Access to Primary Care and Mental Health Care in Renfrew County

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Executive Summary

This report presents a geostatistical analysis of access to primary care, adult and child/youth mental health care, and broadband internet services in Renfrew County, Ontario. We located and mapped primary-care and mental-health providers within and near Renfrew County, and calculated the average travel burden to access these providers within each of Renfrew County's 19 census subdivisions.

The analysis found strong evidence that Renfrew County's residents face urban/rural disparities in access to both primary care and mental health care. We found that care providers are largely located in urban areas, and that, on average urban residents have much shorter travel times to access care than rural residents. In some cases, rural residents of Renfrew County can need to travel over twenty times longer than urban residents to access care. The situation was similar for mental health services, both for adults and for children and youth.

We also found that much of Renfrew County has good access to wired broadband networks. Coverage tended to be better in regions with better health care access, including urban centres along the Highway 17 corridor, but there was also coverage in some rural areas.

Taken together, this suggests that telemedicine services could play an important role in increasing access to health care in Renfrew County. Since telemedicine services are provided over the internet, travel times and physical distance are irrelevant. Residents in parts of Renfrew County with long average travel times and few local providers could therefore benefit greatly from telemedicine, and this analysis suggests that many residents in these regions have at least some broadband access.

"Primary care" was defined to include family physicians and nurse practitioners, and "mental health care" was defined to include publicly funded organizations providing primarily mental health care services to the community. Access was measured based on average travel times via road to the nearest one or five providers, depending on the type of provider. All data was collected from publicly available sources including the College of Physicians and Surgeons of Ontario's (CPSO) website, Statistics Canada, Innovation, Science and Economic Development Canada, and OpenStreetMap.

This report is also available in a web-based html version with interactive maps and figures.

Introduction

Project Purpose

This project is intended to inform and improve the provision of primary health care services by studying the capacity of and need for health care in and near Renfrew County, Ontario. It combines geospatial and statistical methods to analyze access to and need for health care in Renfrew County. Data from publicly available sources, including the CPSO's website and Statistics Canada, is presented and analyzed in conjunction with geospatial data, including road networks, to measure local access to and need for health care at a fine-grained level across the region. This project will support an evaluation of virtual care models in Renfrew County.

Renfrew County

Renfrew County is the largest county in Ontario, covering an area of approximately 7,500 sq. km with a population of approximately 107,000 (Government of Ontario 2021). There is a mix of urban, rural and remote communities as well as the First Nation community of Pikwakanagan. There are no walk-in centres or urgent care clinics in Renfrew County, and so for the approximately 26,000 residents (24.3% of the population) who do not have a family physician or other primary care provider, their only access to any form of health care is through one of the five emergency departments (Renfrew County Primary Care Network 2021).

Interactive Version Available

This report is also available in a web-based html version with interactive maps and figures. The interactive version follows the same structure, but also contains data visualizations that are not possible in static documents. Any references to interactivity in this report are referring to the interactive version.

Methods

Data Sources

Primary Care Providers

In this study, "primary care providers" are defined as family physicians and nurse practitioners who provide comprehensive primary care to the general public. Physicians who provide only emergency or hospital-based services and physicians with a solely focused practice (e.g. sports medicine) were excluded.

Since Renfrew County's residents may travel to receive health care, this study used a data set of primary care providers practicing in Ontario within 50km of Renfrew County. Primary care provider data came from two sources based on geography:

- **Within Renfrew County,** all primary care provider data was provided by the Renfrew County Primary Care Network. This data included community-based family physicians and nurse practitioners.
- **Outside of Renfrew County,** data was collected from the College of Physicians and Surgeons of Ontario's (CPSO) online "Doctor Search" using the "advanced" search setting (CPSO 2021).[1]

These two groups were combined to create the final study data set.

Mental Health Care Providers

To better understand access to publicly funded mental health care in Renfrew County, in this study "mental health care providers" are defined as publicly funded organizations providing primarily mental health care services to the community. Please note that this definition excludes family physicians, who are important providers of mental health care, as well as private providers like psychologists. Data about mental health care providers was provided by Renfrew County.

Census Data and Geographical Boundaries

Census data and geographical boundaries were collected from Statistics Canada.

- **Dissemination-Area Level Census Data,** including data about population age ranges, was collected from the 2016 Census using Statistics Canada's 2016 Census Profile Web Data Service API, or application programming interface (Government of Canada 2018).
- **Dissemination-Block Population Data** was collected from Statistics Canada's 2016 Geographical Attribute File (Government of Canada 2017).
- **Geographical Boundaries,** including those for CSDs, DAs, and DBs, were collected from Statistics Canada's 2016 Census Boundary Files (Statistics Canada 2016).

Note that Statistics Canada divides Canada into administrative areas of various sizes: Renfrew County itself forms a Census Division (CD) which is divided into 19 Census Subdivisions (CSDs), which are divided into 170 Dissemination Areas (DAs), which are then divided into 2461 Dissemination Blocks (DBs). All of these boundaries align: DBs fit perfectly into DAs, which in turn fit into CSDs, and then CDs. See Appendix A for details.

Road Networks

The travel analysis used the OpenStreetMap road network for Ontario as mirrored on the public Geofabrik download server on February 17, 2021 (Geofabrik GmbH and OpenStreetMap Contributors 2021).

[1] The CPSO's Doctor Search is accessible at: https://doctors.cpso.on.ca/?search=general.

Broadband Access

This report also includes broadband access data from Innovation, Science and Economic Development Canada's (ISED) National Broadband Data (NBD), accessible at this link (Treasury Board of Canada Secretariat 2021).

The NBD divides Canada into hexagons, and in this report hexes are shaded based on whether more than 75% of private dwellings within them have access to broadband services at speeds of 5/1 Mbps or greater. 5/1 Mbps is the minimum speed reported in this data set and an approximate minimum speed that will support video telemedicine/teleconferencing services. See Appendix A for more details.

Measuring "Access"

This project focused on the spatial access to primary care and mental health care in Renfrew County, and specifically on CSD-level travel burden as measured by driving time. There are other ways of measuring community-level "access" to a service (for example, wait times), and other ways of measuring spatial access (for example, area-based density, or two-step floating catchment areas), but travel burden has several advantages:

- Its results are intuitive and easy to understand, since it measures access in minutes.
- It recognizes that residents will often cross geographic boundaries (neighbourhoods, cities, etc.) to access care.
- It works well with geographic regions that may not contain any service providers, as is the case in this analysis.

Calculating Travel Burden

Travel burden was measured in terms of driving distances to access health care using the Valhalla routing engine, an open-source road-network analysis platform that can provide turn-by-turn directions and respects travel laws and speed limits. All analysis was done in R using the **tidyverse** and related packages, including the **valhallr** package for access to Valhalla APIs (Wickham and RStudio 2021; Belanger 2021).

Four separate analyses were run: one for primary care, and three for mental health care based on population characteristics (general population to any provider; adults to adult care providers; and children/youth to child/youth care providers). The analyses followed slightly different procedures that will be described below, but the overall algorithm was the same:

1. **Calculate travel time for all possible trips.** First, Valhalla was used to find the shortest trip from each DB to each care provider. The majority of trips were calculated from each DB's geographic centre, but for some largely unpopulated rural DBs it used a custom starting point closer to the main access road.
2. **Find the shortest trip(s) to create a DB-level travel time.** For primary care, we averaged the five shortest travel times. For mental health care, we took the single shortest trip to the applicable sub-group of service providers.

3. **Adjust DB populations, if applicable.** For the adult and child/youth mental health analyses, we adjusted DB populations based on the DA-level percentage of the population in the applicable age range. For children and youth we used the percentage aged 0-19, and for adults we used the percentage over age 19.
4. **Create CSD-level population-weighted averages.** We then "rolled up" these granular results to the CSD level using population-weighted averaging, to reflect the "average" resident's lived experience. Where applicable, we used adjusted populations to estimate the number of residents in the relevant age group.

These DB- and CSD-level average travel times are the substantial analytical results, and will be discussed more in the next section.

Results

Primary Care Access in Renfrew County

This map shows census sub-division (CSD)-level population-weighted average travel times to the **five nearest FPs**. The analysis was run at the dissemination block (DB) level, the smallest level possible, and then population-weighted up to the CSD level. More granular plots can be found in Appendix B, and detailed data tables are attached in Appendix C.

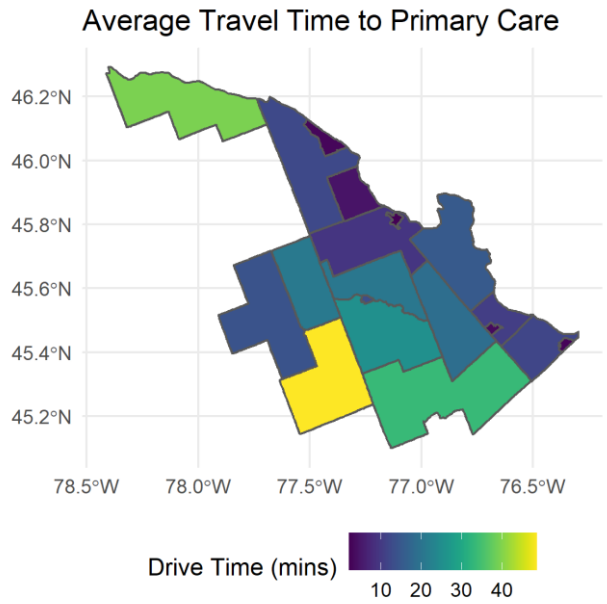

Figure 1: Average census-subdivision-level travel times to the five nearest primary care providers. Results are population-weighted based on the 2016 census.

The average travel time to primary care varies greatly between regions, with generally lower times in urban centres and larger times in rural areas. Smaller urban centres like Pembroke, Arnprior, and Deep River have very short average travel times (2.2 minutes, 2.6 minutes, and 2.8 minutes respectively). Larger rural areas tend to have much longer

average travel times, ranging from Greater Madawaska's 33.4 minutes to Brundell, Lyndoch and Raglan's 48.6 minutes. This suggests that there may be substantial inequities in health-care access between urban and rural regions of Renfrew County.

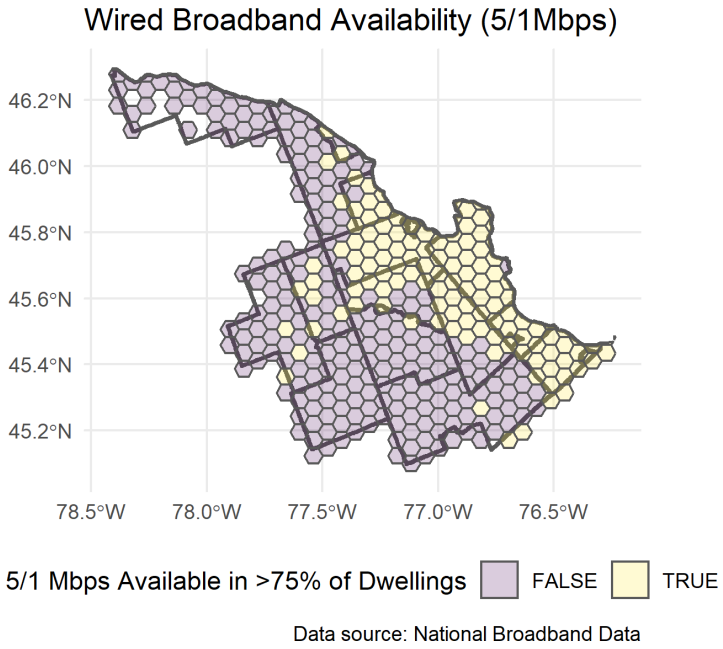

Figure 2: Availability of wired broadband internet in Renfrew County.

Consider next the broadband access data, showing regions in which at least 75% of private dwellings have access to broadband speeds of 5/1 Mbps or greater. We can see that high-speed 5/1 Mbps wired internet is available in many regions of Renfrew County. First, access is near-universal in the eastern more-populated regions along Highway 17. While access is less consistent in other areas–and is low in the south-west and north-west–there are pockets of access in many rural regions with long average travel times. For example, several regions in Killaloe, Hagarty and Richards have high levels of broadband access, as does Pikwakanagan and Bonnechere Valley. This suggests that online telemedicine services could be effective in increasing access in rural regions with fewer local primary health care practitioners.

Mental Health Care Access in Renfrew County

These maps shows census sub-division (CSD)-level population-weighted average travel times to the **one nearest mental health provider**. The map on the left is for access to child and youth services, and the map on the right is for access to adult services including addictions treatment. The colour scales are identical, enabling comparisons between the two maps. The analysis was run at the dissemination block (DB) level, the smallest level possible, and then population-weighted up to the CSD level. More granular plots can be found in Appendix B, and detailed data tables are attached in Appendix C.

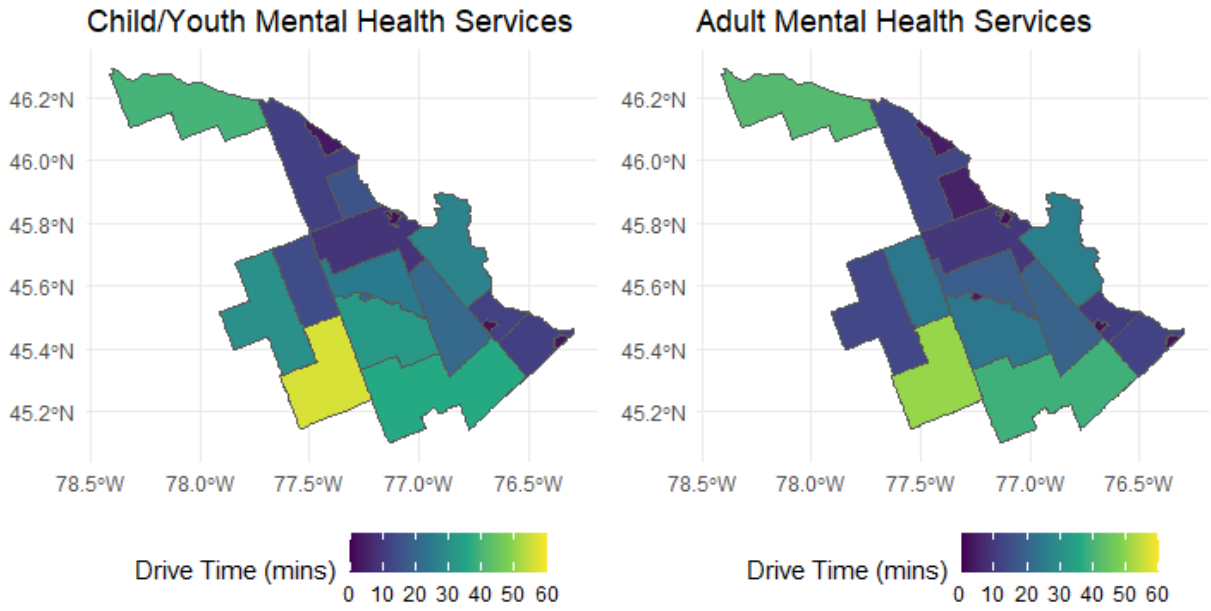

Figure 3: Average census-subdivision-level travel times to the single nearest child/youth (left) and adult (right) mental-health services provider. Results are population-weighted based on the 2016 census distributions of the client populations.

The average travel time to mental health care also varies greatly between regions. For child and youth services, Pembroke, Arnprior, and Deep River still have very short travel times (1.7 minutes, 1.9 minutes, and 3.09 minutes respectively). However, rural travel times for child and youth services are often longer than for primary care, ranging from 36.2 minutes for Greater Madawaska to a full 56.2 minutes for Brundell, Lyndoch and Raglan. In addition, there are more facilities offering services for adults than for children and youth, meaning that in many regions travel times are substantially longer for child and youth services compared to adult services. As was the case with primary care, this suggests that there may be substantial inequities in mental-health care access between urban and rural regions of Renfrew County.

When we consider broadband internet availability in relation to travel times, we again see that high-speed 5/1 Mbps wired internet is available in some regions with long travel times. This suggests that online telemedicine services could be effective in increasing access in rural regions without local mental-health care services.

Access to Care and Population/Socioeconomic Indicators

Travel Time to Primary Care and Household Income

The map below is a *bivariate choropleth* which shows the spatial relation between two variables using colour.

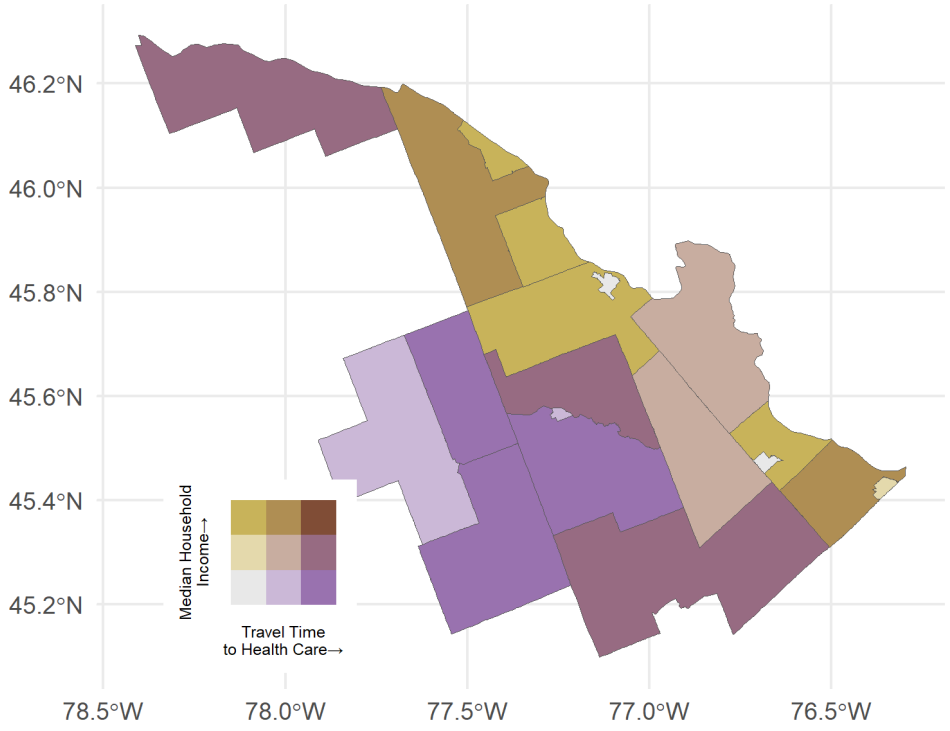

Figure 4: A bivariate map showing the relationship between travel time to comprehensive primary health care and median household income for Renfrew County.

This map shows Renfrew County's census sub-divisions based on their population-weighted average travel time to primary care and their median household income as reported in the 2016 census. All regions were divided into the bottom third, middle third, or top third for median income and for average travel time. We can see that urban centres like Renfrew and Pembroke have relatively low median incomes and short travel times to care. Rural regions tend to have longer times to access care, but also show large variations in income.

Travel Time to Primary Care and Population

This plot shows CSD-level travel times to FPs as a function of CSD population. We can see signs that CSDs with higher populations tend to have shorter travel times.

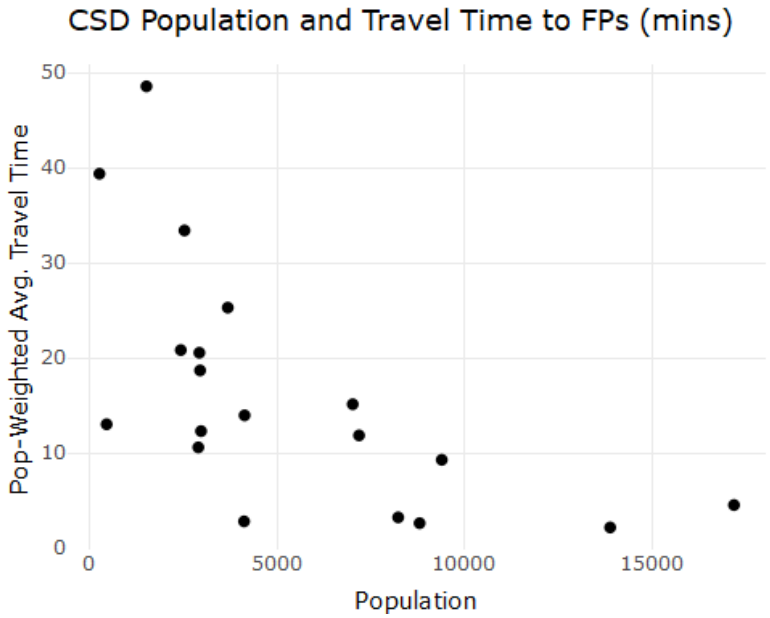

Figure 5: A scatterplot showing the relationship between census-subdivision-level average travel time to access comprehensive primary care and population.

Although this relationship looks non-linear, if we run a simple linear regression we find it is statistically significant with $p < 0.05$ and an adjusted R^2 of 0.36.

Discussion

Clear Disparities in Access

This analysis found strong evidence for urban/rural disparities in access to health care in Renfrew County. Primary care providers and mental-health facilities are mainly located in urban centres like Arnprior, Renfrew, Pembroke, and Deep River, and so on average urban residents have much shorter travel times to access care than rural residents. The situation was similar for access to child and youth mental-health services, and adult mental-health services. On average, rural residents of Renfrew County can need to travel over twenty times longer than urban residents to access care.

Widespread–But Not Universal–Broadband Access

We also found that large areas of Renfrew County have good access to wired broadband networks, according to the Government of Canada's National Broadband Data. Coverage

tended to be better in regions with better access to health care, including urban areas and along the Highway 17 corridor. Many rural areas, especially in the south-west and north-west, had little to no residential wired broadband access. However, there was also evidence of good broadband access in some more rural areas with longer average travel times to access care.

A Potential Role for Telemedicine

Taken together, this suggests that telemedicine services could play an important role in increasing access to health care in Renfrew County. Since telemedicine services are provided over the internet, travel times and physical distance are irrelevant. Residents in parts of Renfrew County with long average travel times and few local providers could therefore benefit greatly from telemedicine, and this analysis suggests that many residents in these regions have at least some broadband access.

Future Research Directions

This work could be expanded in several ways to help inform care provision and health-system planning. First, it could look at different ways of measuring access, for example using measures that combine supply and demand like two-step floating catchment areas. Second, travel times could be measured more granularly, for example by averaging over many random origin points within dissemination blocks or using purpose-built start-points like the National Broadband Data's "pseudo-households" (Treasury Board of Canada Secretariat 2021). More granular broadband data could also be used, including access to wired and wireless internet at the local level, to accurately map broadband availability in light of population distributions and health care access. To refine the analysis, it could be augmented with data about how people react to travel burdens, to understand the real-world impacts of extra travel minutes. And finally, this quantitative study could be augmented with qualitative research about residents' experiences traveling and accessing care in Renfrew County.

Limitations

This study also has several limitations that should be kept in mind when interpreting its results. First, we used only one access measure, population-weighted average travel times to the closest provider(s). While this metric can be interpreted as giving the "average" resident's travel experience to a provider, there is no guarantee that these providers actually have the capacity to serve all nearby residents. Complementary access measures, for example two-step floating catchment areas, could shed light on different aspects of accessibility, including the extent to which existing supply compares to population demand. Second, while the census data used in this analysis is the most recent available, it is now five years old. As a result, the population and demographic data in this report may be out of date. Third, access was measured from dissemination block centroids, and as such travel times in some large rural blocks may be unreliable. However, we took steps to mitigate this by using some custom start-points, and by averaging over all blocks. And finally, the broadband-access data presented here is very high-level and relates only to wired access.

Looking at finer-grained access data, including wireless access data, would help to refine the analysis.

Conclusion

This study located and mapped primary-care and mental-health providers within and near Renfrew County, and calculated the average travel burden to access these providers within each of Renfrew County's 19 census subdivisions. We found that care providers are largely located in urban areas, and that on average, rural residents of Renfrew County can need to travel over twenty times longer than urban residents to access care. We also mapped the availability of wired broadband internet access. We found that broadband internet is generally available in Renfrew County's eastern regions, especially urban regions along the Highway 17 corridor, and generally unavailable in rural areas in the north-west and south-west. However, there are large parts of Renfrew County with both long average travel times to health care and good access to broadband internet. This suggests that telemedicine may be an important tool to increase access to health care for Renfrew County's rural residents.

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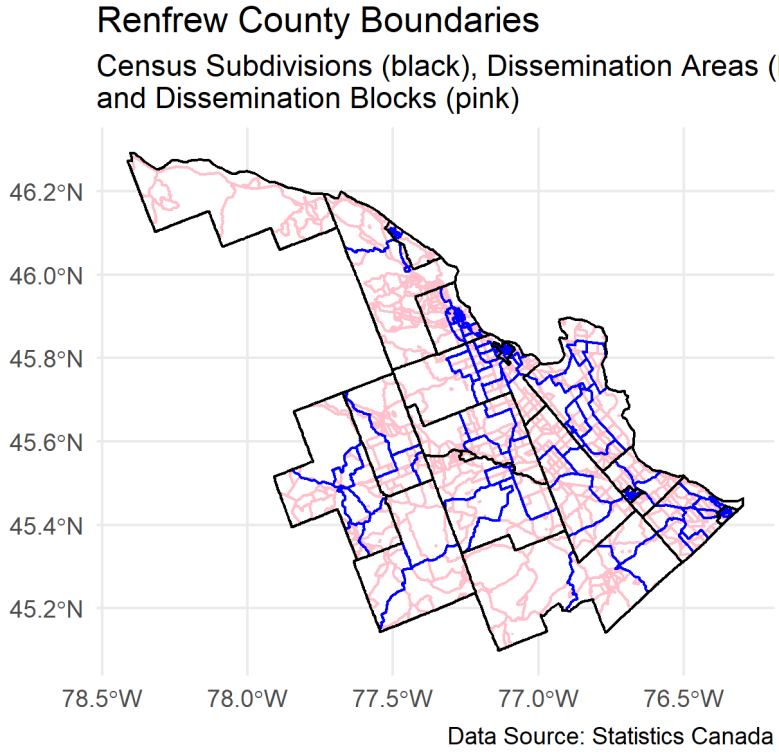
Appendices

Appendix A: Additional Details about Data Sets

StatsCan Geography: Subdivisions, Dissemination Areas, and Dissemination Blocks



National Broadband Data

Data about broadband access comes from Innovation, Science and Economic Development Canada's (ISED) National Broadband Data (NBD), accessible at this link.

The NBD divides Canada into hexagons and reports data about internet access within those hexagons. These hexes do not map neatly onto census tracts, so comparing internet access and census-based data would take careful analysis.

The NBD also includes more granular data about hex populations and access to higher internet speeds, but 5/1 Mbps is the lowest speed reported and is a good benchmark for access to internet speeds that can support videoconferencing/telemedicine.

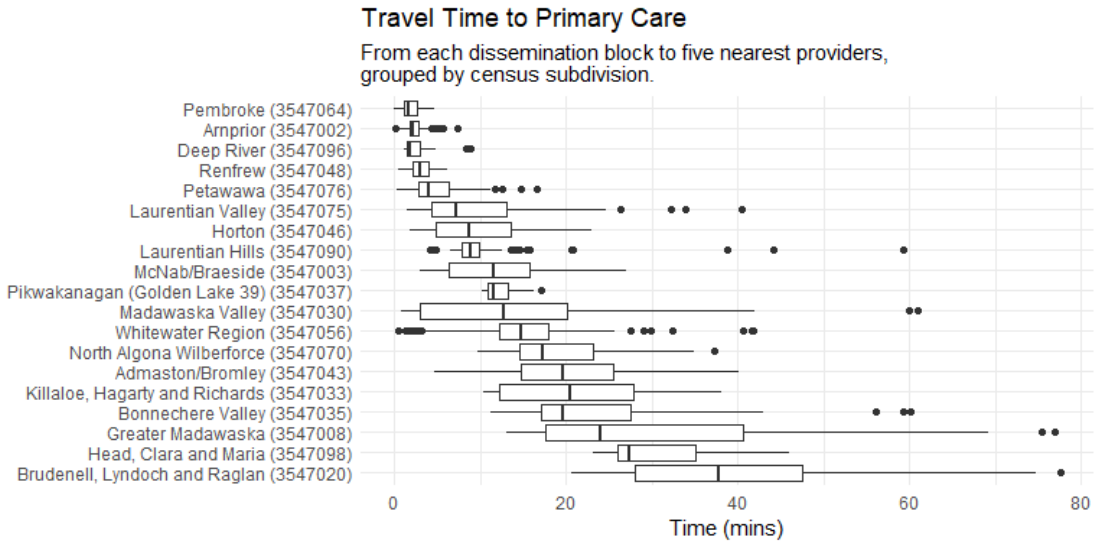
The NBD also provides more detailed broadband access metrics at the level of "pseudo-households," which are artificial constructs representing "typical" households and that map more neatly onto StatsCan census geometries. Although a more thorough analysis is out of scope for the present project, broadband access data at the pseudo-household level could be helpful for future analyses of virtual care access in Renfrew County.

Appendix B: Visualizing Detailed Access Metrics

This section provides visualizations of fine-grained travel times to access primary care and mental health care in Renfrew County. Each box plot shows DB-level travel times grouped by their CSD, to show the range of values within and between CSDs. Note that some outliers represent large DBs with fewer residents, so these travel times may not be representative.

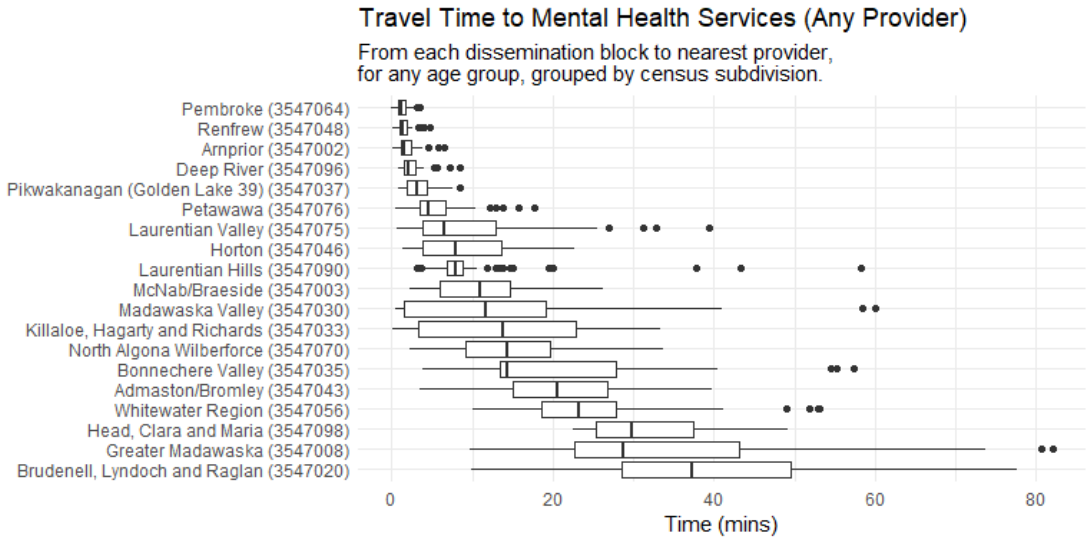
Primary Care

This set of boxplots shows the distribution of average travel times to the **five nearest FPs** for populated DBs grouped by their CSD.



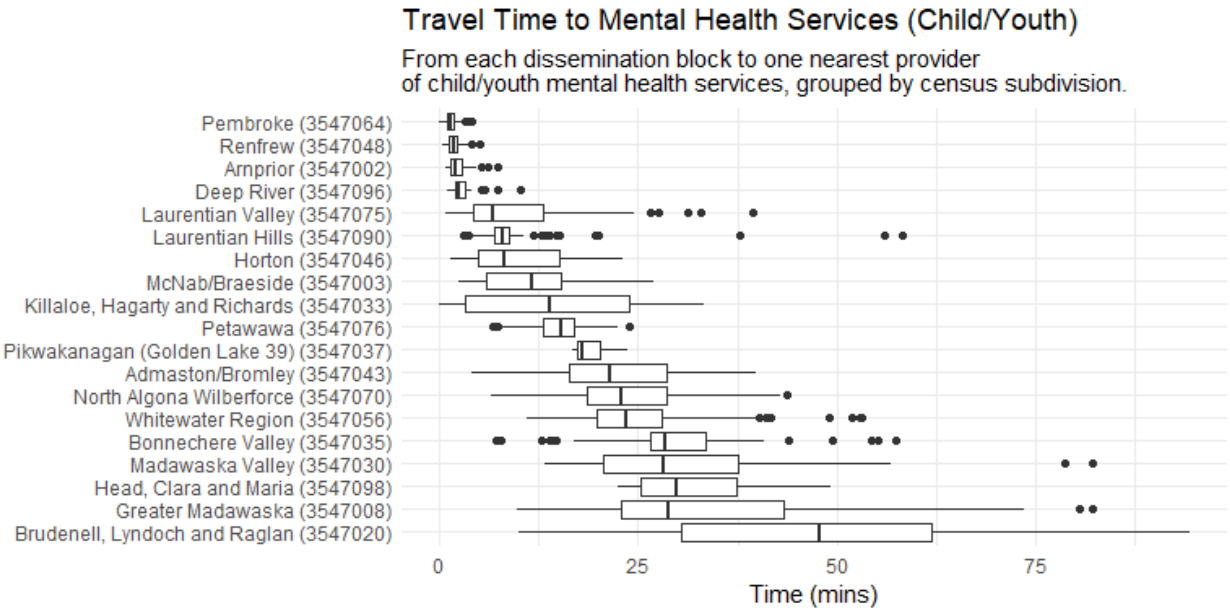
Mental Health: Any Provider

This set of boxplots shows the distribution of travel times for the general population to the **one nearest mental health provider** for populated DBs grouped by their CSD.



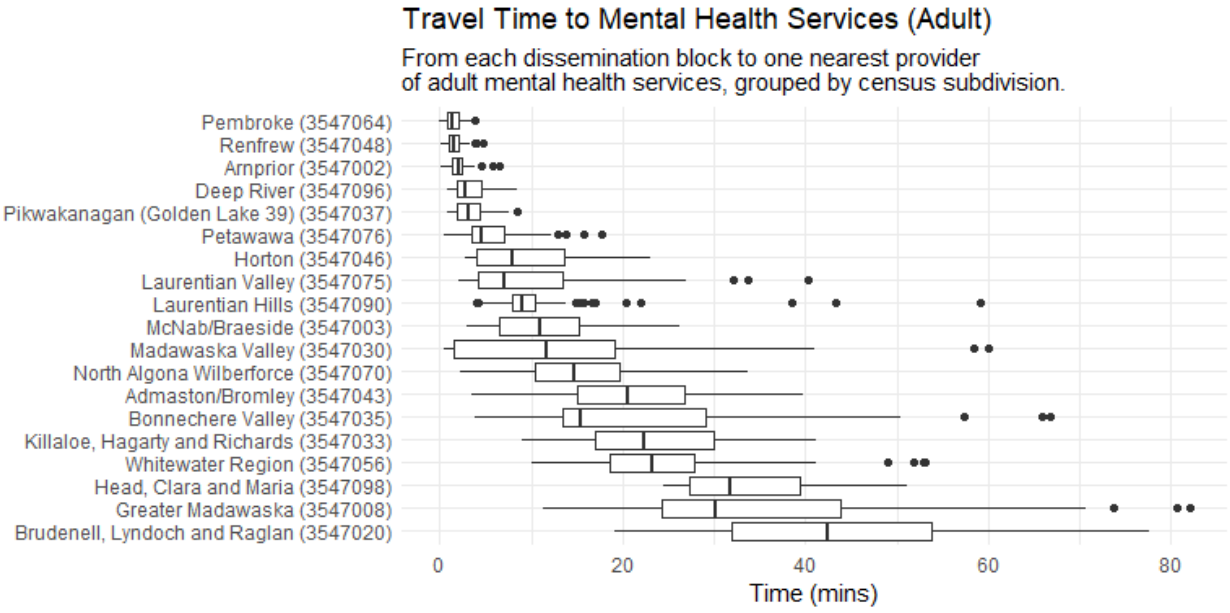
Mental Health: Child/Youth Services

This set of boxplots shows the distribution of travel times for the estimated child and youth population (ages 0-19) to the **one nearest child/youth mental health provider** for populated DBs grouped by their CSD.



Mental Health: Adult Services

This set of boxplots shows the distribution of travel times for the estimated adult population (ages 20+) to the **one nearest adult mental health provider** for populated DBs grouped by their CSD.



Appendix C: Data Tables

These data tables show the census sub-division (CSD)-level population-weighted average travel times to care providers. The analysis was run at the dissemination block (DB) level, the smallest level possible, and then population-weighted up to the CSD level. Primary-care travel times are to the five nearest providers, and mental-health travel times are to the one nearest in-scope (i.e. adult or child/youth) provider.

Primary Care

Table 1:Average Travel Times to Primary Care

CSDUID	Census Subdivision	Time (mins)
3547020	Brudenell, Lyndoch and Raglan	48.59
3547098	Head, Clara and Maria	39.39
3547008	Greater Madawaska	33.42
3547035	Bonnechere Valley	25.30
3547033	Killaloe, Hagarty and Richards	20.83
3547070	North Algona Wilberforce	20.55
3547043	Admaston/Bromley	18.69
3547056	Whitewater Region	15.13
3547030	Madawaska Valley	13.96
3547037	Pikwakanagan (Golden Lake 39)	13.02
3547090	Laurentian Hills	12.30
3547003	McNab/Braeside	11.85
3547046	Horton	10.59
3547075	Laurentian Valley	9.28
3547076	Petawawa	4.52
3547048	Renfrew	3.22
3547096	Deep River	2.80
3547002	Arnprior	2.61
3547064	Pembroke	2.16

CSDUID	Census Subdivision	Time (mins)

Population-weighted average travel times to the five nearest primary care practitioners for all census subdivisions in Renfrew County.

Mental Health: Any Provider

Table 2:Average Travel Times to Mental Health Care (Any Provider)

CSDUID	Census Subdivision	Time (mins)
3547020	Brudenell, Lyndoch and Raglan	46.61
3547098	Head, Clara and Maria	39.28
3547008	Greater Madawaska	37.20
3547056	Whitewater Region	25.82
3547035	Bonnechere Valley	22.43
3547043	Admaston/Bromley	19.19
3547070	North Algona Wilberforce	17.28
3547033	Killaloe, Hagarty and Richards	14.06
3547030	Madawaska Valley	12.66
3547090	Laurentian Hills	11.30
3547003	McNab/Braeside	11.03
3547046	Horton	10.03
3547075	Laurentian Valley	8.57
3547076	Petawawa	4.92
3547037	Pikwakanagan (Golden Lake 39)	3.98
3547096	Deep River	2.84
3547002	Arnprior	1.98
3547048	Renfrew	1.65
3547064	Pembroke	1.52

Population-weighted average travel times to the five nearest mental health care providers (including both adult and child/youth providers) for all census subdivisions in Renfrew County.

Mental Health: Child/Youth

Table 3:Average Travel Times to Mental Health Care (Child/Youth Services)

CSDUID	Census Subdivision	Time (mins)
3547020	Brudenell, Lyndoch and Raglan	56.18
3547098	Head, Clara and Maria	39.28
3547008	Greater Madawaska	36.20
3547035	Bonnechere Valley	32.28
3547030	Madawaska Valley	29.88
3547056	Whitewater Region	26.89
3547070	North Algona Wilberforce	24.56
3547043	Admaston/Bromley	20.81
3547037	Pikwakanagan (Golden Lake 39)	19.65
3547076	Petawawa	15.60
3547033	Killaloe, Hagarty and Richards	13.74
3547046	Horton	11.29
3547090	Laurentian Hills	11.18
3547003	McNab/Braeside	11.16
3547075	Laurentian Valley	8.78
3547096	Deep River	3.09
3547002	Arnprior	2.38
3547048	Renfrew	1.91
3547064	Pembroke	1.71

Population-weighted average travel times to the five nearest child/youth mental health care providers for all census subdivisions in Renfrew County.

Mental Health: Adult

Table 4:Average Travel Times to Mental Health Care (Adult Services)

CSDUID	Census Subdivision	Time (mins)
3547020	Brudenell, Lyndoch and Raglan	50.31
3547098	Head, Clara and Maria	41.25
3547008	Greater Madawaska	38.53
3547056	Whitewater Region	25.75
3547033	Killaloe, Hagarty and Richards	23.53
3547035	Bonnechere Valley	23.50
3547043	Admaston/Bromley	19.04
3547070	North Algona Wilberforce	17.74
3547030	Madawaska Valley	12.73
3547090	Laurentian Hills	12.67
3547003	McNab/Braeside	11.45
3547046	Horton	10.20
3547075	Laurentian Valley	9.07
3547076	Petawawa	4.99
3547037	Pikwakanagan (Golden Lake 39)	3.98
3547096	Deep River	3.87
3547002	Arnprior	2.06
3547048	Renfrew	1.85
3547064	Pembroke	1.75

Population-weighted average travel times to the five nearest adult mental health care providers for all census subdivisions in Renfrew County.

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