Health & Place 18 (2012) 841–853

Contents lists available at SciVerse ScienceDirect

Health & Place

journal homepage: www.elsevier.com/locate/healthplace

Neighbourhoods and potential access to health care: The role of spatial and aspatial factors

Laura Bissonnette [a], Kathi Wilson [a,*], Scott Bell [b], Tayyab Ikram Shah [b]

[a] Department of Geography, University of Toronto Mississauga, 3359 Mississauga Rd. N., Mississauga, Ontario, Canada L5L 1C6
[b] Department of Geography, University of Saskatchewan, Saskatoon, SK, Canada S7N 5A5

ARTICLE INFO

Article history:
Received 10 November 2010
Received in revised form
13 March 2012
Accepted 15 March 2012
Available online 23 March 2012

Keywords:
Neighbourhoods
Access to health care
Primary health care
Geographic information systems

ABSTRACT

The availability of, and access to, primary health care is one neighbourhood characteristic that has the potential to impact health thus representing an important area of focus for neighbourhood-health research. This research examines neighbourhood access to primary health care in the city of Mississauga, Ontario, Canada. A modification of the Two Step Floating Catchment Area method is used to measure multiple spatial and aspatial (social) dimensions of potential access to primary health care in natural neighbourhoods of Mississauga. The analysis reveals that neighbourhood-level potential access to primary care is dependant on spatial and aspatial dimensions of access selected for examination. The results also show that potential accessibility is reduced for linguistic minorities as well as for recent immigrant populations who appear, on the surface, to have better access to walk-in clinics than dedicated physicians. The research results reinforce the importance of focusing on intra-urban variations in access to care and demonstrate the utility of a new approach for studying neighbourhood impacts that better represents spatial variations in health care access and demand.

1. Introduction

The study of neighbourhoods and their effects on the health and well-being of residents has quite a lengthy history in the social sciences (e.g., sociology and geography) (Garner and Raudenbush, 1991; Mullins, 1973; Russ-Eft, 1979; Herbert, 1976; Johnston, 1976; Smith, 1980). More recently, interest has grown in other fields, most notably in public health and epidemiology (Kawachi and Berkman, 2003; Diez Roux, 2001; Schempf et al., 2011). Despite the growth in neighbourhood-health studies there is no single definition of what constitutes a neighbourhood. Rather, it seems that definitions of neighbourhood and methods for operationalizing neighbourhood and measuring neighbourhood-effects appear to be strongly linked to both the research question and the type of data (i.e., secondary or primary) available for analysis. That said, within the neighbourhood-health field, there are some key commonalities in conceptualizations of neighbourhoods (see Weiss et al., 2007). For example, Galster (2001, p. 28) in critiquing early work that employed ecological definitions (e.g., a physical area with specific boundaries) or a mix of ecological and social definitions (a geographically bounded area in which residents interact socially), stresses the importance of also accounting for features of the local environment in defining neighbourhoods: "the bundle of spatially based attributes, associated with clusters of residences, sometimes in conjunction with other land uses." Similarly, (Lebel et al., 2007) define neighbourhood as "a place characterised by a specific collection of spatially-based features that can be found at a specific geographic scale."

In employing these and other similar definitions, studies have shown a strong relationship between neighbourhood of residence and a number of health outcomes including low birth weight and infant mortality (Buka et al., 2003; O'campo et al., 1997; Szwarcwald et al., 2002), self-rated health (Wen et al., 2006; Patel et al., 2003; Kawachi et al., 1999), cardiovascular disease and other chronic conditions including coronary heart disease (Sundquist et al., 2004; Diez-Roux et al., 1997), stress, and depression (Matheson et al., 2006; Boardman et al., 2001). In addition, neighbourhood contextual characteristics have also been shown to influence health related behaviours, such as smoking (Frohlich et al., 2002; Duncan et al., 1999; Kleinschmidt et al., 1995), alcohol consumption (Stockdale et al., 2007; Pollack et al., 2005; Duncan et al., 2002), diet (Morland et al., 2002; Lee and Cubbin, 2002; Ecob and Macintyre, 2000), and physical activity (Harrison et al., 2007; Fisher et al., 2004; Giles-Corti and Donovan, 2002).

In searching for the links among neighbourhoods, health status, and health behaviours, research has concentrated on the social and physical characteristics of neighbourhood environments. In doing so, it has been shown that neighbourhood-level characteristics have an impact on health above and beyond the characteristics of individuals. In particular, research has pointed

* Corresponding author. Tel.: +1 905 828 3864; fax: +1 905 828 5273.
E-mail address: kathi.wilson@utoronto.ca (K. Wilson).

1353-8292
http://dx.doi.org/10.1016/j.healthplace.2012.03.007

to the importance of key neighbourhood social attributes such as socioeconomic status, perceptions of crime and safety, and social ties and networks (Kawachi, 2000; Kawachi and Glass, 2000). Physical characteristics of neighbourhoods have also been shown to directly impact the health and health behaviours of neighbourhood residents (Witten et al., 2003; Finkelstein et al., 2003; Auchincloss et al., 2008; Rodríguez et al., 2008; Gauvin et al., 2008; Sallis et al., 2009). For example, research has demonstrated the importance of proximity to health inhibiting and health promoting resources and services such as parks (Giles-Corti and Donovan, 2002; Li et al., 2005; Henderson et al., 2005), grocery stores (Kubzansky et al., 2005; Mobley et al., 2008; Moudon et al., 2005), alcohol, and fast food outlets (Farley et al., 2006; Britt et al., 2005; Sturm and Datar, 2005; Lopez, 2007). An important, but smaller group of studies has concentrated on access to health care resources, identifying disparities in access to health care in multiple contexts and demonstrating that differential access to health care may impact health care utilisation and health outcomes (Schuurman et al., 2010; Jaffee and Perloff, 2003; Kubzansky et al., 2005; Kendrick et al., 2005; Haynes et al., 2003; Law et al., 2005; Pearce et al., 2006; Kirby and Kaneda, 2006; Kirby and Kaneda, 2005; Yip et al., 2002).

The availability of, and access to, primary health care is one neighbourhood characteristic that has the ability to directly impact health. Research has demonstrated that increased distance to health care services results in reduced utilisation of the health care system (Hiscock et al., 2008; Haynes, 2003), and increased area-based inequities in health status (Hiscock et al., 2008; Korda et al., 2007; Haynes, 2003). Because the presence or absence of health care has the potential to directly impact emergent health outcomes in a neighbourhood, the neighbourhood itself becomes an important unit of analysis for examining health care accessibility. Thus, the goal of this research is to contribute to an emerging body of literature on neighbourhoods and access to health services by examining potential access to primary health care at the neighbourhood level in the City of Mississauga, Ontario, Canada. We take a locally relevant or "natural" view of urban neighbourhoods. Ross and her colleagues have shown that locally relevant or "natural" neighbourhoods may be more meaningful units of analysis than neighbourhoods defined by data availability (e.g., census tracts, dissemination areas, etc.). Such neighbourhood units of analysis are often defined by administrative institutions not associated with the local area (Federal, Provincial, State-level government agencies) (Ross et al., 2004). One of the challenges of using natural neighbourhoods is the ability to develop straightforward comparative studies between and among cities. Locally defined neighbourhoods are by definition only truly relevant to the city in which they exist; their local definition can be the result of demographic patterns, planning needs, annexations, or the unique historical development of the area. Beyond the challenges of comparing units that can be quite different in spatial extent and demographic character (such as our study site, Mississauga, compared to many other Canadian cities), a limited amount of data is available for such units. Most health, demographic, economic, household, political and similar data are collected at units that are defined similarly (e.g., census tracts) across much larger administrative areas (provinces and the country). In order to support comparative analysis of access in multiple cities while maintaining the use of locally developed neighbourhood units we have extended an accepted method for calculating access that has been used with units of analysis that are similar across cities (see *study area* below for details).

This study offers three areas of insight to the field of neighbourhoods and health research. First, we demonstrate the utility of a GIS methodology that contributes to the recent and increasing body of literature that uses GIS and additionally demonstrates the use of a new methodology that better represents spatial variation in health care accessibility and demand. Second, the use of "natural" neighbourhood boundaries in this research reflects the use of areal units that may better represent how individuals actually choose to access health care. Lastly, the research considers a number of aspatial population and physician characteristics that make headway towards revealing a more comprehensive picture of health care accessibility at the neighbourhood level.

2. Data and methods

2.1. Study area

The setting for this research is the city of Mississauga, located in Ontario, Canada (see Fig. 1). Mississauga represents a unique geographic and social setting for conducting research on access to health care. Mississauga has a population of almost 700,000 individuals, ranking it as Canada's sixth-largest city (Mississauga, 2006; Statistics Canada, 2007a). It is located approximately 20 km west of the city of Toronto and is one of 25 municipalities that constitute the Greater Toronto Area (GTA). Over the past 20 years, Mississauga has been characterised by steady population growth and increasing population diversity.

Data from the most recent census reveal that immigrants comprise approximately 20 per cent of the total Canadian population (Statistics Canada, 2007b). In stark contrast to this, over half of the total population in Mississauga are immigrants. Additionally, over 20 per cent of Mississauga's foreign-born population are recent immigrants (i.e., immigrated in the last 5 years) (Peel, 2008). Immigration to the city has resulted in a very diverse population with over 50 per cent of the population reporting a mother tongue other than English or French (Statistics Canada, 2007c).[1] The ethnic and linguistic diversity of Mississauga's population may plausibly constitute significant barriers in health care accessibility.

Mississauga is also characterised as a sprawling, low-density suburban municipality that has developed rapidly and recently as a suburb of Canada's largest city, Toronto. Historically, Mississauga developed through the amalgamation of several pre-existing communities and subsequent annexation. Many individual neighbourhoods in Mississauga can trace their origins and boundaries (to a lesser extent) to one of these two processes. As a young and rapidly developing city, Mississauga has grown in a patchwork of sprawling suburban and industrial tracts of land connected by high-volume highways. With a population spread across almost 300 km^2 this type of development favours travel by vehicle, resulting in potentially large difficulties in accessing services for those without access to private transportation. In the context of this research, the aforementioned aspatial and spatial characteristics of Mississauga may create unique neighbourhood-level barriers to accessing primary health care.

Certainly the impacts of the combined role of urban sprawl and population growth on access to health care services is acknowledged by many key players within the city and the broader Region of Peel in which Mississauga is situated. With respect to urban planning, in the face of limited space for growth, the city is now turning towards intensification (Mississauga, 2009). In addition, the two hospitals in the city are taking steps towards merging in order to provide better health care in the face of a growing population that is expected to increase over 20 per cent by 2018 (Clay, 2011). Anecdotal and research evidence also

[1] "Mother Tongue" is the first language learned in the home and still spoken at the time the census was taken (http://www.statcan.gc.ca/concepts/definitions/language-langue01-eng.htm).

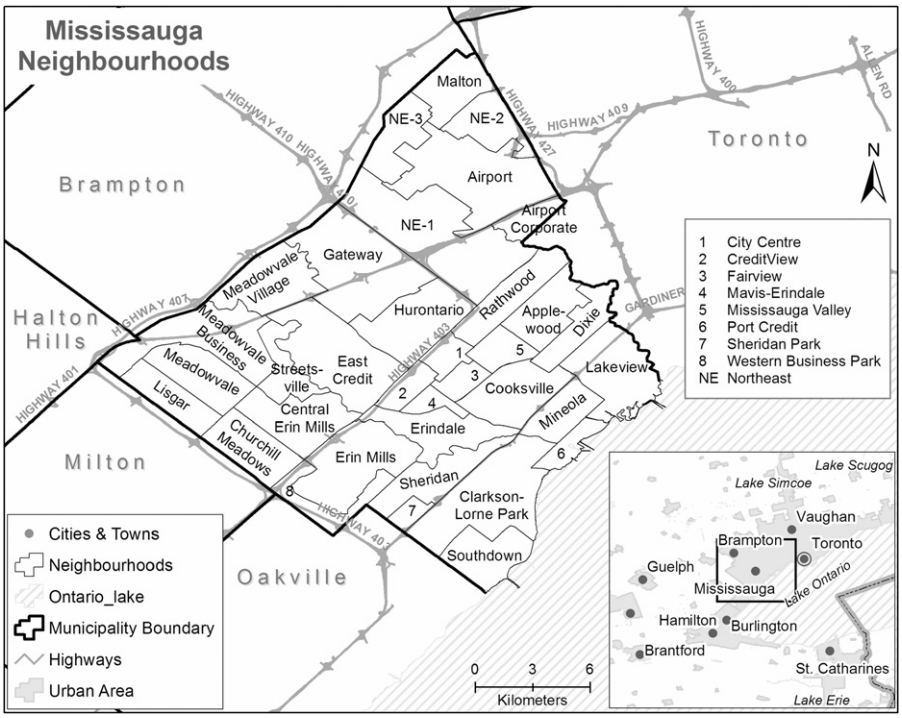

Fig. 1. Neighbourhoods in the city of Mississauga, Ontario.

suggests that the city is under-serviced and that some residents are finding it difficult to find a family physician, particularly newcomers (Antonacci, 2010; Asanin and Wilson, 2008; Le, 2011). Recently the health planning authority for Mississauga launched a community awareness campaign that included the development of a website (www.feelbetterfaster.ca) designed to disseminate information on the availability of local health services including family doctors, walk-in clinics and urgent care services (Credit Valley Hospital, 2010). The website provides information on the locations of walk-in clinics as well as the names and contact information of physicians accepting new patients in an attempt to facilitate access to care for residents (Shephard, 2010). Examining access to health services in such a complicated urban setting requires sensitivity to geographic, spatial analytic and aspatial phenomena.

When conducting neighbourhood-level research, the choice of units of analysis is of utmost importance. In a recent review, De Marco and De Marco (2010) identify a range of methods used for measuring neighbourhoods including the use of administrative units (e.g., census tracts, block groups), the use of specified distances (e.g., radius from homes) and the use of resident-defined boundaries. Much of the research uses census based units (e.g., census tracts) to represent neighbourhoods (Wang and Luo, 2005; Wang, 2007; Pearce et al., 2006; Guagliardo et al., 2004). The importance of choosing neighbourhood units appropriately is linked to the modified areal unit problem (MAUP) (see Openshaw, 1983). The MAUP describes the differences in empirical results that may occur based on the choice of units used for analysis (Haynes et al., 2007) and has two aspects. The first is termed the zonation effect, which relates to how empirical results are dependent upon where area boundaries are drawn. A shift in the location of boundaries can easily cause results to change between positive and negative in terms of health outcomes or service availability, depending on whether boundaries include or exclude data. The second aspect of the MAUP is termed the scale effect, and relates to the change in empirical results that may occur based on the level of aggregation of data, which in turn depends on the scale of analysis (Flowerdew et al., 2008). The MAUP effect has been demonstrated in health literature to produce both different and consistent empirical outcomes based on the units of analysis used (e.g., Mobley et al., 2008; Apparicio et al., 2008; Briggs et al., 2009; Bell et al., in press), illustrating why the delineation of neighbourhoods should be carefully undertaken. It has been argued that although formal neighbourhood units such as census tracts offer readily available data, they may not be at the right scale or zonation to accurately reflect or measure health related process and outcomes (Flowerdew et al., 2008). In particular, census tracts may be too large and thus not represent the appropriate scale for the study of health care accessibility, and consequently may mask important neighbourhood-level variations (Apparicio et al., 2008). Furthermore, Lebel et al. (2007) argue that the use of borders that have been established in a more or less arbitrary fashion can result in biases and reduce the validity of the analyses. Weiss et al. (2007) also note that while predefined boundaries are easily identified and enable the easy use of existing data, they may not reflect residents' perceptions. To this we would add that predefined boundaries might also not reflect the activity spaces of residents. That is, residents may seek out some health-related activities (e.g., walking, consulting a physician) within their own neighbourhood but may seek out other health-related activities outside their own neighbourhood boundaries (e.g., cycling, grocery shopping). However, without conducting comprehensive time-geography studies of health-related activities (i.e., the geographic extent over which a person's activities take place) (Golledge and Stimson, 1997, p. 270), which are very expensive and time-consuming to do, it is difficult to know where these activities are actually taking place and how adequately boundaries reflect activity spaces. In addition, in our own research (Bell et al., in press), we found that a comparison of census tracts to locally relevant neighbourhoods (i.e., those defined by the municipality and recognised by residents as being neighbourhoods) in two Canadian cities resulted in some minor variation in patterns of health care accessibility but did not meaningfully change our

interpretation of those patterns. These results reinforced our belief in the utility of locally relevant neighbourhoods and their value for health care services that are intended to benefit the residents of local communities (neighbourhoods, towns, cities, etc.). While individual choice of family doctor or primary health care is not a decision that is bounded by space alone (shortest distance) we do believe that proximity has a role to play, particularly in situations where health care needs are not being met by a long term family doctor but by a more periodic, sporadic, or urgent service provider. In our accessibility measure described below we use a 3 km area surrounding services and neighbourhoods that we believe represents a nearby locale to which people might drive.

Taking this into consideration the use of what is known as natural or meaningful neighbourhood units may be more appropriate in health. Natural and meaningful are terms used to describe functional neighbourhood units that are delineated to better represent the local-level activity spaces of individuals by containing the appropriate composition of physical and social characteristics (Ross et al., 2004). For example, a neighbourhood may be delineated to incorporate all elements required in residents' day-to-day activities, such as an area containing necessary services and amenities, housing and public transportation (Lebel et al., 2007). Alternatively neighbourhoods may be drawn based on the desired mix of residential and commercial zoning or desired population demographics (Ross et al., 2004). The problem with the delineation of natural neighbourhoods based on their composition is that some neighbourhoods may be characterised by a particular demographic while others are defined by housing type. In addition, some neighbourhoods may be defined based on homogeneity in population or housing characteristics (e.g. see Flowerdew et al., 2008) while other may be better characterised by heterogeneity in the built and social environments. It is clear that the determination of neighbourhoods for empirical purposes is problematic, and any definition may be challenged (Ross et al., 2004).

The delineation of neighbourhoods is much less challenging in situations when municipalities recognise existing neighbourhood boundaries for planning purposes. In such cases, neighbourhood boundaries are locally defined and based on a variety of locally relevant factors (Ross et al., 2004; Lebel et al., 2007). In cases where neighbourhoods formed from pre-existing communities prior to municipal amalgamation, as is the case in Mississauga, individuals may recognise those historical boundaries defining their home community (Ross et al., 2004). In addition to furthering empirical and theoretical understandings on neighbourhood-level access to health care, there are highly pragmatic, policy-relevant reasons for examining access to care in locally relevant and meaningful neighbourhood units. As mentioned, many municipalities recognise neighbourhood units that are used as the unit of city planning (Kallus and Law-Yone, 2000). Such neighbourhoods may be the targets of renewal projects aimed at alleviating health inequalities. Key examples of this include the renewal of the Regent Park neighbourhood in the City of Toronto, Canada (Toronto Coummunity Housing, 2009), the renewal of nearly two-dozen neighbourhoods in the state of Victoria, Australia (State of Victoria, 2007), and nine neighbourhoods in Yorkshire, England (Goyh, 2009). In addition, the Region of Peel (in which Mississauga is situated) in conjunction with municipal planners and research scientists at the Centre for Research on Inner City Health are developing a tool to be used for health-oriented planning at the neighbourhood level. The tool is to be used by cities to assess the impacts of proposed housing developments on increasing physical activity and reducing obesity (Peel, 2001). In Australia, neighbourhood renewal is currently aimed at reducing disparities between the most disadvantaged communities in Victoria and the rest of the state. Local action plans are being developed around six key objectives including increasing pride, enhancing housing and the physical environment, improving employment opportunities, improving safety and reducing crime, promoting health and well-being and improving government responsiveness to individual community's needs (State of Victoria, 2007). Examples like these demonstrate that neighbourhoods are increasingly becoming a policy focus for implementing changes relevant to public health and well-being. Hence, in the study of health research it is logical to select units of analysis that are most amenable to policy interventions. A less favourable alternative would be to generate empirical data using administrative units and adapt the results to the neighbourhood units where planning will occur, although this is often the case.

In this case of this research we have chosen to use municipally defined neighbourhoods. The City of Mississauga has 35 neighbourhoods that are recognised by the city and are used for municipal planning purposes (see Fig. 1). These current neighbourhoods are a result of two processes: (1) the amalgamation of historically distinct smaller communities in 1974, and (2) the creation and development of new neighbourhoods as a result of incremental population growth and urban expansion (sometimes associated with annexation). As a result, the neighbourhood boundaries are partially based on historical communities and partially on urban growth and development. As with many urban areas there are places in the city where these neighbourhood boundaries coincide with census boundaries, as well as residents' perceptions of where neighbourhood boundaries should lie (McFadyen, 2009, personal communication). Because of the recent amalgamation of Mississauga from existing developed suburbs, the city lacks a clear downtown core and can be described as a collection of older developed communities interspersed with tracts of recent residential developments and industrial and commercially zoned land. The older pre-existing communities tend to reside along the city's SW and SE borders, corresponding to the geographical corridors of Dundas St. West in the south and the Credit River in the west. Three of the city's neighbourhoods comprise the Lester B. Pearson International Airport and surrounding industrial area, and have no population (see Fig. 1). For the purpose of this research these three neighbourhoods are not considered in the analysis that follows.

2.2. Data

While access to health care has multiple definitions and opportunities for measurement, in this research we focus on potential access to primary care due to its gatekeeper role in the Canadian health care system. Primary care generally focuses on diagnosis and treatment, illness prevention, health promotion as well as referrals to specialists. Specifically, in Canada, primary care refers to first-point-of-contact health services between an individual and a health care practitioner such as a family physician, nurse practitioner, or pharmacist (Health Canada, 2006). Within the Canadian health care system, access to secondary care (e.g., specialist) and tertiary care is mediated through primary care providers (e.g., family physicians). Thus, in this research, we focus only on physicians given the important role they play in gate-keeping access to other levels of care. While it is true that other venues exist for the delivery of such services (emergency rooms, mobile health buses, nurse practitioners, etc.) such delivery mechanisms are hard to locate (or give a fixed location) and generally do not rely on an ongoing practitioner/patient relationship like that between a family doctor and their regular cohort of patients. Most are responses to the uneven access (broadly defined, see below) and are a less important part of the local neighbourhood landscape.

In conceptualising access to primary care it is important to distinguish between potential and realized access (Joseph and Phillips, 1984). The latter refers to the actual use of health services while the former refers to the supply of health care resources (Andersen et al., 1983). That is, potential access measures the spatial distribution of health services across a given area. Potential access is an important component of accessibility because it allows for the assessment of whether or not the distribution of services is equitable.

In this research we use two measures of primary care. First, physician data was retrieved from the College of Physicians and Surgeons of Ontario (CPSO) search engine http://www.cpso.on.ca/docsearch/ in the fall of 2008. For each physician located in the city of Mississauga we were able to collect practice address, languages spoken, and whether the physician is accepting patients.[2] Second, the street addresses of walk-in clinics in Mississauga were obtained from the "Health Care Connect" search engine on the Ontario Ministry of Health and Long Term Care website (Ministry of Health, 2009). In the province of Ontario, walk-in clinics are sites where individuals can receive primary care from physicians without appointment. They also frequently offer care beyond the typical 9 am–5 pm work hours. Walk-in clinics are of importance particularly for individuals who do not have a dedicated family doctor or those who are in need of care but may have difficulty making an appointment during daytime hours (Brown et al., 2002). Thirty walk-in clinic records were retrieved, and following verification of current operation by telephone, twenty-six locations were deemed to be active and entered into a database for geocoding. It is important to acknowledge that primary health care is delivered by other practitioners (e.g., nurses) and in settings other than doctor's offices or walk-in clinics (e.g., mobile clinic, and emergency room). While our data do not represent the breadth of primary health care services, the doctor-patient relationship is an important mechanism for ensuring timely access to health care services and the long term maintenance of a healthy society (Lambrew et al., 1996). Furthermore, as noted above, in the Canadian context, primary care physicians represent a gateway to specialists and tertiary health care. A lack of access to primary health care physicians will therefore affect access to higher order health care.

An image file of Mississauga's neighbourhoods was received from the City of Mississauga and digitised. Digital GIS files were obtained from the University of Toronto, Mississauga, 2006 census data was obtained at the dissemination area (DA) level. DAs are the smallest unit for which all census data is available in Canada and have a total population between 400 and 700 (Statistics Canada, 2007d). An up to date street address file was obtained to geocode physicians addresses. Additional neighbourhood attributes (e.g., water bodies and surrounding geography) were also obtained.

To measure potential access to physician and walk-in clinic services we focus on distance to care while considering a number of physician and population-based attributes. The majority of existing research examining access to care at the neighbourhood level has focused on access to family physicians for the general population. In doing so, this fails to recognise aspatial characteristics of both the population and physicians that may themselves demonstrate a distinct geographic pattern of access (Khan, 1992). For example, language and gender have been demonstrated to be key barriers to health care especially in locations with high levels of diverse ethnic and immigrant populations (Asanin and Wilson, 2008; Cordasco et al., 2011). In countries that do not have publicly-funded/universal health care, personal, and household income level has been shown to impede access to care (Sanmartin et al., 2006; Lasser et al., 2006). Research has also shown that provider-level characteristics such as gender, language abilities, waiting times, office hours, and practice size can affect both access to and perceived quality of care received (see for example, Wang et al., 2008; Wang, 2007; Campbell et al., 2001; Haggerty et al., 2008; Lurie et al., 1993). Unfortunately, although we acknowledge that these factors are influential in shaping access to care they are largely unavailable in existing data sets. However, we are able to examine some important provider-level and population characteristics relevant to the City of Mississauga as outlined below.

The detailed physician data set obtained from the CPSO in conjunction with census data allow for the investigation of multiple dimensions of potential access to care considering different aspatial characteristics of physicians and of the population. This approach results in a more comprehensive consideration of potential access to health services in this setting. Specifically, in addition to traditional measures of potential access, such as a physician-to-population ratio, and access to walk-in clinics, we also consider access to physicians who are accepting new patients and access to physicians offering primary care in languages other than English. In doing so, we are able to consider access to physicians with particular characteristics in the context of important population characteristics such as recent immigrants and individuals who report a mother tongue other than English. This enables us to comment on potential spatial access to primary care in the context of some key aspatial characteristics of both physicians and the population.

3. Data analysis

Methods used to measure potential access to health care have evolved drastically over time as a result of increasingly sensitive geographic technologies. The earliest methods generally fell into one of two main categories: those counting provider-to-population ratios within given areal units, for example the number of general practitioners-per-1000 population (Brabyn and Barnett, 2004; Kindig and Movassaghi, 1989; Rosenthal et al., 2005), and those measuring the distance between a population and a provider (For example, see Charreire and Combier, 2009; Hiscock et al., 2008; Pearce et al., 2006; Brabyn and Barnett, 2004; Lovett et al., 2002). Both methods are limited, the former because it fails to consider that individuals may cross the borders of areal units to seek care and the latter because it fails to consider actual supply and demand. Newer methods have overcome these limitations. For example, the Two Step Floating Catchment Area (2SFCA) is a recently developed method for examining potential geographical access to health care (see Bagheri et al., 2005; Luo and Wang, 2003). This method is a sophisticated technique that measures provider-to-population ratios within study areas. Unlike simple counts of physicians and population within a neighbourhood, the 2SFCA accounts for the fact that individuals in one neighbourhood may seek care in other neighbourhoods, and thus it provides more accurate measures of levels of accessibility. In the first step, the 2SFCA places a buffer, or catchment, around a point of health care supply and calculates a provider-to-population ratio within it. In the second step, it places a second buffer around a point of population demand and sums the ratios from all provider points within that second buffer. The two-step buffer method therefore accounts for health care being sought across areal unit borders, those places outside the unit of analysis but still nearby. This is important

[2] The practice location information is updated regularly by the CPSO and is considered up-to-date at the time of data retrieval. The information on whether or not physicians are accepting patients is updated annually, and this information retrieved acts as a snapshot for the year 2008.

when the areal units do not represent physical barriers to accessing health care, such as when units are census tracts or neighbourhoods within a municipality.

Two limitations of the 2SFCA is its reliance on a single buffer size assuming access to be uniform within that buffer and its reliance on a unit of analysis that is smaller than the size of the buffer (Luo and Qi, 2009). This can be particularly problematic when the units of analysis vary in size and can result in under and overestimation of access across units (Mcgrail and Humphreys, 2009). There are several cases in which this may occur. For example buffers of facility locations (step 1 of the 2SFCA) may fail to include the centroid of the study area in which they are located, thus resulting in an erroneously large access ratio for that facility. Similarly, buffers of study area centroids (step 2 of the 2SFCA) may fail to include facilities that fall within the given study area boundary, thus underestimating access ratios for that area (see Fig. 2). Study areas that are large or irregularly shaped are more likely to fall prey to this problem and in such instances, the method tends to under-estimate accessibility in larger (i.e., rural) study areas and over-estimate accessibility in smaller urban study areas. Even though this research is intra-urban, the neighbourhoods in Mississauga are variable in size, ranging in size from 1.6 km^2 to 22.3 km^2. To avoid the methodological inaccuracies involved when examining such variably sized neighbourhoods and to avoid being forced to use a buffer size that is large enough to cover the range of neighbourhood sizes, we have developed a 3 Step Floating Catchment Area method (3SFCA) (Bell et al., in press). The first and second steps of the method were consistent with the 2SFCA analysis, using dissemination areas (DAs) as the unit of analysis for population. Dissemination Areas are the smallest unit of analysis used by Statistics Canada for the national census; this allows us to use a wider range of buffer sizes, from walkable (400 m) to larger buffers that represent nearby locations to which walking is likely unsuitable (3 km, in this case). The points of health care supply are the point locations of practicing primary care physicians and walk-in clinics. The points of demand are represented by the Census DA centroids. The third step of our 3SFCA method involves generating an access ratio at the neighbourhood level by averaging the 2SFCA access ratios for all DAs falling within a neighbourhood. In this research DAs included in a neighbourhood's access ratio are those with centroids falling within a neighbourhood's boundaries, other methods of aggregation are also possible. The third step results in a neighbourhood-level access ratio that is independent of neighbourhood size. This reduces methodological inaccuracies because the DAs used are smaller and more uniformly sized than neighbourhoods while accessibility scores are to a neighbourhood unit that is locally relevant. The primary benefit of this method is that is allows for an initial measurement of access that captures each resident's nearby physicians (and those physicians' capacity to serve the local population). This is accomplished by using the DA, which is universally small enough to accommodate buffers as small as 400 m that capture at least the entire DA's spatial extent. Since separate buffers are calculated for every DA in a neighbourhood the collective spatial extent of these buffers captures all of the available primary health care service locations in each neighbourhood as well as locations within 3 km of the DA centroids along the inner edge of the neighbourhood boundary.

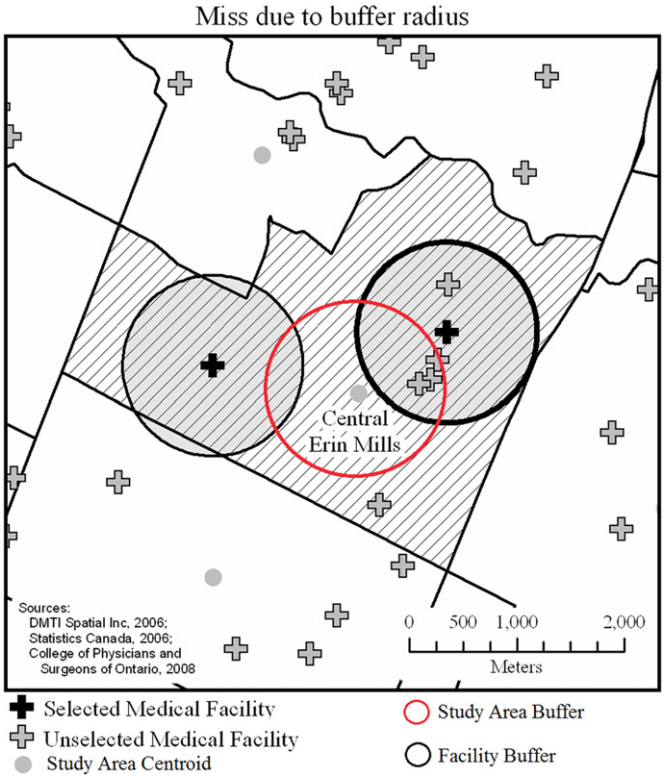

Fig. 2. Demonstration of 2SFCA buffers failing to include population and facility locations within large study areas.

The radius of the catchment area around points of health care and supply and demand are chosen to represent a reasonable distance to travel to health care. There is no consensus in the literature on what this distance should be, and research using distances ranging between 1.5 and 35 miles is common (Luo, 2004). This research employs a more moderate distance of 3000 m, based on the premise that local access to primary care is important even if location is not the only or primary variable in family doctor selection (see Goodman et al., 2003). 3000 m was used as an acceptable local travel distance to health care because this distance is roughly the radius of Mississauga's larger neighbourhoods and therefore a distance we associate with visiting a "local" family doctor. That said, it is important to acknowledge that these measures are limited to physical distance and cannot account for the amount of time it takes to travel set distances a result of both physical (e.g., urban design that does not incorporate connectivity or make use of a straight-line grid; overcoming rail lines and physical features such as rivers) and transportation barriers (e.g., reliance on public transportation that may or may not be well integrated and efficient vs. privately-owned vehicles).

In sum, it is important to acknowledge that while this method integrates a third aggregation step with the existing 2 step method to calculate neighbourhood accessibility it generates a single number representing "access" to primary health care services of a specific type for each neighbourhood. A single value inherently misses much of the richness in the variability and range of accessibility, particularly when the full breadth of the concept of accessibility to health care is considered. We have accepted this tradeoff in order to consider the spatial and corresponding aspatial variation among neighbourhoods and the availability of primary health care in the surrounding landscape. By reaching out to the area surrounding neighbourhoods and service providers (using buffers) we believe we have captured a more relevant measure of the primary health care landscape and how it varies across urban neighbourhoods.

We have calculated access for three different categories of primary health care: 1. All practicing general and family practitioners in Mississauga, 2. Doctors accepting new patients, and 3. Only locations offering walk-in clinic hours. The latter was examined as recognition of the important role that walk-in clinics serve across Canada. The points of health care supply for this calculation represent the point locations of walk-in clinics. For all three methods we benefited from the inclusion of raw data aspatial variables associated with each doctor in the database.

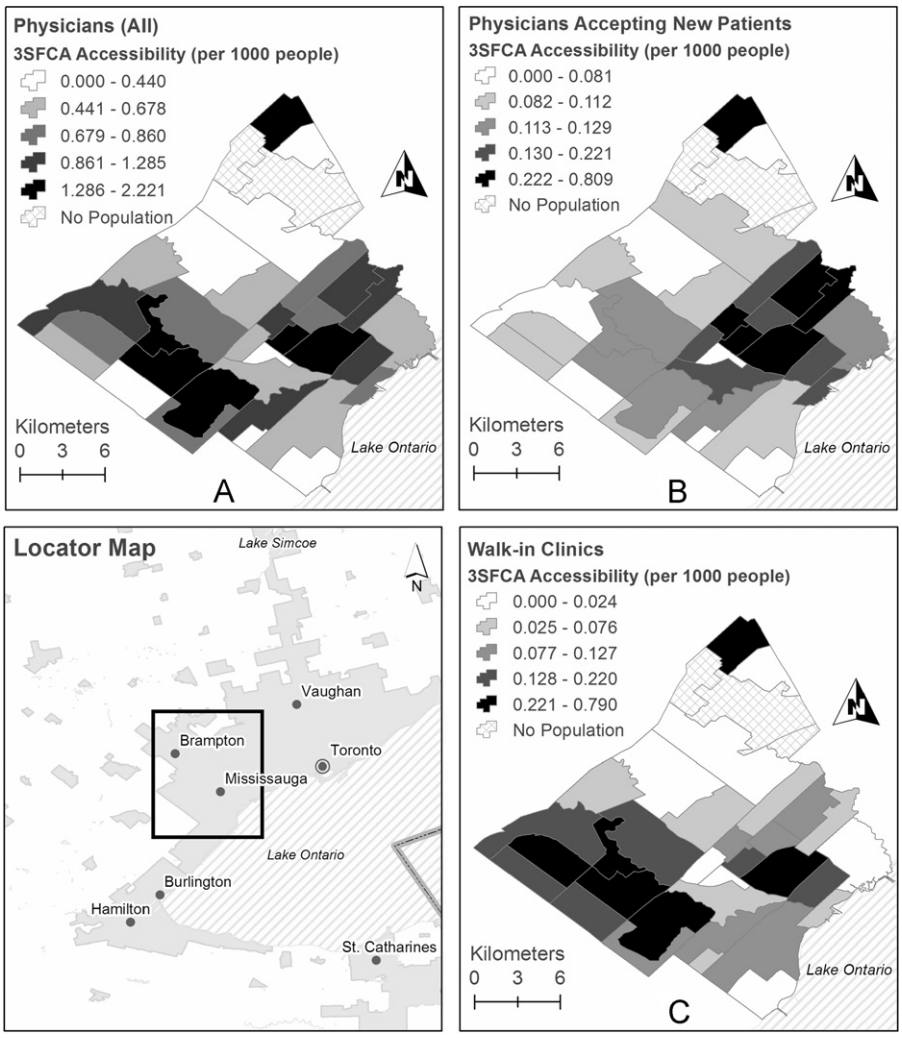

Fig. 3. (A) Distribution of the total number of physicians per 1000 population. (B) Distribution of the total number of physicians accepting new patients per 1000 population. (C) Distribution of the total number of walk-in clinics per 1000 population.

All GIS analysis was conducted using ArcGIS 9.3 software. All dimensions of access were visualised by choropleth mapping of access ratios at the neighbourhood level. All maps were visualised using a quantile classification scheme with five classes. In all cases, darker shading represents higher accessibility ratios (and hence higher levels of health care accessibility) and lighter shading represents lower rations (i.e., lower levels of accessibility).

4. Results

4.1. Access to primary care for the general population

There are a total of 677 general practitioners active in the city of Mississauga, practicing at 204 distinct locations. The three categories of access to care for the general population are displayed in Fig. 3. For all measures higher numbers indicate higher access, where access is indicated by a practitioner to population ratio (practitioners per 1000 people) at the neighbourhood level. The total number of family doctors-per-1000 population ranges from a low of 0.00-per-1000 to a high of 2.221-per-1000 (Fig. 3(A)). In general, the higher access neighbourhoods are concentrated in a south-west to south-east band around the bottom half of the city, with the exception of the Northern-most neighbourhood that is also in this group. This dispersed SW to SE band of high accessibility and lack of clear distance decay pattern outwards reveals a much more varied picture of access than is typically found. Access ratios for family doctors accepting new patients-per-1000 population range from a low of 0.00 to a high of 0.809 (Fig. 3(B)). The spatial pattern of access for this ratio is clearly distinct from the total doctor-per-1000 population ratio discussed previously. In this case, the highest access neighbourhoods are clustered in the central and east area of the city surrounding the neighbourhood City Centre. Accessibility levels decrease in the neighbourhoods immediately surrounding this cluster, and further decrease at the urban periphery. This pattern is much more congruent with existing research than that displayed by the first measure of access examined. A notable exception is Malton, the northern most neighbourhood. Malton is an interesting neighbourhood as the Lester B. Pearson International Airport and surrounding industrially zoned area separate it from other neighbourhoods.

Access ratios for walk-in clinics-per-1000 population range from a low of 0.00[3] to a high of 0.790 (Fig. 3(C)). The highest access neighbourhoods by this measure tend to fall in a SW–SE

[3] It is noteworthy that Northeast 2 in the northern-most end of Mississauga (see Fig. 1) has access ratios of 0.00 for all three measures of access examined thus far.

band along the bottom half of the city, similar to that seen for the general physician to population ratio (Fig. 3(A)). This suggests that the spatial pattern of accessibility is highly dependent on the dimension or conceptualization of access to care considered, and is much more complex than may have been thought.

4.2. Access to primary care for specific language groups

As noted earlier, Mississauga is one of Canada's most diverse cities. Given this diversity, it is important to recognise that the above three dimensions of primary care access may not address the differential needs of the population. One aspatial characteristic of the population that may affect an individual's ability or likelihood to access primary care is language, and specifically language capabilities and preferences. Previous research has shown that language represents a key barrier to accessing health care (Asanin and Wilson, 2008; Hyman and Dussault, 2000). This is particularly pertinent in Mississauga, where 51 per cent of the population has a mother tongue other than English. For this research, access to language specific primary care services was examined for the following mother tongue groups: French, Arabic and Tagalog (a prominent language of the Philippines). Both Arabic and Tagalog were chosen because they comprise two of the most prominent second languages in Mississauga while French is the second official language in Canada. Federal and provincial measures to reduce language barriers to care for the Francophone population are common. However, evaluation of access to care for the Francophone population has not been made priority within Canada, nor have levels of access between official and non-official languages been compared. To evaluate this dimension of access, for individuals reporting French, Arabic and Tagalog as their mother tongue, the point of health care supply in step one of the 3SFCA is the point location of physicians who provide services in these languages of interest. With respect to demand, only those individuals reporting the three specific languages as their mother tongue in the 2006 census are considered. This allows us to calculate the ratio of, for example, the number of physicians speaking Arabic per 1000 individuals with a mother tongue of Arabic per neighbourhood.

Access to language-specific services is displayed in Fig. 4. Access ratios of French speaking physicians to the French mother tongue population range from a low of 0 to a high of 55.573 per 1000 individuals (Fig. 4(A)). The highest access neighbourhoods are slightly clustered in central Mississauga around the downtown core neighbourhoods. Malton, the northernmost neighbourhood also has high access. The far north and south ends of the city have relatively poor access to health care for French speaking individuals. Access ratios for Arabic range from 0 to 12.292 Arabic speaking physicians per 1000 individuals reporting a mother tongue of Arabic (Fig. 4(B)). This ratio is much lower than for

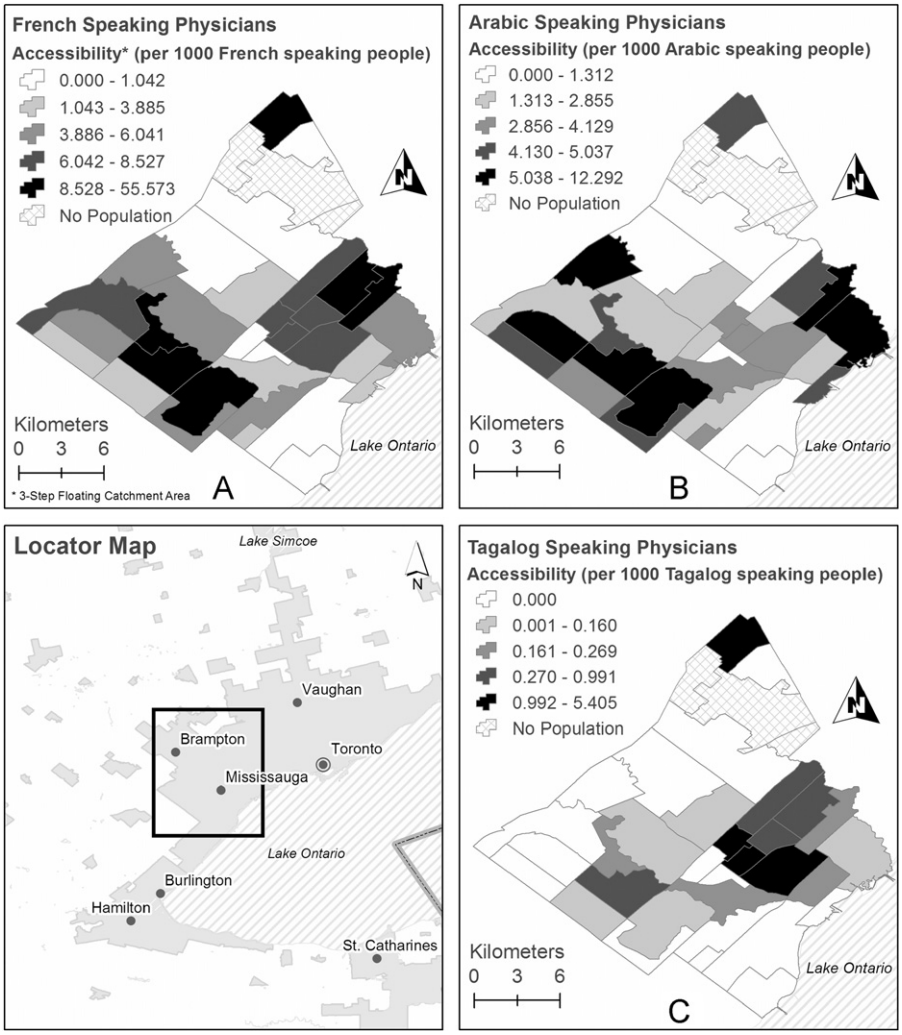

Fig. 4. (A) Total number of French-speaking physicians per 1000 French mother tongue (MT) population. (B) Total number of Arabic-speaking physicians per 1000 Arabic mother tongue population. (C) Total number of Tagalog-speaking physicians per 1000 Tagalog mother tongue population.

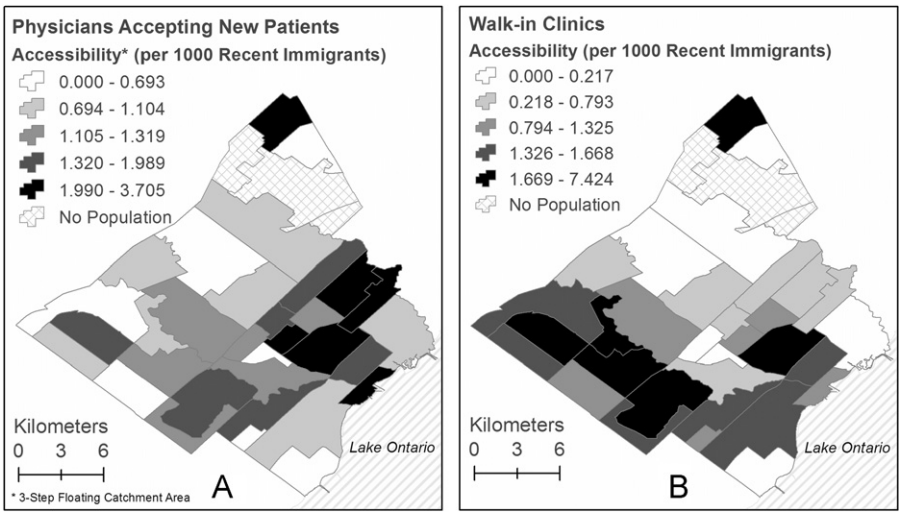

Fig. 5. (A) Total number of physicians accepting new patients per 1000 recent immigrant population. (B) Total number of walk-in-clinics per 1000 recent immigrant population.

the French speaking population. Similar to the French speaking population, the higher access neighbourhoods for the Arabic speaking population are clustered in central Mississauga, with pockets of poor access in the north and south ends of the city. Access ratios for Tagalog speaking individuals are the lowest of the three languages examined, ranging from a low of 0 to a high of 5.405 physicians per 1000 individual reporting Tagalog as their mother tongue (Fig. 4(C)). The high access neighbourhoods are clustered in the east end of the city. Given that the access ratios for Tagalog speaking individuals are clearly much lower than those for the other mother tongues examined, this analysis reveals a possible disparity in access to language-specific primary health services for this linguistic group.

4.3. Access to care for recent immigrants

The final additional aspatial population characteristic examined was access to care for recent immigrants; an important consideration given that over 20 per cent of Mississauga's foreign-born population immigrated in the last 5 years (Peel, 2008). It is common for individuals new to the country to have difficulty finding a family doctor, particularly within their neighbourhood of residence (Asanin and Wilson, 2008). Therefore, dimensions of access of particular importance for recent immigrants are access to walk-in clinics and access to physicians accepting patients. Both were measured using the three-step FCA method. For the former measure, the points of health care supply were walk-in clinics. For the latter measure, the points of supply were only those physicians accepting new patients at the time the data was retrieved. For both measures, the population counts and points of demand were total number of recent immigrants (i.e., those individuals who immigrated to Canada between 2001 and 2006) at each DA centroid.

Access ratios for recent immigrants are displayed in Fig. 5. Access to physicians accepting new patients ranges from 0 to 3.705 per 1000 recent immigrants (Fig. 5), which is much higher than for the general population (see Fig. 3(B)). The highest access neighbourhoods are clustered in the central and east area of the city and accessibility decreases, to some extent, outwards from this location. The northernmost neighbourhood Malton remains an exception and is of very high access by this measure. This is a positive finding, given that Malton has the second-largest recent immigrant population in Mississauga.[4] Access ratios to walk-in clinics range from 0.000 to 7.424 per 1000 recent immigrants (Fig. 5(B)). The highest accessibility neighbourhoods lie along the SW and SE border of Mississauga, with lower accessibility neighbourhoods in central and north Mississauga, similar to that of other dimensions of access examined. Many neighbourhoods that were of low accessibility to physicians accepting new patients (for recent immigrants) are of high accessibility to walk-in clinics (e.g., Lisgar, Churchill Meadows, Meadowvale Business). This indicates that while recent immigrants may have difficulty finding a family doctor, higher access to walk-in clinics may help to alleviate some of their health care needs. However, walk-in clinics should not be considered a substitute for having access to a dedicated family physician.

5. Discussion

The goal of this research was to contribute to the growing field of study focused on neighbourhood-level access to health care. In doing so, we sought to highlight the importance of both spatial and aspatial characteristics of both the supply (i.e., physicians) and demand (i.e., population) side of access using a three-step floating catchment area method of analysis.

The highest access neighbourhoods for the general measure of physicians per 1000 population were primarily located along the south-west and south-east borders of the city. In contrast, neighbourhoods in the highest access quartile for the ratio of physicians accepting new patients per 1000 population were primarily in the eastern-most tip of the city. Potential access to walk-in clinics showed the same spatial distribution as that of the first, with high access neighbourhoods situated mainly along the south-west and south-east borders of the city, and many of the same high access neighbourhoods identified. These findings clearly demonstrate that potential levels of access to care are highly dependent on the particular dimension of access selected for examination. This reveals a much more nuanced picture of potential access than is typically considered in research. However, this research also identified several neighbourhoods characterised

[4] Data not shown.

by high access (e.g., Cooksville, Fairview & Applewood) and others characterised by low access for all three measures (e.g., Northeast 1, Southdown). This indicates that neighbourhood-level variation in access to care does exist, regardless of the particular measure of access.

Given of the diversity of Mississauga's population, it was pertinent to determine if access to primary care differs amongst the population based on aspatial population and physician characteristics such as mother tongue and immigrant status. The exploration of population characteristics reveals significant geographic disparities in access for language-related population subgroups. Specifically, for each mother tongue examined, access to physicians with matching language-specific capabilities varies significantly between neighbourhoods, suggesting that some population subgroups may be better served than others. Access to health care for each language explored displays some degree of spatial clustering, meaning that individuals not residing in or near those clusters of high access neighbourhoods may face significant difficulties in accessing language-specific health care, which in turn has implications for realized access (i.e., utilisation). Furthermore, access ratios were much higher among French language speakers but quite low for those reporting Tagalog as a mother tongue. This suggests that the provision of language appropriate health care services may be more obtainable for some population groups in the city than it is for others. While the traditional policy focus in Canada is to equalise accessibility between the two official languages, French and English, these findings indicate a need to focus on facilitating accessibility for non-official linguistic groups. This is especially important considering the increasing cultural and language diversity of cities like Mississauga.

Before discussing the contributions of this study, a few limitations deserve mention. First, the use of a buffering technique to count provider-to-population ratios assumes that individuals falling within a facility catchment have equal access, and those outside of it do not have access at all. This is an oversimplification, when in reality there is generally a gradation of access based on distance, and not an absolute cut-off. Additionally, the use of buffers requires choosing a radius that represents an acceptable distance. In this research, we used buffers of 3 km to represent adequate local scale accessibility. However, the time or cost required to traverse this distance may differ significantly depending on the location in the city, the presence of traffic congestion, road type, construction, and time of day. Such differences are impossible to take into account with the available data. Related to this, it is important to acknowledge that distance and location are not the only factors (or even the most important) affecting an individual's access to primary care. Indeed the presence or absence of health care is only one determining factor in this complex field of study. This is one reason we chose to examine different categories of primary care (e.g., physicians accepting new patients and walk-in clinics) but in doing so we also recognise the importance of other types of primary care providers not included in this analysis (e.g., nurses). In addition, individuals may choose to access care within or outside their neighbourhood for a multitude of reasons including quality of care, convenience (e.g., ability to access near employment), waiting times, etc. Certainly, potential access is only one piece of the puzzle. This speaks to the need for research that simultaneously examines the relative importance of potential access, realized access (i.e., actual utilisation) and perceptions of access to primary care. Neighbourhood-level surveys that collect data on realized access to health care can be used to complement neighbourhood-level data on potential access to care such as the measures employed in this study. In addition to collecting data on realized access (e.g., frequency of contact with primary health care providers, frequency of use of walk-in/after hours clinics and reasons for use) the results of this study suggest the importance of also collecting information on whether or not individuals have a regular family physician, reasons underlying physician selection (i.e., why an individual might choose to consult one physician over another), experiences with unmet health care needs and barriers to receiving care (e.g., language, distance, etc.), etc. We believe the patterns revealed in our results suggest such outcomes might be affected by the physical availability of primary care and shed light on areas of concern or neglect in the primary care landscape.

One final limitation of this study relates to potential edge effects that may have occurred when conducting the analysis. This study considered population and physician data for the city of Mississauga alone, and did not consider data for neighbouring municipalities. Mississauga is bordered on three sides by other cities and it is plausible that individuals in the peripheral neighbourhoods of the city may choose to seek care in other municipalities rather in their neighbourhood of residence. This hypothesis awaits testing in future research. However, such problems would be less likely to occur in the analysis of cities that are more isolated and surrounded by sparsely populated rural areas. Despite these limitations, the study makes a number of important contributions.

The study of neighbourhood-level access to health care is a relatively small and recent field of enquiry within the broader study of neighbourhoods and health. Within this field, research findings have continually utilised statistical units (i.e., census tracts) as proxy for neighbourhoods. Such studies typically demonstrate that access to health care is higher in urban centres and lower in urban peripheries. Problematic with these findings is that they are highly dependent on choices made with regards to research methodology and neighbourhood boundaries. This research contributes to the existing body of literature on neighbourhood level access to care by identifying the existence of local level variation in access to primary care within this particular urban setting. This is accomplished through the use of meaningful neighbourhoods that are recognised by Mississauga residents and used in city planning. Through this analysis it was demonstrated that access to care showed a much more nuanced spatial pattern than is typically identified. While existing research has tended to find higher accessibility areas to be in the central core of cities with accessibility decreasing radially outwards, the neighbourhoods of highest accessibility in Mississauga were in a SW to SE band, corresponding more closely to preexisting neighbourhoods than with the city core. This demonstrates that the investigation of intra-urban access to care is a highly relevant line of enquiry.

This research additionally contributes to the current dialogue on neighbourhoods and access to health care by demonstrating how one methodology can be adapted to examine multiple dimensions of access. While it is recognised in the literature that potential access differs based on both spatial and aspatial components of primary care physicians (Khan, 1992; Penchansky and Thomas, 1981), the majority of the literature focuses on narrow definitions of potential access. This may be due to the fact that there has yet to be a precedent established for how such dimensions of access can be measured using readily available data. The measurement of access to physicians accepting new patients, to walk-in clinics and access for particular population subgroups in this analysis demonstrates how a more detailed understanding of access to care can be obtained using both spatial and aspatial data. In performing this analysis, a highly variable picture emerged whereby the spatial pattern of accessibility differed significantly based on the dimension of access studied. This demonstrates a need for future research to take into account alternative dimensions of potential access.

Within the body of literature focusing on potential access to care, there has been little attention paid to how potential access may

differ based on aspatial characteristics of the population, including language and immigrant status. Such inquiries are much more common in studies of realized access where utilisation of health care is the focus (Asanin and Wilson, 2008; Wang, 2007). Our research shows that potential access to physicians accepting new patients is low in some neighbourhoods relative to the recent immigrant population and that neighbourhood inequalities exist in language-specific potential access to primary care. These findings, combined with the general lack of focus on aspatial population characteristics, demonstrate a need for additional research into this line of enquiry. Most beneficial would be studies that could examine the impact of similar potential access measures on realized access for various subpopulation groups.

This research has provided valuable information on potential access to primary care. This information may be used in future research to further the dialogue of neighbourhood-level access to care, as well as to refine the methods used to examine potential access. First and foremost, this research demonstrates the importance of focusing on intra-urban variations in access to care. While the majority of existing research has found little neighbourhood-level variation in access to health care, these findings may result from an over-reliance on the use of statistical units as proxy for neighbourhoods and failure to consider alternative dimensions and conceptualizations of potential access. Future research should conduct more nuanced examinations of local level variations in access to care using neighbourhood boundaries that are recognised by residents, used in city planning, and are more likely to correspond to the scale that health related processes occur at. This research has demonstrated that this objective can be pursued using one methodology (i.e., 2SFCA or modified 3SFCA) and readily available data. Future research should build upon this example and begin to investigate the dimensions of access examined here in other Canadian and possibly in international settings. Additionally, dimensions of access that further explore the availability of physicians such as by full time equivalencies (FTEs) and the potential need of the population as adjusted for age, gender, ethnicity and other demographic characteristics would further this research. Lastly, while potential access is a fundamental component of access to care, it is only one factor that may lead to realized use of health services. Additional individual characteristics including age, gender, ethnicity, socioeconomic status, beliefs about health and the actual need for care will also determine whether and where an individual seeks care (Gatrell, 2002; Aday and Andersen, 1974). There is a need for ongoing research to examine how potential access translates to realized access, and how it is moderated by individual characteristics to influence decision-making and overall health outcomes. This research provides the first step in this line of enquiry.

Acknowledgements

Funding for this research was provided by the Canadian Institutes of Health Research (CIHR).

References

Aday, L.A., Andersen, R., 1974. A framework for the study of access to medical care. Health Services Research 9, 208–220.

Andersen, R.M., Mccutcheon, A., Aday, L.A., Chiu, G.Y., Bell, R., 1983. Exploring dimensions of access to medical care. Health Services Research 18, 49–74.

Antonacci, J.P., 2010. Health Centre Plans Revealed. Mississauga News December 11, 2010, 〈http://www.mississauga.com/community/article/915926–health-centre-plans-revealed〉; last accessed December 2011.

Apparicio, P., Abdelmajid, M., Riva, M., Shearmur, R., 2008. Comparing alternative approaches to measuring the geographical accessibility of urban health services: distance types and aggregation-error issues. International Journal of Health Geographics 7, 7.

Asanin, J., Wilson, K., 2008. I spent nine years looking for a doctor: exploring access to health care among immigrants in Mississauga, ON, Canada. Social Science & Medicine 66, 1271–1283.

Auchincloss, A.H., Diez Roux, A.V., Brown, D.G., Erdmann, C.A., Bertoni, A.G., 2008. Neighborhood resources for physical activity and healthy foods and their association with insulin resistance. Epidemiology 19, 146–157.

Bagheri, N., Benwell, G.L., Holt, A., 2005. Measuring Spatial Accessibility to Primary Health Care. Annual Colloquium of the Spatial Information Research Centre, University of Otago, New Zealand.

Bell, S., Wilson, K., Bissonette, L., Shah, T.I., Access to primary health care: does neighbourhood of residence matter? Annal of the Association of American Geographers, in press.

Boardman, J.D., Finch, B.K., Ellison, C.G., Williams, D.R., Jackson, J.S., 2001. Neighborhood disadvantage, stress, and drug use among adults. Journal of Health and Social Behavior 42, 151–165.

Brabyn, L., Barnett, A.R., 2004. Population need and geographical access to general practitioners in rural New Zealand. Journal of the New Zealand Medical Association 117, 1199.

Briggs, D., Sabel, C., Lee, K., 2009. Uncertainty in epidemiology and health risk and impact assessment. Environmental Geochemistry and Health 31, 189–203.

Brown, J.B., Bouck, L.M.S., Østbye, T., Barnsley, J.M., Mathews, M., Ogilvie, G., 2002. Walk-in clinics in Ontario: an atmosphere of tension. Canadian Family Physician 48, 531–536.

Buka, S., Brennan, R., Rich-Edwards, J., Raudenbush, S., Earls, F., 2003. Neighborhood support and the birth weight of urban infants. American Journal of Epidemiology 157, 1–8.

Campbell, S.M., Hann, M., Hacker, J., Burns, C., Oliver, D., Thapar, A., Mead, N., Safran, D.G., Roland, M.O., 2001. Identifying predictors of high quality care in English general practice: observational study. British Medical Journal 323, 784.

Charreire, H., Combier, E., 2009. Poor prenatal care in an urban area: a geographic analysis. Health & Place 15, 412–419.

Clay, C., 2011. Hospitals Announced Merger. Retrieved September 01, 2011 from. 〈http://www.mississauga.com/news/article/977809–hospitals-announce-merger〉.

Cordasco, K., Ponce, N., Gatchell, M., Traudt, B., Escarce, J., 2011. English language proficiency and geographical proximity to a safety net clinic as a predictor of health care access. Journal of Immigrant and Minority Health 13, 260–267.

Credit Valley Hospital, 2010. Feel Better Faster — Community Awareness Campaign Seeks to Promote Access to Care and Reduce Emergency Waiting Times. Retrieved September 2011 from. 〈http://www.cvh.on.ca/mediaroom/2010/feel-better-faster.php〉.

De Marco, A., De Marco, M., 2010. Conceptualization and measurement of the neighborhood in rural settings: a systematic review of the literature. Journal of Community Psychology 38, 99–114.

Diez-Roux, A.V., Nieto, F.J., Muntaner, C., Tyroler, H.A., Comstock, G.W., Shahar, E., Cooper, L.S., Watson, R.L., Szklo, M., 1997. Neighborhood environments and coronary heart disease: a multilevel analysis. American Journal of Epidemiology 146, 48–63.

Diez Roux, A.V., 2001. Investigating neighborhood and area effects on health. American Journal of Public Health 91, 1783–1789.

Duncan, C., Jones, K., Moon, G., 1999. Smoking and deprivation: are there neighbourhood effects? Social Science & Medicine 48, 497–505.

Duncan, S.C., Duncan, T.E., Strycker, L.A., 2002. A multilevel analysis of neighborhood context and youth alcohol and drug problems. Prevention Science 3, 125–133.

Ecob, R., Macintyre, S., 2000. Small area variations in health related behaviours; do these depend on the behaviour itself, its measurement, or on personal characteristics? Health & Place 6, 261–274.

Farley, T.A., Mason, K., Rice, J., Habel, J.D., Scribner, R., Cohen, D.A., 2006. The relationship between the neighbourhood environment and adverse birth outcomes. Paediatric and Perinatal Epidemiology 20, 188–200.

Finkelstein, M.M., Jerrett, M., Deluca, P., Finkelstein, N., Verma, D.K., Chapman, K., Sears, M.R., 2003. Relation between income, air pollution and mortality: a cohort study. Canadian Medical Association Journal 169, 397–402.

Fisher, K.J., Li, F., Michael, Y., Cleveland, M., 2004. Neighborhood-level influences on physical activity among older adults: a multilevel analysis. Journal of Aging and Physical Activity 12, 45–63.

Flowerdew, R., Manley, D.J., Sabel, C.E., 2008. Neighbourhood effects on health: does it matter where you draw the boundaries? Social Science & Medicine 66, 1241–1255.

Frohlich, K.L., Potvin, L., Gauvin, L., Chabot, P., 2002. Youth smoking initiation: disentangling context from composition. Health & Place 8, 155–166.

Galster, G., 2001. On the nature of neighbourhood. Urban Studies 38, 2111–2124.

Garner, C.L., Raudenbush, S.W., 1991. Neighborhood effects on educational attainment: a multilevel analysis. Sociology of Education 64, 251–262.

Gatrell, A.C., 2002. Geographies of Health: An Introduction. Blackwell, Oxford.

Gauvin, L., Riva, M., Barnett, T., Richard, L., Craig, C.L., Spivock, M., Laforest, S., Laberge, S., Fournel, M.-C., Gagnon, H., Gagné, S., 2008. Association between neighborhood active living potential and walking. American Journal of Epidemiology 167, 944–953.

Giles-Corti, B., Donovan, R.J., 2002. Socioeconomic status differences in recreational physical activity levels and real and perceived access to a supportive physical environment. Preventive Medicine 35, 601–611.

Golledge, R.G., Stimson, R.J., 1997. Spatial Behavior: A Geographic Perspective. Guilford Press, New York.

Goodman, D.C., Mick, S.S., Bott, D., Stukel, T., Chang, C.-H., Marth, N., Poage, J., Carretta, H.J., 2003. Primary care service areas: a new tool for the evaluation of primary care services. Health Services Research 38, 287–309.
Goyh, 2009. Neighbourhood Renewal. Retrieved August, 20, 2009 from. 〈http://www.gos.gov.uk/goyh/mpcs/neiren/〉.
Guagliardo, M.F., Ronzio, C.R., Cheung, I., Chacko, E., Joseph, J.G., 2004. Physician accessibility: an urban case study of pediatric providers. Health & Place 10, 273–283.
Haggerty, J.L., Pineault, R., Beaulieu, M.-D., Brunelle, Y., Gauthier, J., Goulet, F., Rodrigue, J., 2008. Practice features associated with patient-reported accessibility, continuity, and coordination of primary health care. The Annals of Family Medicine 6, 116–123.
Harrison, R.A., Gemmell, I., Heller, R.F., 2007. The population effect of crime and neighbourhood on physical activity: an analysis of 15,461 adults. Journal of Epidemiology and Community Health 61, 34–39.
Haynes, R., 2003. Geographical access to health care. In: Gulliford, M., Morgan, M. (Eds.), Access to Health Care. Routledge, London.
Haynes, R., Daras, K., Reading, R., Jones, A., 2007. Modifiable neighbourhood units, zone design and residents' perceptions. Health & Place 13, 812–825.
Haynes, R., Lovett, A., Sunnenberg, G., 2003. Potential accessibility, travel time, and consumer choice: geographical variations in general medical practice registrations in Eastern England. Environment and Planning A 35, 1733–1750.
Health Canada, 2006. About Primary Health Care. .Retrieved August 20, 2009 from. 〈http://www.hc-sc.gc.ca/hcs-sss/prim/about-apropos-eng.php#a1〉.
Henderson, C., Diez Roux, A.V., Jacobs, D.R., Kiefe, C.I., West, D., Williams, D.R., 2005. Neighbourhood characteristics, individual level socioeconomic factors, and depressive symptoms in young adults: the CARDIA study. Journal of Epidemiology and Community Health 59, 322–328.
Herbert, D.T., 1976. The study of delinquency areas: a social geographical approach. Transactions of the Institute of British Geographers 1, 472–492.
Hiscock, R., Pearce, J., Blakely, T., Witten, K., 2008. Is neighborhood access to health care provision associated with individual-level utilization and satisfaction? Health Services Research 43, 2183–2200.
Hyman, I., Dussault, G., 2000. Negative consequences of acculturation on health behaviour, social support and stress among pregnant Southeast Asian immigrant women in Montreal: an exploratory study. Canadian Journal of Public Health 91, 357–360.
Jaffee, K.D., Perloff, J.D., 2003. An ecological analysis of racial differences in low birthweight: implications for maternal and child health social work. Health and Social Work 28, 9–22.
Johnston, R.J., 1976. Political behaviour and the residential mosaic. In: Herbert, D.T., Johnston, R.J. (Eds.), Social Areas in cities, 1. John Wiley & Sons.
Joseph, A.E., Phillips, D.R., 1984. Accessibility and Utilization: geographical perspectives on Health Care Delivery. Saga Publications Ltd.
Kallus, R., Law-Yone, H., 2000. What is a neighbourhood? The structure and function of an idea. Environment and Planning B 27, 815–826.
Kawachi, I., 2000. Income inequality and health. In: Berkman, L.F., Kawachi, I. (Eds.), Social epidemiology. Oxford University Press, New York, USA.
Kawachi, I., Berkman, L.F., 2003. Why study neighbourhoods?. In: Kawachi, I., Berkman, L.F. (Eds.), Neighborhoods and Health. Oxford University Press, New York.
Kawachi, I., Glass, T.A., 2000. Social interaction, social networks, social support and health. In: Berkman, L.F., Kawachi, I. (Eds.), Social Epidemiology. Oxford University Press, NY, USA.
Kawachi, I., Kennedy, B.P., Glass, R., 1999. Social capital and self-rated health: a contextual analysis. American Journal of Public Health 89, 1187–1193.
Kendrick, D., Mulvaney, C., Burton, P., Watson, M., 2005. Relationships between child, family and neighbourhood characteristics and childhood injury: a cohort study. Social Science & Medicine 61, 1905–1915.
Khan, A.A., 1992. An integrated approach to measuring potential spatial access to health care services. Socio-Economic Planning Sciences 26, 275–287.
Kindig, D.A., Movassaghi, H., 1989. The adequacy of physician supply in small rural counties. Health Affairs 8, 63–76.
Kirby, J.B., Kaneda, T., 2005. Neighborhood socioeconomic disadvantage and access to health care. Journal of Health and Social Behavior 46, 15–31.
Kirby, J.B., Kaneda, T., 2006. Access to health care: does neighborhood residential instability matter? Journal of Health and Social Behavior 47, 142–155.
Kleinschmidt, I., Hills, M., Elliott, P., 1995. Smoking behaviour can be predicted by neighbourhood deprivation measures. Journal of Epidemiology and Community Health 49, S72–S77.
Korda, R.J., Butler, J.R., Clements, M.S., Kunitz, S.J., 2007. Differential impacts of health care in Australia: trend analysis of socioeconomic inequalities in avoidable mortality. International Journal of Epidemiology 36, 157–165.
Kubzansky, L.D., Subramanian, S.V., Kawachi, I., Fay, M.E., Soobader, M.-J., Berkman, L.F., 2005. Neighborhood contextual influences on depressive symptoms in the elderly. American Journal of Epidemiology 162, 253–260.
Lambrew, J.M., Defriese, G.H., Carey, T.S., Ricketts, T.C., Biddle, A.K., 1996. The effects of having a regular doctor on access to primary care. Medical Care 34, 138–151.
Lasser, K.E., Himmelstein, D.U., Woolhandler, S., 2006. Access to care, health status, and health disparities in the United States and Canada: results of a cross-national population-based survey. American Journal of Public Health 96, 1300–1307.
Law, M., Wilson, K., Eyles, J., Elliott, S., Jerrett, M., Moffatt, T., Luginaah, I., 2005. Meeting health need, accessing health care: the role of neighbourhood. Health & Place 11, 367–377.
Le, J., 2011. Amgen helps newcomers access healthcare. Mississauga News March 14, 2011, 〈http://www.mississauga.com/community/community/article/966553〉 last accessed December 2011.
Lebel, A., Pampalon, R., Villeneuve, P., 2007. A multi-perspective approach for defining neighbourhood units in the context of a study on health inequalities in the Quebec city region. International Journal of Health Geographics 6, 27.
Lee, R.E., Cubbin, C., 2002. Neighborhood context and youth cardiovascular health behaviors. American Journal of Public Health 92, 428–436.
Li, F., Fisher, K.J., Brownson, R.C., Bosworth, M., 2005. Multilevel modelling of built environment characteristics related to neighbourhood walking activity in older adults. Journal of Epidemiology and Community Health 59, 558–564.
Lopez, R.P., 2007. Neighborhood risk factors for obesity. Obesity 15, 2111–2119.
Lovett, A., Haynes, R., Sünnenberg, G., Gale, S., 2002. Car travel time and accessibility by bus to general practitioner services: a study using patient registers and GIS. Social Science & Medicine 55, 97–111.
Luo, W., 2004. Using a GIS-based floating catchment method to assess areas with shortage of physicians. Health & Place 10, 1–11.
Luo, W., Qi, Y., 2009. An enhanced two-step floating catchment area (E2SFCA) method for measuring spatial accessibility to primary care physicians. Health & Place 15, 1100–1107.
Luo, W., Wang, F., 2003. Measures of spatial accessibility to health care in a GIS environment: synthesis and a case study in the Chicago region. Environment and Planning B 30, 865–884.
Lurie, N., Slater, J., Mcgovern, P., Ekstrum, J., Quam, L., Margolis, K., 1993. Preventive care for women — does the sex of the physician matter? New England Journal of Medicine 329, 478–482.
Matheson, F.I., Moineddin, R., Dunn, J.R., Creatore, M.I., Gozdyra, P., Glazier, R.H., 2006. Urban neighborhoods, chronic stress, gender and depression. Social Science & Medicine 63, 2604–2616.
Mcgrail, M.R., Humphreys, J.S., 2009. Measuring spatial accessibility to primary care in rural areas: improving the effectiveness of the two-step floating catchment area method. Applied Geography 29, 533–541.
Ministry of Health, 2009. Health Care Options: Medical Services Directory. .Retrieved December 9, 2009 from. 〈http://www.hco-on.ca/English/Home-Page/〉.
Mississauga, 2006. Population, Demographics & Housing. .Retrieved January 29, 2012 from. 〈http://www.mississauga.ca/file/COM/Population__Housing___Demographics.pdf〉.
Mississauga, 2009. 2008 growth forecasts — Mississauga Plan Review (Corporate Report). Retrieved January 30, 2012 from. 〈http://www5.mississauga.ca/agendas/planning/2009/01_12_09/Item04GrowthForecasts2008.pdf〉.
Mobley, L.R., Kuo, T.-M., Andrews, L., 2008. How sensitive are multilevel regression findings to defined area of context? Medical Care Research and Review 65, 315–337.
Morland, K., Wing, S., Roux, A.D., 2002. The contextual effect of the local food environment on residents' diets: the atherosclerosis risk in communities study. American Journal of Public Health 92, 1761–1768.
Moudon, A.V., Lee, C., Cheadle, A.D., Collier, C.W., Johnson, D., Schmid, T.L., Weather, R.D., 2005. Cycling and the built environment, a US perspective. Transportation Research Part D: Transport and Environment 10, 245–261.
Mullins, P., 1973. Neighbourhood perception and the effects of forced residential mobility. Journal of Sociology 9, 45–48.
O'campo, P., X., X., Wang, M.C., 1997. Neighbourhood risk factors for low birthweight in Baltimore: a multi-level analysis. American Journal of Public Health 87, 1113–1118.
Openshaw, S., 1983. The Modifiable Areal Unit Problem. Geo Books, Norwich, UK.
Patel, K.V., Eschbach, K., Rudkin, L.L., Peek, M.K., Markides, K.S., 2003. Neighborhood context and self-rated health in older Mexican Americans. Annals of Epidemiology 13, 620–628.
Pearce, J., Witten, K., Bartie, P., 2006. Neighbourhoods and health: a GIS approach to measuring community resource accessibility. Journal of Epidemiology and Community Health 60, 389–395.
Peel, 2001. Healthy Peel by Design. from. 〈http://www.peelregion.ca/health/resources/healthbydesign/〉 Retrieved December 5, 2011.
Peel, 2008. Immigration and Language: City of Mississauga, 2006. .Retrieved January 2012 from. 〈http://www.portraitsofpeel.ca/pdf/immlan06/Mississauga.pdf〉.
Penchansky, R., Thomas, J.W., 1981. The concept of access: definition and relationship to consumer satisfaction. Medical Care 19, 127–140.
Pollack, C.E., Cubbin, C., Ahn, D., Winkleby, M., 2005. Neighbourhood deprivation and alcohol consumption: does the availability of alcohol play a role? International Journal of Epidemiology 34, 772–780.
Britt, R., Carlin, H., Toomey, B., Wagenaar, A., T., 2005. Neighborhood level spatial analysis of the relationship between alcohol outlet density and criminal violence. Environmental and Ecological Statistics 12, 411–426.
Rodríguez, D.A., Aytur, S., Forsyth, A., Oakes, J.M., Clifton, K.J., 2008. Relation of modifiable neighborhood attributes to walking. Preventive Medicine 47, 260–264.
Rosenthal, M.B., Zaslavsky, A., Newhouse, J.P., 2005. The geographic distribution of physicians revisited. Health Services Research 40, 1931.
Ross, N.A., Tremblay, S.S., Graham, K., 2004. Neighbourhood influences on health in Montreal, Canada. Social Science Medicine 59, 1485–1494.
Russ-Eft, D., 1979. Identifying components comprising neighborhood quality of life. Social Indicators Research 6, 349–372.
Sallis, J.F., Saelens, B.E., Frank, L.D., Conway, T.L., Slymen, D.J., Cain, K.L., Chapman, J.E., Kerr, J., 2009. Neighborhood built environment and income: examining multiple health outcomes. Social Science & Medicine 68, 1285–1293.

Sanmartin, C., Berthelot, J.-M., Ng, E., Murphy, K., Blackwell, D.L., Gentleman, J.F., Martinez, M.E., Simile, C.M., 2006. Comparing health and health care use in Canada and the United States. Health Affairs 25, 1133–1142.

Schempf, A.H., Kaufman, J.S., Messer, L.C., Mendola, P., 2011. The neighborhood contribution to black-white perinatal disparities: an example from two North Carolina counties, 1999–2001. American Journal of Epidemiology 174, 744–752.

Schuurman, N., Bérubé, M., Crooks, V.A., 2010. Measuring potential spatial access to primary health care physicians using a modified gravity model. Canadian Geographer 54, 29–45.

Shephard, T., 2010. Trillium Urges ER Awareness. Retrieved May 13, 2010 from. 〈http://www.mississauga.com/community/health/article/816066–trillium-urges-er-awareness〉.

Smith, C.J., 1980. Neighbourhood effects on mental health. In: Herbert, D.T., Johnston, R.J. (Eds.), Geography and the Urban Environment: Progress in Research and Applications. John Wiley & Sons.

State of Victoria, 2007. Neighbourhood Renewal. Retrieved August 20, 2009 from. 〈http://www.neighbourhoodrenewal.vic.gov.au/home〉.

Statistics Canada, 2007a. 2006 community profiles. Retrieved January 28, 2012 from. 〈http://www12.statcan.ca/census-recensement/2006/dp-pd/prof/92-591/details/page.cfm?Lang=E&Geo1=CSD&Code1=3521005&Geo2=PR&Code2=35&Data=Count&SearchText=Mississauga&SearchType=Begins&SearchPR=01&B1=All&GeoLevel=PR&GeoCode=3521005〉.

Statistics Canada, 2007b. 2006 community profiles: Immigration and Citizenship. Retrieved January 30, 2012 from. 〈http://www12.statcan.ca/census-recensement/2006/dp-pd/prof/92-591/index.cfm?Lang=E〉.

Statistics Canada, 2007c. Mississauga, Ontario (Code3521005) (table). 2006 Community Profiles.Retrieved January 30, 2012 from. 〈http://www12.statcan.ca/census-recensement/2006/dp-pd/prof/92-591/index.cfm?Lang=E〉.

Statistics Canada, 2007d. More Information on Dissemination Area (DA).Retrieved October 14, 2009 from. 〈http://www12.statcan.ca/census-recensement/2006/ref/dict/geo021a-eng.cfm〉.

Stockdale, S.E., Wells, K.B., Tang, L., Belin, T.R., Zhang, L., Sherbourne, C.D., 2007. The importance of social context: neighborhood stressors, stress-buffering mechanisms, and alcohol, drug, and mental health disorders. Social Science & Medicine 65, 1867–1881.

Sturm, R., Datar, A., 2005. Body mass index in elementary school children, metropolitan area food prices and food outlet density. Public Health 119, 1059–1068.

Sundquist, K., Malmström, M., Johansson, S.-E., 2004. Neighbourhood deprivation and incidence of coronary heart disease: a multilevel study of 2.6 million women and men in Sweden. Journal of Epidemiology and Community Health 58, 71–77.

Szwarcwald, C.L., Andrade, C.L.T.D., Bastos, F.I., 2002. Income inequality, residential poverty clustering and infant mortality: a study in Rio de Janeiro, Brazil. Social Science & Medicine 55, 2083–2092.

Toronto Coummunity Housing, 2009. Regent Park Revitalization. Retrieved August 20, 2009 from. 〈http://www.torontohousing.ca/regentpark〉.

Wang, F., Luo, W., 2005. Assessing spatial and nonspatial factors for healthcare access: towards an integrated approach to defining health professional shortage areas. Health & Place 11, 131–146.

Wang, L., 2007. Immigration, ethnicity, and accessibility to culturally diverse family physicians. Health & Place 13, 656–671.

Wang, L., Rosenberg, M., Lo, L., 2008. Ethnicity and utilization of family physicians: a case study of Mainland Chinese immigrants in Toronto, Canada. Social Science & Medicine 67, 1410–1422.

Weiss, L., Ompad, D., Galea, S., Vlahov, D., 2007. Defining neighborhood boundaries for urban health research. American Journal of Preventive Medicine 32, S154–S159.

Wen, M., Hawkley, L.C., Cacioppo, J.T., 2006. Objective and perceived neighborhood environment, individual SES and psychosocial factors, and self-rated health: an analysis of older adults in Cook County, Illinois. Social Science & Medicine 63, 2575–2590.

Witten, K., Exeter, D., Field, A., 2003. The quality of urban environments: mapping variation in access to community resources. Urban Studies 40, 161–177.

Yip, A.M., Kephart, G., Veugelers, P.J., 2002. Individual and neighbourhood determinants of health care utilization. Implications for health policy and resource allocation. Canadian Journal of Public Health 93, 303–307.