A geospatial analysis of disparities in access to primary care for official language and other linguistic minorities in Ottawa, Ontario

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Abstract

Background: While language concordance between patients and primary care physicians results in better quality of care and health outcomes for patients, little research has been done to measure inequities in travel burden to primary care physicians for linguistic minorities in Canada.

Methods: This study measured travel burden for all residents in Ottawa, Ontario to primary care physicians (family physicians in community practice), and compared it to the travel burden for French-only speakers to language-concordant primary care. Dissemination block (DB) level population sizes for all residents and French-only speakers were estimated using Statistics Canada's 2016 Census of Population, and neighbourhood demographics were obtained from the Ottawa Neighbourhood Study (ONS). The primary practice location and language(s) spoken for primary care physicians (n=868) were obtained through the College of Physicians and Surgeons of Ontario (CPSO). Travel burden was measured using the Valhalla routing engine, an open-source road-network analysis platform.

Results: Our results show that average travel burden in neighbourhoods is significantly larger for French-only speakers than for the general population. Neighbourhood rurality had a similar effect for the general population and French-only speakers, with travel burden being largest in rural neighbourhoods and shortest in urban neighbourhoods.

Interpretation: Our results indicate that there are neighbourhood-level travel burden inequities for official language minorities in Ottawa, ON. These inequities are generally smaller, however, in neighbourhoods with a larger proportion of French-only speakers. Our methods use open-sourced data and algorithms and can be replicated for other geographical regions in Canada.

Introduction

Being able to receive healthcare services in one's preferred language is an important element of healthcare accessibility (1), and can produce better quality of care and health outcomes (2). Language barriers for Francophone minorities seeking medical care in Canada are associated with misdiagnoses, longer treatment times (3), and negative patient experiences (4–6). Non-French-speaking physicians also experience barriers and feelings of inadequacies when treating Francophone patients (7). These findings highlight the importance of language concordance in primary care, which account for ~72% of all outpatient doctor visits (8). Outside of Quebec, French-speaking residents represent a significant percentage of the population in several cities, including Ottawa, ON (40.1%), Timmins, ON (52.7%), Moncton, NB(50.1%), Greater Sudbury, ON (39.5%), and Edmundston, NB (98.3%) (9). However, between 2001-2016, the proportion of French-speaking healthcare providers outside Quebec dropped steadily from 12.3% to 11.5% of the workforce (10). Moreover, less than 20% of Canadian physicians outside of Quebec speak French (10). As a result, French-speaking Canadians may face a higher travel burden than English-speakers to obtain language-concordant services. However, language-based travel inequities are an under-studied area, and there is little empirical evidence to help healthcare providers and policy-makers understand and address this issue.

To address this gap, we developed a geospatial approach to assess access to language-concordant primary care services for official language minority communities across defined neighbourhoods from the Ottawa Neighbourhood Study (ONS), a community-based not-for-profit organization that uses data to help address local health and policy challenges (https://www.neighbourhoodstudy.ca/). The ONS has profiled these neighbourhoods with health and socio-economic data, which inform health and social resource system planning (11).

Many Canadians face transportation barriers, so proximity to healthcare services is an important factor affecting their ability to access these services and receive care (12–14). Geospatial mapping has been used to study disparities in access to primary care and other services across populations, including linguistic groups (15), to understand human resource shortages (16–18), and demonstrate the link between proximity to these services and emergency room utilization (19).

The main objective of the present study is to describe the geospatial access for French-only-speakers to French-speaking family physicians, and of the general population to any family physician, regardless of language, across neighbourhoods in Ottawa, Ontario (Canada). A secondary objective was to create an interactive tool for patients to easily locate family physicians near them by filtering for language(s) spoken. For this objective, we also included all allophone (non-English, non-French) languages spoken by physicians in Ottawa (52 languages).

Methods

Study Design
We conducted a descriptive cross-sectional geospatial analysis of knowledge of official language and family physician availability by spoken languages for the Ottawa area. Ottawa is the Capital city of Canada, a country with universal healthcare coverage and two official languages (French and English).

Participants
We used the College of Physicians and Surgeons of Ontario (CPSO) database of all registered Ontario physicians, which is publicly available, to identify family physicians providing comprehensive primary care in the Ottawa region. We relied on the data captured in the annual renewal form to identify their spoken languages and practice site. The registry, accessed on January 18th and 19th 2021, contains the physician's name, specialty, practice address, and language(s) spoken. We limited the dataset to physicians practicing in Ontario within 50 kilometers of the city of Ottawa boundaries (n=4,997). We manually reviewed the list and identified comprehensive primary care family physicians as those 1) whose specialty was recorded as "Family Medicine" and whose primary practice location was a facility that provides services to the general public (e.g. excluding long-term care homes, specialized clinics, or government offices), and 2) for those physicians without an identified specialty, whose primary practice location was a primary care practice. This data cleaning and review included verifying physician addresses on a map, reviewing clinic websites, and making phone calls to clinics. We then captured the language(s) they reported speaking as reported on the CPSO website. We assumed that physicians only report competency in a language to the CPSO if they can provide care in that spoken language.

Ottawa residents
We used data from Statistics Canada's 2016 Census of Population to identify the population members living in private households (i.e., excluded populations living in institutional settings such as long-term care homes) within Ottawa's geographical boundaries. Census data is only available in aggregate form; population counts are available at the dissemination block (DB) level, or approximately the size of a city block, while demographic data, including language proficiency, is available at the larger dissemination area (DA) level, or approximately 400 to 700 individuals. We used the population counts at the DB level to identify where residents are living, and language data at the DA level to estimate the number of French-only speakers in each DB. In the Ottawa Neighbourhood Study, the Ottawa region is divided into 108 defined neighbourhoods which contain 8,086 DBs and 1,372 DAs, in which a total of 916,855 individuals resided in 2016 (20).

Variables/Data sources/Measurements

Primary objective: Travel burden: drive time and walking distance
We assessed the burden for each resident to travel from their location to the five family physicians located nearest to them. Since there are no official data sources indicating which family physicians are accepting new patients, we measured patient access using the five nearest family physicians as a reasonable balance between proximity to a physician and the density of

physicians nearby. We also chose five physicians as our metric because data from the Canadian Physician's survey (most recent available: 2011) indicating that about 20% of physicians are accepting new patients at any point in time (21). We considered two travel burden measures: travel time by car, and, because a considerable proportion of individuals in Ottawa's urban neighbourhoods (~14%) regularly commute by foot (22), the walking distance. We approximated each resident's location (the origins) as the geographical centre (i.e., the "centroid") of the dissemination block in which they live. Physician practice addresses (the destinations) obtained from the CPSO were geocoded to latitude and longitude using Google's geocoding API.

Our travel-burden analysis used the Valhalla routing engine, an open-source road-network analysis platform that provides turn-by-turn directions and respects traffic laws and speed limits (23). To evaluate Valhalla's performance, for a small sample of trips we compared Valhalla's predictions to simple distance calculations along Statistics Canada's road networks and to distance and time predictions using Google Maps' online service. We found that Valhalla provided realistic routes and reliable travel-time estimates. Driving travel burden was measured as time in minutes, and walking travel burden was measured as distance in kilometres. Our driving and walking analyses used Valhalla's "auto" and "pedestrian" costing methods respectively, which means that, for example, driving trips prioritized highways and avoided walking paths, and walking trips prioritized streets with sidewalks and avoided highways. Time of day and traffic were not considered, and it was assumed that vehicles travel the speed limit for the entire trip. Road network data was obtained from OpenStreetMap (24). All analysis was done using the open-source statistical software packages R (25) and RStudio (26), with the interface to Valhalla through the R package **valhallr** (27).

Our walking and driving travel-burden analyses both followed the same four steps:

- First, we calculated the travel burden for each of Ottawa's 8,086 DBs to each applicable family physician. For the general population we used all family physicians, and for French-only-speakers we used the subset of French-speaking family physicians.
- Second, for each DB we found the average distance and time of the five shortest trips.
- Third, we determined the applicable DB-level population. For the general population we used the 2016 census population. For French-only-speakers we weighted each DB's 2016 census population by the DA-level percentage of residents who reported speak French but not English in the 2016 census (28), assuming an even distribution of language proficiency across the DA.
- Fourth, we used population-weighted averaging to calculate 108 neighbourhood-level travel burdens from the DB-level metrics. This method assigns more weight to more populated areas and is an attempt to reflect the "average" resident's lived experience in each neighbourhood. Each DB was mapped to the populated neighbourhood it overlapped the most.

The result is a set of neighbourhood-level average distances and times to primary care, via walking and driving, for the general population to any family physician and for French-only-speakers to French-speaking family physicians.

Secondary Objective: Interactive map of physicians and language spoken
We also used our data to develop an interactive online map of family physicians, filterable by language spoken, to allow members of the public to easily locate family physicians in and near Ottawa who speak their preferred language.

Statistical methods
We performed Wilcoxon signed-rank tests to compare neighbourhood-level measures for French-only speakers and the general public. The Wilcoxon signed-rank test is a non-parametric test with the null hypothesis that differences in observations have a distribution centred around zero (29). The alternative hypothesis in each case was that the differences between observations are centred around a value other than zero, corresponding to overall greater travel burdens for French-only-speakers. Tests were performed to compare driving time for the general population compared to French-only-speakers and walking distance for the general population compared to French-only-speakers across all neighbourhoods and across rurality classes.

Data Access
Physician Data: The CPSO's website (30) hosts publicly available data allowing users to identify physicians practicing in each city/town in Ontario. The "advanced search" tool allows users to search for physicians in specific cities/towns. We searched for physicians practicing in all of the 40 cities/towns in Ottawa and the surrounding area in Ontario (See Appendix A).

Neighbourhood-level Data: Geographical boundaries defining neighbourhoods in Ottawa, as well as data demographic data for these neighbourhoods, were obtained from the Ottawa Neighbourhood Study (20).

Dissemination-Area Level Language Data: Data for the language knowledge of Ottawa residents in DAs was collected from Statistics Canada's 2016 Census Profile Web Data Service application programming interface (API) (31). Data was collected at the dissemination area (DA) level and the main row of interest was row 7002, "French Only," of the "Language" theme.

Dissemination-Block Data: Data for dissemination blocks (DB), including geographic boundaries (32) and population (33), was collected from Statistics Canada.

Road Network Data: The travel analysis used the OpenStreetMap road network for Ontario as mirrored on the public Geofabrik download server on February 17, 2021 (24).

Hospitals and Other Health Care Facilities: Location data for hospitals, long-term care homes, and retirement homes were collected both from official government websites and from institution webpages found using Google. For more details about source websites, please see Appendix G.

Data cleaning methods
Selection: To ensure that the physicians included in the study were providing primary care services that are accessible to the general public, we excluded physicians whose primary practice locations were located in long-term care homes, retirement homes, and military bases. For physicians whose primary practice location was a hospital, we used online resources to determine whether the physician was part of a family health team at the hospital. Physicians who were part of family health teams in hospitals were included in the study; all other physicians

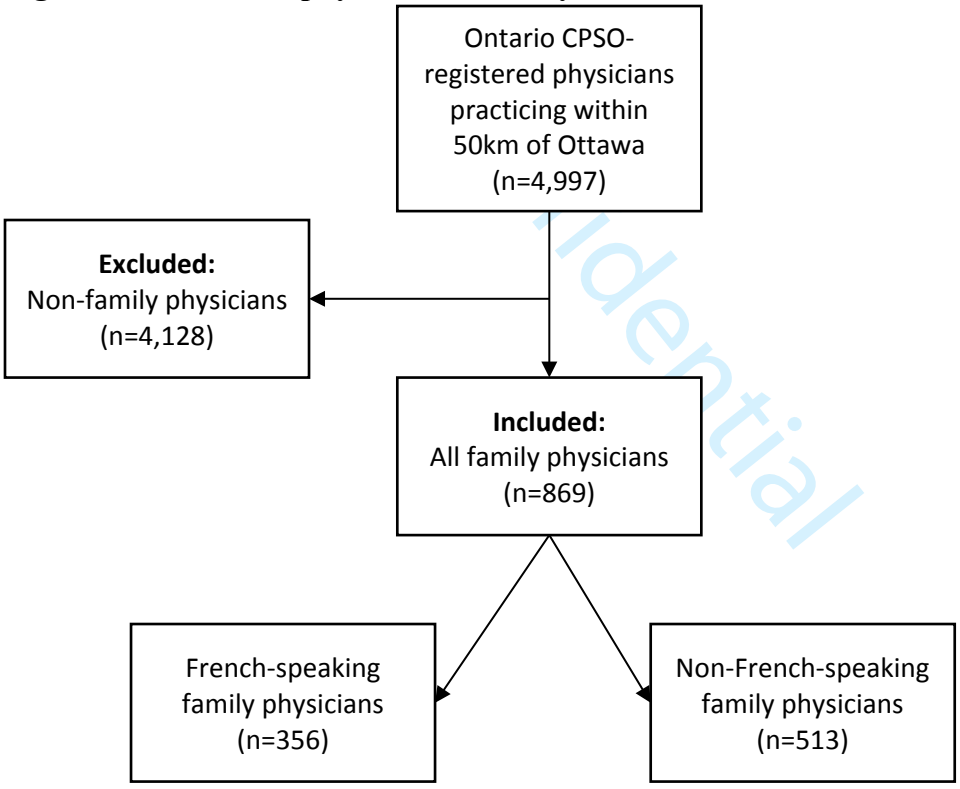
practicing in hospitals were excluded. Our initial data cleaning was supplemented with local expertise from ONS's community partners, who made further revisions to the list of physicians based on recent events (e.g. retirements, office moves) and local knowledge (e.g. practice types).

Results

Participants and Descriptive data

Of the 4,997 initial physicians found on the CPSO website, we identified 869 family physicians providing family medicine services to the community in this study's geographic scope. 4,128 were excluded because they do not provide primary care to the community (for example, physicians working in the Coroner's Office or for private sports medicine clinics) (Figure 1). All family physicians reported "English" as a language spoken, and 356 (41.0%) also reported "French".

Figure 1. Selection of physicians for study inclusion



The profiles of the neighbourhoods are shown in **Table 1**. The total number of individuals in all 108 neighbourhoods was 916,855, 1.35% of whom were French-only speakers. The median neighbourhood population size was 6,983 and the majority (62.2%) had less than 1% French-only speakers.

Table 2. ONS neighbourhoods: population and selected demographics

Neighbourhood attributes	Results
Population (median (IQR))	
All neighbourhoods- n=108	6,914 (4,689 – 10,963)
Urban: n=48	6,914 (5,854 – 10,309)
Suburban: n=42	10,213 (4,658-14,358)
Rural: n=18	4,178 (3,311-5,765)
Proportion of French-only speakers (# (%) of neighbourhoods)	
< 1%	65 (60.2%)
1-3%	25 (23.1%)
3-5%	15 (13.9%)
> 5%	3 (2.8%)

Main results

Results of the travel burden analysis are summarized in Table 2. In all cases results were strongly significant ($p<0.001$) suggesting that Ottawa's French-only speakers face greater travel burdens to access family health care in French than the general population does to access family health care. While the general population living in suburban neighbourhoods face a slightly higher median travel burden than those living in urban neighbourhoods (an additional 0.63 minutes and 0.63 km of drive time and walking distance, respectively), those living in rural neighbourhoods face a much larger median travel burden (7.60 minutes and 8.83 km, respectively) than those living in urban neighbourhoods. The effect of rurality was similar for French-only speakers, with suburban French-only speakers facing an additional median travel burden of 1.11 minutes and 0.94 km and rural French-only speakers facing an additional median travel burden of 8.76 minutes and 10.57 km than urban French-only speakers for drive time and walking distance, respectively.

For two neighbourhoods, Orléans Industrial and Wateridge Village, there was no difference in travel burden for driving time or walking distance. These two neighbourhoods have the smallest populations in Ottawa (170 and 255, respectively). We found eight neighbourhoods (five urban and three suburban) to have smaller drive times and walking distances for French-only speakers than for the general population. We found one rural neighbourhood, Dunrobin, to have a higher walking distance (an additional 0.25 km) but a slightly lower drive time (0.03 minutes less) for French-only speakers than for the general population.

Table 2. Travel burden to five nearest physicians in Ottawa neighbourhoods

		The general population to all family physicians, regardless of language (Median (IQR))	French-only speakers to French-speaking family physicians (Median (IQR))	P-Value*	Difference between French-only speakers and the general population** (Median (min-max))
Driving time (minutes)	Overall	2.17 (1.83-3.4)	3.04 (2.2-4.68)	<0.001	0.64 (-0.62-9.29)
	Urban neighbourhoods	1.86 (1.51-2.09)	2.39 (1.88-2.82)	<0.001	0.40 (-0.5-2.03)
	Suburban neighbourhoods	2.49 (2.11-3.17)	3.50 (2.72-4.29)	<0.001	0.61 (-0.62-2.96)
	Rural neighbourhoods	10.09 (8.35-11.81)	12.26 (9.46-15.71)	<0.001	2.26 (-0.03-9.29)
Walking distance (km)	Overall	1.28 (0.95-2.15)	1.81 (1.25-3.27)	<0.001	0.45 (-0.47-11.12)
	Urban neighbourhoods	0.96 (0.73-1.16)	1.32 (0.86-1.62)	<0.001	0.29 (-0.26-2.05)
	Suburban neighbourhoods	1.59 (1.13-2.05)	2.26 (1.61-2.94)	<0.001	0.48 (-0.47-2.30)
	Rural neighbourhoods	10.42 (7.33-11.85)	12.83 (8.94-15.73)	<0.001	2.18 (0.19-11.12)

*Wilcoxon signed-rank test with null hypothesis that the difference in paired observations is centred around zero.

**A negative value indicates that the travel burden is less for French-concordant care than for general care independent of language.

Figure 2. Neighbourhood-level average drive times to any family physicians for the general population and to language-concordant family physician for French-only speakers]

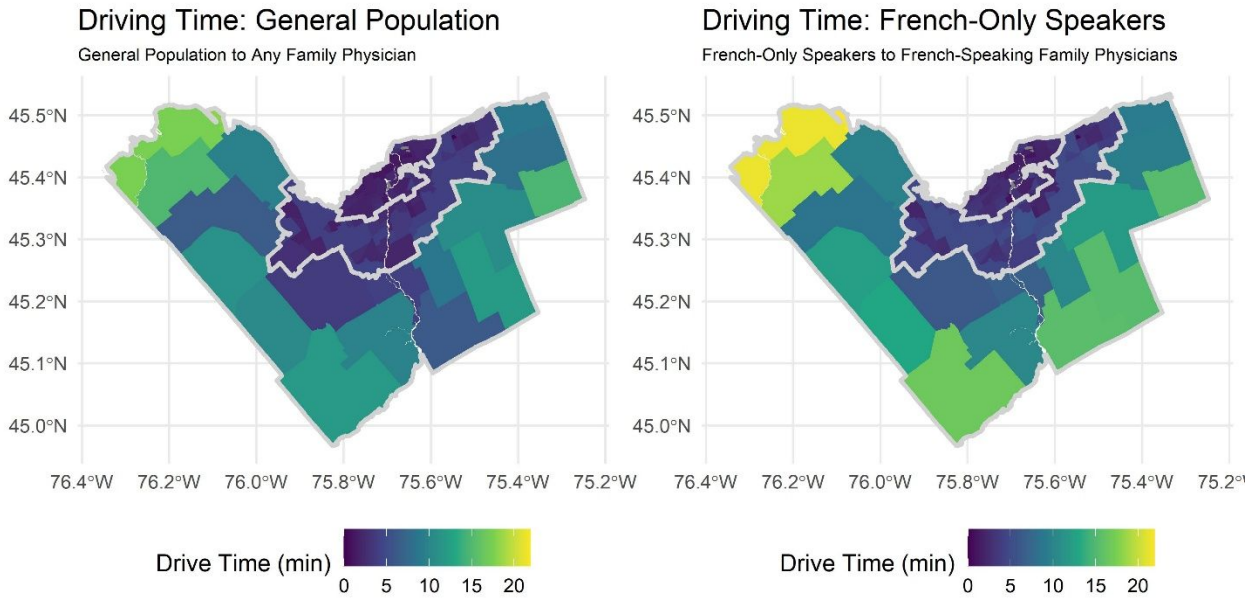
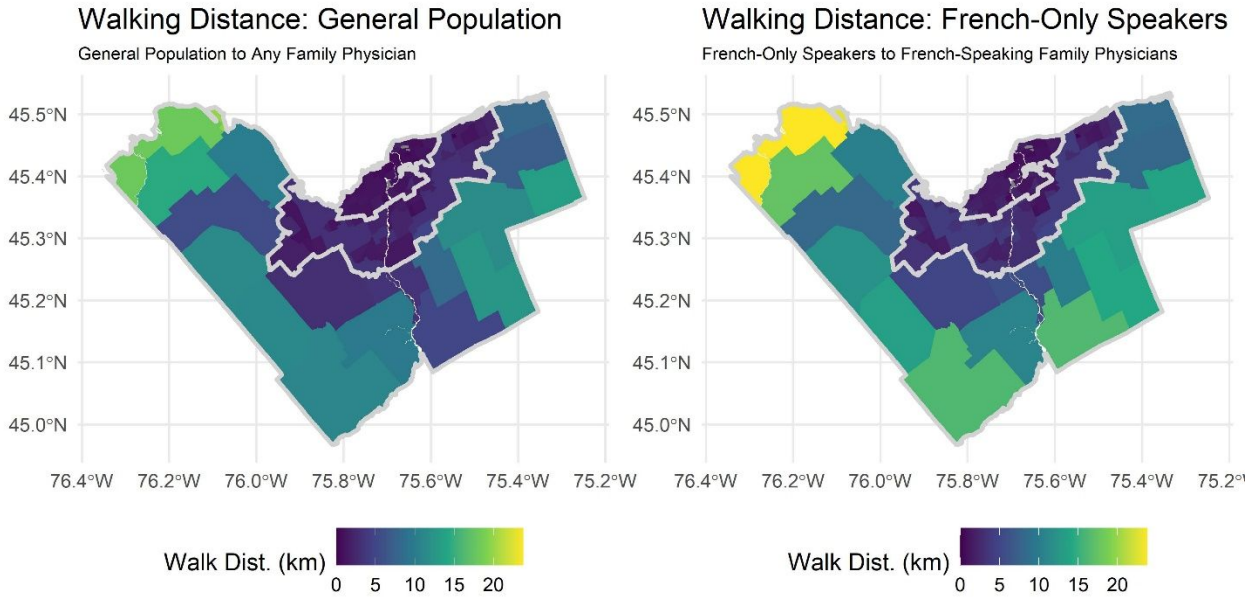


Figure 3. Neighbourhood-level average walking distances to language-concordant family physicians for the general population and for French-only speakers]



Interactive map of physicians and language spoken

An interactive tool was created to identify the languages spoken by family physicians in the Ottawa area, and their primary practice locations. A total of 58 different languages, including English and French, are spoken by physicians in the Ottawa area. An English version of the map is available at https://www.docmapper.ca/, and a French version is available at https://www.trouvezunmedecin.ca/.

Other analyses

We also compared the difference in drive time between French-only speakers to French-speaking family physicians (i.e. concordant language care) and all residents to any physician, in relation to the proportion of French-only speakers in each neighbourhood. We found that the largest drive time disparities exist in neighbourhoods where a very small proportion of the population is French-only speaking (see Figure 4). This relationship between drive time disparities and proportion of French-only speakers was much stronger in rural neighbourhoods than in urban and suburban neighbourhoods. Simple linear regression line equations, R square values and P-values were calculated for the three neighbourhood rurality groups.

Figure 2. Difference in drive time between French-only speakers to French-speaking family physicians and the general population to all family physicians, in relation to the proportion of French-only speakers in each neighbourhood. Rural: y=-0.6926x + 2.9969, R^2=0.1471, P=.1161. Suburban: y=-0.2275x + 1.0588, R^2=0.1196, P=.02518. Urban: y=-0.132x + 0.6823, R^2=0.2176, P= .000812].

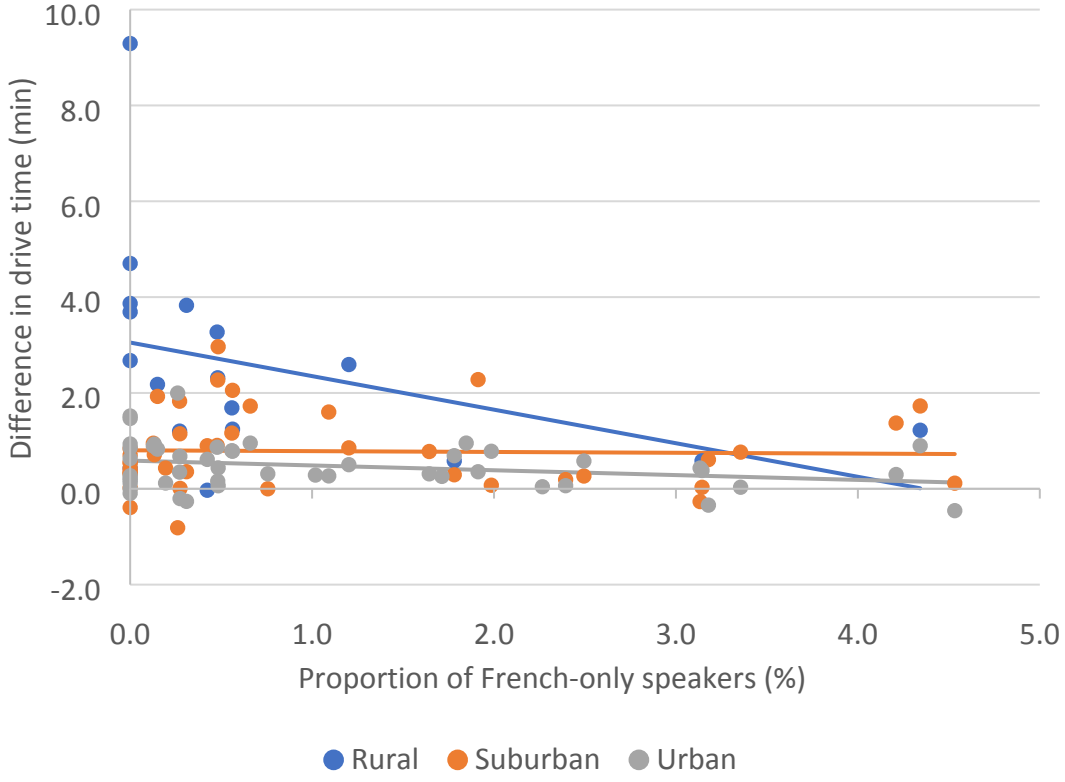
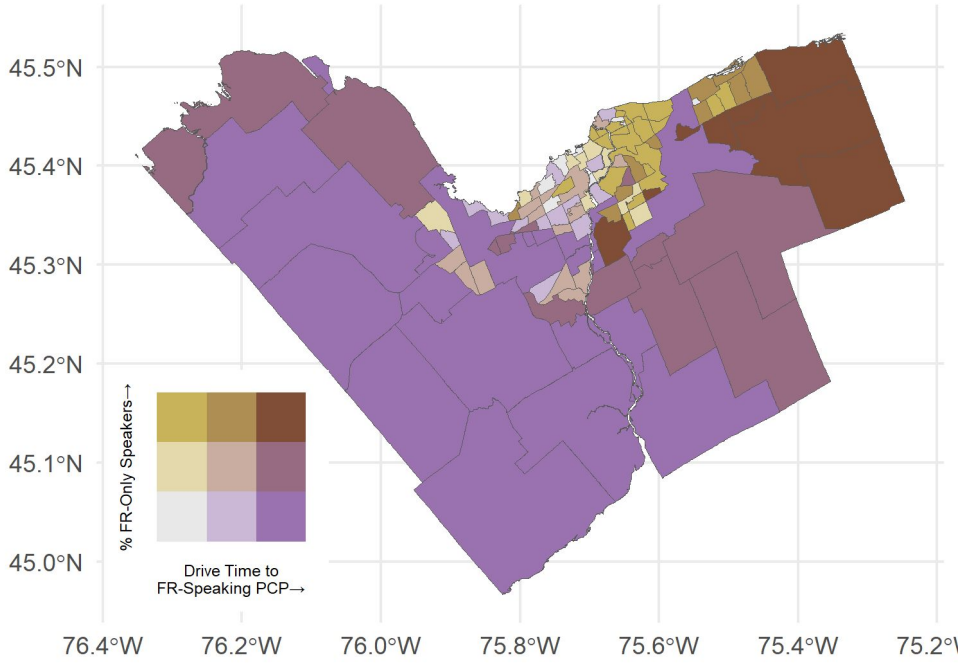


Figure 3. Bivariate choropleth showing the neighbourhood-level relationships between % French-only speakers and average drive time for French-only speakers to a French-speaking family physician.



To explore this relation further, we created a bivariate choropleth that maps neighbourhood-level driving times to French-speaking family physicians and the percentage of residents who are French-only-speakers (see Figure 4). Bivariate maps show the relationship between two variables across geographic regions, and have been used to study patterns in cancer rates (34), HIV and hepatitis C rates (35), and respiratory health (36). In Figure 5, regions that are more purple have higher drive times to French-speaking family physicians, regions that are more gold have higher percentages of French-only speakers, and regions that are dark brown have high values of both. Many regions in the south and west with the longest drive times to French-speaking family physicians also have the lowest proportion of French-only speakers, which may suggest that these larger burdens fall on a smaller percentage of residents. We can also see that many central neighbourhoods with the highest proportions of French-only-speakers have among the shortest drive times, suggesting that access needs may be relatively well met in these areas. Finally, areas in the east and north-west have both high percentages of French-only speakers and high travel burdens, suggesting that inequities among French-only speakers in these areas may be more impactful.

Interpretation

Main Results of Study

Our analysis found evidence that Ottawa's French-only-speakers generally face a higher travel burden to accessing family medicine than does the general population. Both language groups have similar travel-burden patterns, with smaller travel burdens in denser urban neighbourhoods and larger travel burdens in outlying rural neighbourhoods, but travel times for French-only-speakers were found to be generally longer. These differences tend to be larger in more rural neighbourhoods, and are especially acute at the south and west edges of the city. Some neighbourhoods had slightly smaller travel burdens for French-only-speakers, likely due to population-weighting in cases where French-only-speakers happen to live closer to French-speaking family physicians. Neighbourhoods with larger travel burdens for French-only-speakers also tended to have a lower proportion of French-only-speakers, suggesting that French-speaking family physicians are often located near clusters of French-speaking residents.

Explanation of Findings

Our geospatial analysis of travel burden for language concordant family medicine services in Ottawa demonstrated that Francophone residents, in general, experience a greater travel burden than the general population. In particular, the bivariate analysis showed that Francophones residing in the rural regions of the city, where there are also lower populations of French-speaking residents, experience the longest driving times to access care from a French-speaking physician (Figure 5). Interestingly, despite a high density of French-speaking residents in the North-eastern edges of the city (Cumberland Ward), drive times in these areas to language concordant care are some of the highest in Ottawa. These findings highlight areas of the city in greatest need of local French-speaking primary care services, i.e. North-eastern and North-western Ottawa.

Increasing the availability of French-speaking physicians in Ottawa's higher need areas would lead to greater healthcare access (e.g. number of GP visits; number of patients attached to a family physician) (2,37) for thousands of Francophone residents. Therefore, healthcare funding should be prioritized towards the opening of French-speaking primary care practices in areas of high Francophone density and long travel times (Figure 5), as well as the implementation of high-quality, virtual primary care programs (offered in patients' language of choice). These measures would help decrease travel burden to language concordant primary care, thus facilitating improved health outcomes for Francophones in the Ottawa region (2–6).

Future Directions

Our results and methods have the potential to inform health-system planning and may be of interest to patients, policymakers, and physicians. While this study used Ottawa, ON as its target location for analysis, it used open-sourced data and could be replicated for any other geographical area, in which population census data is available for small geographical units, and data is available for practice location and language(s) spoken by primary care physicians. The use of both driving time and walking distance as measures of travel burden render these methods applicable for urban, suburban, and rural areas. Further implication of our methodology in other highly populated, geographical regions across Canada is recommended to identify regional areas in greatest need of language concordant care for linguistic minorities.

Limitations of Study

This study has several limitations. First, there is no centralized data about which physicians are accepting new patients, so our access metric represents a best-case scenario. Second, the population and language data we used is from the 2016 Canadian census, and population demographics may have changed. Third, this study cannot account for the fact that non-physicians in a given practice (such as nurses and nurse practitioners) may speak French or another language, and may contribute to improving access to language-concordant care. Finally, our study cannot account for any cross-border use of care by Ontario patients from Quebec physicians located in the Gatineau area, which lies just north of Ottawa on the other side of the Ottawa River. However, anecdotally, access to care in general is quite difficult in the Gatineau area, and consequently, the proportion of Ottawa residents obtaining care in Quebec is likely to be negligeable.

Conclusion

This study found evidence that Ottawa's French-only-speakers generally face a higher travel burden to accessing care by family physicians than does the general population. We collected data for family physicians from the CPSO's website and developed a novel method for calculating neighbourhood-level travel burden using the Valhalla routing software and population weighting. We produced several visualizations to explore neighbourhood-level access inequities and found statistical evidence that there are population-level differences in access between French-only-speakers and the general population. We also produced a patient-facing online tool to help Ottawa-area residents find family physicians who speak their language of choice. Lastly, our methods use open-sourced data and algorithms which can be replicated for other geographical regions in Canada.

Other information

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Accessibility of code

Map data copyrighted OpenStreetMap contributors and available from https://www.openstreetmap.org.

The R code used in this analysis is freely available from https://github.com/Belanger-Analytics/ottawa_franco_physician_access_study

APPENDICES

A- List of all cities/towns searched on CPSO website

Almonte
Arnprior
Blackburn Hamlet
Cardinal Heights
Carleton Place
Carlsbad Springs
Carp
Centreville
Constance Bay
Cornwall
Cumberland
Dunrobin
Embrun
Fitzroy Harbour
Gloucester
Hazeldean
Kanata
Kemptville
Manotick
Merrickville
Navan
Nepean
North Gower
Orleans
Orléans
Ottawa
Osgoode
Oxford Mills
Oxford Station
Pakenham
Richmond
Rockcliffe
Rockcliffe Park
Rockland
Russell
Sarsfield
Smiths Falls
Stittsville
Vanier
Vars

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