

THE CHANGING SPATIAL ORGANIZATION OF ETHNIC RETAILING:  
A CASE STUDY OF CHINESE AND SOUTH ASIAN GROCERY RETAILERS IN THE  
TORONTO CMA FROM 2001 TO 2016

By

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A Major Research Paper  
presented to Ryerson University

in partial fulfillment of the  
requirements for the degree of  
Master of Spatial Analysis  
in the program of  
Spatial Analysis

Toronto, Ontario, Canada, 2019  
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The changing spatial organization of ethnic retailing: A case study of Chinese and South Asian grocery retailers in the Toronto CMA from 2001 to 2016  
2019

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## **Abstract**

Understanding the changing spatial structure of ethnic grocery retailing in Canadian urban regions can provide insights into ethnic business development and the well-being of residents, particularly relating to the availability of healthy food and risk of nutrition-related illnesses. This study explores this through a case study of Chinese and South Asian grocery retailing in the Toronto Census Metropolitan Area (CMA). In particular, the changing spatial relationship between ethnic grocery business distribution, ethnic residential patterns, and spatial accessibility is examined between 2001 and 2016. A combination of location quotients and global and local indicators of spatial autocorrelation were utilized to assess the relationship between ethnic groups while measures of spatial central tendency and a nearest neighbor analysis assessed the distribution of grocery retailers. An integrated marginalization-accessibility index was then developed to highlight any spatial mismatch between the level of material deprivation and grocery store access, highlighting patterns of inequality throughout the CMA. The results of the study reveal that Chinese and South Asian grocery retailers and residents have suburbanized over the study period. Index results also indicate that some census tracts (CTs) experienced limited access to both mainstream and ethnic grocery stores, particularly among the South Asian community. Finally, there is a growing number of CTs that are well-serviced to Chinese and South Asian grocery stores but are under-serviced to mainstream retailers, potentially identifying areas where ethnic grocers are filling gaps in service.

Key words: ethnic grocery retailing, ethnic residential patterns, accessibility, healthy food provision, marginalized neighbourhoods, Toronto Census Metropolitan Area

## **Acknowledgements**

Throughout the writing of this Major Research Paper I have received a great deal of support and encouragement. I would first like to thank my supervisor, Dr. Lu Wang, for the invaluable guidance and expertise she has offered throughout the entire process. I am beyond grateful that she recognized my potential and dedicated time outside of her busy schedule to mentor me. I would also like to express my profound gratitude to all of the important women in my life - my mother, sister, grandmother, and close friends - for their continuous love, patience, and encouragement. Finally, I would like to thank my partner for inspiring me to pursue this degree and for his unwavering support in all that I do.

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## **1. Introduction**

Ethnic retailing plays an important role in the development of Canada's metropolitan regions. Ethnic businesses and consumers make up an increasingly large portion of the urban economy and have a growing influence on the goods and services provided within commercial systems (Wang, 2004). As immigration continues to be the main source of population growth, the ethnic retailing sector is expected to further expand and transform (Morency et al., 2017). Specifically, changes to immigration policies in recent decades have altered the ethnic composition of immigration, where the majority of contemporary immigrants are migrating from Asia, rather than Europe (Zhuang and Hernandez, 2009; Statistics Canada, 2016a). Chinese and South Asian communities are the two largest recent immigrant groups, comprising nearly 29% of immigration between 2011 and 2016 (2016 Canadian Census). As a result, many Canadian cities have seen an increase in the number of businesses and consumers from these communities, strengthening their presence among the ethnic retailing sector.

The changing composition of immigration, along with shifts in location preferences, have led to variations in traditional ethnic residential patterns across Canada. While ethnic groups historically settled in enclaves within inner cities, many incoming immigrants and ethnic residents are choosing to move to suburban areas (Zhuang, 2015; Zhuang and Chen, 2017). Since the geographic distribution of ethnic businesses is strongly related to the distribution of their co-ethnic consumer population (consumers from the same ethnic group), many ethnic economies have also expanded into suburban areas in recent decades (Zhuang and Hernandez, 2009). Among these economies, ethnic grocery retailing has become one of the most prominent and complex sectors due to increasing diversification and involvement of mainstream companies (Wang and Hernandez, 2018). Ethnic grocery retailers are the primary shopping choice for many members of the co-ethnic population due to the provision of familiar ethnic products and services, as well as the sense of 'place' and 'identity' they offer customers (Wang and Lo, 2007; Lo, 2009; Baumann, Szabo, and Johnston, 2017). Since they are also often considered to be an important source of healthy food options (i.e. produce), assessing the spatial accessibility of ethnic grocers can provide insights into the well-being of residents. Limited accessibility to healthy food providers may negatively impact the overall health of residents by increasing the risk of nutrition-related illnesses (Health Canada, 2013), especially among low-resource communities (Tarasuk, Mitchell, and Dachner, 2016; Khojasteh and Raja, 2017).

Despite increasing scholarly interest on ethnic retailing and the residential patterns of ethnic groups in Canada (Simmons, Hernandez, and Kamikihara, 2010; Zhuang and Chen, 2017; Wang and Hernandez, 2018), there is limited research exploring the changing spatial relationship between the two over time (Zhuang and Hernandez, 2009; Zhang, 2012). Additionally, much of the current literature on the accessibility of grocery stores in North American urban regions has focused solely on mainstream retailers (Kirkpatrick and Tarasuk, 2010; Dai and Wang, 2011; Polsky et al., 2014; Kuai and Zhao, 2017). As a result, there is a need for an analysis of the spatial accessibility of ethnic grocery retailers among co-ethnic and non co-ethnic populations.

In an attempt to fill these gaps in the literature, this study aims to expand on the research by Zhang (2012) through the exploration of the spatial structure of Chinese and South Asian grocery retailing in the Toronto CMA. In particular, this study will focus on the changing spatial relationship between ethnic grocery business distribution and ethnic residential patterns between 2001 and 2016, as well as examine the spatial accessibility of mainstream and ethnic grocery retailers over the 15-year time period. For this analysis, ethnic grocery retailers will refer to grocery stores and supermarkets owned and operated by members of an ethnic group. Two overarching research questions guide the analysis of this study, which include:

- i) How have the spatial distributions of Chinese, South Asian, and mainstream grocery retailers and the residential patterns of co-ethnic populations changed between 2001 and 2016?
- ii) What are the relationships between spatial accessibility to Chinese, South Asian, and mainstream grocery stores and marginalized neighbourhoods, and how have they changed between 2001 and 2016?

Understanding the changing spatial relationship between the distribution of ethnic grocery stores and their co-ethnic consumers over the study period provides important insights into future ethnic businesses development within the Toronto CMA, highlighting neighbourhoods that can be considered emerging hotspots for expansion. Additionally, comparing the geographic accessibility of Chinese, South Asian, and mainstream grocery stores over time and against various socio-economic and demographic groups provides insight on any

inequalities that are present within the CMA. Determining areas of inequal access to grocery stores is important for understanding the well-being of residents, particularly relating to the availability of healthy food options and risk of nutrition-related illnesses.

## **2. Literature review**

### **2.1 Changing composition of immigration**

Canada has a long and complex history of immigration, one that has been central to the economic, social, and cultural development of the country (Teixeira and Truelove, 2007). National immigration policies largely control the quantity and characteristics of incoming migrants (Beach, Worswick, and Green, 2011). Consequently, recent policy changes have resulted in contemporary immigrants being significantly different than previous generations. Within the past few decades there have been considerable changes to the number of immigrants admitted annually, along with their ethnic composition, socio-economic status, and settlement patterns upon arrival (Fong, 2006; Hou and Picot, 2016; Morency et al., 2017).

The number of immigrants admitted into Canada each year has fluctuated for over a century based on admission levels outlined within federal policies. However, the number of landed immigrants has gradually increased in recent decades and has remained relatively high since the early 1990s (Statistics Canada, 2016a). Currently, Canada receives one of the largest proportions of immigrants of all developed countries, with an average of approximately 235,000 new immigrants per year (Statistics Canada, 2016a; Morency et al., 2017). This value is projected to increase in upcoming years as immigration continues to be the main driver of population and economic growth (Bohnert, Chagnon, and Dion, 2015; Costigan, 2016). Since the immigrant population living in Canada is not distributed evenly, large cities such as Toronto will continue to see the largest concentrations of immigrants (Fong, 2006; Morency et al., 2017).

Europe was the dominant source of immigration for Canada until the introduction of the immigration point system in 1967 (Reitz, 2012; Statistics Canada, 2016a). The new system aimed to reduce discrimination and inequality while attracting highly skilled and capital abundant migrants, resulting in substantial changes to the ethnic composition of immigrants (Fong, 2006; Beach, Worswick, and Green, 2011). Specifically, in the decades following the system's inception, the main immigration source regions shifted from Europe to Asia (Zhuang

and Hernandez, 2009). China and various South Asian nations have been among the most prominent immigrant source countries since 1991 and currently make up the majority of recent immigrants (2016 Canadian Census). As a result, Chinese and South Asian ethnic groups have become two of the most dominant in Canada, particularly within the Toronto CMA.

In addition to changes in the ethnic composition of contemporary immigrants, there has also been a shift towards the selection of immigrants with a higher socio-economic status than previous generations (King, 2009). Since the Immigration and Refugee Protection Act was passed in 2001, point allocation has increasingly emphasized factors such as education, work experience, language skills, secured employment, and adaptability (Zhuang and Hernandez, 2009; Bohnert, Chagnon, and Dion, 2015). This has resulted in a growing number of economic immigrants who can contribute to Canada's economy through their ability to meet labour market needs, make an investment, or create their own employment (Statistics Canada, 2019a). However, while there is an increasing number of skilled and affluent newcomers, mainly arriving from East and South Asia, a large portion of immigrants living in Canada still have a low socioeconomic status (Lu and Picot, 2017). Specifically, recent immigrants and non-permanent residents make up the largest proportion of all low-income households and are largely concentrated in marginalized neighbourhoods (Statistics Canada, 2019b).

As a result of high levels of immigration for a long period of time, Canada is home to an increasingly large number of second-generation citizens, or non-immigrants with at least one parent born abroad. This population is expected to grow over the next few decades, where nearly one in five people in Canada would be second generation by 2036 (Morency et al., 2017). This will continue to strengthen the ethnic diversity of the country and could lead to potential growth among ethnic businesses consumer populations.

## **2.2 Spatial transformation of immigrant settlement patterns**

### **2.2.1 Ethnic enclaves**

Traditionally, the majority of newcomers settled in ethnic enclaves within inner cities upon arrival. Often defined as concentrated communities of immigrants and visible minorities of the same ethnicity, enclaves are marked by institutions and businesses that reflect the cultural values and symbols of the dominant ethnic group (Logan, Zhang, and Alba, 2002; Preston and Lo, 2009). Numerous push and pull factors contribute to the attraction of immigrants to ethnic

enclaves in Canadian cities. Push factors often include racial segregation and discrimination, along with limited housing and job opportunities elsewhere, while pull factors include shared cultural values, increased access to ethnic products and services, and a sense of place and identity (Qadeer, Agrawal, and Lovell, 2010). Ethnic enclaves are often considered to be a transitional stage for newcomers as they provide residents with a familiar language and increased job opportunities from co-ethnic employers during the adjustment period (Logan, Zhang, and Alba, 2002). Since Toronto is the main destination for immigrants in Canada (Morency et al., 2017), there are numerous long-established ethnic enclaves located near the city core, such as Chinatown near Dundas St. W. and Spadina Ave.

### **2.2.2 Emergence of ethnoburbs**

While ethnic enclaves were previously the main port of entry for new immigrants, changes to public policy, immigrant economic mobility, local housing markets, and location preferences have re-shaped immigrant settlement patterns (Zhuang and Chen, 2017). Specifically, the changing socio-economic composition of immigration has resulted in recent immigrants having more available capital and higher educational attainment than previous generations. This, combined with shifts in real estate trends and neighbourhood preferences, has resulted in some new immigrants directly settling in suburban areas, or ethnoburbs (Wen, Lauderdale, and Kandula, 2009; Zhuang and Chen, 2017). Proposed by Li (1998), ethnoburbs are clusters of ethnic residents and businesses in suburban areas of metropolitan regions. They co-exist with traditional ethnic enclaves in inner cities and are often multi-ethnic communities, “in which one ethnic minority group has a significant concentration but does not necessarily comprise a majority” (Li, 1998). In Canada, numerous ethnoburbs have developed around city cores due to the gradual suburbanization of ethnic groups. Prominent examples in the Toronto CMA are concentrations of Chinese residents in Markham and Richmond Hill, and though slightly more dispersed, clusters of South Asian residents in Brampton and Mississauga (Lo and Wang, 1997; Simmons, Hernandez, and Kamikihara, 2010; Wang and Hernandez, 2018).

### **2.3 Spatial organization of ethnic economies**

The ethnic economy is an ongoing area of interest for academic scholars worldwide, with studies focusing on ethnic business distribution and development, co-ethnic consumer markets, and factors that influence consumer choices between ethnic or mainstream retailers (Fong et al.,

2007; 2008; Lo, 2009; Wang, 2004; Wang and Lo, 2007, Zhuang and Hernandez, 2009; Zhuang, 2015). The changing composition and spatial distribution of immigrants and ethnic residents has complicated ethnic economies in metropolitan regions and has altered the traditional definition and framework of ethnic retailing.

### **2.3.1 Traditional ethnic economy framework**

Traditionally, an ethnic economy consists of businesses that are owned and operated by members of an ethnic group that provide cultural products and services to co-ethnics (Light et al., 1994; Zhuang and Hernandez, 2009). Prominent within ethnic enclaves, this type of economy often “[forms] an isolated system where money is retained within the same ethnic group” (Wang and Hernandez, 2018), and include five key factors; ethnic ownership, employment, customer base, sectoral specialization, and spatial concentration (Kaplan and Li, 2001). These components work together to form ethnic markets that can provide benefits to both ethnic employers and employees, such as cheap labour and job opportunities. According to the Ethnic Enclave Theory, the spatial concentration of ethnic businesses and the proximity to their co-ethnic consumers are the most important attributes of an ethnic economy (Kaplan, 1998).

### **2.3.2 Evolving definition and suburbanization of ethnic economies**

The rapid diversification of metropolitan regions, suburbanization of ethnic residents and businesses, and increasing involvement of mainstream retailers within ethnic economies has drastically altered the landscape of ethnic retailing (Zhuang, 2015). As a result, traditional, more segregated ethnic economies that are typically concentrated in ethnic enclaves have become less prominent in recent decades. There has been a shift towards mixed economies that have increased integration with the mainstream economy (Nee, Sanders, and Sernau, 1994; Light and Gold, 2000), as well as the emergence of new frameworks to attempt to better outline contemporary ethnic economies (Wang and Hernandez, 2018).

While co-ethnic populations are still the main consumers of ethnic retailers, an increasing number of people from differing ethnicities are shopping at ethnic businesses. Mainstream or non-ethnic companies are becoming increasingly interested in and involved with the urban ethnic economy, realizing the vast potential of ethnic markets. Mainstream retailers have begun to offer wider selections of culturally specific products, and some mainstream companies have acquired ethnic retailers (Wang and Hernandez, 2018). As a result, a growing number of ethnic businesses

are no longer owned and managed by ethnic groups, complicating the traditional definition of ethnic retailing. Based on this relatively new development, it has been suggested that customer orientation should be the most important factor in ethnic retailing, rather than ethnic ownership (Wang and Hernandez, 2018).

Since the majority of customers are still members of the co-ethnic community, the success of ethnic grocery businesses is highly dependent upon the presence and distribution of co-ethnic consumer residential patterns (Wang and Hernandez, 2018). As a result, the suburbanization of ethnic residential patterns in many urban regions has led to a gradual shift in ethnic business development towards the suburbs. The growing number of residents in ethnoburbs has increased the need for businesses, resulting in an increase in the development of ethnic retailers in suburban regions surrounding large Canadian cities such as Toronto. Since food is a necessity and stores that provide familiar ethnic products are often preferred among ethnic groups (Wang and Lo, 2007; Lo, 2009), ethnic grocery retailers have become increasingly prominent in ethnoburbs.

#### **2.4 Ethnic grocery retailers as sources of healthy food**

Access to safe, affordable, and nutritious food is crucial for the development and maintenance of healthy eating patterns among Canadians (Health Canada, 2013; Khojasteh and Raja, 2017). Geographic access, referring to the quantity and type of food providers available to nearby populations, has found to be correlated to the overall health of residents, as well as the prevalence of food insecurity and nutrition-related health concerns such as obesity and diabetes (Health Canada, 2013; Larsen et al., 2015; Tarasuk, Mitchell, and Dachner, 2016; Morland and Evenson, 2009; Walker, Keane, and Burke, 2010; Zou, 2019). As a result, limited geographic accessibility to healthy food providers (i.e. grocery stores) may negatively impact the well-being of residents. Socio-economic and demographic characteristics such as income, ethnicity, and immigration have been found to affect the prevalence food insecurity (Tarasuk, Mitchell, and Dachner, 2016). Marginalized communities, those that may be materially deprived, experience housing instability, or have high concentrations of recent immigrants and members of visible minority groups (Matheson, 2018), may be more negatively affected by limited geographic accessibility to healthy food providers as they may have fewer opportunities to travel to or access nutritious items (Raine, 2005; Power, 2005; Zenk et al., 2005; Health Canada, 2013). This is

particularly evident in ‘food deserts,’ which can be defined as disadvantaged areas with relatively poor access to healthy and affordable food and have largely been identified in the U.S. and U.K. (Larsen and Gilliland, 2008).

For many ethnic residents, access to ethnic grocery retailers plays an important role in the way healthy foods are obtained (Wang, 2018; Wang and Hernandez, 2018) as they are often the primary type of grocery outlet chosen by ethnic groups (Lo, 2009; Wang and Lo, 2007). Additionally, while much smaller in comparison to the number of co-ethnic consumers, ethnic grocery stores are servicing a growing number of non-ethnic residents and members of differing ethnicities due to the rapid diversification of Canadian cities (Wang and Hernandez, 2018). This has further expanded the role of ethnic grocery stores in providing healthy food options in both enclaves and ethnoburbs.

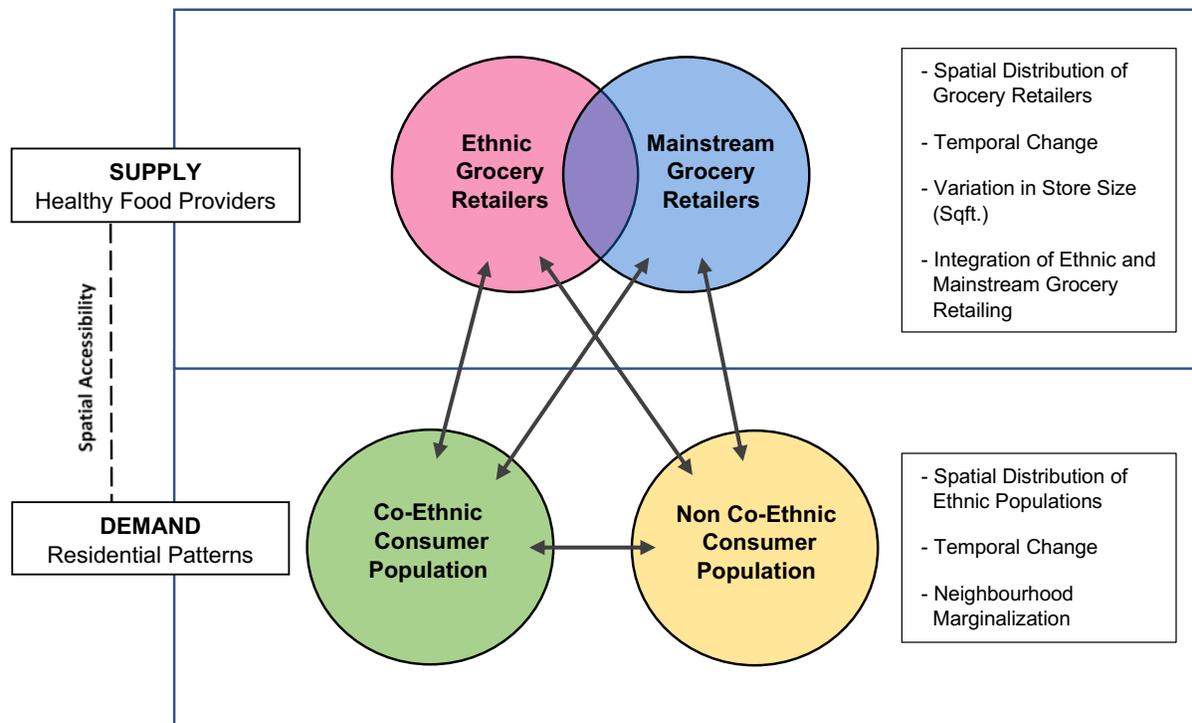
Currently, much of the academic literature on the spatial accessibility of grocery stores in large Canadian cities has found that there is generally adequate access to healthy foods and that there is little connection between marginalization and the prevalence of grocery stores (Kirkpatrick and Tarasuk, 2009; 2010; Polsky et al., 2014; Liadsky and Ceh, 2017). However, the majority of studies focus solely on mainstream retailers (e.g. Loblaws) in providing healthy food options. There is very limited research on the role of ethnic grocery retailers as sources of healthy food, despite their recent expansion and growing popularity. Consequently, there is a need for the analysis of the spatial accessibility of ethnic grocery retailers, to see if they follow a similar trend as their mainstream counterparts. Understanding the differences in spatial accessibility among marginalized neighbourhoods to ethnic grocery stores could provide a better assessment of food security in Canadian urban regions. Despite the increase in highly skilled and capital abundant immigrants, there is still a large number of ethnic residents and immigrants living in low-income households, with the low-income rate remaining higher among immigrants than the Canadian-born population (Lu and Picot, 2017). Specifically, the prevalence of low income among recent immigrants in Canada is 18.9% higher than non-immigrants (Statistics Canada, 2019b).

### **3. Conceptual framework**

Figure 1 displays the relationship between the four main components of this analysis; ethnic grocery retailers, mainstream grocery retailers, co-ethnic consumer populations, and non

co-ethnic consumer populations. These four components represent the major players from the supply and demand portions of the market. The supply category is comprised of ethnic and mainstream grocery retailers as they are the main providers of healthy food (i.e. produce) while the demand category is comprised of the residential patterns of co-ethnic and non co-ethnic consumers. Non co-ethnic consumer population refers to both non-ethnic residents and those belonging to a different ethnic group. Due to increasing complexity of ethnic economies, largely the relationships between ethnic and mainstream retailers and consumers, the components have become closely interrelated over time and often interact with each other.

Represented by overlapping circles in the diagram, the two types of grocery retailers are becoming increasingly linked. This is largely due to growing competition as many mainstream companies have begun to offer ethnic products and have purchased or partnered with ethnic companies (Wang and Hernandez, 2018). Additionally, though many ethnic residents choose to shop at grocery stores owned and operated by members of the co-ethnic population because they offer familiar products and services, many ethnic residents choose to shop at both for different needs. In this way, the two types of grocery stores are often viewed as complimentary to each other, notably among the Chinese population in the Toronto CMA (Wang and Lo, 2007; Lo, 2009). Non co-ethnic populations are also becoming increasingly involved, shopping more frequently at ethnic grocery stores. The increasing involvement of non co-ethnic populations in ethnic grocery retailing and co-ethnic populations in mainstream retailing has further connected the two residential groups. More frequent interactions in grocery retail settings are now possible due to this social integration, particularly within ethnoburbs as they are often home to multiple ethnicities (Li, 1998). Finally, the spatial accessibility of ethnic residents (demand) to grocery stores (supply) will be assessed to determine the availability of healthy foods in the Toronto CMA, highlighting areas of inequality where marginalized neighbourhoods have poor access to grocery retailers.



**Figure 1.** Conceptual framework illustrating the relationship between major components in the study

#### 4. Study area and groups

The Toronto CMA was selected as the study area for this paper because it has the largest ethnic minority population and receives the highest number of immigrants in Canada (Morency et al., 2017). Of the 2016 population, 46.1% were immigrants and 51.4% belonged to a visible minority group, as compared to the 21.9% and 22.3% Canadian averages (Statistics Canada, 2017). Specifically, Chinese and South Asian ethnicities were selected as the study groups because they are the two most prominent ethnicities in the Toronto CMA. The majority of contemporary immigrants migrate from China, India, Pakistan, and other South Asian nations (Morency et al., 2017). In addition, Chinese and South Asian populations have notably different ethnic economies throughout the Toronto CMA, which allows for an interesting comparison of the two over time. Chinese grocery stores are often larger in size and belong to more developed economies than South Asian stores, and there is a larger quantity throughout the region (Wang and Hernandez, 2018). Table 1 displays the total number of immigrants, recent immigrants, and ethnic origin responses for the Chinese and South Asian study groups at a municipal and national level.

**Table 1.** Chinese and South Asian immigrants and ethnic origin responses at the CMA and national level

Ethnic Group	Toronto CMA			Canada		
	Immigrants	Recent Immigrants (2011-2016)	Ethnic Origin (Total Responses)	Immigrants	Recent Immigrants (2011-2016)	Ethnic Origin (Total Responses)
Chinese	266,840 (9.9%)	49,815 (14%)	700,705 (11.8%)	649,260 (8.6%)	129,015 (10.6%)	1,769,195 (5%)
South Asian	560,290 (20.7%)	94,835 (26.6%)	995,125 (16.8%)	1,080,240 (14.3%)	223,045 (18.4%)	1,963,330 (5.6%)
	2,705,550 Total Immigrants	356,930 Total Recent Immigrants	5,928,040 Enumerated Population of Toronto	7,540,830 Total Immigrants	1,212,075 Total Recent Immigrants	35,151,728 Enumerated Population of Canada

Source: Statistics Canada 2016 Canadian Census (Statistics Canada, 2017)

## 5. Data

The grocery retailing dataset was compiled from a list of ethnic grocery businesses from the Centre for the Study of Commercial Activity (CSCA) and a survey of Chinese grocery businesses from Wang and Lo (2002), both of which were verified by fieldwork. The data provides information on the locations and characteristics of Chinese, South Asian, and mainstream grocery store locations in the Toronto CMA in 2001 and 2016 (Table 2).

Demographic data was obtained from Statistics Canada’s 2001 and 2016 Canadian censuses and the 2001 and 2016 Ontario Marginalization Indices, which were developed by Public Health Ontario and the Centre for Urban Health Solutions at St. Michael’s hospital. The Ethnic Origin variable from the Canadian censuses was used to identify changes in residential patterns among the Chinese and South Asian study groups at the census tract (CT) level. According to Statistics Canada’s Census of Population dictionary, ethnic origin refers to the ethnic or cultural origins of a person’s ancestors (2016b). Since a person may have recorded more than one ethnicity, the total number of responses was used to account for all persons that identify as having Chinese and South Asian ethnic origins. While some studies use the Place of Birth variable, this only considers immigrants in the analysis. Since Chinese and South Asian immigration in the Toronto CMA has been occurring for many decades, there are many residents that belong to these ethnic groups that were born in Canada. Therefore, the use of the Ethnic Origin variable accounts for all residents who identify as Chinese and South Asian, including immigrants and those who were born in Canada (Simmons, Hernandez, and Kamikihara, 2010). This is important as it accounts for all the potential co-ethnic consumers of ethnic grocery

businesses. The South Asian Ethnic Origin variable includes responses from the following origins; Bangladeshi, Bengali, Bhutanese, East Indian, Goan, Gujarati, Kashmiri, Nepali, Pakistani, Punjabi, Sinhalese, Sri Lankan, Tamil, and South Asian origins not included elsewhere (Statistics Canada, 2016b).

The Material Deprivation Index at CT level (2001 and 2016) was obtained from the Ontario Marginalization Indices. The Index is closely related to poverty and refers to the inability of communities and individuals to access basic material needs, and included indicators such as income, quality of housing, family structure, and educational attainment (Matheson, 2018). As such, it provides further insights into the socioeconomic conditions of neighbourhoods in the Toronto CMA.

**Table 2.** Sources and descriptions of data

Year	Data Name	Data Source	Description
2001	Grocery Retailers	CSCA, Wang and Lo (2002)	Store name, address, postal code, city, width, length, estimated floor size, geographic coordinates
	Ethnic Origin Census Variable	Statistics Canada 2001 Census	Total number of people with Chinese and South Asian ethnic origins (total responses)
	Ontario Marginalization Indices	Public Health Ontario, Centre for Urban Health Solutions	Residential Instability, Material Deprivation, Dependency, and Ethnic Concentration indices created at the CT level
2016	Grocery Retailers	CSCA	Store name, address, postal code, city, width, length, estimated floor size, geographic coordinates
	Ethnic Origin Census Variable	Statistics Canada 2016 Census	Total number of people with Chinese and South Asian ethnic origins (total responses)
	Ontario Marginalization Indices	Public Health Ontario, Centre for Urban Health Solutions	Residential Instability, Material Deprivation, Dependency, and Ethnic Concentration indices created at the CT level

## 6. Methods

### 6.1 Analyzing the changing spatial relationship of ethnic residential patterns

To assess the changing spatial relationship of Chinese and South Asian ethnic groups between 2001 and 2016, location quotients and global and local indicators of spatial autocorrelation were applied. Location quotient (LQ) is a crude measure that quantifies how concentrated a feature is in an area in relation to a larger region. LQ has been widely used in migration pattern analysis by measuring the relative concentration of a defined group in a local environment compared to a regional or national level (Di Biase and Bauder, 2005; Borruso, 2008; Scardaccione et al., 2010). A ratio of percentages, LQ values between 0.8 and 1.2 typically

indicate an equal representation of the defined group in an area, values over 1.2 indicate a relative over-representation, and values under 0.8 indicate an under-representation (Anderson and Bogart, 2001) The further the LQ values are from 1, the more concentrated or dispersed the groups are. For this analysis, LQ is calculated per Census Subdivision (CSD) in the Toronto CMA for South Asian and Chinese populations in 2001 and 2016 using the following formula:

$$Ethnic\ Population_{LQ} = \frac{\left(\frac{Ethnic\ Population_{CSD}}{Ethnic\ Population_{CMA}}\right)}{\left(\frac{Total\ Population_{CSD}}{Total\ Population_{CMA}}\right)} \quad (1)$$

LQ values provide an overview of the spatial distribution of Chinese and South Asian ethnic groups in the Toronto CMA at the CSD level. The distribution of over- and under-represented CSDs between 2001 and 2016 are analyzed to assess the changing residential patterns of Chinese and South Asian populations.

A combination of global and local indicators of spatial autocorrelation were used in this analysis to determine whether the residential patterns of Chinese and South Asian ethnic groups in the CMA were clustered, dispersed, or random at the CT level. The Global Moran's *I* correlation coefficient was first calculated to measure the degree of spatial autocorrelation at a global level, taking into account both feature locations and their values simultaneously. Local Indicators of Spatial Association (LISA) were then applied for each of the study groups to identify areas of statistically significant clustering, dispersion, and spatial outliers at a local level, using the Anselin Local Moran's *I* statistic (Anselin, 1995). Results of both global and local Moran's *I* analyses were examined to identify the spatial changes in Chinese and South Asian residential patterns over the 15-year time period.

## 6.2 Analyzing the distribution of ethnic grocery retailers

Measures of spatial central tendency and a nearest neighbor analysis were employed to gain a thorough understanding of the distribution of Chinese and South Asian grocery stores throughout the Toronto CMA, and to see how they have changed between 2001 and 2016. First, median centres were calculated to define the central location within the sets of grocery store locations, based on the proximity of all features in the dataset. The median centre was utilized as it may be less affected by outliers than the mean centre (Lee and Wong, 2005). Standard

deviational ellipses were then computed to measure the compactness and orientation of grocery store locations, which was used to visualize changes in their dispersion and direction over the 15-year time period. This is useful in assessing whether ethnic businesses in the CMA have suburbanized as suggested by previous studies (Fong et al., 2007; 2008), and for understanding the changing spatial relationship between contemporary ethnic residential patterns and the location of ethnic grocery stores.

Nearest Neighbour indices were calculated to further quantify the degree of clustering amongst the grocery store locations based on the average distance from each feature to the nearest neighbouring feature. Index values greater than 1 indicate that the features exhibit a clustered pattern, and values below 1 indicate dispersion (ESRI, n.d.a). The index is an effective point pattern analyzer that is particularly useful for the comparison of the locations and spatial characteristics over time (Lee and Wong, 2005). The results of this analysis can identify whether the distributions of ethnic grocery stores have become more clustered or dispersed within the 15-year study period.

### **6.3 Examining the accessibility of healthy food providers**

The enhanced two-step floating catchment area (E2SFCA) model and its variations are widely used as a reliable measure of the spatial accessibility to healthy food providers (Dai and Wang, 2011; Kuai and Zhao, 2017) and health care services (Delamater, 2013; Gilliland et al., 2019; Guagliardo, 2004; Luo and Qi, 2009; Ngui and Apparicio, 2011; McGrail, 2012; Ngui and Vanasse, 2012; Shah et al., 2016; Wang, 2018; Wang and Dorkenoo, 2018; Wang and Ramroop, 2018).

For this study, the E2SFCA model was utilized to assign each census tract in the Toronto CMA an accessibility score based on its access to Chinese, South Asian, and mainstream grocery retailers for the 2001 and 2016 study years. The model is a simplified version of a gravity measure and requires three datasets as input; point locations of grocery businesses representing supply, census tract centroids containing the associated populations as demand, and a travel network of the Toronto CMA. The first step of the model is the calculation of grocery store-to-population ratios for each grocery store location:

$$R_j = \frac{S_j}{\sum_{j \in \{d_{ij} \leq d_0\}} P_k} \quad (2)$$

where  $R_j$  is the calculated ratio,  $P_k$  is the population of census tract  $k$  whose centroids are within the grocery store catchment area ( $d_{kj} \leq d_0$ ),  $S_j$  is the supply capacity (estimated size of grocery store) at location  $j$ , and  $d_{kj}$  is the travel threshold between  $k$  and  $j$ . The second step is the summation of all grocery store-to-population ratios that fall within the travel threshold of each census tract:

$$A_i^F = \sum_{j \in \{d_{ij} \leq d_0\}} R_j = \sum_{j \in \{d_{ij} \leq d_0\}} \frac{S_j}{\sum_{k \in \{d_{kj} \leq d_0\}} P_k} \quad (3)$$

where  $A_i^F$  is the accessibility score of location  $i$ ,  $R_j$  is the grocery store-to-population ratio at grocery store location  $j$  that is within the threshold of location  $i$ , and  $d_{ij}$  is the travel time between  $i$  and  $j$  (Wang and Dorkenoo, 2018).

A 15-minute drive-time was specified to define the catchment areas and the resulting accessibility scores were multiplied by a factor of 10,000 for analysis purposes. While travel distance thresholds vary among studies that utilized E2SFCA models for access to service providers, a 15-minute cut-off was one of the most commonly used among grocery store accessibility literature (Wang and Lo, 2007; Kirkpatrick and Tarasuk, 2010; Kuai and Zhao, 2017). The 15-minute threshold accounts for the increased travel time that many ethnic residents are often willing to travel to grocery stores that offer familiar, ethnic products (Wang, 2007). The estimated floor size of the grocery stores was used for the supply capacity as larger retailers are often more desirable due to increased selection, and potentially fresher items (Raja, Ma, and Yadav, 2008).

#### **6.4 Creation of an integrated accessibility-marginalization index**

Geographic accessibility indices were created for 2001 and 2016 by classifying the E2SFCA accessibility scores into three tertiles, representing high, medium, and low access to grocery stores. While some studies use the standardized z-score classification (Frank et al., 2010; Wang and Ramroop, 2018), this method was inappropriate due to skewed distributions caused by

large quantities of CTs with very low accessibility scores. To account for this, scores were divided into tertiles, similar to the classification method used by Zenk et al. (2005). Marginalization indices were then created for both study years by classifying Material Deprivation scores for CTs in the Toronto CMA into high, medium, and low levels of deprivation based on tertiles. High marginalization CTs are associated with a decreased ability to access basic material needs and therefore may have a greater chance of having limited access to healthy food providers. Conversely, low marginalization CTs likely have an increased ability to access basic needs, and therefore fewer barriers in accessing healthy food providers. Transforming the E2SFCA and material deprivation scores into categorical variables allows for a more intuitive understanding of accessibility and marginalization among CTs in the CMA.

Similar to the method used in the study by Wang and Ramroop (2018), the marginalization and accessibility indices were combined to create an integrated marginalization-accessibility index for each type of grocery store and each study year. The final indices are used to determine any spatial mismatch between the level of material deprivation and grocery store access, highlighting patterns of inequality throughout the CMA. Specifically, determining areas with medium to high marginalization and low accessibility is useful for understanding which neighbourhoods are under-serviced, and therefore have a higher risk of not being able to access healthy foods or their preferred type of grocery store.

## **7. Results**

### **7.1 Spatial distribution of ethnic residential patterns**

#### **7.1.1 Ethnic origin location quotients**

The calculated location quotients (LQ) for Chinese and South Asian ethnic origins at CSD level are presented in Table 3. LQ values greater than 1.2 for the Chinese population were largely concentrated in the north-eastern portion of the City of Toronto (North York and Scarborough) and the suburban CSDs of Markham and Richmond Hill for both study years. The high LQ values in these CSDs indicate a relative overrepresentation of the population as compared to the Toronto CMA. Comparing values between 2001 and 2016 shows that all six of the former CSDs within the City of Toronto saw no change or a decrease in LQ values, while the majority of suburban CSDs saw an increase in LQ values. This suggests that the overall

distribution of Chinese residential patterns in the Toronto CMA shifted away from the city core and towards the suburbs over the 15-year time period. Specifically, Markham had the largest concentration of Chinese residents with an LQ of 4.0, while Aurora and Whitchurch-Stouffville saw the largest LQ growth of all CSDs.

LQ values for the South Asian population also suggest a pattern of suburbanization. CSDs with values above 1.2 were more scattered throughout the CMA than the Chinese population, with clusters present in the east (Ajax), west (Brampton, Mississauga, and Milton), as well as Scarborough. Former CSDs within the City of Toronto saw no change or a decrease in values between 2001 and 2016, while many suburban CSDs saw increased LQ values. In particular, Brampton, Ajax, and Milton experienced relatively rapid LQ growth and were among the most overrepresented CSDs in 2016.

**Table 3.** Location quotients of Chinese and South Asian populations in the Toronto CMA in 2001 and 2016

CSD Name	2001					2016				
	Proportion Total Population (%)	Proportion Chinese (%)	Proportion South Asian (%)	Chinese LQ	South Asian LQ	Proportion Total Population (%)	Proportion Chinese (%)	Proportion South Asian (%)	Chinese LQ	South Asian LQ
<i>City of Toronto</i>										
Old Toronto	14.4	15.6	6.2	1.1	0.4	13.0	11.7	5.1	0.9	0.4
North York	12.9	16.6	11.1	1.3	0.9	11.0	13.9	6.3	1.3	0.6
Scarborough	12.6	25.2	20.4	2.0	1.6	10.3	18.2	16.1	1.8	1.6
Etobicoke	7.6	2.5	8.5	0.3	1.1	6.0	1.8	5.0	0.3	0.8
York	3.2	1.3	1.5	0.4	0.5	2.4	0.7	0.7	0.3	0.3
East York	2.4	1.7	3.3	0.7	1.3	1.9	1.1	2.0	0.6	1.1
<i>Suburbs</i>										
Mississauga	13.2	9.2	20.0	0.7	1.5	11.8	9.3	16.9	0.8	1.4
Brampton	6.9	1.8	14.2	0.3	2.1	9.7	2.2	26.5	0.2	2.7
Markham	4.4	14.7	5.5	3.3	1.2	5.4	21.7	5.9	4.0	1.1
Richmond Hill	2.8	6.8	1.8	2.4	0.7	3.2	8.3	1.5	2.6	0.5
Pickering	1.8	0.6	1.5	0.3	0.8	1.5	0.6	1.5	0.4	1.0
Ajax	1.6	0.5	1.1	0.3	0.7	2.0	0.8	2.6	0.4	1.4
Aurora	0.9	0.1	0.1	0.2	0.1	0.9	0.9	0.2	1.0	0.2
Milton	0.7	0.0	0.1	0.1	0.1	1.8	0.5	2.3	0.3	1.3
Whitchurch-Stouffville	0.5	0.1	0.0	0.2	0.1	0.7	1.0	0.6	1.3	0.8
Other CSDs	14.2	3.4	4.6	0.1	0.2	18.5	7.3	6.7	0.3	0.3
				(Average)	(Average)				(Average)	(Average)

### 7.1.2 Spatial autocorrelation of ethnic origin populations

Results from the global and local indicators of spatial autocorrelation aim to further describe and quantify the degree of clustering among Chinese and South Asian ethnic groups in 2001 and 2016. Changes in the Global Moran's *I* correlation coefficient values are reported in Table 4. Global Moran's *I* values range between -1 (extremely negative spatial autocorrelation) and 1 (extremely positive spatial autocorrelation), with values near 0 being closer to a random distribution. While positive spatial autocorrelation is detected for both Chinese and South Asian populations in the two study years, the Chinese population displayed higher levels of clustering overall. Both populations reported an increase in values from 2001 to 2016, indicating that they became more clustered over the 15-year period. All four indices had P-values of 0.000 confirming they are statistically significant.

**Table 4.** Global Moran's *I* index values for Chinese and South Asian populations

<b>Ethnic Group</b>	<b>2001 Global Moran's <i>I</i></b>	<b>2016 Global Moran's <i>I</i></b>
Chinese	0.18	0.24
South Asian	0.11	0.16

Cluster maps from the LISA analysis for the Chinese population in 2001 and 2016 are presented in Figure 2. Census tracts categorized in the High-High and Low-Low categories have positive spatial autocorrelation, while those in the Low-High and High-Low categories correspond to negative spatial autocorrelation. High-High CTs were largely concentrated in the CSDs of Markham, Richmond Hill, North York, and Scarborough for both study years. Represented by the colour red, these CTs have a large Chinese population and are surrounded by other CTs with large Chinese populations. As seen on the map, these areas have decreased in number near the city core but have expanded into more northern, suburban CSDs such as Aurora and Whitchurch-Stouffville. Highlighted in the colour pink, CTs in the High-Low category have a high proportion of the Chinese population but are surrounded by areas of low population. When previously in the Low-Low or Low-High categories, these CTs may represent neighbourhoods that are becoming more desirable to residents. Based on the cluster map, the Chinese population in Mississauga and Oakville became increasingly clustered over the 15-year period and could potentially be new, favourable destinations for Chinese residents.

Figure 3 visualizes the results of the LISA cluster maps for the South Asian population in the Toronto CMA for the 2001 and 2016 study years. CTs with significant High-High clustering are located in the east and west regions, in CSDs such as Brampton, Mississauga, and Scarborough. Residential patterns for the South Asian population have not seen a drastic change over time but have expanded slightly away from the city centre. Populations have shifted towards CTs in the eastern portion of Markham and Scarborough as well as the northwest portion of Ajax. Additionally, while Richmond Hill was largely comprised of CTs with low South Asian population in 2001, there was an increased concentration in 2016, indicating a potentially new desirable area for South Asian residents.

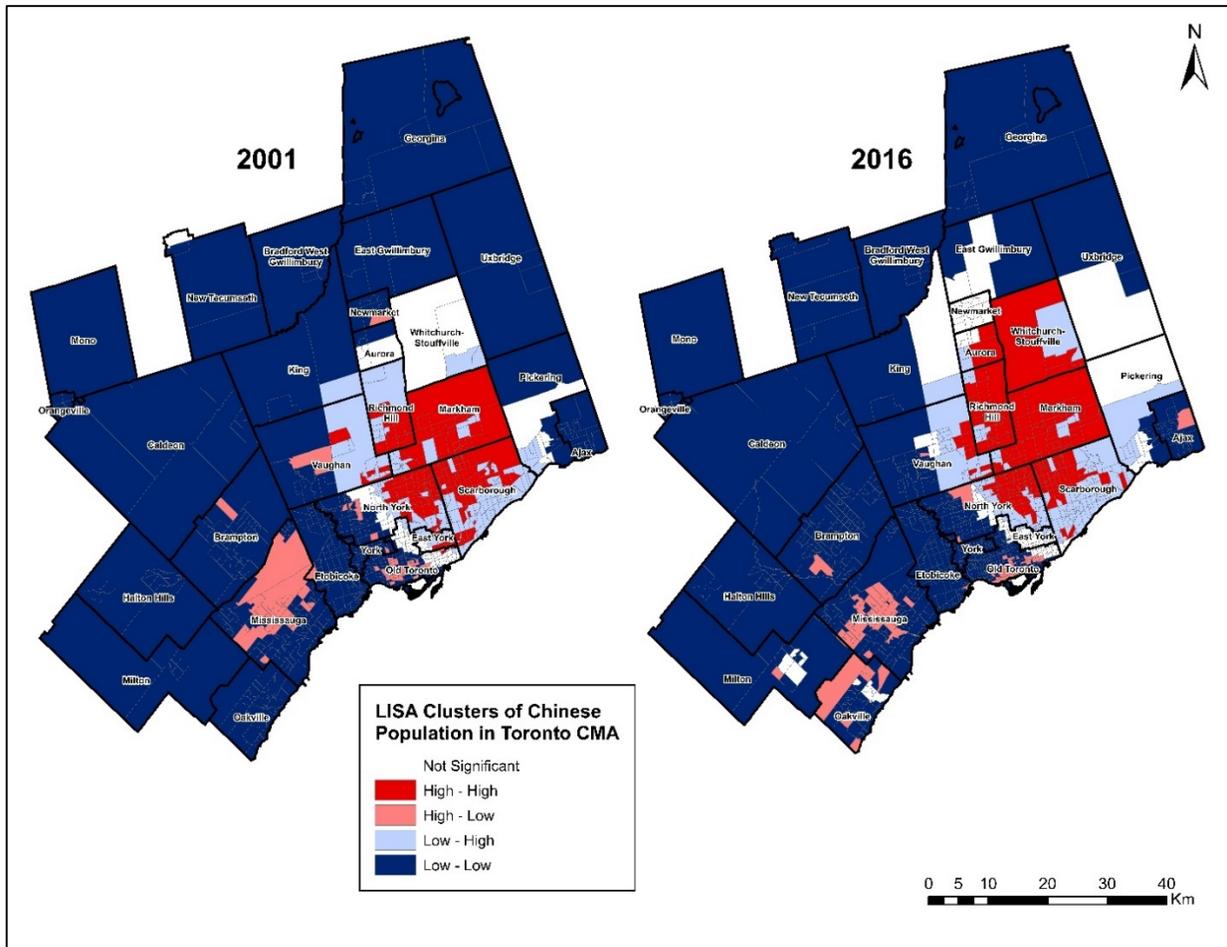


Figure 2. LISA cluster map of Chinese population in the Toronto CMA in 2001 and 2016

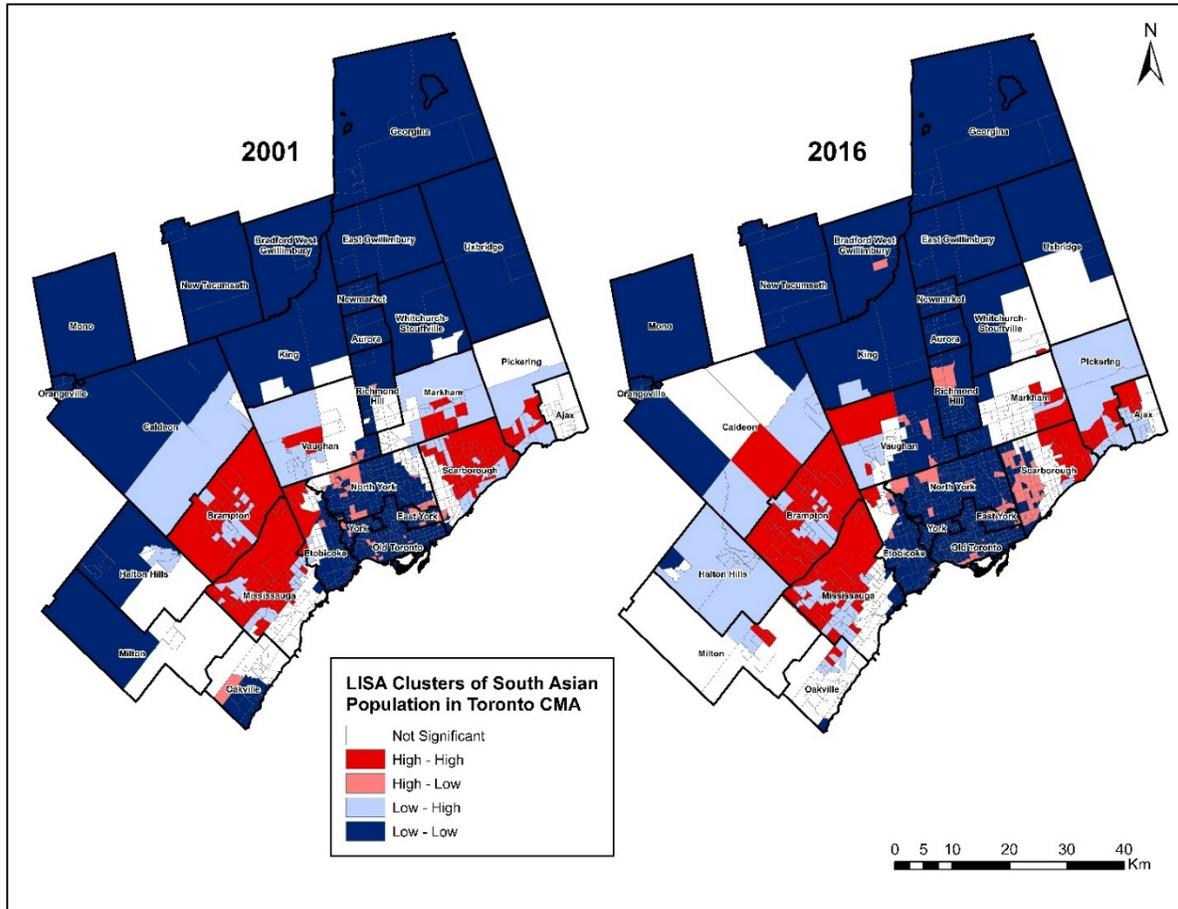


Figure 3. LISA cluster map of South Asian population in the Toronto CMA in 2001 and 2016

## 7.2 Ethnic grocery store distribution

Table 5 provides the number of Chinese and South Asian grocery stores and their average estimated size (sqft.) for select CSDs within the Toronto CMA. For both 2001 and 2016, Chinese and South Asian grocery stores are highly clustered, predominately located in six CSDs; Brampton, Markham, Scarborough, Mississauga, North York, and Old Toronto. The rest of the CMA has little to no presence of these retailers. Overall, the number of South Asian grocery stores in the CMA increased by 21 while the number of Chinese stores decreased by 3. Brampton and Mississauga saw the largest growth in South Asian stores while Old Toronto saw a substantial decrease in both ethnic grocery stores. On average, grocery stores were larger in suburban CSDs than those in the City of Toronto for both study years. Additionally, South Asian grocery retailers were notably smaller in size than their Chinese counterparts, with a much larger difference occurring in 2016 (23,570 sqft. for Chinese stores vs. 3,803 sqft. for South Asian stores), implying that South Asian grocery retailers may be in an earlier stage of development than Chinese retailers.

**Table 5.** Grocery store distribution and average estimated size for select CSDs, 2001 and 2016

CSD Name	No. Chinese Grocery Stores		Chinese Grocery Stores Average Size (Sqft.)		No. South Asian Grocery Stores		South Asian Grocery Stores Average Size (Sqft.)		No. Mainstream Grocery Stores		Mainstream Grocery Stores Average Size (Sqft.)	
	2001	2016	2001	2016	2001	2016	2001	2016	2001	2016	2001	2016
<i>City of Toronto</i>												
Etobicoke	0	3	N/A	25000	1	8	2000	1464	35	26	20202	26755
North York	6	12	7650	14575	4	1	1063	750	51	39	25097	40430
Old Toronto	22	9	1502	7511	16	7	800	757	70	118	17375	15206
Scarborough	18	14	6703	26084	10	11	1200	2777	45	36	29235	38310
<i>Suburbs</i>												
Brampton	2	2	13250	25813	1	18	2000	8631	23	36	36873	38167
Markham	6	11	7650	37537	3	0	1167	2000	16	12	30176	36799
Mississauga	7	8	4229	34866	10	20	2475	2757	53	62	32803	32827
Richmond Hill	5	3	2420	14333	1	0	750	N/A	7	9	28912	51255
<i>CMA Total</i>	<i>68</i>	<i>65</i>	<i>4534</i> <i>(Average)</i>	<i>23570</i> <i>(Average)</i>	<i>49</i>	<i>70</i>	<i>1291</i> <i>(Average)</i>	<i>3803</i> <i>(Average)</i>	<i>396</i>	<i>466</i>	<i>27142</i>	<i>30420</i>

### **7.2.1 Comparing spatial median centres and standard deviational ellipses**

Figure 4 is comprised of three maps that display the spatial median centres and standard deviational ellipses for Chinese, South Asian, and mainstream grocery retailers in 2001 and 2016. The median centre for Chinese grocery retailers has shifted north towards Markham and Richmond Hill while the South Asian median centre shifted north-west towards Brampton. These changes are consistent with the increase in Chinese and South Asian ethnic grocery business development in those suburban CSDs in 2016. The standard deviational ellipses for both ethnic groups are oriented in an east-west direction, due to the concentration of grocery retailers in eastern CSDs such as Scarborough as well as western CSDs such as Mississauga. Specifically, the Chinese standard deviational ellipse is slightly longer in 2016 than in 2001 and has migrated to the north slightly. This is consistent with the increased dispersion of Chinese grocers into more northern, suburban CSDs. Standard deviational ellipses for the South Asian grocers saw a greater change over the study period. In addition to a slightly longer and taller ellipse in 2016 than the one from 2001, the development of new South Asian grocery retailers in the Brampton-Mississauga region has resulted in an overall shift away from the city core and towards the north-west. The median centre and standard deviational ellipse for mainstream grocery retailers did not see a large change over the study period, with only a slight shift towards the south.

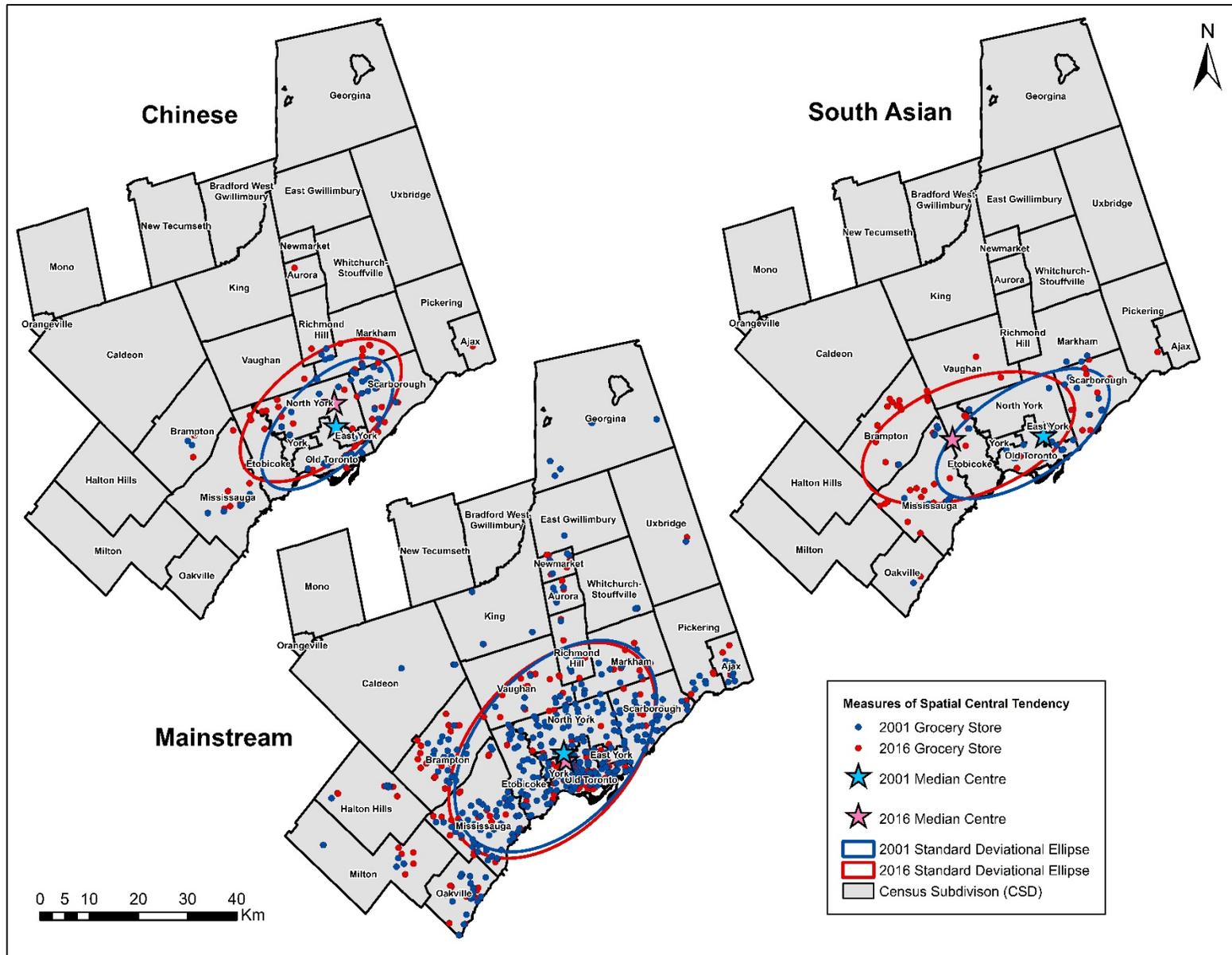


Figure 4. Median centres and standard deviational ellipses for Chinese and South Asian grocery retailers in 2001 and 2016

### 7.2.2 Nearest neighbour analysis

Table 5 displays the results of the Nearest Neighbour analysis which quantifies and further compares the distribution of grocery stores between 2001 and 2016. All six index values are below 1, indicating that various levels of clustering were present among the distribution of grocery stores for each group and year. The index value for mainstream grocery retailers saw a slight decrease from 0.57 in 2001 to 0.55 in 2016, indicating businesses became slightly more clustered over time. The index value for Chinese grocery stores increased from 0.53 in 2001 to 0.74 in 2016, meaning that the stores became less clustered over the 15-year time period. Conversely, South Asian grocery stores became slightly more clustered, as index values decreased from 0.68 in 2001 to 0.62 in 2016. These values are consistent with the development of Chinese grocery businesses in more distant CSDs (Aurora, Ajax) and the increased concentration of South Asian grocery businesses in a smaller number of more central CSDs (Brampton, Mississauga) in 2016, as shown in Figure 4.

**Table 6.** Nearest Neighbour indices for Chinese and South Asian grocery retailers in 2001 and 2016

<b>Grocery Business Distribution</b>	<b>2001</b>	<b>2016</b>
Chinese NN Index	0.53	0.74
South Asian NN Index	0.68	0.62
Mainstream NN Index	0.57	0.55

### 7.3 Spatial distribution of E2SFCA and material deprivation scores

Figures 5 and 6 display the E2SFCA scores for Chinese, South Asian, and Mainstream grocery stores. For both years, mainstream grocery retailers were the most accessible to the total population of the CMA. Suburban CTs had the greatest geographic accessibility to these retailers, particularly in Newmarket, Caledon, and Mississauga. On average, accessibility to both categories of ethnic grocery stores decreased towards the edges of the CMA due to the highly clustered distribution of ethnic grocery businesses in and near the City of Toronto. In 2001, clusters of high accessibility to Chinese grocery stores are largely present in Markham, Scarborough, and North York, while clusters of high accessibility to South Asian stores are concentrated in Brampton, Mississauga, and Scarborough. The changing spatial distribution of grocery stores over the 15-year period resulted in Chinese grocery retailers being more accessible to suburban CTs in 2016, particularly in Aurora, Richmond Hill, Vaughan, and

Markham. South Asian grocery stores were also more accessible in 2016, with higher scores in suburban Brampton, Pickering, Ajax, and Oakville. Despite the relatively high number of Chinese and South Asian grocery stores in Old Toronto for both years, their smaller floor size decreased their overall attractiveness, ultimately lowering the accessibility scores and placing more emphasis on larger stores in suburban CSDs (Table 5).

For both Chinese and South Asian grocery retailers, CTs with the greatest accessibility largely aligned with the residential patterns of their co-ethnic consumer population. This can be seen by comparing the E2SFCA maps with the LISA cluster maps (Figures 2 and 3). For example, many CTs near Markham and Scarborough in the 2016 Chinese E2SFCA map had relatively high accessibility scores. In the LISA cluster map for the same year, these areas also had a large concentration of the Chinese population. Therefore, the co-ethnic consumer populations were generally well-aligned with the location of grocery retailers. This suggests that there is a relatively strong relationship between ethnic residential patterns and the distribution of ethnic grocery stores.

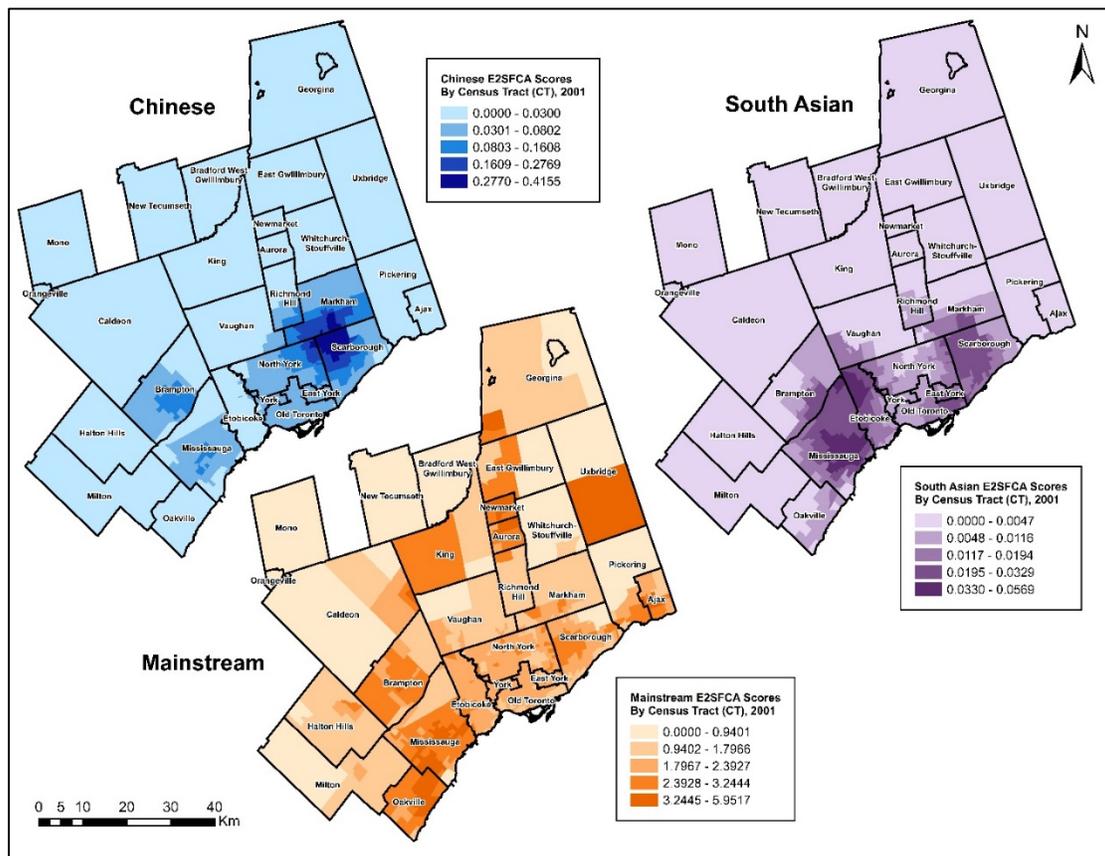


Figure 5. E2SFCA scores for Chinese, South Asian, and Mainstream grocery retailers at the CT level, 2001

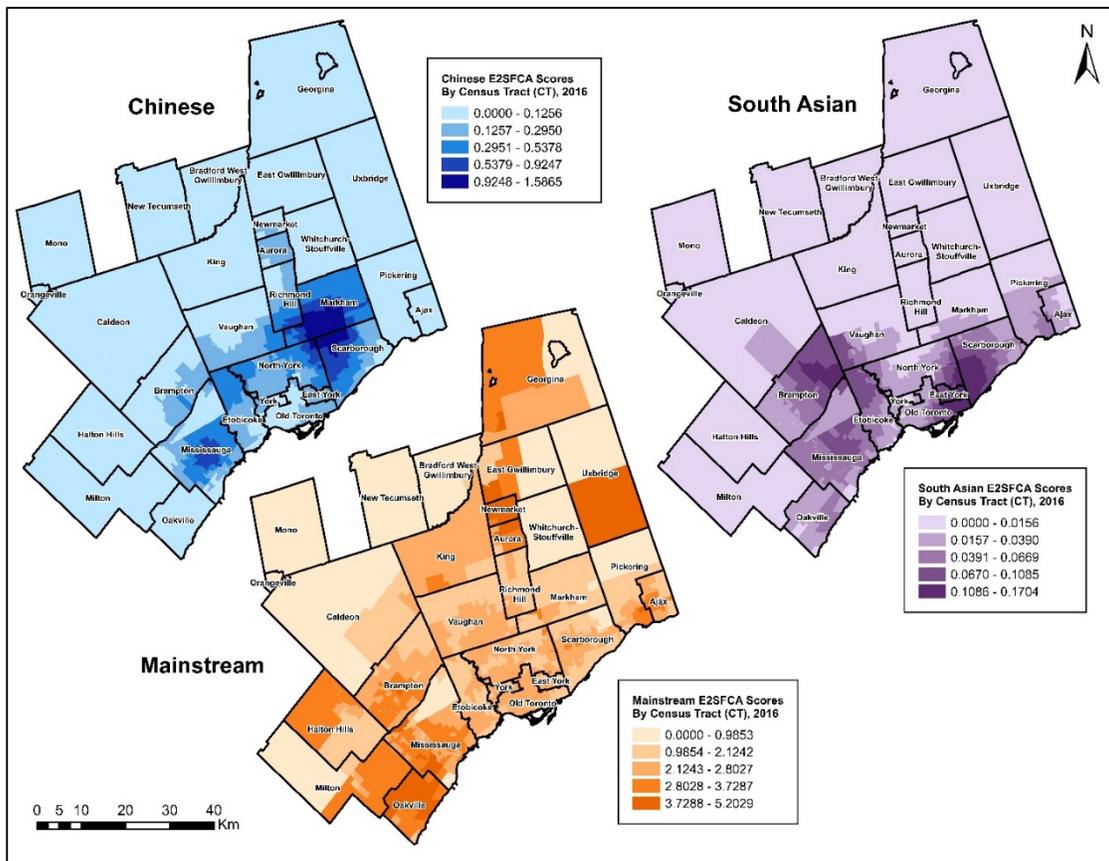


Figure 6. E2SFCA scores for Chinese, South Asian, and Mainstream grocery retailers at the CT level, 2001

Material deprivation scores from the Marginalization Index for the Toronto CMA are visualized in Figure 7. CTs with the highest marginalization scores were largely clustered in the CSDs of Scarborough, North York, York, and Old Toronto for the 2001 study year. In 2016, concentrations of high scores expanded to encompass more CTs within the City of Toronto, largely in Scarborough, Etobicoke, and North York, as well as CTs in suburban regions such as Brampton, Mississauga, and Ajax. The general pattern of material deprivation in the CMA has notable similarities to the residential patterns of the ethnic groups, as shown in Figures 2 and 3. This is particularly evident with the South Asian residential patterns in 2016, where the increased population in Brampton and Mississauga aligned with the increased marginalization scores in the same CSDs.

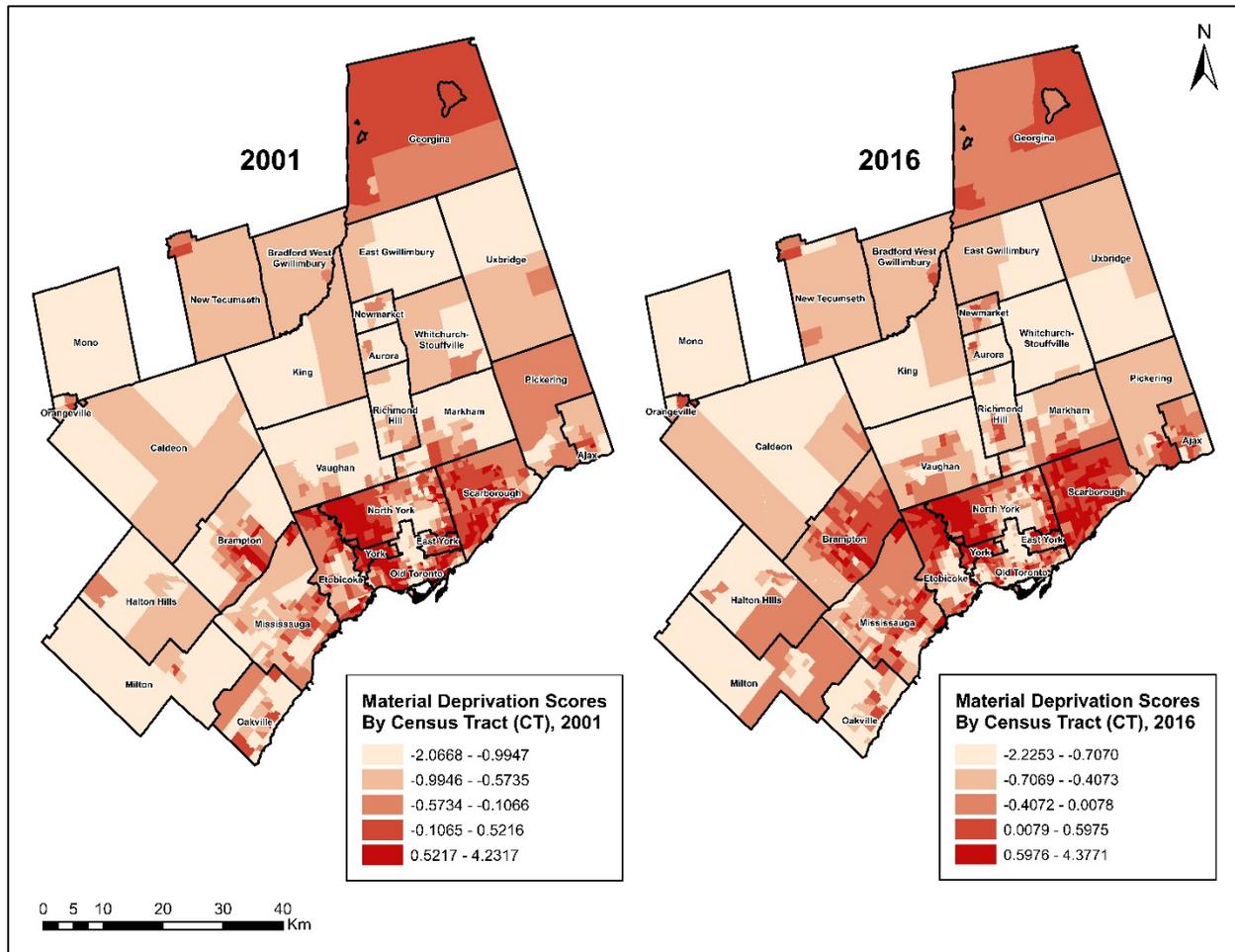


Figure 7. Material Deprivation quintiles per CT in 2001 and 2016

#### 7.4 Integrated marginalization-accessibility index

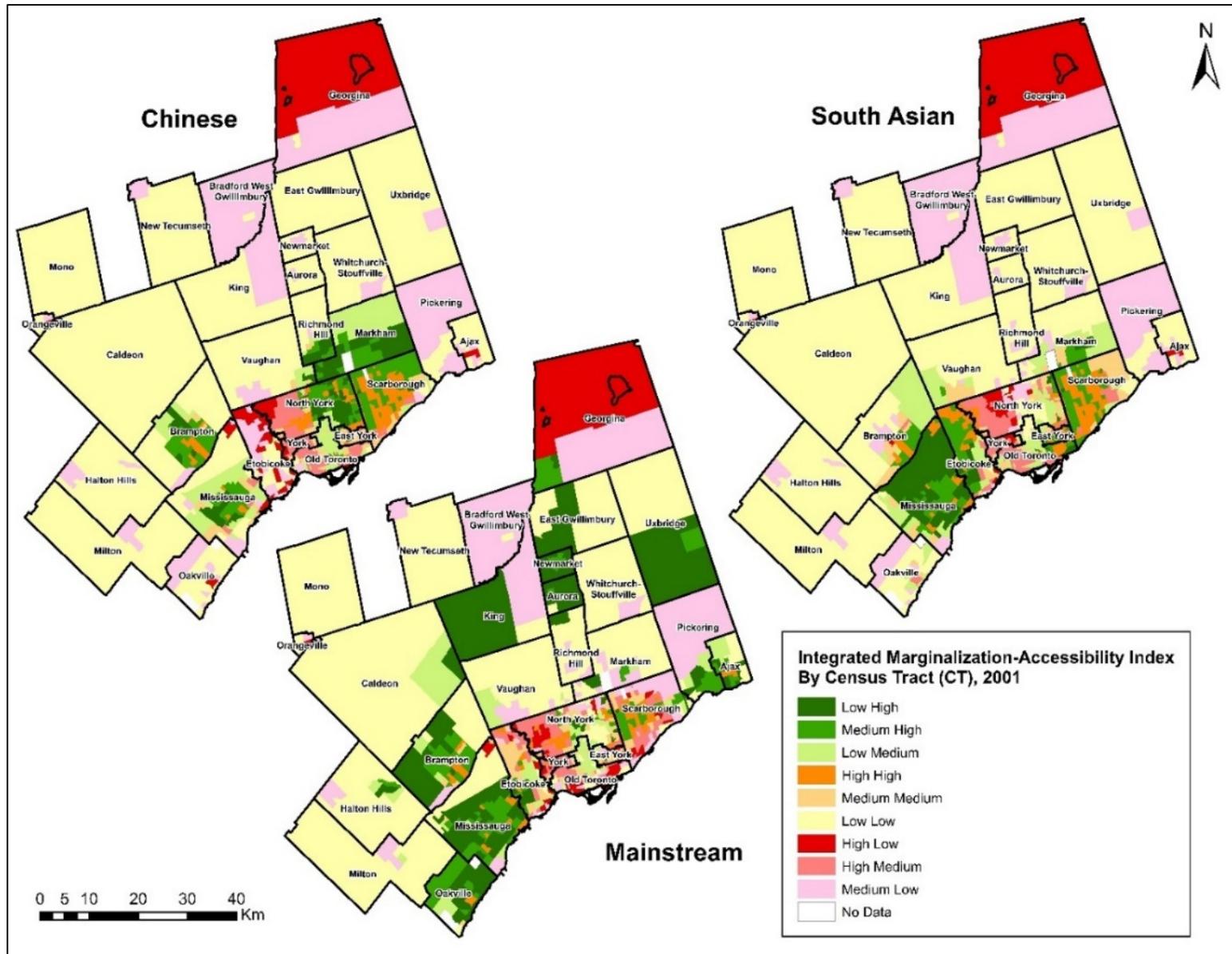
E2SFCA scores were joined with Material Deprivation scores in Figures 7 and 8 to identify the relationship between neighbourhood marginalization and spatial accessibility to grocery stores. The maps display the results of the integrated marginalization-accessibility index for Chinese, South Asian, and mainstream grocery retailers in 2001 and 2016. CTs in the Low-High and Medium-High categories have relatively low levels of marginalization yet high accessibility, indicating that they may have been over-served, and those in the Low-Medium and High-High were likely well-served. Conversely, under-served CTs are those in the High-Low, High-Medium, and Medium-Low categories that have increased levels of marginalization but low access to grocery stores.

The overall spatial distribution of well- and over-serviced CTs to Chinese and South Asian grocery retailers mainly aligned with the location of the corresponding ethnic residential patterns for both study years. As indicated in Table 7, the proportion of well- and over-serviced CTs for Chinese and South Asian grocery stores only increased by 1.3% and 1.9%, respectively. However, the spatial distribution of these CTs saw an overall shift towards the suburbs, mainly towards Markham and Aurora for Chinese stores, and Oakville and Caledon for South Asian stores. This indicates that in 2016, Chinese and South Asian residents in these suburban CTs were more appropriately serviced to their corresponding ethnic grocery retailers than in 2001. A similar trend was observed for mainstream grocery stores, as the distribution of well- and over-serviced CTs encompassed more suburban regions over the 15-year time period.

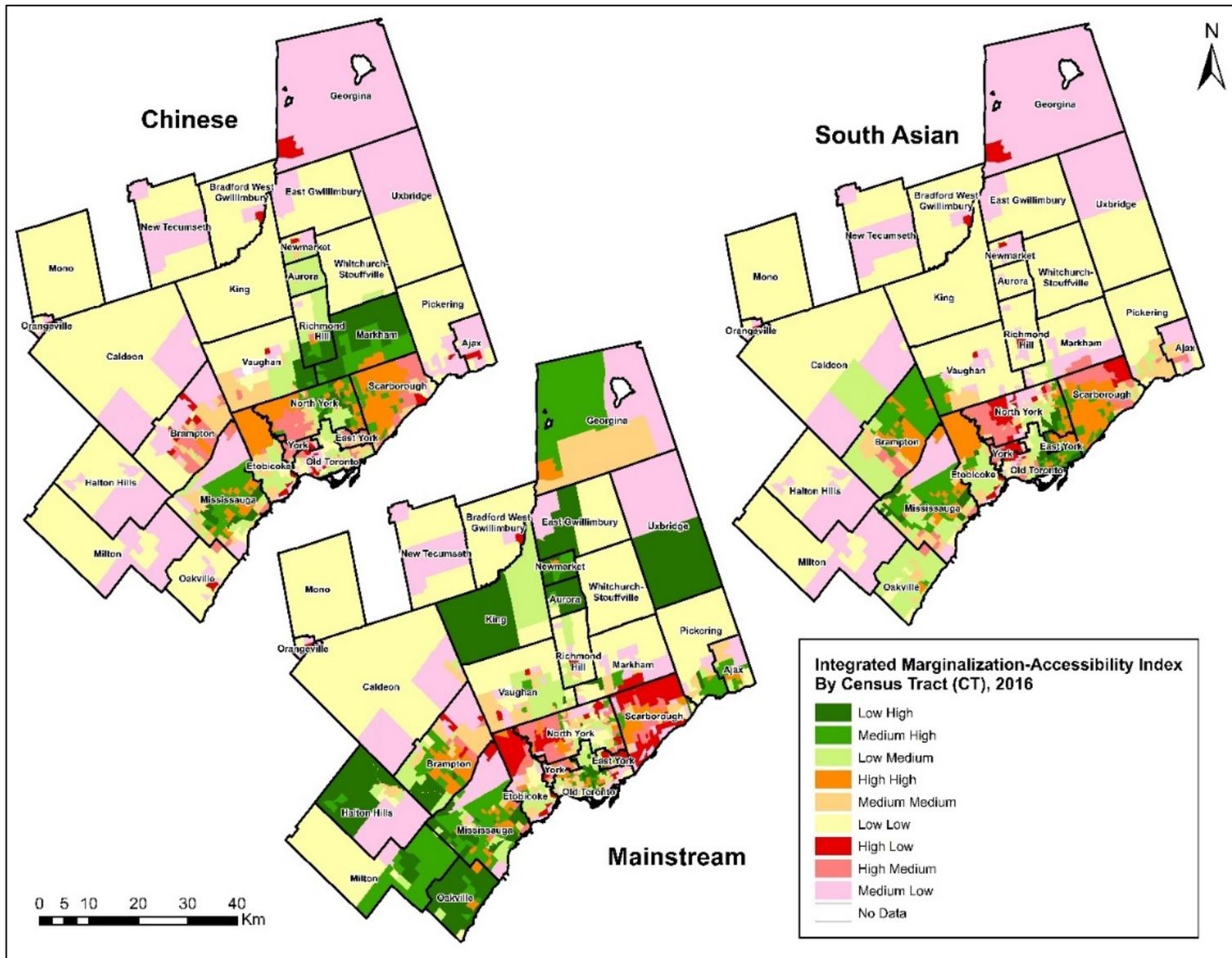
While the proportion of under-serviced CTs for all three types of grocery stores saw minimal changes between 2001 and 2016, the spatial distribution transformed (Figures 7 and 8). This means that while the number of vulnerable CTs with inadequate access did not improve over time, the location of under-serviced CTs changed based on varying E2SFCA and marginalization scores. For mainstream grocery stores, increased clustering was present in 2016 within the City of Toronto, mainly in Etobicoke, North York, and Scarborough. Both ethnic grocery stores had an increase in the number of under-serviced CTs in suburban CSDs, such as Halton Hills, Milton, Ajax, and Caledon. Additionally, for both types of ethnic grocers, Scarborough saw an increase in under-serviced neighbourhoods, making it one of the CSDs with consistently lower service for each retailer and year.

**Table 7.** Summary statistics of 2001 and 2016 integrated marginalization-accessibility indices

Classification	Integrated Marginalization-Accessibility Index	Proportion of CTs 2001 (%)			Proportion of CTs 2016 (%)		
		Chinese	South Asian	Mainstream	Chinese	South Asian	Mainstream
Over-serviced	Low – High	8.0	5.3	12.4	7.0	4.7	10.7
Over-serviced	Medium – High	14.9	13.5	13.4	10.5	12.0	13.5
Well-serviced	Low – Medium	10.0	10.1	9.1	10.9	11.6	10.9
Well-serviced	High – High	10.1	14.2	7.3	15.9	16.7	9.2
Moderately-serviced	Medium – Medium	8.0	8.9	8.9	10.1	11.2	11.4
Moderately-serviced	Low – Low	16.9	19.4	13.3	14.2	15.8	10.5
Under-serviced	High – Low	6.1	3.2	9.1	3.6	4.6	11.6
Under-serviced	High – Medium	15.1	13.8	14.8	12.3	10.4	10.9
Under-serviced	Medium – Low	10.0	10.4	10.5	15.2	12.6	10.9



**Figure 8.** Integrated Marginalization-Accessibility Index for Chinese, South Asian, and mainstream grocery stores at the CT level, 2001



**Figure 9.** Integrated Marginalization-Accessibility Index for Chinese, South Asian, and mainstream grocery retailers at the CT level, 2016

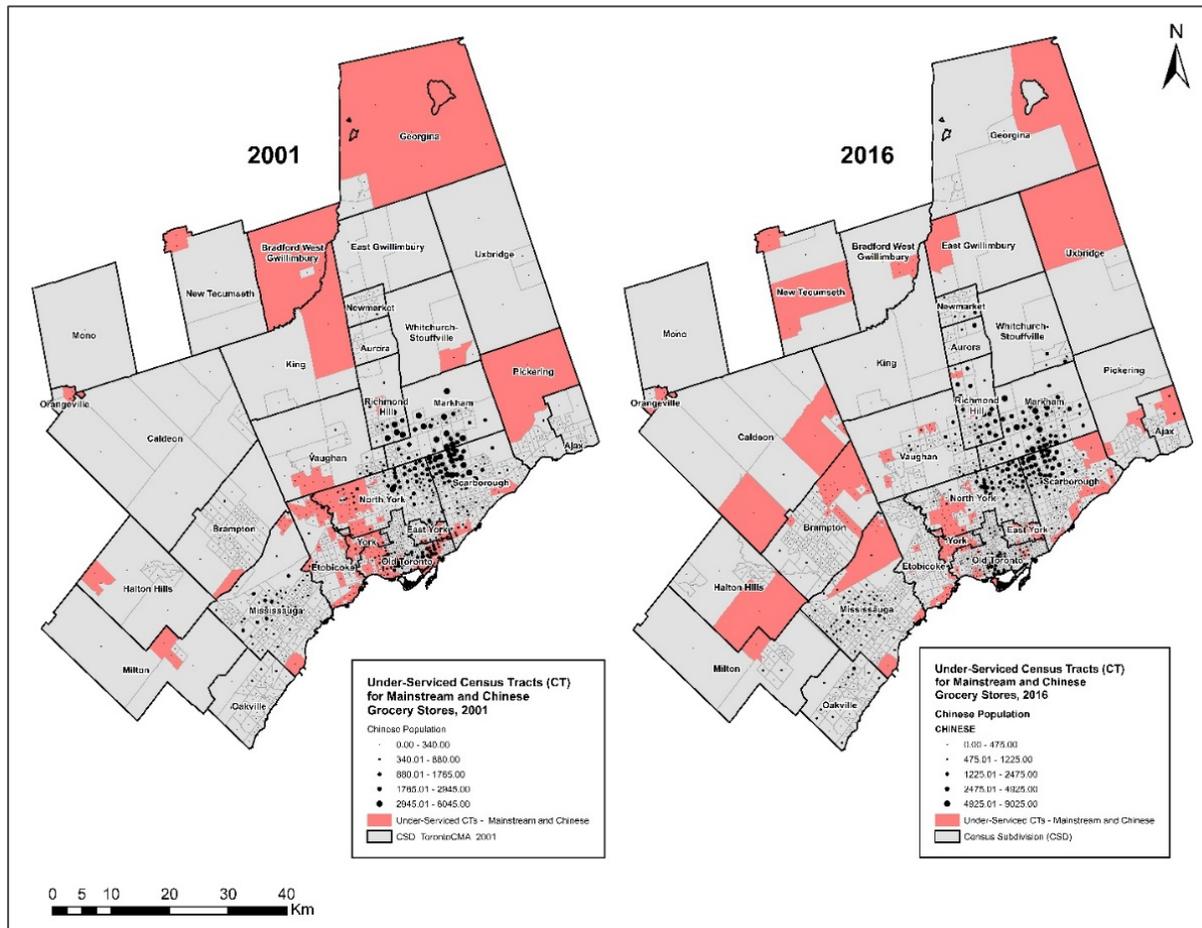
To further examine the geographic distribution of accessibility and marginalization, mainstream marginalization-accessibility index maps were compared and overlaid on top of the Chinese and South Asian marginalization-accessibility index maps, separately. The resulting visualizations display CTs that are classified as under-serviced for both mainstream and Chinese grocery stores (Figure 9) as well as CTs that are under-serviced for both mainstream and South Asian grocery stores (Figure 10). These under-serviced areas are especially concerning if they have a sizeable population of the corresponding ethnic group as they would have limited access to both mainstream grocery providers as well as their ethnic stores. As a result, poor access could result in a decrease in healthy food options, and a potential increase in nutrition-related food illnesses (Health Canada, 2013; Larsen et al., 2015; Tarasuk, Mitchell, and Dachner, 2016).

As shown in Figure 10, a large portion of the Chinese population in 2001 had relatively good access to either mainstream or Chinese grocery retailers. An exception to this was a portion of Old Toronto, where residents had poorer access to both and would therefore need to travel further to access a preferred type of grocer. This highly under-serviced area was largely absent in 2016, indicating that the majority of neighbourhoods with large Chinese populations had decent access to either one, or both, of the grocery retailers. This is consistent with the 7.6% decrease in CTs in this category over the 15-year time period (Table 8).

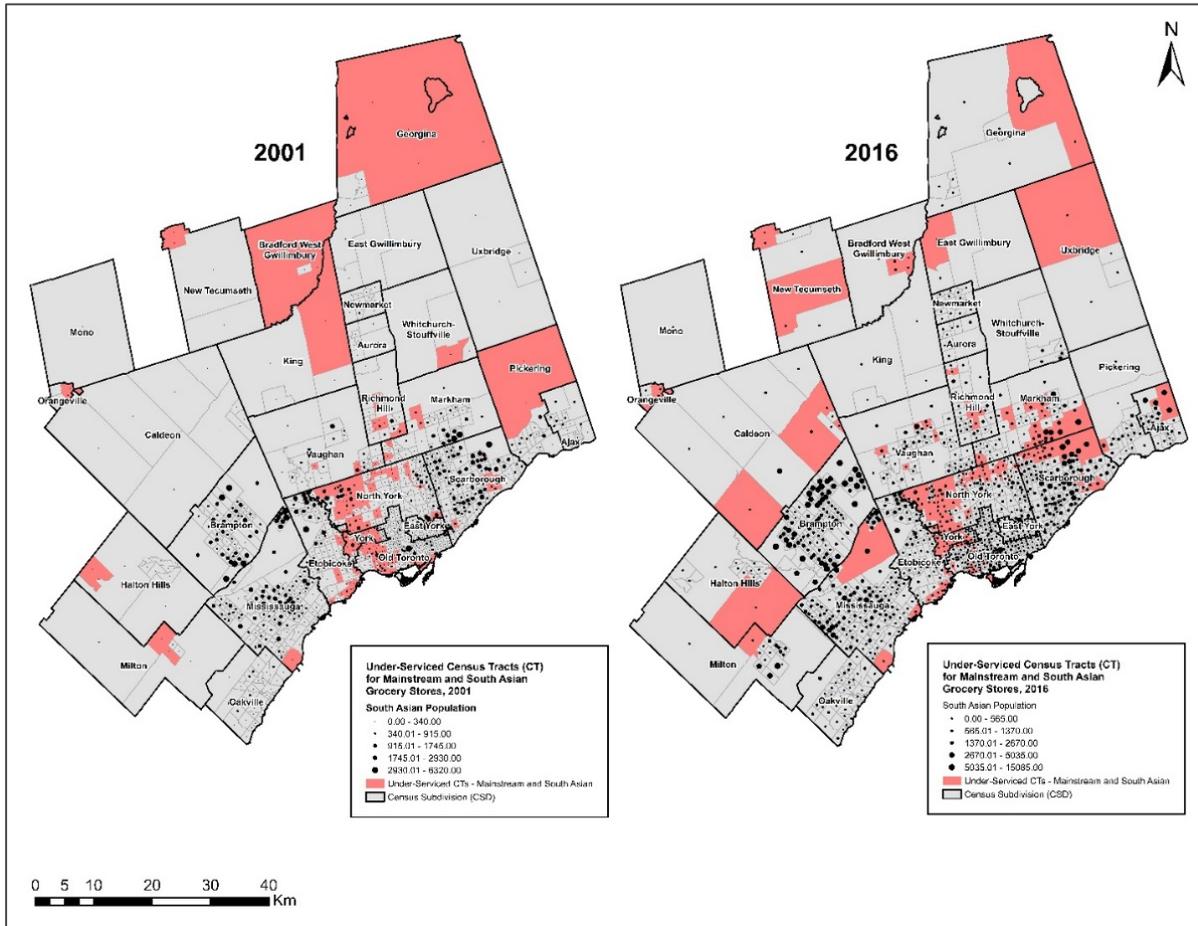
In 2001, the majority of the South Asian population had reasonable access to at least one type of grocery store, with some areas of concern in western York and North York (Figure 11). However, despite a 3% decrease in the proportion of CTs that were under-serviced to both South Asian and mainstream grocery retailers over the study period, there was a substantial increase in affected neighbourhoods with large South Asian populations in 2016 (Table 8). Specifically, the increase in under-serviced CTs became more prominent in the eastern portion of the CMA, in southeast Markham, north Scarborough, and northeast Ajax, in addition to the previous concentrations in York and North York from 2001. This trend shows a decrease in the overall accessibility to mainstream and South Asian grocery stores for South Asian residents in these areas over the 15-year time period, suggesting that more residents had limited access to healthy food, and a potential decrease in the overall health of communities. This is particularly present in suburban CSDs such as Ajax that saw an increase in South Asian residents over the study period but have not yet developed a sufficient number of grocery businesses to accommodate the new ethnic population.

**Table 8.** Summary statistics of 2001 and 2016 CTs under-served for mainstream and ethnic grocery retailers

Classification	Proportion of CTs 2001 (%)	Proportion of CTs 2016 (%)
Under-served to mainstream and Chinese grocery retailers	23.0	15.4
Under-served to mainstream and South Asian grocery retailers	19.7	16.7



**Figure 10.** Under-Served CTs to both mainstream and Chinese grocery retailers in 2001 and 2016



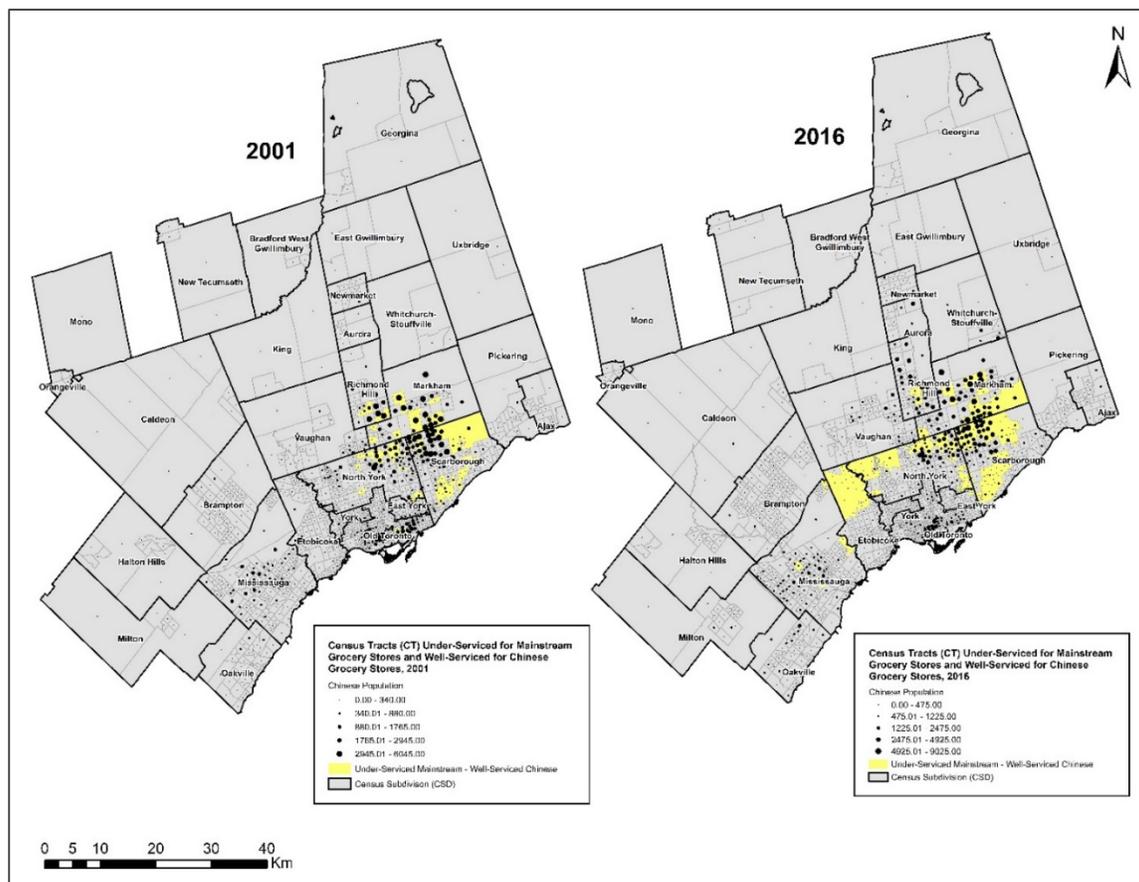
**Figure 11.** Under-Served CTs to both mainstream and South Asian grocery retailers in 2001 and 2016

CTs that were under-served for mainstream grocery stores but well- and over-served for ethnic grocery stores were also overlaid over each other to identify neighbourhoods where ethnic grocery retailers filled gaps in providing healthy food to vulnerable ethnic residents that would otherwise not have reasonable access to options from mainstream stores. CTs that were well- and over-served for Chinese grocers, under-served for mainstream grocers, and had sizeable Chinese populations in 2001 and 2016 are shown in Figure 12. In 2001, these areas mainly comprised of CTs in south Richmond Hill, south central Markham, northeast North York, and portions of north Scarborough. As shown in Table 9, the proportion increased by 6.3% in 2016, with affected neighbourhoods expanding to encompass CTs in northwest Scarborough. This suggests a possible increase in the closure of mainstream stores and new development of Chinese grocery businesses due to increased competition between the two types of grocers or to fill the void in providing services to the co-ethnic consumer population.

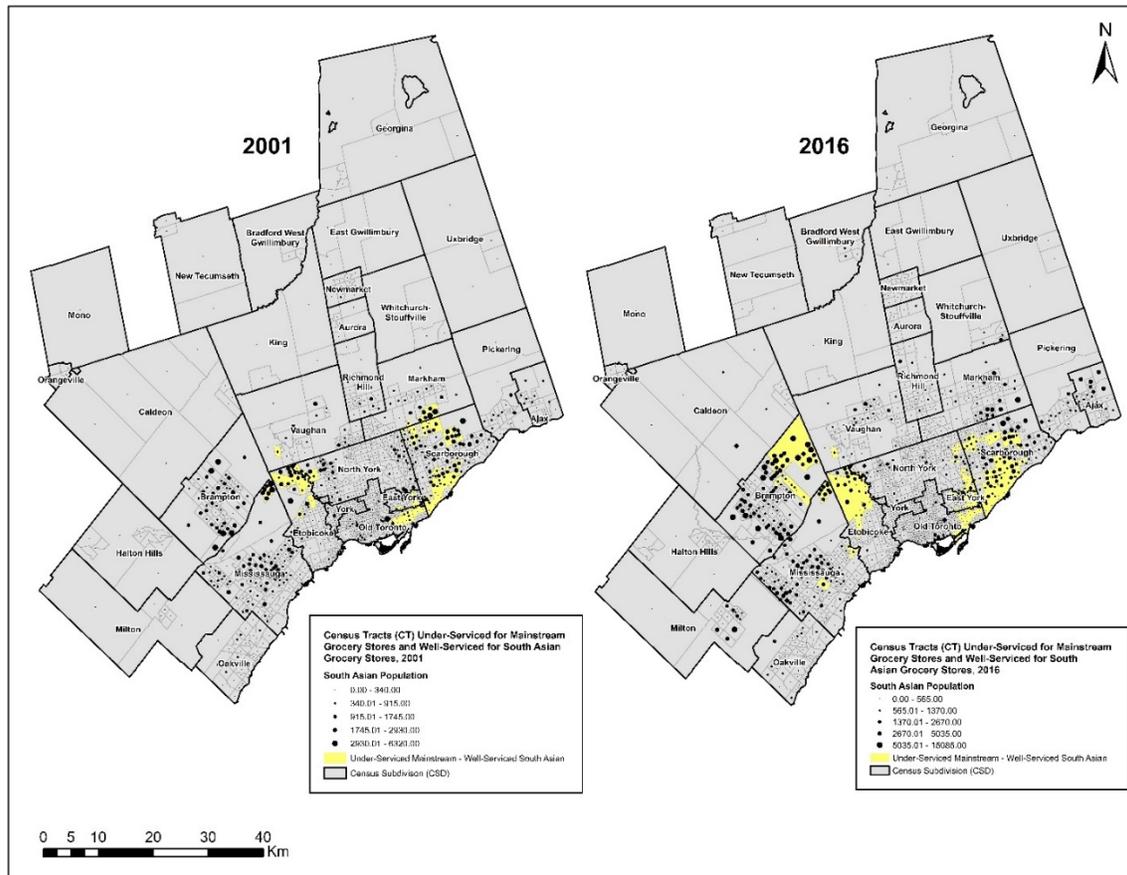
Figure 13 visualizes the changing spatial pattern of CTs that were well- and over-served for South Asian grocers yet under-served for mainstream grocers, and also had sizeable South Asian populations in 2001 and 2016. In 2001, these CTs were concentrated within the City of Toronto, in north Etobicoke, north and southwest Scarborough, and a small portion of south-central Markham. While the proportion of these CTs increased by 2.7% in 2016 (Table 9), the spatial distribution shifted to include suburban CTs in northeast Brampton, and saw a decrease in Markham.

**Table 9.** Summary statistics of 2001 and 2016 CTs under-served for mainstream and well/over-served for ethnic grocery retailers

Classification	Proportion of CTs 2001 (%)	Proportion of CTs 2016 (%)
Under-served to mainstream and Well/Over-Served to Chinese grocery retailers	9.2	15.5
Under-served to mainstream and Well/Over-Served to South Asian grocery retailers	12.0	14.7



**Figure 12.** CTs Under-Served to mainstream grocery retailers and Well/Over-Served to Chinese grocery retailers in 2001 and 2016



**Figure 13.** CTs Under-Served to mainstream grocery retailers and Well/Over-Served to South Asian grocery retailers in 2001 and 2016

## 8. Discussion, limitations, and future research

Understanding the changing spatial structure of ethnic grocery retailing in Canadian urban metropolitan regions is increasingly important as immigration levels continue to rise and ethnic economies become more complex. The spatial relationships between ethnic and mainstream grocery businesses and their consumer populations can provide valuable insights on patterns and connections present amongst cities, as well as the into future ethnic business development. Additionally, assessing the spatial accessibility of ethnic grocery stores against various socio-economic and demographic communities can highlight inequalities that are present within a region. However, only a limited number of studies have focused on these topics over time. Therefore, this paper aimed to address these gaps in the literature through a case study of Chinese and South Asian grocery businesses and residential patterns in the Toronto CMA between 2001 and 2016.

The first research question of this study was answered by comparing the spatial distribution of Chinese and South Asian grocery retailers and residential patterns over the study period, using a combination of location quotients, global and local indicators of spatial autocorrelation, measures of spatial central tendency, and nearest neighbour indices. The results of these analyses revealed that the spatial distribution of ethnic grocery stores and residential patterns follow a similar pattern, supporting the theory that the development and success of ethnic businesses is largely dependent upon the presence of co-ethnic consumers (Wang and Hernandez, 2018). The analysis also found that the Chinese and South Asian grocery retailers and populations experienced suburbanization over the 15-year time period, aligning with recent literature on the prominence of ethnoburbs and decline of inner-city enclaves (Simmons, Hernandez, and Kamikihara, 2010; Zhuang and Chen, 2017). Chinese residents and retailers shifted towards the north-east, clustering in the CSDs of Markham, Richmond Hill, North York, and Scarborough, while South Asian businesses and consumers shifted to both the east (Pickering and Ajax) and west (Brampton and Mississauga). Based on these relationships, new or upcoming locations of ethnic grocery retailers can potentially be predicted based on the location of new residential concentration. The CSD of Whitchurch-Stouffville, in particular, may be an emerging zone of Chinese ethnic business development based on the rapid increase of residents. Ethnic grocery retailers are likely to emerge if the Chinese population continues to increase in this region.

In order to answer the second research question of this study, E2SFCA scores were calculated to assess the spatial accessibility of Chinese, South Asian, and mainstream grocery retailers over time. The scores were then combined with neighbourhood marginalization scores to develop an integrated marginalization-accessibility index. Understanding this accessibility is highly important as grocery stores are one of the main providers of healthy food for vulnerable, urban communities, and limited accessibility has been linked to a rise in nutrition-related illnesses (Smoyer-Tomic, Spence, and Amrhein, 2006; Health Canada, 2013). Ethnic grocery retailers in particular play an important role in the consumption of healthy foods among immigrants and ethnic residents as ethnic retailers are often their preferred choice (Lo, 2009).

Results of the index highlight inequitable, under-serviced CTs that are highly marginalized yet have low accessibility to grocery stores, such as those in the Scarborough and Etobicoke areas. Neighbourhoods with a sizeable Chinese or South Asian population that were

under-serviced for both mainstream and the corresponding ethnic grocery retailers were particularly disadvantaged, such as South Asian residents in Scarborough in 2016. Poor access to both of the preferred grocery outlets has the potential to negatively affect residents by limiting healthy food options and increasing health concerns. Additionally, the index identified CTs that were under-serviced for mainstream grocery businesses but well or over-serviced for ethnic grocery businesses, and also had a relatively large co-ethnic consumer population. This is useful in locating neighbourhoods where ethnic grocery stores have filled a gap in providing healthy food to residents that may have otherwise had little to no options. This observation was also present in Scarborough for both ethnic groups, indicating that residents in this region may be reliant on ethnic grocery retailers for the provision of groceries, including healthy food selections. These index results can be used to highlight areas of concern, where new grocery businesses should be developed to provide more equitable services to residents.

A number of limitations are present in this study. First, while the use of the Ethnic Origin census variable encompasses both immigrants and those born in Canada, responses reflect each respondent's perception of their ethnic ancestry and may be limited to their understanding or opinions on the topic. Consequently, two respondents with the same ethnic ancestry could record different responses (Statistics Canada. (2016b). The use of this variable also does not account for the fact that second-generation residents may have differing dietary habits than their immigrant parents, and therefore may not be frequent customers of ethnic grocery retailers. Next, marginalization-accessibility index scores for CTs located near the edge of the Toronto CMA should be interpreted with caution due to the "edge effect" (Luo and Wang, 2003). Scores may be higher for these CTs because the population and grocery stores outside of the boundary are not considered, potentially skewing the results. Similarly, large CTs with low population densities, such as those in the CSD of King, should also be interpreted carefully as scores could be biased due to the small number problem. Another consideration involving the accessibility analysis is regarding the use of centroids to represent the demand of the entire CT population. The E2SFCA model assumes that the entire population with a CT has the same level of access, regardless of the size of the CT or where the population is located within it. Finally, the 15-minute threshold for the E2SFCA method was selected based on limited research that is available, and does not take into consideration traffic, which could impact the distance residents are able to travel in the time period. Future research should consider other methods of

determining an appropriate travel threshold, such as through primary or survey data. It is also important to note that while neighbourhoods that are under-serviced for both mainstream and ethnic grocery retailers may be related to food deserts, they are not classified as such in this study because other types of ethnic grocery stores (i.e. South American, African, etc.) could be present in these areas, but are not assessed in this study.

Despite these limitations, this study provides a comprehensive framework to examine the changing spatial structure of ethnic retailing in a large metropolitan region. It does so by assessing the spatial relationship between Chinese and South Asian ethnic grocery retailers and residential patterns in the Toronto CMA over a 15-year time period. It also measures the geographic accessibility of ethnic grocery stores among marginalized neighbourhoods, providing insights on the accessibility of healthy food among CTs in the CMA. While this is a small-scale, exploratory study, the results could be utilized to further understand ethnic grocery business development in the Toronto CMA and highlight areas where future research is necessary. Specifically, the changing spatial organization and accessibility of ethnic grocery retailers in the Toronto CMA could be explored further, potentially incorporating additional socio-economic and demographic variables for comparison, as well as other modes of transportation (public transit, walking), as many urban residents do not travel by car (Larsen and Gilliland, 2008). Qualitative methods including interviews and surveys could also provide an enhanced understanding of the ongoing transformation of ethnic grocery retailing at the individual or community level.

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