SPATIAL ANALYSIS OF HALAL RETAIL FOOD STORES IN THE GREATER TORONTO AREA

by

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Abstract

Spatial Analysis of Halal Retail Food Stores in the Greater Toronto Area
Master of Spatial Analysis
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This major research paper analyzes the distribution of Halal restaurants in the Greater Toronto Area (GTA) and explores how factors like population density, income, commuting patterns, and proximity to mosques affect access to Halal food. Using data from Zabihah.com and the 2021 Canadian Census, the research reveals that Halal restaurants are concentrated in areas with significant Muslim populations, such as Scarborough, North York, Mississauga, and Brampton. In contrast, suburban regions like Durham and parts of York have fewer Halal options, reflecting disparities in access. The study highlights the strong relationship between Halal restaurants and mosque locations, suggesting that religious infrastructure is key to food accessibility. This research contributes to a deeper understanding of food accessibility within diverse urban environments and underscores the need for culturally sensitive approaches in urban planning.

Keywords: food accessibility; halal food; spatial analysis; Greater Toronto Area

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CHAPTER ONE: INTRODUCTION

1.1. Introduction

This research explores access to halal food in the City of Toronto, Ontario with specific focus on locations and patterns of restaurants serving halal items. Food is a necessary part of daily life. Food is not only differentiated by ethnic and cultural origins, but also through faith-based restrictions. There are different types of faith-based dietary restrictions for different groups of religious people. For instance, in Islam, Muslim people only eat food that is considered halal.

In Islam if something is halal it refers to something that is considered permissible or lawful. Alternatively, something that is Haram is, something that is impermissible or unlawful (Dali et al., 2009). The general guidelines for halal foods are (see Dali et al., 2009):

1. All materials and ingredients used must be halal.
2. Animals considered to be naturally halal, such as cattle and goats are required to be slaughtered by a Muslim of sound mind following Islamic ritual, and must sever the blood and respiratory animals, and drain the blood.
3. Halal ingredients must not be mixed with Haram products such as meat from pigs and donkeys at any point along the food process.

Studying the accessibility of culturally and religious specific foods, such as halal foods, holds a significant place in the broader context of food distribution and accessibility. For Muslim communities, the consumption and availability of halal foods is a critical component of maintaining not only their livelihood, but of religious obligatory duty, as well as cultural and spiritual identity. The consumption of halal food is seen as a means of maintaining purity and

connection with God. The availability and accessibility to halal foods is important for Muslim individuals to observe with their faith and engage in religious practices.

1.2. Research Context

Access to halal foodstuff can be integrated into a broader context of food accessibility. Food accessibility is a critical aspect of making sure that all people have equitable access to a sufficient and nourishing food supply (Ashik et al., 2022; Andreyeva et al., 2008). Food accessibility refers to the degree at which people have physical, economical, and social means to acquire a nutritionally adequate diet. This includes people's geographic proximity to necessary food outlets, the cultural specificity of the foods they have access to, the affordability of those foods, as well as the social acceptance of the available food (Hill et al., 2012; Arsil et al., 2018). Learning to understand the barriers and challenges affecting food accessibility, can work to promote the health and social wellbeing of the population. Studying the complexities of food accessibility and distribution is important due to its direct impacts on a community's food security, and overall health outcomes (Hill et al., 2012).

Understanding the distribution and accessibility of halal foods aligns with the principles of equity and inclusions that food accessibility aligns with. Ensuring equitable access to halal foods is readily available and easily accessible to Muslim populations allows for Muslims to fully participate in society and enjoy equal opportunities with regards to food choices (Al-Teinaz, 2020). By addressing the specific needs of Muslim people, a more inclusive and diverse food system can be fostered. This can promote social cohesion and enhance the overall wellbeing of the population (Baharuddin et al., 2015). Studying the distribution and accessibility of halal foods also recognized the intersectionality of identities in food justice. Muslim people are a

marginalized group, and face many layers of marginalization, and analyzing the distribution of halal foods can contribute to dismantling systemic barriers and promoting justice in diverse communities (Hanniman, 2008).

Additionally, social acceptance pertains to the overall endorsement and integration of food outlets within a community, encapsulating the community's general approval, alignment with cultural norms, and the perceived value these establishments offer to the local population. Cultural appropriateness within food accessibility, preferences, dietary needs, or religious beliefs. In the context of halal food accessibility, this dimension becomes particularly relevant.

1.3. Research Questions

Within this context, accessibility to culturally appropriate food can be explored using spatial analysis techniques. These can identify different dimensions of accessibility: *physical accessibility* refers to the presence and distribution of food outlets in a geographic area; and *economic accessibility* refers to the affordability and the cost of food within a geographic area. Many factors such as income levels, cost of food, transportation costs to access food, all influence an individual's capability of accessing food.

Spatial analysis techniques can be used to identify areas with higher concentrations of halal food outlets, while statistical analysis can explore the relationships between halal food options and certain demographic factors. Given this, this research considers the following question: *what is the spatial pattern of access to halal restaurants in the Greater Toronto Area?* To address the question, there are three more focused research questions:

RQ1: Where are halal restaurants in the Greater Toronto Area?

RQ2: What is the relationship between the restaurant and socio-economic factors?

RQ3: What the spatial relationship between restaurants and mosques?

Although food accessibility research generally focuses on access to grocery stores, butchers, and other primary food sources, this study focuses on access to food from restaurants. Traditional studies on food accessibility often prioritize the need for individuals to obtain food for their homes, but this approach neglects the importance of people's lives outside of their residences (Hill et al., 2012; Andreyeva et al., 2008). Social life is a critical component of a person's daily experience, and access to appropriate foods should include the foods available in social settings, such as when dining out with friends or family. This study expands the concept of accessibility by considering not just food as a necessity but also as a key social activity and source of pleasure. Having access to culturally appropriate foods in social contexts, such as restaurants, contributes significantly to overall food accessibility (Arsil et al., 2018). By including restaurants in this study, we are acknowledging that food accessibility encompasses not only domestic consumption but also social, cultural, and community-oriented spaces.

Additionally, the inclusion of mosques in this study alongside halal restaurants is based on the significant role mosques play in the daily lives of Muslims. Mosques are a central element of Muslim social and religious life, as Muslim men are required to pray at the mosque for each of the five mandatory daily prayers (Al-Teinaz, 2020). This ensures that there is consistent foot traffic in and around mosques throughout the day. People spend much of their time outside of their homes, and since mosques are an integral part of life for practicing Muslims, they become focal points for the Muslim community. Given that halal food is a religious requirement for Muslims, it is logical that individuals in or around mosque areas will seek halal food options during their time outside of the home. Thus, the connection between mosque locations and halal

food establishments is a critical aspect of understanding how and where Muslim individuals access culturally appropriate foods (Baharuddin et al., 2015).

Where people choose to eat depends largely on where they spend their time during the day. Food is a necessity throughout the day, and examining where people are located at different times provides insights into their access to halal food. One key element is where Muslim individuals live; identifying areas with larger Muslim populations provides an essential starting point for understanding food accessibility (Arsil et al., 2018). Additionally, mosque locations are central to the daily habits of many Muslims, offering further insight into where people may seek halal food options. For example, people who live close to their workplace may eat lunch in their neighborhood, whereas those with longer commute times might look for food options along their commute routes or destination (Hill et al., 2012). By analyzing commute times and mosque locations, we can explore how access to halal food varies across different areas and how Muslim individuals navigate food accessibility throughout their daily routines.

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

Food accessibility plays an important role in people having an equitable and reasonable access to a nutritional diet. This literature review chapter will provide a comprehensive overview of the food accessibility, including its definitions, key concepts, and relevant theories. It explores various facets of food accessibility, encompassing physical availability, economic accessibility, cultural appropriateness, and social acceptability. Additionally, it introduces a conceptual grounding to support the spatial and statistical analyses, aiming to facilitate a comprehensive examination of the distribution, and subsequent accessibility of foods, specifically sourced from a user-contributed platform.

2.2. Factors Influencing Food Accessibility

Food accessibility is a multifaceted concept influenced by various individual and structural factors that shape individuals' ability to obtain and consume nutritious food. This section presents a literature review of the factors that impact food accessibility, examining both individual-level determinants and structural influences. Understanding these factors is crucial for addressing food inequalities and developing effective strategies to enhance access to healthy food options.

Income is a fundamental individual-level determinant of food accessibility, with higher incomes associated with greater purchasing power and the ability to afford a wider range of food choices (Yaktine & Caswell, 2013). Educational attainment also plays a significant role, as individuals with higher education levels often possess greater knowledge of nutrition and make

informed food decisions (Ashik et al., 2022). Cultural and religious beliefs influence dietary preferences, and individuals adhering to specific dietary practices, such as halal or vegetarian diets, may encounter challenges in finding suitable food options (Arsil et al., 2018).

Structural factors have a substantial impact on food accessibility at community and societal levels. Geographic location is a critical determinant, with individuals residing in rural areas or food deserts facing significant challenges in accessing affordable and nutritious food (Andreyeva et al., 2008). Food deserts, characterized by limited proximity to grocery stores or supermarkets, necessitate individuals to travel long distances to obtain fresh and healthy food options (Sharkey & Horel, 2008).

Transportation infrastructure plays a vital role as well. Limited access to public transportation or inadequate transportation systems can restrict individuals' ability to reach food retail outlets, particularly for those without personal vehicles (Sharky and Horel, 2008). The availability and affordability of transportation options, such as buses or community programs, are important considerations in understanding food accessibility.

Policy and regulatory frameworks shape the food environment and subsequently impact food accessibility (Andreyeva et al., 2008). Government policies that support the establishment of grocery stores in underserved areas or provide incentives for healthy food retailers can improve accessibility (Hill et al., 2012). Conversely, zoning regulations, licensing requirements, and a lack of government support may contribute to the concentration of unhealthy food options in marginalized communities, exacerbating food inequalities (Larson et al., 2009).

In addition, individual-level determinants, including income, education, dietary preferences, and cultural or religious beliefs, significantly impact individuals' ability to access appropriate food (Baharuddin et al., 2015). Structural factors such as geographic location, the

presence of food deserts, transportation infrastructure, and policy and regulatory frameworks further shape food accessibility (Hill et al., 2012). Understanding these factors is crucial for developing evidence-based strategies that address both individual and structural determinants, leading to a more equitable and accessible food system. Policymakers, researchers, and communities must collaborate to design interventions that promote equitable access to nutritious food for all individuals, irrespective of socioeconomic status or geographic location.

2.3. Halal Foods: Concept and Importance

Halal foods hold significant cultural and religious importance to Muslim individuals and communities worldwide. This section provides a literature review on the concept and importance of halal foods, exploring the principles and guidelines governing halal dietary practices. Additionally, it discusses the cultural and religious contexts in which halal foods are consumed and the potential challenges faced by Muslim individuals in accessing halal food options.

Halal, an Arabic term meaning "permissible," refers to foods and products that are permissible for consumption according to Islamic dietary laws (Baharuddin et al., 2015). These laws, derived from the Quran and the teachings of the Prophet Muhammad, provide guidelines on the types of foods and the manner of their production and preparation that are deemed lawful for Muslims (Al-Teinaz, 2020). Halal dietary practices encompass several key principles, including the prohibition of pork and pork by-products, the avoidance of intoxicants, and the requirement for animals to be slaughtered in a specific manner, among others (Al-Teinaz, 2020).

Halal foods are of great significance to Muslim individuals and communities globally. The consumption of halal foods is seen as an act of obedience to religious obligations and a means of maintaining purity and spiritual well-being (Al-Teinaz, 2020). It fosters a connection

between individuals and their faith, promoting a sense of identity and belonging within the Muslim community. Halal foods also play a vital role in Islamic rituals and celebrations, such as during Ramadan and Eid al Adha, where adherence to halal dietary practices is essential (Al-Teinaz, 2020).

The consumption of halal foods is deeply intertwined with cultural and religious contexts. Halal food options are not only sought after by Muslims for their adherence to religious guidelines but also for the cultural significance they hold (Al-Teinaz, 2020; Arsil et al., 2018). Halal foods often reflect cultural traditions, local cuisines, and regional flavors, making them an integral part of cultural identity and heritage for Muslim communities (Al-Teinaz, 2020; Baharuddin et al., 2015). However, accessing halal food options can be challenging, particularly in non-Muslim majority countries or areas with limited halal food availability (Al-Teinaz, 2020; Baharuddin et al., 2015). Muslim individuals may face difficulties in finding halal-certified restaurants or suitable halal food products, which can pose a barrier to adhering to their dietary practices (Arsil et al., 2018; Baharuddin et al., 2015).

Halal foods hold significant importance to Muslim individuals and communities, serving as an embodiment of religious principles and cultural heritage. The concept of halal foods is rooted in Islamic dietary laws and governs the permissibility of various food items (Al-Teinaz, 2020). Accessing halal food options can be challenging, particularly for Muslim individuals residing in non-Muslim majority areas or locations with limited halal food availability.

2.4. Intersectionality of Social Determinants

Understanding the cultural and religious contexts surrounding halal foods and the challenges faced by Muslim individuals in accessing them is crucial for promoting inclusivity

and ensuring equitable food access for diverse populations. Policymakers, food industry stakeholders, and community organizations should collaborate to address these challenges and enhance the accessibility and availability of halal food options, thereby facilitating the religious practices and cultural identities of Muslim individuals and communities (Al-Teinaz, 2020; Baharuddin et al., 2015). Furthermore, understanding the intersectionality of social determinants and its impact on food accessibility is crucial for addressing disparities within diverse populations (Atewologun, 2018). This section provides a literature review on the intersectionality of food accessibility, specifically focusing on the influence of intersecting identities, such as race, ethnicity, gender, and socioeconomic status, on the accessibility of halal foods within Muslim communities (Ashik et al., 2022).

Food accessibility is deeply intertwined with various social determinants, including race, ethnicity, gender, and socioeconomic status. Intersectionality theory recognizes that individuals experience multiple forms of disadvantage simultaneously, and the interaction between different identities can result in unique challenges and barriers (Atewologun, 2018). For example, racial and ethnic minorities often face systemic inequities and discrimination that impact their access to resources, including food (Larson et al., 2009). For instance, individuals from marginalized racial and ethnic groups may encounter limited availability of halal food options in their neighbourhoods, leading to reduced access and reliance on non-halal substitutes (Arsil et al., 2018; Al-Teinaz, 2020). Furthermore, socioeconomic disparities can create additional barriers, as lower-income individuals may struggle to afford halal foods, which are sometimes priced higher than non-halal alternatives (Ashik et al., 2022). Gender dynamics can also play a role in shaping halal food accessibility. Cultural norms and gender roles within Muslim communities may restrict women's mobility and ability to access food outlets, thereby affecting their access to halal

food options. This can particularly impact women from conservative backgrounds who may face challenges in navigating public spaces to obtain halal foods (Baharuddin et al., 2015).

Understanding the intersectionality of social determinants and its impact on food accessibility is essential for addressing disparities within Muslim communities. The intersecting identities of race, ethnicity, gender, and socioeconomic status shape the accessibility of halal foods for different groups within Muslim populations (Atewologun, 2018). Racial and ethnic minorities, women, and individuals from lower socioeconomic backgrounds may face unique barriers in accessing halal food options due to systemic inequities, spatial distribution, cultural preferences, and affordability constraints (Arsil et al., 2018; Hill et al., 2012). Efforts to improve halal food accessibility should consider the diverse needs and experiences of different groups within Muslim communities, and policymakers, community organizations, and food industry stakeholders should collaborate to develop strategies that address the intersectional challenges and promote equitable access to halal foods for all individuals, regardless of their intersecting identities.

CHAPTER THREE: DATA AND METHODS

3.1. Introduction

To address the study research questions (see section 1.3) a quantitative and spatial approach was used. The integration of multiple sources and types of data allowed for a spatial analysis that: 1) identified where halal restaurants are located; 2) the relationship between these restaurants and socio-demographic factors; and 3) the spatial patterns of restaurants and mosques.

3.2. Data

The primary data source for this research was Zabiha.com, an online directory that specializes in listing halal restaurants and businesses across various regions, particularly catering to the needs of Muslim consumers. Zabiha.com allows users to search for halal-certified eateries and businesses, providing a comprehensive and user-verified database. The platform categorizes these establishments by location, offering detailed information about each restaurant, including its address, type of cuisine, and halal certification status. For this study, there were two key areas of focus: restaurant and mosque locations.

For this study, listings available on Zabiha.com were scraped for the Greater Toronto Area (GTA), while mosque locations were scraped from Salatomatic.com (a subsidiary of Zabiha.com). The GTA was selected due to its significant and diverse Muslim population, making it an ideal area for analyzing the availability and distribution of halal food options. The data collection from Zabiha.com was conducted in May 2022. The restaurants were geocoded,

allowing for a detailed spatial analysis of the distribution of halal dining options across the region.

To complement the data collected from Zabiha.com, demographic data was obtained from the 2021 Canadian census through CHASS. The census provided comprehensive demographic data in several areas at the census tract level: 1) Muslim population, to provide a social context, as well as a proxy for demand; 2) household income, to serve as a measure of economic barrier; and 3) commuting times (both less than 15-minutes and less than 1-hour), to capture structural barriers to restaurant access. This data was essential for contextualizing the distribution of halal restaurants against the backdrop of the region's Muslim population.

3.2.1. Data Collection

The data collection process involved two primary steps:

1. **Halal Restaurant Data Collection**:
    - The data on halal restaurants were collected from Zabiha.com in May 2022. Using the platform's search and filter functionalities, I extracted a list of all halal-certified restaurants within the GTA. The data included the name of each restaurant, its location, type of cuisine, and any additional notes on its certification status.
    - The collected data were organized using Microsoft Excel, where each restaurant's information was systematically entered into a spreadsheet. This organization facilitated the subsequent analysis and ensured that the data were easily manageable.

- To analyze the spatial distribution of the restaurants, the listed addresses were geocoded—a process that converts addresses into geographic coordinates (latitude and longitude). These coordinates were then plotted on a map using ArcPro, a geographic information system (GIS) software. This mapping process enabled a visual analysis of the distribution patterns of halal restaurants across different neighborhoods in the GTA.

2. **Demographic Data Collection**:
    - Demographic data were gathered from the 2021 Canadian Census, focusing on the GTA. This included data on population size, density, and the distribution of the Muslim population. These statistics were crucial for understanding the relationship between the availability of halal food options and the needs of the local Muslim community.

3.3. Methods

There were two primary methods used in this analysis. The first was a descriptive cartographic approach that was used to identify the locations of halal restaurants in the GTA, and to compare them to the distribution (at the census tract level) of the different socio-demographic structures that could impact access. This approach evaluated research questions 1 and 2.

The second approach, Getis-Ord Gi*, measure the spatial autocorrelation in the distances between mosques and halal restaurants (ESRI, 2024a). The basis for Gi* is that each feature (i.e., a mosque) is examined within the context of neighboring features (i.e. a defined set of neighbouring mosques). A feature with a high value is interesting but may not be a statistically significant hot spot. To be a statistically significant hot spot, a feature will have a high value and

be surrounded by other features with high values as well. In this study, the distance from the mosque to the nearest halal restaurant was analyzed. This was captured as a linear distance using the *Near* calculation in ArcPro. As a result, the Gi* can identify clusters where there are consistently large (or small) distances from neighbouring mosques the nearest culturally appropriate restaurant.

Getis-Ord Gi* is defined as (see ESRI, 2024a):

$$G_i^* = \frac{\sum_{j=1}^{n} w_{i,j}x_j - \bar{x}\sum_{j=1}^{n} w_{i,j}}{S\sqrt{\frac{n\sum_{j=1}^{n} w_{i,j}^2 - \left(\sum_{j=1}^{n} w_{i,j}\right)^2}{n-1}}}$$

Where x_j is the distance to the nearest mosque at location j, $w_{i,j}$ is the spatial relationship between features i and j, and n is the total number of census tracts in the Toronto CMA (n = 1227). In addition, $\bar{x}$ (the mean) is calculated as:

$$\bar{x} = \frac{\sum_{j=1}^{n} x_j}{n}$$

and the standard deviation S:

$$S = \sqrt{\frac{\sum_{j=1}^{n} x_j^2}{n} - (\bar{x})^2}$$

Together, the Gi* calculates a Z-score, where values beyond =/- 1.96 are considered significant cold and hotspots (ESRI, 2024a). In the context of this study, a cold spot would be areas where there is a consistently short distance between mosques in proximity and the nearest restaurant. Alternatively, a hotspot would be areas where there is a consistently long distance between mosques in proximity and the nearest restaurant.

A key consideration of Gi* is how spatial relationships are defined through the weights matrix (w). To determine the number of neighbours, a second measure of spatial autocorrelation

– Global Moran's I – was employed. Global Moran's measures spatial autocorrelation based on both feature locations and feature values simultaneously, and is defined as (see ESRI, 2024b):

$$I = \frac{n}{W}\left(\frac{\sum_{i=1}^{n}\sum_{j=1}^{j} w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_{i=1}^{n}(x_i - \bar{x})^2}\right)$$

A series of permutations were used on the number of neighbours, with the *I* value, *z*-score and *p*-value used to determine the optimum number for *w*. Summarized in Table 3.1, k=5 has the highest Moran's Index, though all were broadly similar, k=15 has the highest z-score, and k=15 has the lowest p-value. Considering all the criteria, k=15 appears to be the best choice for your Global Moran's I analysis. Although k=5 has the highest Moran's Index, k=15 has the highest z-score and the lowest p-value, indicating the strongest and most statistically significant spatial autocorrelation.

Table 3.1: Moran's I outputs

	K= 5	K=8	K = 10	K = 15
Moran's Index	0.049849	0.042628	0.043596	0.035716
Expected Index	-0.000779	-0.000779	-0.000779	-0.000779
Variance	0.000245	0.000155	0.000124	0.000083
z-score	3.231530	3.487743	3.982240	4.016610
p-value	0.001231	0.000487	0.000068	0.000059

CHAPTER FOUR: RESULTS

4.1. Locations of Restaurants and Mosques

Figure 4.1 summarizes the distribution of halal restaurants in the Greater Toronto Area (GTA). Overall, there were 1836 locations identified, across three categories: restaurants (n = 1148), markets (n = 198), and caterers (n = 490). As Figure 4.1 shows, there is a dense concentration of these establishments in certain areas, particularly in Toronto and Mississauga. This is further supported by a regional summary of halal locations (see Table 4.1) which highlights that Toronto (n = 750) and Peel Region (i.e., Mississauga and Brampton; n = 610) were the areas of the GTA with the largest number of locations. Notably, in Toronto there is a large clustering of food locations in Scarborough (the eastern region of Toronto in Figure 4.1), having 257 businesses.

Table 4.1: Halal and Mosque Locations

Region	Restaurants	Markets	Caterers	Mosques
Durham	70	16	25	15
Toronto	490	84	176	85
Halton	95	18	45	7
York	122	21	64	22
Peel	371	59	180	47

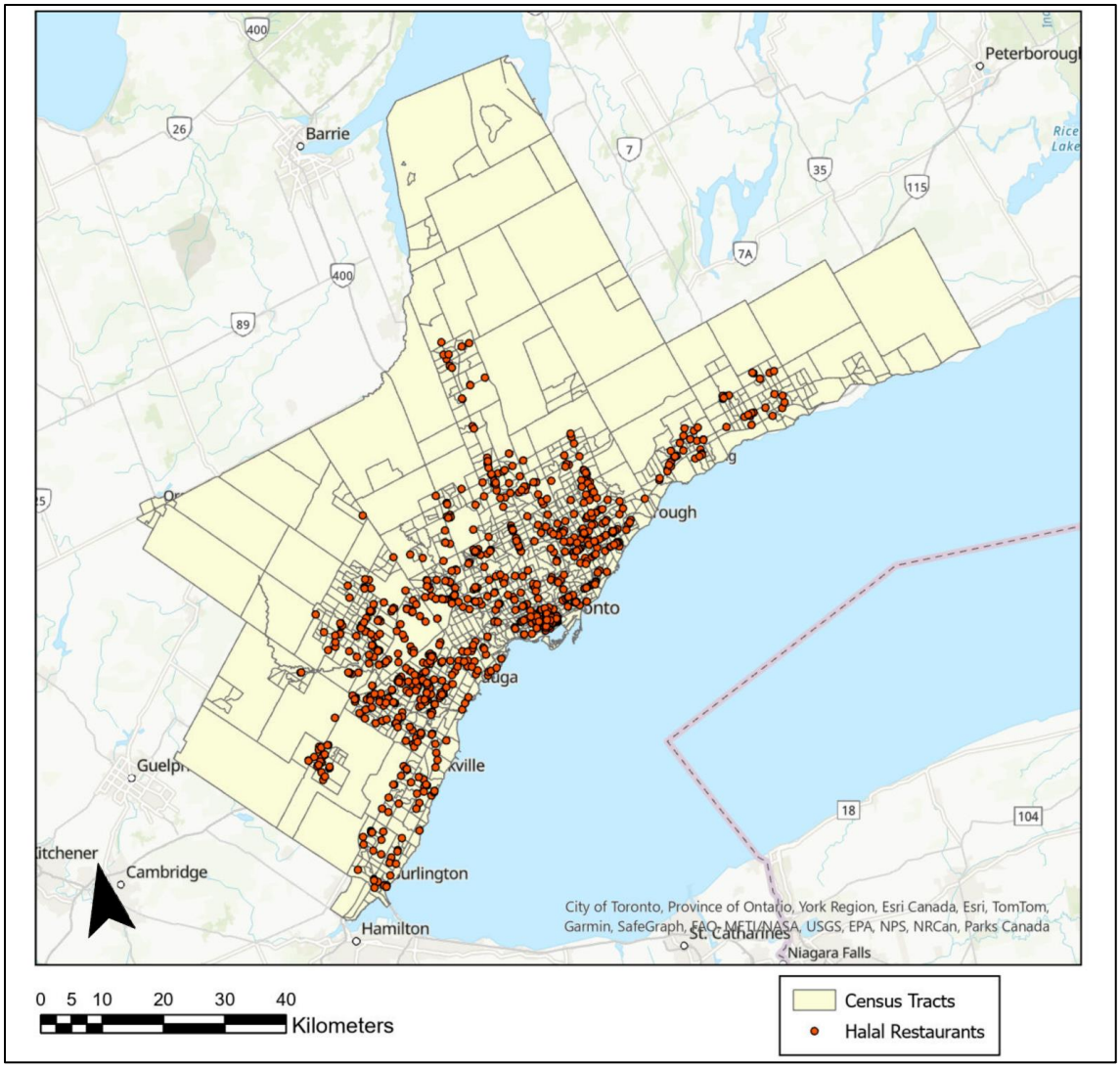

Figure 4.1: Halal food locations in the Greater Toronto Area

Figure 4.2 summarizes the distribution of mosques in the Greater Toronto Area (GTA). Overall, there were 176 locations identified. As Figure 4.2 shows, this smaller number of locations leads to a more dispersed pattern of mosques. This contrasts halal food locations (see Figure 4.1) which were concentrated in Toronto and Mississauga. Notably, despite having the largest number of mosques, there is a large portion of central Toronto where there are none. Instead, a large proportion (i.e., 35 of 85 mosques) were located in the Scarborough area of the

city. Similar to food locations, there are few mosques in the northern – more exurban and rural – areas of the GTA.

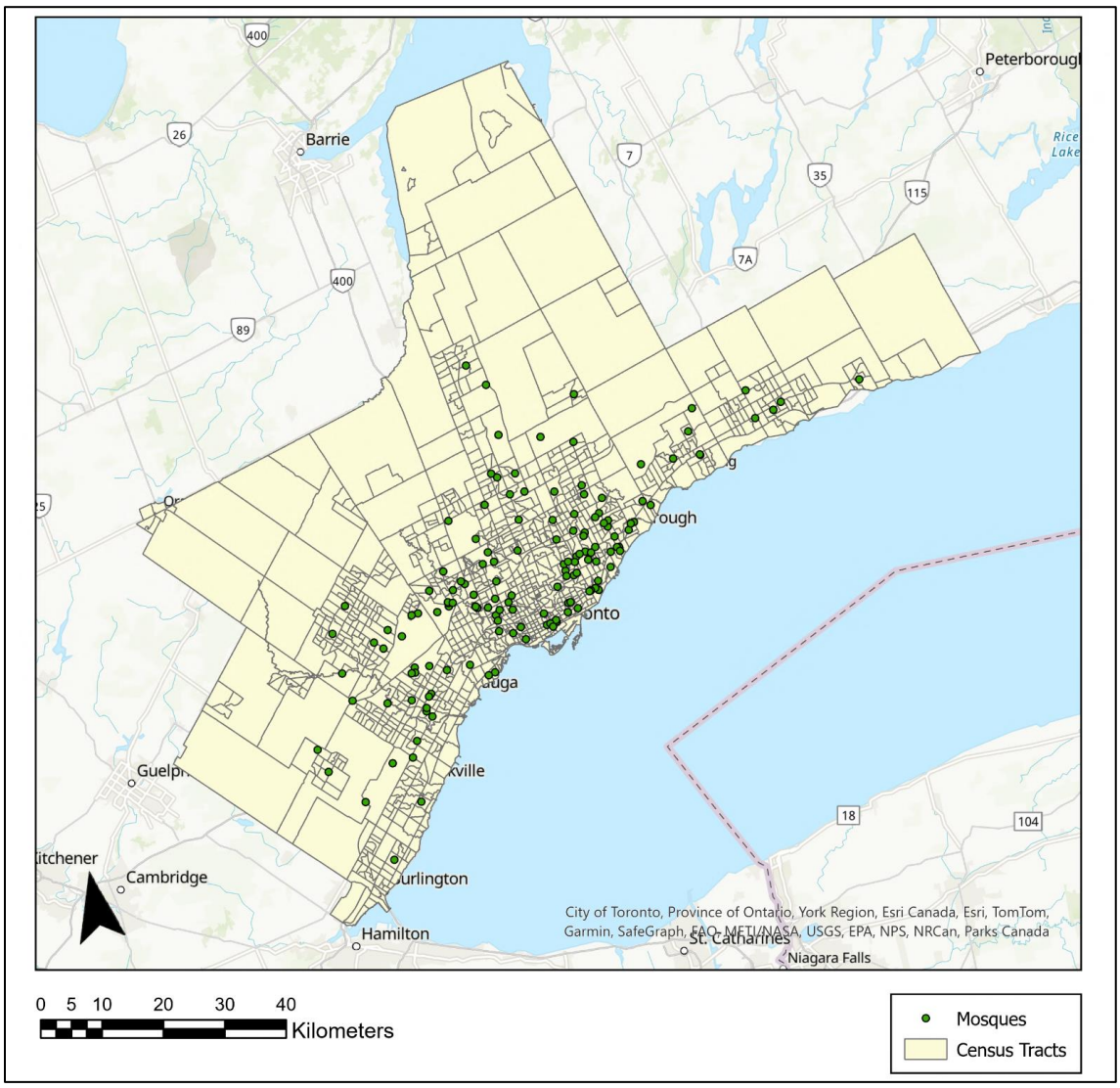

Figure 4.2: Mosque Locations in the Greater Toronto Area

4.2. Descriptive Analysis of Socio-Economic Barriers to Access

Figure 4.3 presents the distribution of the Muslim population of the GTA. This granular data allows for a precise examination of where the Muslim population is concentrated within the GTA. The map in Figure 4.3 uses a gradient color scale to represent the population distribution: lighter shades of orange indicate census tracts with smaller Muslim populations (ranging from 0

to 310 individuals), while darker shades of brown denote areas with the highest concentrations (from 2,486 to 6,640 individuals).

High-concentration areas are primarily found in parts of Toronto, Mississauga, and Brampton. These regions are likely to have a stronger demand for halal services, including restaurants and mosques, reflecting the community's religious and cultural needs. Comparing Figure 4.3 to 4.1 reveals that these areas often coincide with clusters of halal restaurants and mosques, as seen in the other maps, suggesting a strong relationship between population distribution and the availability of religious and cultural amenities. Conversely, areas with lower Muslim populations are often located in the more suburban or rural parts of the GTA. These areas may have fewer halal restaurants and mosques, potentially due to the lower demand, and are significant for identifying potential gaps in service availability, which could inform future planning and community services.

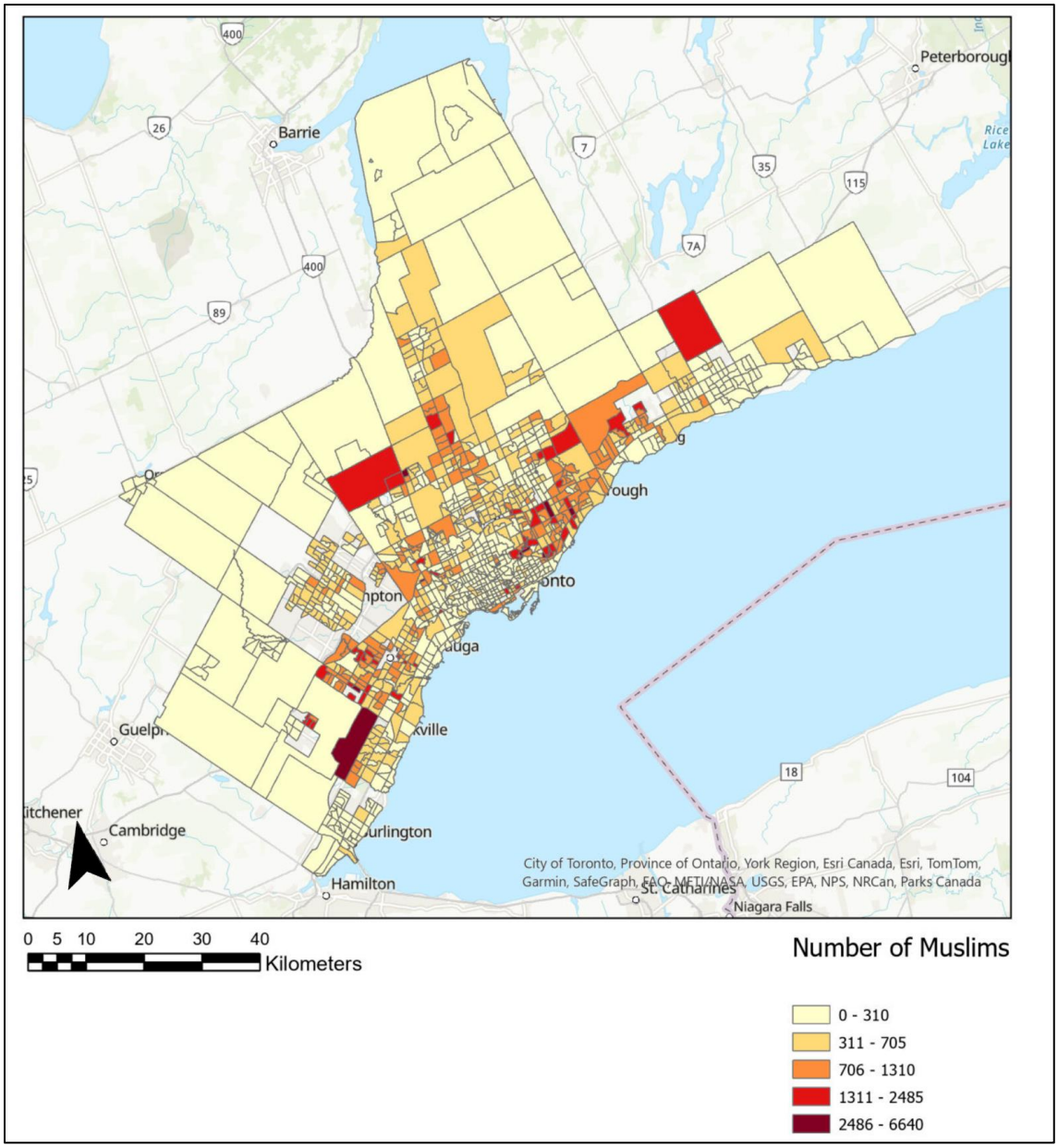

Figure 4.3: Muslim Population in the GTA

Figures 4.4 and 4.5 highlight the number of people who have short and long commutes in the GTA. Figure 4.4 identifies regions in the GTA where many people have very short commutes to work, less than 15 minutes. Darker green areas are concentrated in central Toronto and nearby suburbs like Mississauga, where strong local workforces and vibrant community life are evident. Comparing this with the Muslim population distribution, these areas also correspond to

neighborhoods with significant Muslim communities, which helps explain the dense presence of halal restaurants in these regions, as seen in the halal restaurant distribution map. The combination of short commuting times, higher income levels, and substantial Muslim populations in these areas supports a thriving local halal food scene, emphasizing the importance of proximity and community in the availability of halal dining options.

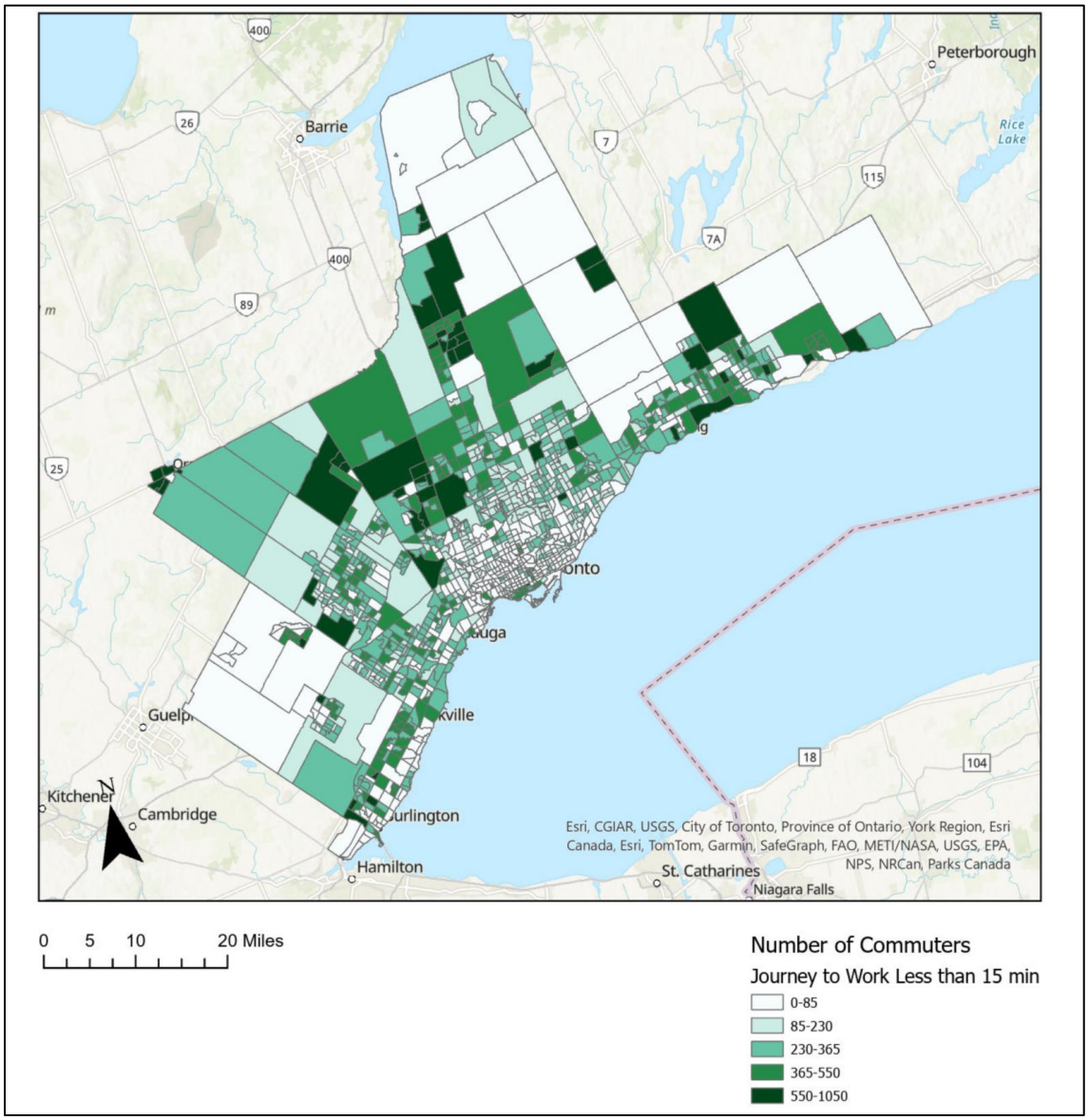

Figure 4.4: Commuting Duration (Less than 15 Minutes)

Figure 4.5 shows the distribution of commuters in the GTA who spend 45 to 59 minutes traveling to work, with darker green areas indicating higher numbers of commuters, particularly in suburban regions like Vaughan, Richmond Hill, and the outskirts of Toronto. These areas are characterized by significant commuting populations who may have fewer local halal restaurant options, as residents might dine near their workplaces instead of locally. When compared to the Muslim population and halal restaurant distribution maps, it's evident that areas with high commuting durations might have fewer halal restaurants despite having sizable Muslim populations. This highlights a potential gap in local service provision, suggesting that there may be unmet demand for halal dining options in these suburban communities where people travel long distances for work.

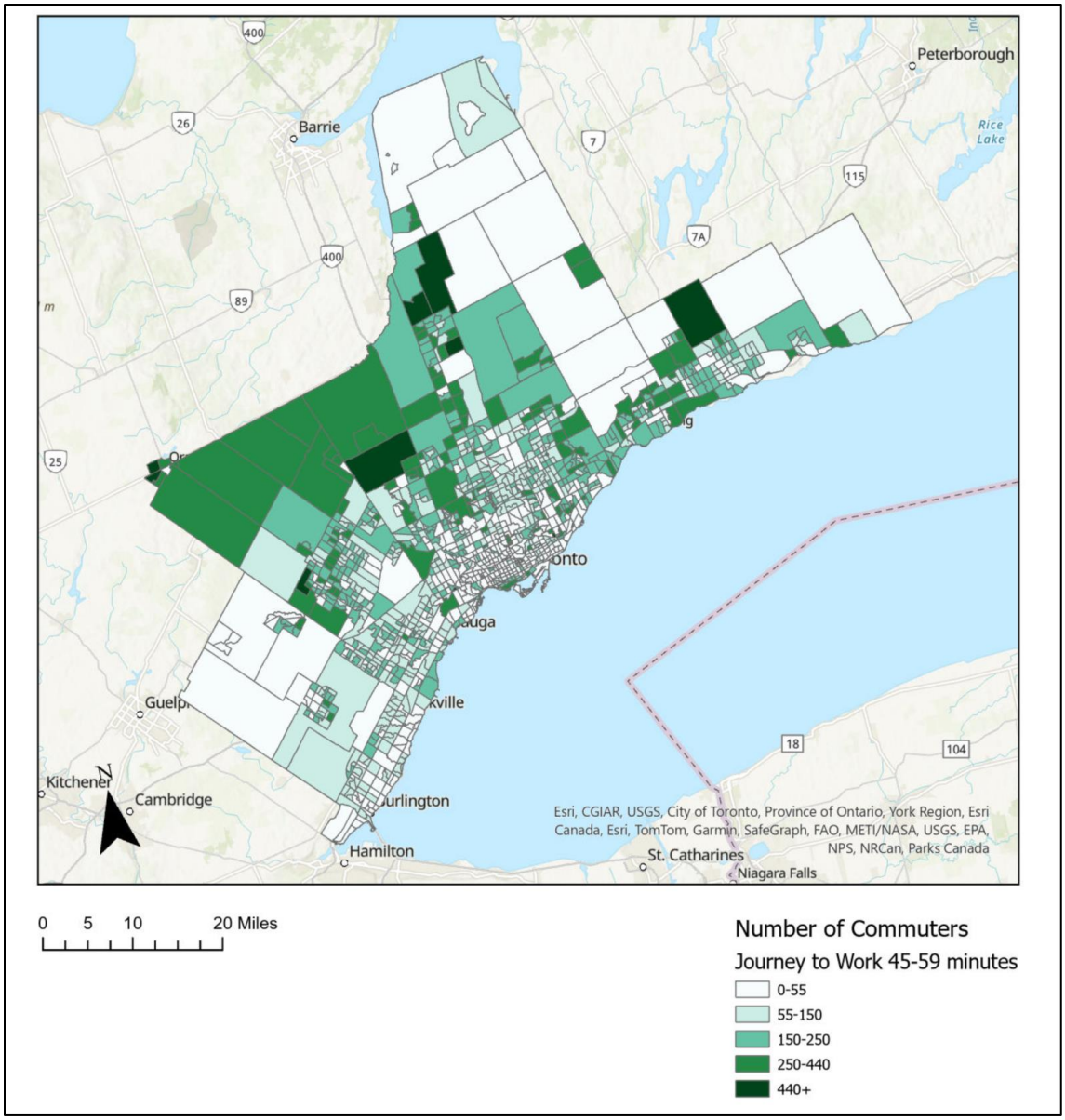

Figure 4.5: Commuting Duration (45-59 Minutes)

Finally, Figure 4.6 illustrates the distribution of average household income across the Greater Toronto Area census tracts. The average income map reveals important patterns in the distribution of halal restaurants and mosques across the Greater Toronto Area (GTA). Regions with moderate to high household incomes, such as North York, Mississauga, and Brampton, are characterized by a higher concentration of halal restaurants. This pattern suggests that these

middle to upper-middle-class neighborhoods, which also have significant Muslim populations, are well-positioned to support a thriving halal food industry.

Conversely, areas with lower average incomes, including parts of Durham Region and northern York Region, tend to have fewer halal restaurants. These regions not only have lower income levels but also smaller Muslim populations and longer commute times, factors that together contribute to reduced access to halal food options. Additionally, the presence of mosques plays a critical role; areas with established mosques typically see more halal restaurants nearby, underscoring the importance of religious infrastructure in shaping the availability of halal food. This analysis highlights how income, population density, and religious institutions collectively influence the spatial distribution of halal services in the GTA.

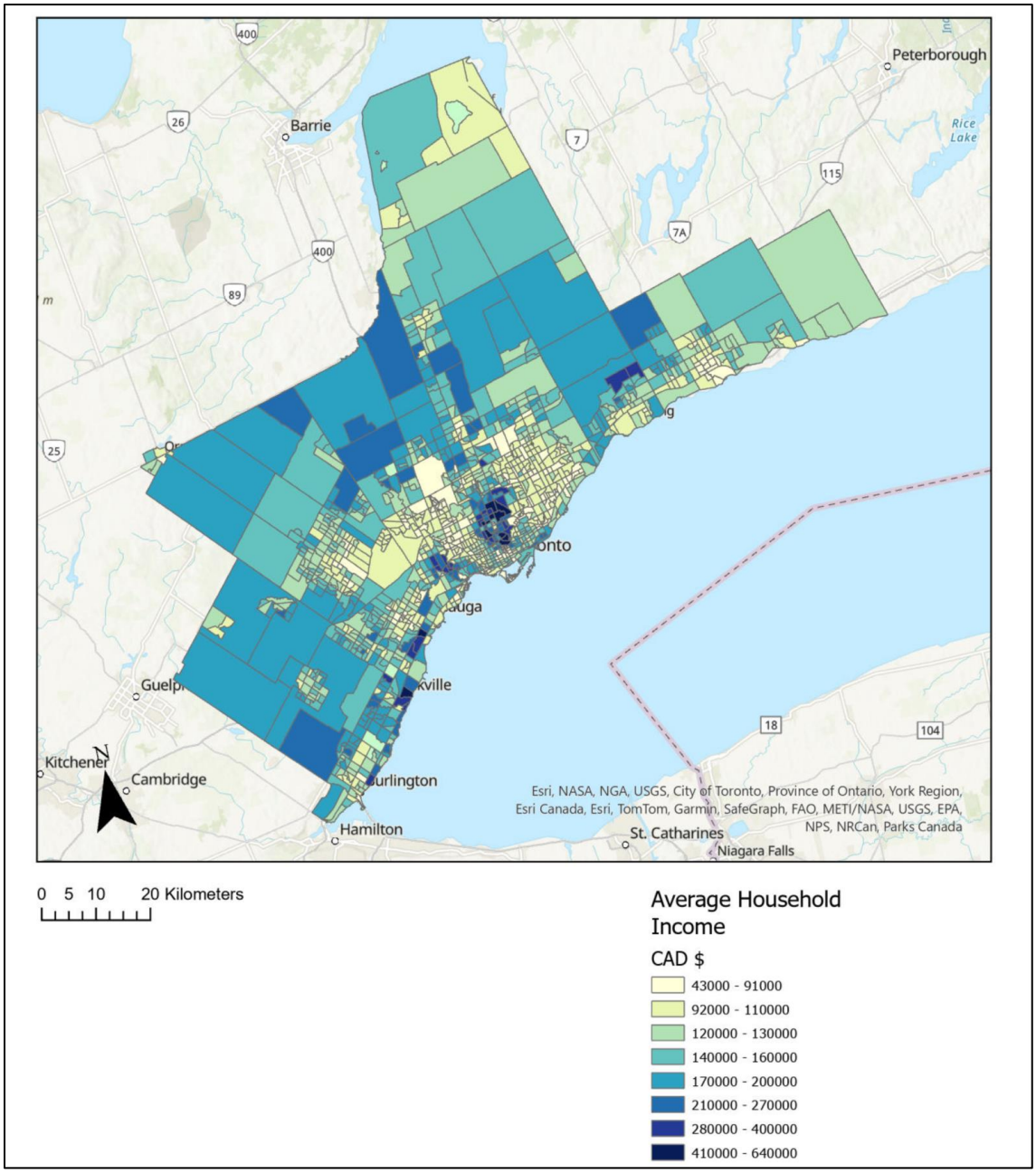

Figure 4.6: Average household income

4.3. Relationship between Restaurants or Mosques

Figure 4.7 presents the Getis-Ord Gi* Hot Spot Analysis of mosques in relation to their proximity to halal restaurants across the Greater Toronto Area (GTA). The analysis identifies areas where there is significant clustering of halal restaurants either close to or farther from

mosques. The color-coded areas provide insights into the spatial distribution of these restaurants relative to religious centers, with blue areas indicating restaurants that are closer to mosques and red areas showing those that are farther away.

The hot spots in Figure 4.7, are particularly located in southern parts of the GTA, such as Mississauga, Oakville, and Hamilton, indicate regions where halal restaurants are statistically farther from mosques. The highly statistically significant hotspots suggest that in these areas, restaurants are less likely to be situated near mosques, possibly reflecting a broader or more dispersed population base. These areas might have halal restaurants that cater to a diverse population that doesn't necessarily prioritize proximity to religious centers, possibly because these communities are more spread out or because the demand for halal food extends beyond the immediate vicinity of mosques.

In contrast, the statistically significant cold spots, are concentrated in central Toronto and surrounding areas, represent clusters where halal restaurants are significantly closer to mosques. This pattern suggests a strong spatial relationship, likely influenced by the high population density during the day. In downtown or central Toronto, many people commute in for work, school, or attractions, even if they do not reside in these areas. As a result, there is a higher demand for both mosque access and halal dining options, as Muslims who work, study, or visit downtown may seek convenient access to religious and dietary facilities. The proximity of halal restaurants to mosques in these areas could be a response to the needs of a transient but sizable population that spends significant time in the city during the day.

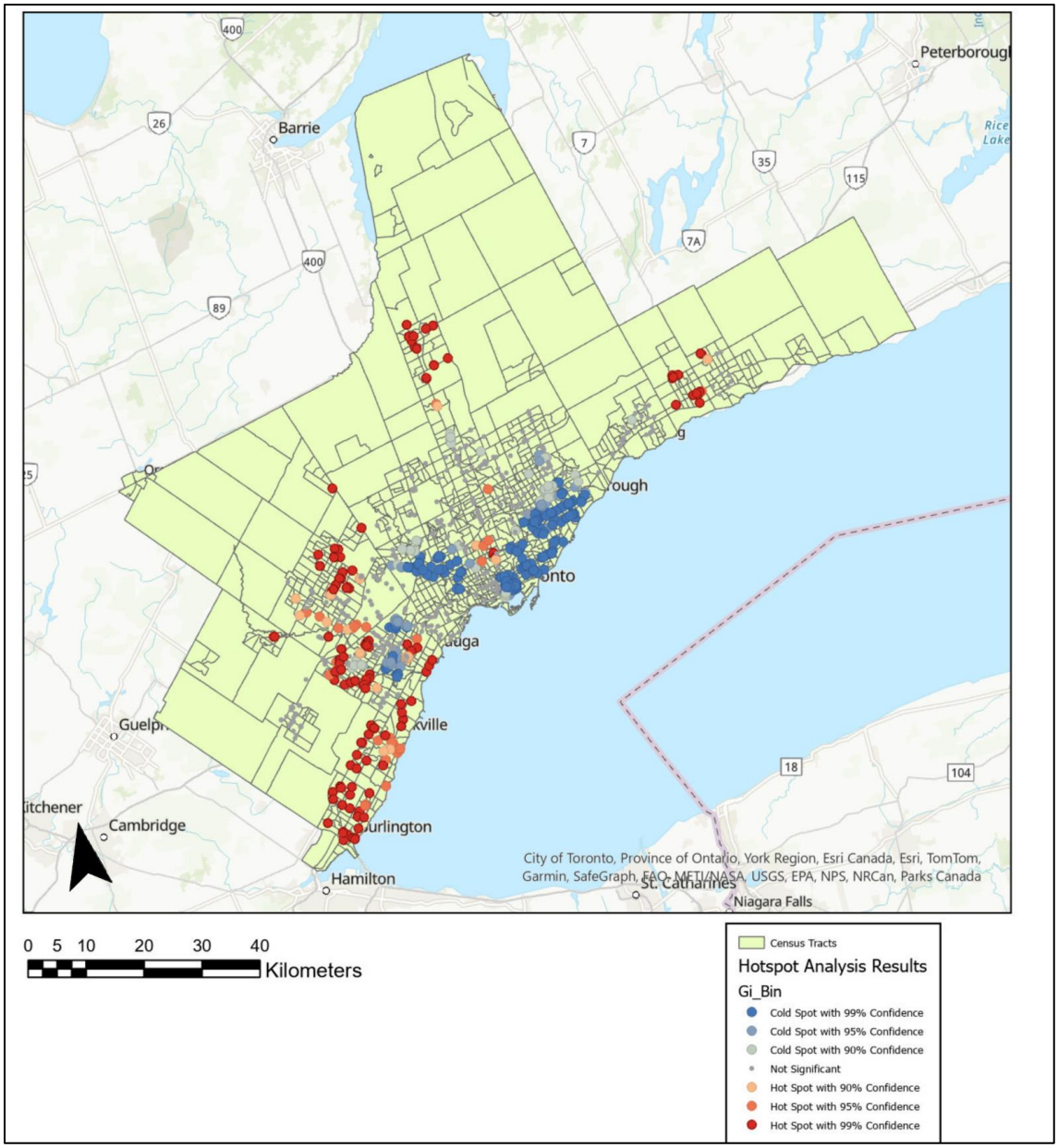

Figure 4.7: Getis-Ord Gi* Hotspots – mosques and halal restaurants

There are also large areas in the GTA that have significant clustering of mosques based on their distance to halal restaurants. This suggests that in some parts of the GTA, the distribution of halal restaurants is more random. In these regions, the spatial relationship between restaurants and mosques does not show any strong patterns, possibly reflecting varied factors such as the diversity of the local population, varying levels of demand for halal options, or different community structures.

CHAPTER FIVE: DISCUSSION AND CONCLUSION

5.1. Revisiting the Research Questions

The distribution of halal restaurants in the Greater Toronto Area (GTA) is highly concentrated in specific regions, particularly in the City of Toronto (notably in neighborhoods such as Scarborough and North York) and in the Peel Region (Mississauga and Brampton). These areas show a dense clustering of halal food options, indicating a high demand for such services. Scarborough and North York are especially prominent, reflecting their substantial Muslim populations. Similarly, Mississauga and Brampton in Peel Region exhibit significant concentrations of halal restaurants, particularly along major thoroughfares like Hurontario Street. In contrast, regions such as Durham Region and parts of York Region show a much sparser distribution of halal restaurants, suggesting either a smaller Muslim population or less demand for halal dining options in these areas.

Commute times provide additional context for the distribution of halal restaurants and mosques in the GTA. Areas with shorter commutes (less than 15 minutes), typically closer to Toronto's core, tend to have higher densities of halal restaurants and mosques. This pattern suggests that residents in these areas benefit from easy access to both religious and culinary services, which supports community cohesion. However, there are anomalies, such as census tracts in northeast Oshawa and northwest Vaughan, where a high number of people have both short (under 15 minutes) and long (45-59 minutes) commutes. These areas also have moderately high incomes and significant Muslim populations, yet lack halal restaurants and mosques. This could be due to these being newer communities that have not yet developed these services, or possibly due to zoning or reliance on nearby areas for these needs. In contrast, suburban areas

with longer commutes generally show a more dispersed distribution of halal services, reflecting a more spread-out lifestyle and different urban dynamics.

Areas with a high concentration of halal food options generally correspond with neighborhoods that have large Muslim populations and moderate to high income levels. For instance, neighborhoods in Scarborough, North York, Mississauga, and Brampton, where there are dense clusters of halal restaurants, are also home to significant Muslim communities. The Muslim population density map supports this, showing that these areas have the highest concentrations of Muslims in the GTA. Additionally, the average household income map reveals that these regions tend to have moderate to high incomes, further indicating that these communities have both the cultural and economic means to support a robust halal food industry. Conversely, in areas with fewer halal restaurants, such as Durham Region and parts of York Region, the Muslim population density is lower, and the communities may have a mix of lower to moderate incomes. These areas also tend to have longer commute times, as shown on the commute duration maps, which could contribute to the more dispersed nature of halal food services, reflecting a different urban lifestyle and possibly newer or less established Muslim communities.

When comparing the distribution of halal restaurants with the map showing the Muslim population in the GTA, a clear pattern emerges. The City of Toronto, particularly in the neighborhoods of Scarborough, North York, and parts of Etobicoke, shows a high density of Muslims, which aligns with the high concentration of halal restaurants. Similarly, in Mississauga and Brampton within the Peel Region, large Muslim populations correspond with numerous halal food establishments.

Figure 4.6, depicting average household income, shows that areas with moderate to high household incomes, such as parts of Mississauga, Brampton, and North York, also have a substantial number of halal restaurants. These areas likely represent middle-class to upper-middle-class Muslim communities who have both the means and cultural inclination to support a robust halal food industry. Conversely, areas with very high incomes, such as central Toronto and some parts of Oakville, show fewer halal food options, which may suggest a lower Muslim population in these high-income areas or a preference for non-halal dining options.
In contrast, areas with fewer halal restaurants, such as parts of Durham Region (e.g., Oshawa, Pickering), correspond with regions that have smaller Muslim populations and a mix of lower to moderate incomes, indicating lower demand for halal food services in these regions.

The relationship between halal food options and mosques is highlighted through the *Getis-Ord Gi** hotspot analysis (Figure 4.7), which examined the spatial proximity between halal restaurants and mosques. Cold spots on the map, where halal restaurants are located close to mosques, are primarily found in neighborhoods like Scarborough, North York, Mississauga, and Brampton. These cold spots suggest a strong, integrated Muslim community where both religious and culinary needs are met within close proximity, reflecting a high demand for accessible halal food near places of worship.

In contrast, hot spots, where halal restaurants are located further away from mosques, are observed in more suburban areas, such as in parts of York Region and Durham Region. These areas may have a more dispersed or newer Muslim population, leading to a greater distance between these essential community services. The maps of commute times further explain this pattern, as regions with longer commute times (often suburban) align with these hot spots, suggesting a car-dependent lifestyle and a more spread-out distribution of services.

When combined with the income and Muslim population density maps, it's evident that areas with cold spots not only have a high density of Muslims but also moderate to high incomes and shorter commute times. This convergence of factors results in a more concentrated and accessible network of halal food options. On the other hand, areas with hot spots, where halal restaurants are more distant from mosques, tend to have lower Muslim densities, potentially lower incomes, and longer commute times, reflecting different spatial and socioeconomic dynamics within the GTA.

5.2. Discussion

This study highlights the significant disparities in access to Halal food within the Greater Toronto Area (GTA), echoing broader trends in food accessibility research. The uneven distribution of Halal restaurants, as identified in this research, reflects the patterns observed in the literature, where food accessibility is often influenced by factors such as income, commuting patterns, and proximity to religious institutions (Andreyeva et al., 2008; Baharuddin et al., 2015). Similar to general food deserts, areas with lower income levels and less accessible transportation options in the GTA tend to have fewer Halal food options, limiting the ability of Muslim communities in these regions to adhere to their dietary practices (Sharkey & Horel, 2008; Hill et al., 2012).

Uneven Access to Halal Food: The findings align with previous studies on food accessibility, which emphasize that low-income and geographically isolated populations face significant barriers to accessing culturally appropriate food (Sharkey & Horel, 2008; Larson et al., 2009). In the context of the GTA, neighborhoods with higher Muslim populations, such as those in Scarborough, North York, Mississauga, and Brampton, have a greater concentration of

Halal restaurants, reflecting their larger demand for such services (Al-Teinaz, 2020; Arsil et al., 2018). However, in more suburban or economically disadvantaged areas like parts of Durham Region and northern York Region, access to Halal food is significantly reduced. This disparity is consistent with the literature's identification of income and geographic location as critical determinants of food accessibility (Andreyeva et al., 2008; Hill et al., 2012).

***Barriers to Halal Food Access**:* Income levels, commuting times, and the proximity of mosques are major barriers affecting Halal food accessibility, as supported by the literature (Baharuddin et al., 2015; Arsil et al., 2018). Higher-income areas with shorter commute times and closer proximity to mosques, such as central parts of Toronto and the Peel Region, generally have better access to Halal food options (Hill et al., 2012).. This relationship underscores the importance of both economic resources and spatial proximity to religious and cultural centers in ensuring equitable access to Halal food (Al-Teinaz, 2020; Baharuddin et al., 2015). In contrast, areas with longer commute times and fewer mosques, often corresponding with lower-income neighborhoods, experience limited availability of Halal food, similar to the barriers faced by other marginalized groups in accessing nutritious food (Larson et al., 2009).

Low-Income Populations and Access Disparities: The study's findings highlight that low-income populations in the GTA are particularly disadvantaged in accessing Halal food. This mirrors broader research on food deserts, where low-income areas often lack sufficient grocery stores or culturally appropriate food outlets (Sharkey & Horel, 2008; Hill et al., 2012). The reduced presence of Halal restaurants in lower-income areas in the GTA suggests that these communities may struggle to maintain their religious dietary practices, contributing to social inequities (Andreyeva et al., 2008). This finding aligns with the literature, which shows that

economic disparities are a significant barrier to food access, particularly for specialized dietary needs like halal (Andreyeva et al., 2008; Baharuddin et al., 2015).

Similarities and Differences: The results of this study both support and expand upon existing literature. As with other research on food accessibility, the distribution of Halal restaurants in the GTA is heavily influenced by income, population density, and transportation infrastructure (Hill et al., 2012; Sharkey & Horel, 2008). However, this study adds a unique dimension by emphasizing the role of mosques as key cultural and religious hubs that significantly affect the spatial distribution of Halal food options (Al-Teinaz, 2020. Unlike general food accessibility studies that focus primarily on economic and geographic factors, this research highlights the importance of considering religious infrastructure in the analysis of food accessibility for Muslim communities (Baharuddin et al., 2015; Arsil et al., 2018).

In conclusion, the study confirms that the distribution of Halal restaurants in the GTA is marked by significant disparities, primarily influenced by income levels, commuting times, and proximity to mosques. These findings underscore the need for a more nuanced approach to urban planning and food policy, one that considers the cultural and religious needs of diverse communities (Al-Teinaz, 2020; Baharuddin et al., 2015).. Addressing these disparities will require targeted interventions to improve access to Halal food in underserved areas, ensuring that all members of the Muslim community in the GTA can meet their dietary and religious needs.

5.3. Implications

The findings from this research have significant implications for urban planning, business development, and community services within the Greater Toronto Area (GTA), particularly in the context of meeting the needs of the Muslim population. One of the most direct applications

of this research is in guiding the strategic placement of new halal restaurants. By identifying areas where there is a high density of the Muslim population but a lack of corresponding halal food options, businesses can target underserved regions to better meet community demand. For instance, neighborhoods in the GTA where the Muslim population is growing but halal restaurants are sparse present clear opportunities for new establishments. This approach can ensure that businesses are located in areas with strong potential customer bases, thereby increasing their chances of success while also addressing community needs.

Furthermore, the research highlights a notable spatial relationship between halal restaurants and the location of mosques. Mosques often serve as central hubs for the Muslim community, and the proximity of halal restaurants to these religious institutions is critical. The findings suggest that areas with established mosques, but few nearby halal food options represent key locations for potential restaurant development. By placing restaurants closer to mosques, business owners can capitalize on the regular foot traffic generated by these religious centers, making their establishments more accessible to the Muslim community. This strategic alignment can also enhance community cohesion by providing convenient dining options that meet religious dietary requirements, fostering a more integrated and supportive urban environment. Additionally, urban planners and policymakers can use this research to identify and address gaps in service provision. Areas where there is a significant Muslim population but a lack of both halal restaurants and mosques may require targeted development initiatives. These could include encouraging the establishment of both religious and commercial services in these underserved areas through zoning adjustments, financial incentives, or community engagement efforts. Such initiatives would not only support the economic viability of halal restaurants but also contribute

to the overall well-being of the Muslim population by ensuring that essential cultural and religious services are readily accessible.

In summary, this research provides valuable insights that can be used to inform the strategic placement of halal restaurants, ensuring they are located in areas with strong demand and near key community hubs like mosques. By addressing the current disparities between population density, mosque locations, and the availability of halal food options, stakeholders can better serve the needs of the GTA's Muslim community, ultimately fostering a more inclusive and well-planned urban landscape.

5.4. Strengths of the Study

The spatial analysis of halal restaurant distribution in the Greater Toronto Area (GTA) provides new insights into an under-researched area of urban geography. While much has been written about ethnic enclaves and food accessibility in diverse cities, the specific distribution patterns of halal restaurants remain largely unexplored. This research aims to fill that gap by examining where halal food options are concentrated and how they correlate with demographic factors such as population density, income levels, and proximity to religious institutions like mosques.

For this analysis, I utilized data from Zabihah.com, an open-source platform that provides comprehensive listings of halal restaurants and food outlets worldwide. Zabihah.com is particularly valuable for this research because it is community-driven, meaning that the listings are frequently updated and reflect real-time changes in the availability of halal food options. This crowdsourced approach ensures a high level of accuracy and relevance, making it an excellent data source for examining the spatial distribution of halal restaurants across the GTA.

The use of open-source data from Zabihah.com provides an interesting data source. Traditional studies often rely on government or commercial datasets that may not capture the nuances of specific communities, particularly minority populations. By leveraging community-generated data, this research is able to map the distribution of halal restaurants with a level of detail and cultural specificity that would be difficult to achieve using conventional data sources.

Furthermore, this research sheds light on the dynamics of food accessibility in one of the most culturally diverse regions in the world. The findings from this spatial analysis can inform urban planners, policymakers, and community organizations about the distribution of halal food options and identify potential areas of need. By understanding where halal restaurants are located and how they align with the Muslim population and other demographic factors, this research contributes to a more nuanced understanding of food landscapes in multicultural urban settings.

5.5. Limitations and Future Research

While this study provides valuable insights into the distribution of halal restaurants in the Greater Toronto Area (GTA), several limitations must be acknowledged. One primary limitation is the assumption that all halal food establishments serve the same function for the Muslim community. In reality, halal restaurants vary widely in quality, price, and cuisine, and some may only offer one or a few halal items on their menu rather than the entire selection. This inconsistency in the variety of halal food available at different restaurants can impact their accessibility and appeal to various segments of the population.Future research could address this by developing a rating system that accounts for these variations, allowing for a more nuanced analysis of how different types of halal restaurants serve the community.

Another significant limitation of this study stems from the use of open-source data from Zabihah.com. While this platform offers an extensive list of halal food options, it relies on user contributions, meaning that some restaurants may be missed or inaccurately represented. This could lead to gaps in the data, particularly in areas where the Muslim community is smaller or less active in updating listings. To mitigate this issue, future research could incorporate more field data collection to verify and supplement the online data. This approach would ensure a more comprehensive and accurate mapping of halal food options across the GTA.

The study also focuses primarily on the spatial distribution of halal restaurants without fully considering the dynamics of population growth and immigration, which play a crucial role in shaping the demand for halal food. The Muslim population in the GTA is not static; it is influenced by ongoing immigration trends, which can lead to shifts in the demand for halal food in different neighborhoods. Future research should consider integrating demographic projections and immigration data to better understand how these factors influence the spatial distribution of halal restaurants over time.

Additionally, the methods used to assess accessibility in this study could be expanded in future research. This study primarily relied on spatial proximity to mosques and population density within census tracts, but there are other, more sophisticated measures of accessibility that could be employed. For example, the use of Geographically Weighted Regression (GWR) could help analyze the spatial relationships between halal restaurants, mosques, and population centers with greater precision. Alternatively, the Huff model could be applied to better understand how the attractiveness of different halal restaurants influences their accessibility to different population groups. These advanced models would provide deeper insights into the spatial patterns of food accessibility in the GTA.

Finally, while this study focuses on the Muslim population, future research could explore the distribution of halal restaurants in relation to other demographic groups. For instance, understanding how non-Muslim communities engage with halal food options could provide valuable insights into the broader food landscape of the GTA. Similarly, a comparative analysis within the Muslim population, examining differences in food preferences among various ethnic or sectarian groups, could reveal important intra-community dynamics that this study does not address.

In summary, while this study offers a foundation for understanding the distribution of halal restaurants in the GTA, there are several avenues for future research that could enhance the findings. By addressing these limitations, future studies could provide a more comprehensive and detailed analysis of the factors shaping halal food accessibility in diverse urban environments.

5.6. Conclusion

This study provides a detailed analysis of the distribution of halal restaurants in the Greater Toronto Area (GTA), revealing important patterns related to population density, income levels, commuting times, and proximity to mosques. The findings show that halal restaurants are predominantly concentrated in areas with significant Muslim populations, such as Scarborough, North York, Mississauga, and Brampton. These regions not only have high densities of Muslims but also moderate to high household incomes and shorter commute times, which together contribute to the accessibility and success of halal food establishments.

Conversely, the research identifies disparities in halal food accessibility in other parts of the GTA, particularly in suburban areas like Durham Region and parts of York Region. These areas tend to have lower Muslim populations, longer commute times, and fewer halal restaurants,

highlighting the uneven distribution of halal food options across the region. The relationship between halal restaurants and mosques is particularly significant, with a strong correlation observed between the presence of mosques and the availability of halal food options. This suggests that future efforts to increase halal food accessibility should consider locating new restaurants near existing mosques to better serve the Muslim community.

In conclusion, the study offers valuable insights for urban planners, business owners, and policymakers aiming to enhance food accessibility for the Muslim population in the GTA. By addressing the current disparities in halal food distribution and considering factors such as population density, income, and mosque proximity, stakeholders can make informed decisions that support the needs of this diverse community. While the study has limitations, including reliance on open-source data and the need for more detailed analyses, it lays a strong foundation for future research to further explore and address the challenges of halal food accessibility in urban environments.

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