand the fast-food environment's role fully. Also, most included studies examined various types of food outlets in addition to fast-food, such as convenience stores, sit-down restaurants, and supermarkets.

As Fleishhacker et al.[97] points out, it may be necessary to balance solely examining the associations between the fast-food environment and obesity and examining fast-food outlets as a part of the total food environment. In the non-US category, there were only two non - "Western" countries included: Taiwan and China. More studies must be performed in non -"Western" countries to fully understand the role that the fast-food environment plays as a potential risk factor for developing obesity across cultures. A wide range of countries is included in the non-US category, complicating the interpretation and comparison of associations found between the fast-food environment and rates of obesity in the U.S. *vs.* non-US category. Overall, the vast differences present in methodology across included studies performed in both the U.S. and non-US categories strongly limit our ability to conclude the association between the fast-food environment and overweight/obesity rates.

Thirdly, there is not a world-wide accepted definition of what makes up a neighborhood. However, census tract is widely used across the United States. Not much attention is given to whether census tract or other geographic methods used are consistent with the perceptions of individual of what should constitute a neighborhood. Though the

convenience of utilizing geographic units allowed the literature regarding neighborhood effects to grow and produce compelling results, one major challenge to validity is misclassification. Lastly, to capture the features of the neighborhood, there are a number of strategies that have been employed. One of the strategies used is self-report, which is widely used for capturing data on the neighborhood level. The challenges of self-report strategies are evident. However, one specific issue regarding neighborhood effects is the possibility of source bias. Also, the possibility of systematic bias in the reports of participants may be an issue due to their social desirability, lifestyle and personality. The characteristics of neighborhood perceptions may vary, and it is not appropriate to consider self-report to be compatible with objective reality. In addition, the data emerging from the effects of the neighborhood are persuasive. The challenges pertaining to the methodological aspects are well noted. Thus, improving these data methodology is a potential to corroborate intervention and prevention endeavors in the future. Undeniably, due to extensive differences in the operationalization of the neighborhood food environment, many of the challenges relating to measurement remain unanswered, for example, what to measure, kind of assessment technique etc., Figure 17.

1. What should we measure? (e.g., access, quality, utilization)
2. What are the different dimensions of "food access"? (e.g., geographic accessibility of stores, selection of produce, affordability)
3. What kind of assessment techniques are appropriate for capturing each dimension of access? (e.g., store audits, GIS, surveys)
4. What, if anything, do residents' perceptions of their food environment add to the measurement of food access?
5. What is the "gold standard" for each access dimension, and how should we establish the validity of proposed measures? (e.g., convergent validity of GIS-based measures against store audits)
6. How do we integrate both "good" and "bad" features of food retail so that it accurately reflects the environment of residents? (e.g., neighborhoods that have an abundance of supermarkets as well as fast food outlets)
7. How might the best measure food environments require adaptation by geographic region? (e.g., urban versus rural, U.S. environments versus non-U.S. environments)
8. Which measures of access have been adequately studied and which are most ripe for attention?
9. Which features of the food environment are most important for health? (i.e., how do various measures of the food environment affect dietary patterns?)
10. What features of the food environment might be most amenable to interventions to improve food access?

Figure 17 Challenges unanswered of food environment measurement
Adapted from Caspi et al. 2012

6.4 Implications for social change

Addressing the growing problem of adult obesity in the United States is a challenging prospect. The ever-increasing complexity of the health care sector and difficulties in addressing chronic conditions such as adult obesity reiterates the necessity of doctorate-prepared nurses [156]. In the present study, there were negative associations between obesity and neighborhood fast-food restaurants and socioeconomic levels. As there is a significant gap in the research regarding the association between neighborhood fast-food restaurants and obesity, several implications can be drawn from the present study results. The present study provides a foundation for various social changes and efforts that could be directed toward reversing the trend of adult obesity among residents in NYC.

The present study's findings will contribute to the existing knowledge about obesity and could be used to inform the development of policies to reduce and prevent the

condition among minorities. Besides, this study can be utilized to initiate positive social change in practice by educating residents on the benefits of regular avoiding the consumption of too much calories especially food consumed away from fast-food restaurants which mostly affect minorities. This improved knowledge and awareness would lead to a significant reduction in the rate of obesity in NYC. Numerous obesity-control and prevention initiatives and policies have been launched in several states and localities [129]. For instance, the CDC provides funding for 50 state-based initiatives that aim to control and prevent obesity by promoting physical activity and healthy eating practice[157].

Also, the study's findings can also guide the transformation of environments that are known to discourage physical activity behaviors and eating habits among residents through social action and the development of health policies at the local and community levels. If the local and community-level initiatives promote behavioral change in the adult's behavioral styles, similar interventions could be recommended for other states and minority communities. The latest statistics indicate the prevalence of obesity in all the low-SES and ethnic groups show that adults living in all neighborhoods are still below the Healthy People 2010 goal [158]. Therefore, community-based initiatives that aim to transform the built environments and social and physical environments in low-income areas could be effective in reducing the prevalence of obesity among minorities such as African Americans.

6.5 Conclusion

The impact of obesity on adults cannot be underestimated. Therefore, early recognition, evaluation, and prevention are essential to reducing the condition's prevalence, especially among African American adults and other minorities in the United States. Besides, adult obesity can also increase the risk of psychological and social problems, including low self-esteem and stigma [159]. Most importantly, obese young adults have a higher likelihood of suffering from obesity throughout adulthood[160]. This quantitative study assessed the impact of neighborhood-fast-food restaurants on obesity among adults in NYC. Data analysis was conducted with multiple linear regression using secondary data from the CHS survey for the year 2017.

The multiple linear regression findings indicated that adult obesity was negatively associated with the density of neighboring fast-food restaurants. The relationship is very complex, which suggest that the fast-food environment's impact goes well beyond a mere negative association between density of fast-food and BMI. Rather, there are various components of the fast-food environment that show differences in association with BMI. For example, the different types or classifications of restaurants available in these neighborhoods may function as a striking determinant for weight status. Although the findings were consistent with other studies depicting fast-food outlets and their influence on obesity among adults; it is safe to say that inconsistent findings regarding the availability of fast-food restaurants and obesity can stem from variances in methodological approach, especially when looking at food environment measures. Studies exploring the association of

neighborhood food environment and obesity have used different methodologies to measure fast-food density.

Undoubtedly, further studies are warranted regarding fast-food density and obesity. Nonetheless, this study will add to the developing body of science, which investigates the neighborhood level influence of the fast-food environment on population health. Therefore, as was previously presumed, the study's outcome corroborated with the findings of other investigators who used similar data and methodologies. They supported the assertion that an increased in the density of fast-food restaurants in neighborhoods does not lead to higher obesity prevalence in NYC with socioeconomic status serving as a control variable. It is recommended for future studies to consider looking at the restaurant mix as well as other influential factors of the fast-food environment that may play a role in differences in weight outcome. This study, however, will contribute to existing knowledge and further inform research on the density of the fast-food environment and its influence on obesity.

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