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Journal of Transport & Health 22 (2021) 101112

Contents lists available at ScienceDirect

Journal of Transport & Health

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

The uneven impacts of avoiding public transit on riders' access to healthcare during COVID-19

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ARTICLE INFO

Keywords:
Public transit
Accessibility
Health access
COVID-19
Transportation equity
Transportation to healthcare

ABSTRACT

Background: During the COVID-19 pandemic, many urban residents stopped riding public transit despite their reliance on it to reach essential services like healthcare. Few studies have examined the implications of public transit reliance on riders' ability to reach healthcare when transit is disrupted. To understand how shocks to transportation systems impact healthcare access, this study measures the impact of avoiding public transit on the ability of riders to access healthcare and pharmacy services during lockdowns.

Methods: We deployed a cross-sectional survey of residents of Toronto and Vancouver in May 2020 through Facebook advertisements and community list-serves. Eligibility criteria included riding transit at least weekly prior to the pandemic and subsequent cessation of transit use during the pandemic. We applied multivariable modified Poisson models to identify socio-demographic, transportation, health-related, and neighborhood predictors of experiencing increased difficulty accessing healthcare and getting prescriptions while avoiding public transit. We also predicted which respondents reported deferring medical care until they felt comfortable riding transit again.

Results: A total of 4367 former transit riders were included (64.2% female, 56.1% Toronto residents). Several factors were associated with deferring medical care including: being non-White (Toronto, APR, 1.14; 95% CI, 1.00-1.29; Vancouver, APR, 1.52; 95% CI, 1.26-1.84), having a physical disability (Toronto, APR, 1.20; 95% CI, 1.00-1.45; Vancouver, APR, 1.42; 95% CI, 1.08-1.87), having no vehicle access (Toronto, APR, 1.74; 95% CI, 1.51-2.00; Vancouver, APR, 2.74; 95% CI, 2.20-3.42), and having low income (Toronto, APR, 1.77; 95% CI, 1.44-2.17; Vancouver, APR, 1.51; 95% CI, 1.06-2.14).

Discussion: During COVID-19 in two major Canadian cities, former transit riders from marginalized groups were more likely to defer medical care than other former riders. COVID-19 related transit disruptions may have imposed a disproportionate burden on the health access of marginalized individuals. Policymakers should consider prioritizing healthcare access for vulnerable residents during crises.

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https://doi.org/10.1016/j.jth.2021.101112
Received 12 March 2021; Received in revised form 1 June 2021; Accepted 7 June 2021
Available online 12 June 2021

1. Introduction

Access to health services is a core social determinant of health (Kolak et al., 2020; NEJM Catalyst, 2017). A key precondition to accessing health services is the availability of transportation to doctors' offices, hospitals, laboratory testing facilities, and other locations where individuals can receive care. In many urbanized areas, public transportation provides a critical means of accessing health services, particularly among populations where individual car travel is either impossible (e.g. severe visual impairments, uncontrolled epilepsy, diabetes without hypoglycemic awareness) or economically prohibitive (e.g. lower socioeconomic status) (Boisjoly et al., 2020; Wallace et al., 2005). These characteristics are generally predictive of an individual experiencing lower participation in society due to a lack of transportation, a challenge known as transport related social exclusion (Lucas, 2012). In Canada, public transit is a significant contributor to marginalized urban residents' access to hospitals (Boisjoly et al., 2020). However, the COVID-19 pandemic severely curtailed the availability and perceived safety of many public transportation systems.

Public health responses to COVID-19 severely restricted mobility and changed individuals' approaches to permitted travel. Recommendations for preventing COVID-19 transmission were to maintain a distance 6 ft away from others, and to avoid congregating in confined spaces (CDC, 2020; Government of Canada, 2020). Transportation agencies across North America struggled to maintain these distances on buses and subways (Moore, 2020). Due to issues with crowding, closed spaces, and limitations on cleaning, public transit was perceived as risky. Throughout the pandemic, transit ridership collapsed across North America, although declines were smaller in communities of color and places with more essential workers (Liu et al., 2020; Palm et al., 2021).

Such changes in public transportation accessibility and perceived safety may have had important impacts on individuals' access and use of health care (Syed et al., 2013). In 2017, 5.8 million individuals living in the United States delayed accessing healthcare due to transportation barriers (e.g., cost, inability to connect to existing routes; issues with reliability, frequency and other service limitations, etc.) (Wolfe et al., 2020). Transportation barriers have been associated with negative effects on mood and mental health (Ruggiano et al., 2017), forgone healthcare (Ruggiano et al., 2017), and use of acute care rather than ambulatory clinic appointments (Coster et al., 2017; Kangovi et al., 2013). Barriers to accessing transportation are also frequently cited as a reason for missed healthcare appointments (Sarnquist et al., 2011; Silver et al., 2012; Yang et al., 2006). In turn, missed appointments have been associated with worse quality of clinical care and more intensive healthcare utilization (Hwang et al., 2015; Nguyen and DeJesus, 2010).

Several studies have investigated disparities in COVID-19 related outcomes along racial and economic lines (Muñoz-Price et al., 2020; Whittle and Diaz-Artiles, 2020; Yehia et al., 2020). Some researchers have suggested that disproportionate use of public transit for commuting among communities of color constituted an 'occupational hazard' that may have contributed to racial disparities in COVID-19 deaths (Tai et al., 2021). Health geographers have responded by measuring travel time access to hospital beds, ICU beds and ventilators along sociodemographic lines (Kang et al., 2020).

While prior literature exists characterizing populations who rely on public transit and those who face transportation barriers, COVID-19-related transportation barriers to healthcare provided a unique opportunity to understand the ability of these populations to adapt to disruptions in transit use. Theories of transport related social exclusion would suggest that socially marginalized travelers with limited transportation resources would be most at risk (Lucas, 2012), yet predictors of who faces barriers to transportation in these contexts are unexamined. This paper also fills a broader, identified gap in understanding the role of public transportation in health care access (Syed et al., 2013). Specifically, we examine the effects of urban residents' choice to forgo riding public transit during COVID-19 on their perceived ability to access healthcare and prescriptions, and predictors of barriers to health care access in this context. To do this, we performed a cross-sectional survey of users of public transportation in Toronto and Vancouver, Canada, assessing the association between sociodemographic, health status and healthcare utilization, neighborhood, and transportation predictors with individual choices to defer health care, and self-reported difficulty accessing healthcare and prescriptions. These results may help policy makers gauge the severity of transportation-related barriers on healthcare access during the current pandemic, and offers healthcare providers in urban areas insights into which of their patient populations may be experiencing heightened barriers in accessing care.

2. Methods

2.1. Study sample

Data for this study come from a cross-sectional, web-based survey (the Public Transit and COVID-19 Survey) designed by the investigators to identify the characteristics of individuals who stopped riding public transportation in response to the COVID-19 pandemic, as well as the reasons for, and impacts of, these choices. Recruitment for the survey ran through organizational list serves and Facebook ads in Toronto from May 4 to May 13, 45 days into the closure of non-essential business in that city according to the Canadian Institute for Health Information (CIHI, 2020). At this time, Toronto was reporting between 125 and 190 new cases of COVID-19 each day (City of Toronto, 2020). The survey ran in Vancouver through the same channels from May 19 to May 29, 63 days into the closure of non-essential businesses there (CIHI, 2020), when new COVID-19 cases reported in British Columbia ranged between 4 and 22 per day (Province of British Columbia, 2020a). Ontario was still in Stage 1 of its first-wave re-opening plan during the course of the survey, with non-essential healthcare facilities closed (CIHI, 2020). The survey ran in Vancouver during Stage 2 of B.C.'s re-opening after its first wave, when non-emergency medical facilities were allowed to reopen (CIHI, 2020).

The Qualtrics-hosted survey included 49 items on 7 screens and was advertised on Facebook where respondents could click a link in the ad to arrive at the survey landing page. Residents completing the survey were eligible to win one of 20 $50 gift cards in Vancouver

and one of 30 $50 gift cards in Toronto. Respondents could change their answers, but the survey did not contain a final review option. We deployed Qualitrics' "Prevent Ballot Stuffing" option that uses cookies to prevent duplicate entries. A captcha was also required to prevent bot entries. Adaptive questioning and randomization were not deployed. Only two questions were forced: respondents' postal code and whether the respondent stopped riding transit during the COVID-19 pandemic. This voluntary, open survey was developed through a review of existing travel barrier surveys and pre-tested by six members of local community organizations for readability and functionality prior to distribution.

Inclusion criteria for the study included (i) age 18 years or older and (ii) use of public transportation more than once per week prior to the COVID-19 pandemic; the present study further (iii) restricts to individuals who indicated that they stopped riding public transportation completely since the COVID-19 pandemic began. Advertisements, included as Appendix Fig. 1 and Appendix Fig. 2, were viewed by 484,352 Facebook users in Toronto and 242,816 in Vancouver. A total of 5223 individuals consented to participate in Toronto (0.011% view rate), along with 3711 from Vancouver (0.015% view rate). Of these, 3680 surveys were completed in Toronto (70%) and 3186 were completed in Vancouver (86%). 2449 (36%) of these respondents were still actively using public transit during the pandemic, leaving a final sample of 4367 transit riders that had paused their transit use. For simplicity, we refer to these respondents as "former transit riders" to reflect their transportation status at the time of the survey. All participants provided their informed consent to participate (see informed consent in appendix). Data were held in a bitlocker encrypted university computer under password protected folder. This study was approved by the University of Toronto Research Ethics Board (#00039306).

2.2. Implications of recruitment method

Social media is a valuable recruitment method for surveys with very specific sampling frames or populations that are hard to reach (Carter-Harris et al., 2016; Guillory et al., 2018), but it introduces bias (Boas et al., 2020). Facebook allows advertisements to be targeted in multiple ways. We balanced our ad spending evenly between two of these approaches: *traffic optimization*, in which Facebook shows the ad to users that algorithms predict are most likely to click on the link, and *impressions*, which maximizes the number of unique users that see the ad regardless of their probability of clicking on it. This allowed our ads to reach over 700,000 unique Facebook users across these two cities. Facebook yielded 91% of our sample. Recruitment through the list-servs of nonprofits working with transit dependent populations yielded only 9% of responses. The sample is thus likely to underrepresent the impacts of riders' forgoing transit as it will under-represent digitally disconnected riders.

In a concurrent publication, we detail how our sub-sample of Toronto residents who rode transit regularly before COVID-19 compares with a portrait of the same population in Toronto as measured by a representative household travel survey (*withheld for peer review)*. Our online survey sample from Toronto, which includes continued riders and those who stopped riding during COVID-19, significantly over-represents women (66% vs 55%), and low-income riders (30% versus 20%), relative to the household travel survey (*withheld for peer review)*. In addition, the sample slightly over-represents 30–40 year olds (27%–21%) and apartment dwellers (58% versus 38%). These differences may be explained, in part, by differences in sampling frame: a one-day household travel survey versus our exclusion criteria of more than weekly transit use. Regardless, we find that our sample replicates a binary logistic model predicting vehicle ownership that was specified using the representative household travel survey (*withheld for peer review)*. Specifically, our data can replicate the signs (i.e. positive, negative) between built form and demographic predictors and vehicle ownership as defined by the representative data, while maintaining statistical significance. We note however that coefficient magnitudes are smaller. Successful duplication of known relationships is an emerging approach to establishing the utility of online convenience samples (Boas et al., 2020). Vehicle ownership was specifically chosen for validation as it has traditionally served as a primary measure for defining whether an individual is transit dependent (Brown, 2017). The authors attempted to repeat this process in Vancouver but were not permitted access to comparable travel survey data. Given the limitations of the recruitment strategy, this study emphasizes differences between groups within the sample, and makes no claims as to the true extent of healthcare access difficulties among this population.

2.3. Measures

2.3.1. Outcomes

The primary outcome was deferral or rescheduling of medical trips until transit use became safe again, defined as participants responding "agree" or "strongly agree" vs. "neither agree nor disagree," "disagree," and "strongly disagree" to the statement "There are some medical trips I must put off or reschedule until I can take public transit again." Our secondary outcomes included self-reported difficulty in reaching healthcare or getting prescriptions due to the respondent forgoing use of public transit. The first was defined as a participant responding "much harder" or "somewhat harder" versus "a little bit harder" or "not harder at all" in response to the question "Has giving up public transit made it harder to do any of the following—access healthcare." The second secondary outcome was defined as a participant responding "much harder" or "somewhat harder" versus "a little bit harder" or "not harder at all" in response to the question "Has giving up public transit made it harder to do any of the following—get prescriptions." For all outcome measures, respondents were given the option to select "not applicable" if they were no longer making these trips.

2.4. Predictors

Predictors fell into four categories: socio-demographic factors, neighborhood characteristics, health status and healthcare utilization, and transportation resources. Socio-demographic variables included gender (male vs. female), age (categorical), race or ethnicity (White, non-White and multiracial), after-tax household income (continuous, Canadian dollars), and immigration history

(long-term resident vs. immigrated within the last 5 years). Neighborhood characteristics include respondents' agreement with the statement "my neighborhood is walkable" (agree/strongly agree, neither agree nor disagree, disagree/strongly disagree), agreement with the statement "it is hard to physically distance in my neighborhood" (agree/strongly agree, neither agree nor disagree, disagree/strongly disagree), and distance to nearest pharmacy from the centroid of respondents' six-digit postal code (continuous, meters). Provincial databases of pharmacies were used and Euclidean distances to residents' postal code centroids were calculated in R (version 3.6.3) (Province of British Columbia, 2020b; Province of Ontario, 2020). Health status and healthcare utilization variables included a question on self-reported health status, number of visits to the ER in the past year (continuous, count), whether the respondent felt that they were at risk for severe COVID-19, self-reported physical disability (present vs. absent), as well as use of telehealth prior to COVID-19 (never vs. less than 1 time per month or greater). We measured transportation resources as a categorical variable on vehicle status with three categories: whether the respondent or the respondent's household possessed a vehicle, whether the respondent had access to a vehicle through car share or out-of-home social contacts, or neither of these.

Table 1
Characteristics of respondents who stopped riding transit during COVID-19.

	Overall n=4367	Toronto n=2499	Vancouver n=1868
Sociodemographic characteristics - n (%)			
Sex			
Male	1120 (25.6)	623 (24.9)	497 (26.6)
Female	2803 (64.2)	1506 (60.3)	1297 (69.4)
Age			
18-29	1580 (36.2)	878 (35.1)	702 (37.6)
30-49	1906 (43.6)	1123 (44.9)	783 (41.9)
50-64	600 (13.7)	346 (13.8)	254 (13.6)
65+	250 (5.7)	134 (5.4)	116 (6.2)
Recent Immigrant			
Born here or moved > 5 years ago	3863 (88.5)	2216 (88.7)	1647 (88.2)
Recent immigrant (Moved ≤ 5 years ago)	467 (10.7)	260 (10.4)	207 (11.1)
Race/Ethnicity			
White	2596 (59.4)	1448 (57.9)	1148 (61.5)
Non-White	1355 (31.0)	838 (33.5)	517 (27.7)
Multiethnic	350 (8.0)	166 (6.6)	184 (9.9)
Canadian Indigenous	153 (3.5)	63 (2.5)	90 (4.8)
Pre-tax household income (2019)			
Very High (>$125,000)	750 (17.2)	479 (19.2)	271 (14.5)
High ($80,000-$124,999)	1072 (24.5)	606 (24.2)	466 (24.9)
Middle ($40,000-$79,999)	1289 (29.5)	727 (29.1)	562 (30.1)
Low (<$40,000)	1134 (26.0)	622 (24.9)	512 (27.4)
Health status and risk perception - n (%)			
"I am at risk for severe illness from COVID"			
Disagree/Strongly Disagree	1975 (45.3)	1101 (44.1)	874 (46.8)
Neither Agree or Disagree	851 (19.5)	491 (19.6)	360 (19.3)
Agree/Strongly Agree	1475 (33.8)	867 (34.7)	608 (32.6)
Self-rated health			
Excellent	548 (12.5)	333 (13.3)	215 (11.5)
Very Good	1392 (31.9)	791 (31.7)	601 (32.2)
Good	1704 (39.0)	977 (39.1)	727 (38.9)
Fair	631 (14.4)	350 (14.0)	281 (15.0)
Poor	69 (1.6)	33 (1.3)	36 (1.9)
Number of ER visits in the last year – mean (SD)	0.29 (0.69)	0.29 (0.67)	0.30 (0.71)
Self-reported physical disability	281 (6.5)	159 (6.4)	122 (6.6)
Accessibility and built environment- n (%)			
Car access/ownership			
Owns	2003 (45.9)	1093 (43.7)	910 (48.7)
Access	1027 (23.5)	505 (20.2)	522 (27.9)
Neither	1317 (30.2)	888 (35.5)	429 (23.0)
"My neighborhood is walkable"			
Agree/Strongly Agree	3778 (86.5)	2118 (84.8)	1660 (88.9)
Neither Agree Nor Disagree	238 (5.4)	154 (6.2)	84 (4.5)
Disagree/Strongly Disagree	291 (6.7)	187 (7.5)	104 (5.6)
"It is hard to physical distance in my neighborhood"			
Agree/Strongly Agree	1760 (40.3)	1106 (44.3)	654 (35.0)
Neither Agree Nor Disagree	603 (13.8)	360 (14.4)	243 (13.0)
Disagree/Strongly Disagree	1948 (44.6)	992 (39.7)	956 (51.2)
Distance to nearest pharmacy in meters - mean (SD)	353.43 (356.55)	288.68 (325.81)	439.23 (376.93)
Telehealth use before COVID-19			
Never	3577 (81.9)	1961 (78.5)	1616 (86.5)
Less than 1 time per month	638 (14.6)	458 (18.3)	180 (9.6)
1–2 times a month	79 (1.8)	38 (1.5)	41 (2.2)
3 or more times per month	41 (0.9)	20 (0.8)	21 (1.1)

2.5. Statistics

All analyses were performed using R (version 3.6.3). Descriptive statistics were used to characterize the sample as a whole and stratified by site. Unadjusted associations between covariates and each outcome were estimated using Poisson regression with robust variance estimators (quasi-Poisson) (Barros and Hirakata, 2003; Chen et al., 2018) Given that several variables had missing data (see Appendix Table 1; range: 0.5% (self-rated health) to 10.2% (sex), multiple imputation using chained equations (via the 'mice' package) was used to handle missingness in independent variables. Imputation was conducted for Toronto and Vancouver datasets separately, as our analyses were stratified by study site. For each city, three separate multivariable modified Poisson models were fit to estimate the adjusted association (adjusted prevalence ratio, APR) and 95% confidence interval (CI) between independent variables and each of the outcomes. Modified Poisson models were used in place of logistic regression as the frequency of our outcomes was greater than 10%, indicating that odds ratios would not approximate prevalence ratios (McNutt, 2003; Zou, 2004). Poisson models with robust estimation of standard errors have been used previously to approximate prevalence ratios (McNutt, 2003; Zou, 2004). This paper reports on the multivariable results, while bivariate associations are available in the appendix.

Table 2
Predictors of former transit riders deferring healthcare (self-reported).

	Toronto	Vancouver
	Prevalence Ratio (95% CI)	Prevalence Ratio (95% CI)
Sociodemographic characteristics		
Male sex	0.84 (0.74, 0.97)*	0.68 (0.54, 0.86)***
Age		
18-29	Reference	Reference
30-49	1.01 (0.89, 1.14)	0.87 (0.72, 1.07)
50-64	1.03 (0.86, 1.24)	0.70 (0.52, 0.96)*
65+	1.19 (0.94, 1.51)	0.93 (0.67, 1.29)
Recent immigrant	1.10 (0.92, 1.31)	0.80 (0.60, 1.07)
Race/Ethnicity		
White	Reference	Reference
Non-White	1.14 (1.00, 1.29)*	1.52 (1.26, 1.84)***
Multiethnic	1.08 (0.87, 1.36)	1.12 (0.82, 1.51)
Canadian Indigenous	1.05 (0.76, 1.43)	0.91 (0.64, 1.31)
Pre-tax household income (2019)		
Very High (>$125,000)	Reference	Reference
High ($80,000-$124,999)	1.52 (1.24, 1.86) ***	1.21 (0.85, 1.72)
Middle ($40,000-$79,999)	1.68 (1.38, 2.05) ***	1.43 (1.02, 2.01)*
Low (<$40,000)	1.77 (1.44, 2.17) ***	1.51 (1.06, 2.14)*
Health status and risk perceptions		
"I am at risk for severe illness from COVID"		
Disagree/Strongly Disagree	Reference	Reference
Neither Agree or Disagree	1.17 (1.01, 1.36)*	0.85 (0.66, 1.1)
Agree/Strongly Agree	1.24 (1.09, 1.42)**	1.24 (1.00, 1.52)*
Self-rated health		
Excellent	Reference	Reference
Very Good	1.02 (0.83, 1.24)	1.15 (0.79, 1.67)
Good	1.16 (0.95, 1.40)	1.43 (0.99, 2.05)
Fair	1.33 (1.07, 1.66)*	1.71 (1.16, 2.52)*
Poor	1.17 (0.76, 1.81)	2.02 (1.16, 3.54)*
Number of ER visits in the last year	1.00 (0.93, 1.08)	0.93 (0.84, 1.04)
Physical disability	1.20 (1.00, 1.45)	1.42 (1.08, 1.87)*
Accessibility and built form		
Car access/ownership		
Owns	Reference	Reference
Access but does not own	1.61 (1.37, 1.88)***	1.92 (1.53, 2.39)***
Neither	1.74 (1.51, 2.00)***	2.74 (2.20, 3.42)***
"My neighborhood is walkable"		
Agree/Strongly Agree	Reference	Reference
Neither Agree Nor Disagree	1.06 (0.86, 1.31)	1.15 (0.84, 1.58)
Disagree/Strongly Disagree	1.30 (1.07, 1.57)**	0.97 (0.69, 1.38)
"It is hard to physical distance in my neighborhood"		
Agree/Strongly Agree	Reference	Reference
Neither Agree Nor Disagree	1.06 (0.91, 1.24)	0.99 (0.77, 1.27)
Disagree/Strongly Disagree	0.87 (0.77, 0.99)*	0.78 (0.64, 0.94)*
Distance to nearest pharmacy (km)	0.96 (0.79, 1.18)	1.08 (0.85, 1.37)
Monthly use of telehealth before COVID-19 > 0–1 times	0.96 (0.84, 1.10)	1.14 (0.91, 1.41)

***p < .0001, **p < .01, *p < .05.

3. Results

3.1. Characteristics of former riders

The demographic characteristics of respondents who had stopped riding transit during COVID-19 are described in Table 1. Most respondents identified as White (59.4% [2596 out of 4367]) and 64% [2803 out of 4367] were female. A minority of respondents owned a car (45.9% [2003 out of 4367]) while 23.5% [1027 out of 4367] had indirect access to a car and 30.2% [1317 out of 4367] neither owned nor had any access to a car. Demographic characteristics of samples in both cities were similar, though respondents in Toronto were more likely to agree or strongly agree that it was hard to maintain physical distancing in their neighborhood (44.3% [1106 out of 2499]) compared to Vancouver (35.0% [654 out of 1868]). Distributions of the outcomes varied significantly between the two cities. More respondents in Toronto agreed that they were putting off medical trips until they could use transit again (39%; 95% CI, 37%–41%) compared to those in Vancouver (14%; 95% CI, 13%–16%). Similarly, more Toronto respondents found it somewhat or much harder to access healthcare without public transit (40%; 95% CI, 38%–43%) compared to Vancouver respondents (33%; 95% CI, 30%–35%). The percentage of respondents who reported that giving up public transit made it harder to get prescriptions is statistically indistinguishable between the two cities, at 21% in Toronto (95% CI, 19–23%) and 19% in Vancouver (95% CI, 17%–21%).

Table 3
Predictors of former transit riders reporting difficulty accessing healthcare.

	Toronto	Vancouver
	Prevalence Ratio (95% CI)	Prevalence Ratio (95% CI)
Sociodemographic characteristics		
Male sex	0.87 (0.75, 1.01)	0.66 (0.54, 0.81)***
Age		
18-29	Reference	Reference
30-49	0.99 (0.87, 1.14)	0.89 (0.74, 1.07)
50-64	1.02 (0.84, 1.24)	0.88 (0.67, 1.14)
65+	1.25 (0.97, 1.61)	1.06 (0.78, 1.43)
Recent immigrant	1.00 (0.82, 1.22)	0.89 (0.69, 1.16)
Race/Ethnicity		
White	Reference	Reference
Non-White	1.11 (0.97, 1.27)	1.22 (1.03, 1.45)*
Multiethnic	1.24 (1.00, 1.55)	1.03 (0.79, 1.35)
Canadian Indigenous	0.88 (0.64, 1.22)	0.89 (0.64, 1.24)
Pre-tax household income (2019)		
Very High (>$125,000)	Reference	Reference
High ($80,000-$124,999)	1.1 (0.91, 1.34)	1.22 (0.90, 1.64)
Middle ($40,000-$79,999)	1.21 (1.00, 1.46)	1.07 (0.80, 1.45)
Low (<$40,000)	1.29 (1.05, 1.58)*	1.34 (0.99, 1.82)
Health status and risk perception		
"I am at risk for severe illness from COVID"		
Disagree/Strongly Disagree	Reference	Reference
Neither Agree or Disagree	1.15 (0.98, 1.35)	1.05 (0.84, 1.31)
Agree/Strongly Agree	1.26 (1.10, 1.45)***	1.39 (1.16, 1.68)***
Self-rated health		
Excellent	Reference	Reference
Very Good	1.03 (0.84, 1.27)	1.09 (0.78, 1.51)
Good	1.06 (0.87, 1.29)	1.29 (0.94, 1.78)
Fair	1.20 (0.96, 1.51)	1.34 (0.94, 1.90)
Poor	1.19 (0.79, 1.78)	1.36 (0.83, 2.22)
Number of ER visits in the last year	1.07 (1.00, 1.15)	1.02 (0.94, 1.12)
Physical disability	1.18 (0.97, 1.44)	1.35 (1.05, 1.74)*
Accessibility and built form		
Car access/ownership		
Owns	Reference	Reference
Access but does not own	1.64 (1.39, 1.93)***	2.09 (1.72, 2.54)***
Neither	1.78 (1.54, 2.06)***	2.34 (1.91, 2.86)***
"My neighborhood is walkable"		
Agree/Strongly Agree	Reference	Reference
Neither Agree Nor Disagree	1.26 (1.03, 1.55)*	1.18 (0.88, 1.60)
Disagree/Strongly Disagree	1.2 (0.98, 1.47)	1.26 (0.95, 1.67)
"It is hard to physical distance in my neighborhood"		
Agree/Strongly Agree	Reference	Reference
Neither Agree Nor Disagree	0.93 (0.79, 1.09)	1.04 (0.83, 1.30)
Disagree/Strongly Disagree	0.79 (0.69, 0.90)**	0.76 (0.64, 0.90)**
Distance to nearest pharmacy (km)	1.15 (0.99, 1.33)	1.31 (1.07, 1.61)**
Monthly use of telehealth before COVID-19 > 0 times	1.17 (1.03, 1.33)*	0.98 (0.8, 1.20)

***p < .0001, **p < .01, *p < .05.

3.2. Deferring medical care

Adjusted associations between predictors and deferred medical care, stratified by site, are presented in Table 2. Demographic factors associated with a greater likelihood of deferring medical care included being non-White (Toronto, APR, 1.14; 95% CI, 1.00-1.29; Vancouver, APR, 1.52; 95% CI, 1.26-1.84), and having low income (Toronto, APR, 1.77; 95% CI, 1.44-2.17; Vancouver, APR, 1.51; 95% CI, 1.06-2.14). In contrast, men (Toronto, APR, 0.84; 95% CI, 0.74-0.97; Vancouver, APR, 0.68; 95% CI, 0.54-0.86) were less likely to report deferring medical visits, as well as those who did not find it hard to maintain physical distancing in their neighborhood (Toronto, APR, 0.87; 95% CI, 0.77-0.99; Vancouver, APR, 0.78; 95% CI, 0.64-0.94). Health status and healthcare utilization covariates associated with increased likelihood of care deferral included feeling at risk for severe illness from COVID-19 (Toronto, APR, 1.24; 95% CI, 1.09-1.4; Vancouver, APR, 1.24; 95% CI, 1.00-1.52), having a physical disability (Toronto, APR, 1.20; 95% CI, 1.00-1.45; Vancouver, APR, 1.44; 95% CI, 1.10-1.90), and reporting a fair health status (Toronto, APR, 1.33; 95% CI, 1.07-1.66; Vancouver, APR, 1.71; 95% CI, 1.16-2.52). Respondents were more likely to report deferring medical trips if they had only indirect access a vehicle (Toronto, APR, 1.61; 95% CI, 1.37-1.88; Vancouver, APR, 1.92; 95% CI, 1.53-2.39) or if they neither owned nor had access to a vehicle (Toronto, APR, 1.74; 95% CI, 1.51-2.00; Vancouver, APR, 2.74; 95% CI, 2.20-3.42), compared to those who owned their own car.

Table 4
Predictors of former transit riders reporting difficulty getting prescriptions.

	Toronto	Vancouver
	Prevalence Ratio (95% CI)	Prevalence Ratio (95% CI)
Sociodemographic characteristics		
Male sex	0.83 (0.67, 1.04)	0.65 (0.49, 0.86)**
Age		
18-29	Reference	Reference
30-49	0.84 (0.68, 1.04)	0.62 (0.48, 0.80)***
50-64	0.89 (0.65, 1.21)	0.48 (0.32, 0.73)***
65+	0.90 (0.58, 1.41)	0.81 (0.54, 1.22)
Recent immigrant	1.42 (1.07, 1.87)*	0.73 (0.5, 1.08)
Race/Ethnicity		
White	Reference	Reference
Non-White	1.29 (1.04, 1.59)*	1.48 (1.16, 1.89)**
Multiethnic	1.04 (0.70, 1.54)	0.99 (0.67, 1.47)
Canadian Indigenous	1.19 (0.74, 1.90)	1.02 (0.65, 1.61)
Pre-tax household income (2019)		
Very High (>$125,000)	Reference	Reference
High ($80,000-$124,999)	0.95 (0.69, 1.31)	1.37 (0.89, 2.12)
Middle ($40,000-$79,999)	1.11 (0.82, 1.50)	1.06 (0.66, 1.68)
Low (<$40,000)	1.23 (0.89, 1.68)	1.46 (0.93, 2.29)
Health status and risk perception		
"I am at risk for severe illness from COVID"		
Disagree/Strongly Disagree	Reference	Reference
Neither Agree or Disagree	1.05 (0.81, 1.36)	1.1 (0.79, 1.54)
Agree/Strongly Agree	1.25 (1.00, 1.55)*	1.56 (1.19, 2.04)**
Self-rated health		
Excellent	Reference	Reference
Very Good	1.09 (0.77, 1.54)	1.19 (0.74, 1.93)
Good	1.38 (0.99, 1.94)	1.29 (0.81, 2.06)
Fair	1.50 (1.03, 2.18)*	1.48 (0.90, 2.44)
Poor	1.62 (0.86, 3.05)	1.33 (0.63, 2.81)
Number of ER visits in the last year	1.10 (0.99, 1.23)	0.97 (0.86, 1.1)
Physical disability	1.31 (0.97, 1.78)	1.50 (1.06, 2.11)*
Accessibility and built environment		
Car access/ownership		
Owns	Reference	Reference
Access but does not own	1.59 (1.23, 2.05)***	1.85 (1.40, 2.44)***
Neither	1.37 (1.08, 1.74)**	2.28 (1.72, 3.02)***
"My neighborhood is walkable"		
Agree/Strongly Agree	Reference	Reference
Neither Agree Nor Disagree	1.81 (1.37, 2.40)***	1.48 (1.00, 2.19)*
Disagree/Strongly Disagree	1.60 (1.19, 2.15)**	1.37 (0.93, 2.02)
"It is hard to physical distance in my neighborhood"		
Agree/Strongly Agree	Reference	Reference
Neither Agree Nor Disagree	0.97 (0.75, 1.26)	1.20 (0.88, 1.64)
Disagree/Strongly Disagree	0.81 (0.66, 1.00)	0.85 (0.66, 1.08)
Distance to nearest pharmacy (km)	1.17 (0.94, 1.47)	1.92 (1.47, 2.49)***
Monthly use of telehealth before COVID-19 > 0 times	1.07 (0.87, 1.33)	1.25 (0.96, 1.63)

3.3. Barriers to accessing medical care

Adjusted predictors of difficulty accessing healthcare after giving up public transit are presented in Table 3. As with deferring medical care, men were less likely to report difficulty accessing healthcare (Toronto, APR, 0.87; 95% CI, 0.75-1.01; Vancouver, APR, 0.66; 95% CI, 0.54-0.81), as were those who did not have trouble with physical distancing in their neighborhood (Toronto, APR, 0.79; 95% CI, 0.69-0.90; Vancouver, APR, 0.76; 95% CI, 0.64, 0.90). In contrast, factors associated with a higher likelihood of difficulty accessing healthcare included perceiving oneself as high risk for severe illness from COVID-19 (Toronto, APR, 1.26; 95% CI, 1.10-1.45; Vancouver, APR, 1.39; 95% CI, 1.16-1.68), having access to (but not owning) a car (Toronto, APR, 1.64; 95% CI, 1.39-1.93; Vancouver, APR, 2.09; 95% CI, 1.72-2.54), and those with no car access at all (Toronto, APR, 1.78; 95% CI, 1.54-2.06; Vancouver, APR, 2.34; 95% CI, 1.91-2.86).

Similar results were observed regarding whether giving up public transit made it harder to get prescriptions, presented in Table 4. Demographic and health correlates significantly associated with reporting difficulty getting prescriptions included being non-White (Toronto, APR, 1.29; 95% CI, 1.04-1.59; Vancouver, APR, 1.48; 95% CI, 1.16-1.89), being at risk for severe reaction to COVID-19 (Toronto, APR, 1.25; 95% CI, 1.00-1.55; Vancouver, APR, 1.56; 95% CI, 1.19-2.04), having fair health (Toronto, APR, 1.50; 95% CI, 1.03-2.18; Vancouver, APR, 1.48; 95% CI, 0.90-2.44), and having a physical disability (Toronto, APR, 1.31; 95% CI, 0.97-1.78; Vancouver, APR, 1.50; 95% CI, 1.06-2.11). Significant transportation variables included having only indirect access to a car (Toronto, APR, 1.59; 95% CI, 1.23-2.05; Vancouver, APR, 1.87; 95% CI, 1.40-2.44), and having no access to a car (Toronto, APR, 1.37; 95% CI, 1.08-1.74; Vancouver, APR, 2.28; 95% CI, 1.72-3.02).

4. Discussion

In this cross-sectional survey of former transit riders, several groups were more likely to report deferring medical trips until they could use transit again. This included non-white former riders, those who did not own a vehicle, respondents with a physical disability, those in neighborhoods perceived as difficult to maintain physical distancing in, and those on low incomes. Former riders who were more likely to report that giving up transit made it difficult to access healthcare included those without a vehicle and those who found it hard to maintain physical distancing on their neighborhood streets. Respondents without a vehicle, those in neighborhoods perceived to have poor walkability, and those who found it hard to maintain physical distancing on their neighborhood streets also found it harder to get prescriptions without transit. Men were less likely than women to report difficulties across all three outcomes. To our knowledge, this is the first study to identify how healthcare accessibility has been affected by COVID-19 related changes in public transit.

The strength of associations varied between Toronto and Vancouver. Neighborhood walkability was positively correlated with primary and secondary outcomes in Toronto, but not Vancouver. Differences in built form between the two cities may explain these divergent results, as Toronto is larger and contains many more suburban neighborhoods. Across all three outcomes, having a disability, having fair health and not having access to or owning a car was associated with a larger effect size in Vancouver compared with Toronto. This may be due to Vancouver responses taking place 63 days after the closure of non-essential healthcare, versus only 45 days for Toronto (CIHI, 2020).

Transportation barriers to healthcare are known to impact marginalized, low income, and disabled individuals, as well as those with chronic illness (Wolfe et al., 2020). Although public transit can improve access to healthcare, many regular riders have avoided this mode of travel due to pandemic-related service disruptions and fears of COVID-19 exposure. Data presented here show that the groups identified by Wolfe et al. (2020) as being at greatest risk for missing healthcare appointments due to transportation are also the groups among former transit users most likely to have deferred healthcare until they could access public transit again. Vehicle ownership or access is also known to improve access to healthcare (Syed et al., 2013). In rural settings such as Appalachia, knowing someone outside the home who can provide rides is positively associated with healthcare utilization (Arcury et al., 2005), but it follows that the same should be true in urban settings. Vehicle ownership proved to be a critical enabler of healthcare access among riders avoiding transit during the COVID-19 pandemic. Interestingly, indirect vehicle access through car-shares, ride-hailing, or out-of-home contacts was not found to provide similar benefits. This difference may be due to the perceived risks of exposure to COVID-19 from using car-shares, ride-hailing or securing rides from someone out of the home, perceived risks that have contributed to the collapse of ride-sharing demand throughout the crisis (BBC, 2020).

Little research explicitly examines the role of public transit in supporting healthcare use and utilization, with most studies on the topic focusing on public transit accessibility to hospitals and healthcare (Boisjoly et al., 2020; Syed et al., 2013). The data in this study suggest that public transit is an important component of healthcare access for specific segments of the transit-riding population. These segments include those without vehicles, people with disabilities, and those on low incomes. While there are patchworks of programs in Canada that either support transportation access to health care directly through rides or indirectly through funding, these findings suggest that many individuals still rely on public transit for these purposes. Our results also lend evidence to the importance of practitioners screening patients for transportation needs, a still uncommon practice (Fraze et al., 2019). Transit agencies cutting services during crises like COVID-19 should seek to avoid cuts to services that connect neighborhoods to medical care. Finally, this survey demonstrates the benefits of long-term investments in neighborhoods that provide walkable distances to essential services.

4.1. Limitations

Our results should be interpreted considering several limitations. The data presented here are cross-sectional in nature, precluding

a causal interpretation. The data also measure self-reported changes to healthcare utilization and perceived difficulty in accessing healthcare and prescriptions, rather than objective records of health care use (e.g. appointment attendance) as is used in prior studies. Our recruitment methods provide a large convenience sample that cannot be used to estimate the extent of these problems in the general population. This was necessary due to the need to rapidly gather data without endangering researcher or subject health.

5. Conclusions

In a cross-sectional survey administered in two Canadian cities, we find that many individuals forgoing transit to avoid potential exposure to COVID-19 had difficulty accessing healthcare. We further find that the likelihood of deferring healthcare use, and difficulties accessing healthcare or prescriptions are higher in certain groups. Former riders who did not own a vehicle, as well those who were non-white, disabled, or on low income were significantly more likely to report having to defer appointments until they could use transit again. Individuals with only fair self-assessed health and those who believed they were at risk for severe COVID-19 were also more likely to report deferring care.

Declaration of competing interest

The Authors did not receive any specific funding for this work.

Acknowledgements

We would like to acknowledge Jeff Allen and Bochu Liu for support in appending the data with additional built form covariates, and reviewing the survey instrument. We also acknowledge Yixue Zhang for providing translations of the survey instrument into Mandarin and Cantonese. Funding for this work came from the University of Toronto School of Cities, the Canada Research Chair in Transportation and Health (Widener), the Ontario Research Fund (Farber), and the City of Vancouver.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jth.2021.101112.

Appendix

Appendix Fig. 1. Example Facebook Advertisement in Toronto, browser format.

Appendix Fig. 2. Example Facebook Advertisement in Vancouver, Smartphone App Format.

Appendix Table 1
Missing data

	Overall n=4367	Toronto n=2499	Vancouver n=1868
Sociodemographic characteristics			
Sex – n (%)	444 (10.2)	370 (14.8)	74 (4.0)
Age	31 (0.7)	18 (0.7)	13 (0.7)
Recent Immigrant	37 (0.7)	23 (0.9)	14 (0.7)
Race/Ethnicity	66 (1.5)	47 (1.9)	19 (1.0)
Pre-tax household income (2019)	66 (1.5)	47 (1.9)	19 (1.0)
Health status and risk perception			
"I am at risk for severe illness from COVID"	66 (1.5)	40 (1.6)	26 (1.4)
Self-rated health	23 (0.5)	15 (0.6)	8 (0.4)
Accessibility			
Car access/ownership	20 (0.5)	13 (0.5)	7 (0.4)
"My neighborhood is walkable"	60 (1.4)	40 (1.6)	20 (1.1)
"It is hard to physical distance in my neighborhood"	56 (1.3)	41 (1.6)	15 (0.8)
Telehealth use before COVID-19	32 (0.7)	22 (0.9)	10 (0.5)

Appendix Table 2
Bivariate correlates of former transit riders deferring healthcare (self-reported)

	Toronto		Vancouver	
	Prevalence Ratio (95% CI)	P-value	Prevalence Ratio (95% CI)	P-value
Sociodemographic characteristics				
Male sex	0.74 (0.64, 0.85)	<0.001***	0.61 (0.49, 0.75)	<0.001***
Age				
18-29	Reference	Reference	Reference	Reference
30-49	0.92 (0.82, 1.04)	0.198	0.84 (0.70, 1.02)	0.074
50-64	0.91 (0.77, 1.08)	0.288	0.65 (0.49, 0.86)	0.004**
65+	1.13 (0.90, 1.40)	0.287	1.30 (0.95, 1.73)	0.087
Recent immigrant	1.30 (1.10, 1.53)	0.002**	0.91 (0.68, 1.19)	0.493
Race/Ethnicity				
White	Reference	Reference	Reference	Reference
Non-White	1.19 (1.06, 1.33)	0.003**	1.54 (1.29, 1.84)	<0.001***
Multiethnic	1.19 (0.96, 1.45)	0.103	1.22 (0.92, 1.60)	0.156
Canadian Indigenous	1.42 (1.05, 1.87)	0.019*	1.40 (1.00, 1.91)	0.041*
Pre-tax household income (2019)				
Very High (>$125,000)	Reference	Reference	Reference	Reference
High ($80,000-$124,999)	1.72 (1.41, 2.11)	<0.001***	1.52 (1.08, 2.19)	0.205
Middle ($40,000-$79,999)	2.27 (1.89, 2.76)	<0.001***	2.35 (1.71, 3.31)	<0.001***
Low (<$40,000)	2.69 (2.23, 3.26)	<0.001***	3.01 (2.20, 4.23)	<0.001***
Health status and risk perception				
"I am at risk for severe illness from COVID"				
Disagree/Strongly Disagree	Reference	Reference	Reference	Reference
Neither Agree or Disagree	1.28 (1.10, 1.49)	0.001**	1.00 (0.78, 1.28)	0.97
Agree/Strongly Agree	1.42 (1.26, 1.60)	<0.001***	1.58 (1.32, 1.90)	<0.001***
Self-rated health				
Excellent	Reference	Reference	Reference	Reference
Very Good	1.08 (0.89, 1.33)	0.453	1.30 (0.90, 1.93)	0.172
Good	1.40 (1.16, 1.70)	<0.001***	1.88 (1.33, 2.74)	<0.001***
Fair	1.82 (1.48, 2.25)	<0.001***	2.75 (1.92, 4.07)	<0.001***
Poor	2.02 (1.33, 2.97)	<0.001***	4.01 (2.38, 6.68)	<0.001***
# of ER visits in the last year	1.09 (1.01, 1.16)	0.021*	1.09 (0.98, 1.20)	0.108
Physical disability	1.56 (1.30, 1.85)	<0.001***	2.17 (1.71, 2.72)	<0.001***
Accessibility				
Car access/ownership				
Owns	Reference	Reference	Reference	Reference
Access but does not own	1.87 (1.61, 2.17)	<0.001***	2.38 (1.92, 2.96)	<0.001***
Neither	2.19 (1.93, 2.48)	<0.001***	3.64 (2.96, 4.49)	<0.001***
"My neighborhood is walkable"				
Agree/Strongly Agree	Reference	Reference	Reference	Reference
Neither Agree Nor Disagree	1.21 (0.98, 1.48)	0.073	1.67 (1.20, 2.25)	0.001**
Disagree/Strongly Disagree	1.27 (1.05, 1.53)	0.013*	1.12 (0.79, 1.55)	0.493
"It is hard to physical distance in my neighborhood"				
Agree/Strongly Agree	Reference	Reference	Reference	Reference
Neither Agree Nor Disagree	1.09 (0.93, 1.26)	0.275	0.92 (0.72, 1.17)	0.523

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Appendix Table 2 (*continued*)

	Toronto		Vancouver	
	Prevalence Ratio (95% CI)	P-value	Prevalence Ratio (95% CI)	P-value
Disagree/Strongly Disagree	0.76 (0.67, 0.85)	<0.001***	0.60 (0.50, 0.72)	<0.001***
Distance to nearest pharmacy	1.00 (1.00, 1.00)	0.012*	1.00 (1.00, 1.00)	0.35
Monthly use of telehealth before COVID-19 > 0–1 times	0.96 (0.84, 1.10)	0.582	1.36 (1.09, 1.68)	0.006**

***p < .0001, **p < .01, *p < .05.

Appendix Table 3
Bivariate correlates of former transit riders reporting difficulty accessing healthcare

	Toronto		Vancouver	
	Prevalence Ratio (95% CI)	P-value	Prevalence Ratio (95% CI)	P-value
Sociodemographic characteristics				
Male sex	0.78 (0.68, 0.90)	<0.001***	0.61 (0.50, 0.74)	<0.001***
Age				
18-29	Reference	Reference	Reference	Reference
30-49	0.96 (0.84, 1.09)	0.493	0.85 (0.72, 1.00)	0.055
50-64	0.95 (0.79, 1.13)	0.546	0.81 (0.63, 1.03)	0.087
65+	1.21 (0.95, 1.52)	0.112	1.38 (1.04, 1.81)	0.022*
Recent immigrant	1.07 (0.89, 1.28)	0.438	0.92 (0.71, 1.17)	0.497
Race/Ethnicity				
White	Reference	Reference	Reference	Reference
Non-White	1.05 (0.93, 1.19)	0.413	1.21 (1.03, 1.43)	0.021*
Multiethnic	1.29 (1.05, 1.58)	0.013*	1.18 (0.92, 1.49)	1.187
Canadian Indigenous	1.32 (0.97, 1.76)	0.064	1.35 (1.00, 1.79)	0.043*
Pre-tax household income (2019)				
Very High (>$125,000)	Reference	Reference	Reference	Reference
High ($80,000-$124,999)	1.20 (0.99, 1.46)	0.062	1.51 (1.13, 2.04)	0.007**
Middle ($40,000-$79,999)	1.55 (1.30, 1.86)	<0.001***	1.70 (1.29, 2.28)	<0.001***
Low (<$40,000)	1.91 (1.60, 2.29)	<0.001***	2.47 (1.89, 3.29)	<0.001***
Health status and risk perception				
"I am at risk for severe illness from COVID"				
Disagree/Strongly Disagree	Reference	Reference	Reference	Reference
Neither Agree or Disagree	1.23 (1.05, 1.43)	0.009	1.16 (0.93, 1.44)	0.187
Agree/Strongly Agree	1.41 (1.24, 1.60)	<0.001***	1.71 (1.45, 2.02)	<0.001***
Self-rated health				
Excellent	Reference	Reference	Reference	Reference
Very Good	1.14 (0.93, 1.40)	0.221	1.25 (0.91, 1.76)	0.186
Good	1.33 (1.10, 1.62)	0.004**	1.74 (1.29, 2.42)	<0.001***
Fair	1.72 (1.39, 2.14)	<0.001***	2.33 (1.68, 3.28)	<0.001***
Poor	2.34 (1.58, 3.36)	<0.001***	3.14 (1.99, 4.92)	<0.001***
# of ER visits in the last year	1.17 (1.09, 1.24)	<0.001***	1.16 (1.06, 1.25)	<0.001***
Physical disability = yes	1.62 (1.35, 1.93)	<0.001***	2.12 (1.71, 2.60)	<0.001***
Accessibility				
Car access/ownership				
Owns	Reference	Reference	Reference	Reference
Access but does not own	1.81 (1.55, 2.12)	<0.001***	2.39 (1.99, 2.88)	<0.001***
Neither	2.03 (1.78, 2.31)	<0.001***	2.83 (2.35, 3.42)	<0.001***
"My neighborhood is walkable"				
Agree/Strongly Agree	Reference	Reference	Reference	Reference
Neither Agree Nor Disagree	1.48 (1.21, 1.79)	<0.001***	1.47 (1.08, 1.95)	0.011**
Disagree/Strongly Disagree	1.21 (0.99, 1.47)	0.054	1.42 (1.07, 1.84)	0.011**
"It is hard to physical distance in my neighborhood"				
Agree/Strongly Agree	Reference	Reference	Reference	Reference
Neither Agree Nor Disagree	0.95 (0.81, 1.11)	0.544	1.04 (0.84, 1.29)	0.695
Disagree/Strongly Disagree	0.69 (0.61, 0.78)	<0.001***	0.65 (0.55, 0.76)	<0.001***
Distance to nearest pharmacy	1.00 (1.00, 1.00)	0.986	1.00 (1.00, 1.00)	0.229
Monthly use of telehealth before COVID-19 > 0 times	1.23 (1.09, 1.40)	0.001***	1.14 (0.93, 1.38)	0.199

***p < .0001, **p < .01, *p < .05.

Appendix Table 4
Bivariate correlates of former transit riders reporting difficulty getting prescriptions

	Toronto		Vancouver	
	Prevalence Ratio (95% CI)	P-value	Prevalence Ratio (95% CI)	P-value
Sociodemographic characteristics				

(*continued on next page*)

Appendix Table 4 (*continued*)

	Toronto		Vancouver	
	Prevalence Ratio (95% CI)	P-value	Prevalence Ratio (95% CI)	P-value
Male sex	0.76 (0.60, 0.95)	0.016**	0.61 (0.46, 0.80)	<0.001***
Age				
18-29	Reference	Reference	Reference	Reference
30-49	0.77 (0.63, 0.93)	0.008**	0.59 (0.46, 0.76)	<0.001***
50-64	0.78 (0.59, 1.04)	0.093	0.51 (0.34, 0.73)	<0.001***
65+	0.82 (0.53, 1.21)	0.342	1.15 (0.77, 1.66)	0.469
Recent immigrant	1.64 (1.27, 2.09)	<0.001***	0.87 (0.58, 1.26)	0.486
Race/Ethnicity				
White	Reference	Reference	Reference	Reference
Non-White	1.46 (1.22, 1.76)	<0.001***	1.62 (1.28, 2.05)	<0.001***
Multiethnic	1.18 (0.81, 1.66)	0.360	1.34 (0.92, 1.90)	0.107
Canadian Indigenous	1.68 (1.07, 2.49)	0.016*	1.63 (1.05, 2.40)	0.020*
Pre-tax household income (2019)				
Very High (>$125,000)	Reference	Reference	Reference	Reference
High ($80,000-$124,999)	1.06 (0.78, 1.46)	0.701	1.71 (1.10, 2.73)	0.020*
Middle ($40,000-$79,999)	1.49 (1.12, 1.98)	0.007**	1.69 (1.10, 2.67)	0.021*
Low (<$40,000)	2.07 (1.57, 2.75)	<0.001***	2.99 (2.00, 4.67)	<0.001***
Health status and risk perception				
"I am at risk for severe illness from COVID"				
Disagree/Strongly Disagree	Reference	Reference	Reference	Reference
Neither Agree or Disagree	1.14 (0.89, 1.47)	0.296	1.10 (0.78, 1.53)	0.569
Agree/Strongly Agree	1.43 (1.17, 1.74)	<0.001***	1.79 (1.41, 2.28)	<0.001***
Self-rated health				
Excellent	Reference	Reference	Reference	Reference
Very Good	1.17 (0.83, 1.67)	0.382	1.26 (0.79, 2.13)	0.353
Good	1.64 (1.19, 2.31)	0.003**	1.73 (1.11, 2.86)	0.023*
Fair	2.12 (1.50, 3.05)	<0.001***	2.63 (1.65, 4.42)	<0.001***
Poor	3.43 (1.89, 5.93)	<0.001***	2.75 (1.32, 5.54)	0.005**
# of ER visits in the last year	1.26 (1.14, 1.39)	<0.001***	1.13 (1.00, 1.27)	0.042*
Physical disability	1.76 (1.31, 2.31)	<0.001***	2.10 (1.54, 2.82)	<0.001***
Accessibility				
Car access/ownership				
Owns	Reference	Reference	Reference	Reference
Access but does not own	1.87 (1.47, 2.36)	<0.001***	2.21 (1.69, 2.91)	<0.001***
Neither	1.75 (1.42, 2.16)	<0.001***	2.78 (2.12, 3.64)	<0.001***
"My neighborhood is walkable"				
Agree/Strongly Agree	Reference	Reference	Reference	Reference
Neither Agree Nor Disagree	2.27 (1.71, 2.96)	<0.001***	2.07 (1.36, 3.01)	<0.001***
Disagree/Strongly Disagree	1.71 (1.26, 2.25)	<0.001***	1.77 (1.20, 2.53)	0.003**
"It is hard to physical distance in my neighborhood"				
Agree/Strongly Agree	Reference	Reference	Reference	Reference
Neither Agree Nor Disagree	0.98 (0.76, 1.26)	0.905	1.22 (0.89, 1.66)	0.199
Disagree/Strongly Disagree	0.74 (0.61, 0.90)	0.003**	0.76 (0.60, 0.97)	0.027*
Distance to nearest pharmacy	1.00 (1.00, 1.00)	0.479	1.00 (1.00, 1.00)	<0.001***
Monthly use of telehealth before COVID-19 > 0 times	1.08 (0.88, 1.33)	0.450	1.45 (1.10, 1.88)	0.006**

***p < .0001, **p < .01, *p < .05.

References

Arcury, T.A., Gesler, W.M., Preisser, J.S., Sherman, J., Spencer, J., Perin, J., 2005. The effects of geography and spatial behavior on health care utilization among the residents of a rural region. Health Serv. Res. 40, 135–156. https://doi.org/10.1111/j.1475-6773.2005.00346.x.

Barros, A.J., Hirakata, V.N., 2003. Alternatives for logistic regression in cross-sectional studies: an empirical comparison of models that directly estimate the prevalence ratio. BMC Med. Res. Methodol. 3, 21. https://doi.org/10.1186/1471-2288-3-21.

BBC, 2020. Coronavirus: Uber Customer Activity Falls Sharply. British Broadcasting Corporation, 9.25.20. https://www.bbc.com/news/business-53687422.

Boas, T.C., Christenson, D.P., Glick, D.M., 2020. Recruiting large online samples in the United States and India: Facebook, mechanical Turk, and Qualtrics. PSRM 8, 232–250. https://doi.org/10.1017/psrm.2018.28.

Boisjoly, G., Deboosere, R., Wasfi, R., Orpana, H., Manaugh, K., Buliung, R., El-Geneidy, A., 2020. Measuring accessibility to hospitals by public transport: an assessment of eight Canadian metropolitan regions. J. Transport Health 18, 100916. https://doi.org/10.1016/j.jth.2020.100916.

Brown, 2017. Car-less or car-free? Socioeconomic and mobility differences among zero-car households. Transport Pol. 60, 152–159. https://doi.org/10.1016/j.tranpol.2017.09.016.

Carter-Harris, L., Bartlett Ellis, R., Warrick, A., Rawl, S., 2016. Beyond traditional newspaper advertisement: leveraging facebook-targeted advertisement to recruit long-term smokers for research. J. Med. Internet Res. 18, e117. https://doi.org/10.2196/jmir.5502.

Catalyst, N.E.J.M., 2017. Social determinants of health (SDOH). New england journal of medicine Catalyst, 7.30.20. https://catalyst.nejm.org/doi/full/10.1056/CAT.17.0312.

CDC, 2020. Social distancing. Center for diseases control and prevention, 7.15.20. https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/social-distancing.html.
Chen, W., Qian, L., Shi, J., Franklin, M., 2018. Comparing performance between log-binomial and robust Poisson regression models for estimating risk ratios under model misspecification. BMC Med. Res. Methodol. 18, 63. https://doi.org/10.1186/s12874-018-0519-5.
CIHI, 2020. COVID-19 Intervention Scan. Canadian Institute for Health Information, 7.17.20. https://www.cihi.ca/en/covid-19-intervention-scan.
City of Toronto, 2020. COVID-19: Status of Cases in Toronto. City of Toronto, 8.28.20. https://www.toronto.ca/home/covid-19/covid-19-latest-city-of-toronto-news/covid-19-status-of-cases-in-toronto/.
Coster, J.E., Turner, J.K., Bradbury, D., Cantrell, A., 2017. Why do people choose emergency and urgent care services? A rapid review utilizing a systematic literature search and narrative synthesis. Acad. Emerg. Med. 24, 1137–1149. https://doi.org/10.1111/acem.13220.
Fraze, T.K., Brewster, A.L., Lewis, V.A., Beidler, L.B., Murray, G.F., Colla, C.H., 2019. Prevalence of screening for food insecurity, housing instability, utility needs, transportation needs, and interpersonal violence by US physician practices and hospitals. JAMA Netw Open 2, e1911514. https://doi.org/10.1001/jamanetworkopen.2019.11514.
Government of Canada, 2020. Community-based measures to mitigate the spread of coronavirus disease (COVID-19) in Canada-Transportation. Government of Canada, 7.30.20. https://www.canada.ca/en/public-health/services/diseases/2019-novel-coronavirus-infection/health-professionals/public-health-measures-mitigate-covid-19.html#_Transportation.
Guillory, J., Wiant, K.F., Farrelly, M., Fiacco, L., Alam, I., Hoffman, L., Crankshaw, E., Delahanty, J., Alexander, T.N., 2018. Recruiting hard-to-reach populations for survey research: using Facebook and instagram advertisements and in-person intercept in LGBT bars and nightclubs to recruit LGBT young adults. J. Med. Internet Res. 20, e197. https://doi.org/10.2196/jmir.9461.
Hwang, A.S., Atlas, S.J., Cronin, P., Ashburner, J.M., Shah, S.J., He, W., Hong, C.S., 2015. Appointment "no-shows" are an independent predictor of subsequent quality of care and resource utilization outcomes. J. Gen. Intern. Med. 30, 1426–1433. https://doi.org/10.1007/s11606-015-3252-3.
Kang, J.-Y., Michels, A., Lyu, F., Wang, Shaohua, Agbodo, N., Freeman, V.L., Wang, Shaowen, 2020. Rapidly measuring spatial accessibility of COVID-19 healthcare resources: a case study of Illinois, USA. Int. J. Health Geogr. 19, 36. https://doi.org/10.1186/s12942-020-00229-x.
Kangovi, S., Barg, F.K., Carter, T., Long, J.A., Shannon, R., Grande, D., 2013. Understanding why patients of low socioeconomic status prefer hospitals over ambulatory care. Health Aff. 32, 1196–1203. https://doi.org/10.1377/hlthaff.2012.0825.
Kolak, M., Bhatt, J., Park, Y.H., Padrón, N.A., Molefe, A., 2020. Quantification of neighborhood-level social determinants of health in the continental United States. JAMA Netw Open 3, e1919928. https://doi.org/10.1001/jamanetworkopen.2019.19928.
Liu, L., Miller, H.J., Scheff, J., 2020. The impacts of COVID-19 pandemic on public transit demand in the United States. PloS One 15, e0242476. https://doi.org/10.1371/journal.pone.0242476.
Lucas, K., 2012. Transport and social exclusion: where are we now? Transport Pol. 20, 105–113. https://doi.org/10.1016/j.tranpol.2012.01.013.
McNutt, L.-A., 2003. Estimating the relative risk in cohort studies and clinical trials of common outcomes. Am. J. Epidemiol. 157, 940–943. https://doi.org/10.1093/aje/kwg074.
Moore, O., 2020. How Canadian Transit Systems Are Preparing for Cities to Reopen. The Globe and Mail.
Muñoz-Price, L.S., Nattinger, A.B., Rivera, F., Hanson, R., Gmehlin, C.G., Perez, A., Singh, S., Buchan, B.W., Ledeboer, N.A., Pezzin, L.E., 2020. Racial disparities in incidence and outcomes among patients with COVID-19. JAMA Netw Open 3, e2021892. https://doi.org/10.1001/jamanetworkopen.2020.21892.
Nguyen, D.L., DeJesus, R.S., 2010. Increased frequency of No-shows in residents' primary care clinic is associated with more visits to the emergency department. J Prim Care Community Health 1, 8–11. https://doi.org/10.1177/2150131909359930.
Palm, M., Allen, J., Liu, B., Zhang, Y., Widener, M., Farber, S., 2021. Riders who avoided public transit during COVID-19: personal burdens and implications for social equity. J. Am. Plann. Assoc. https://doi.org/10.1080/01944363.2021.1886974.
Province of British Columbia, 2020a. British Columbia COVID-19 dashboard, 8.28.20. https://experience.arcgis.com/experience/a6f23959a8b14bfa989e3cda29297ded.
Province of British Columbia, 2020b. Pharmacies in BC. British Columbia data catalogue, 7.30.20. https://catalogue.data.gov.bc.ca/dataset/after-hours-pharmacies-in-bc.
Province of Ontario, 2020. Ministry of health service provider locations. Ontario GeoHub, 7.1.20. https://geohub.lio.gov.on.ca/datasets/68853b605c844c6ebe041003b4c71b56_26.
Ruggiano, N., Shtompel, N., Whiteman, K., Sias, K., 2017. Influences of transportation on health decision-making and self-management behaviors among older adults with chronic conditions. Behav. Med. 43, 61–70. https://doi.org/10.1080/08964289.2015.1065788.
Sarnquist, C.C., Soni, S., Hwang, H., Topol, B.B., Mutima, S., Maldonado, Y.A., 2011. Rural HIV-infected women's access to medical care: ongoing needs in California. AIDS Care 23, 792–796. https://doi.org/10.1080/09540121.2010.516345.
Silver, D., Blustein, J., Weitzman, B.C., 2012. Transportation to clinic: findings from a pilot clinic-based survey of low-income suburbanites. J. Immigr. Minority Health 14, 350–355. https://doi.org/10.1007/s10903-010-9410-0.
Syed, S.T., Gerber, B.S., Sharp, L.K., 2013. Traveling towards disease: transportation barriers to health care access. J. Community Health 38, 976–993. https://doi.org/10.1007/s10900-013-9681-1.
Tai, D.B.G., Shah, A., Doubeni, C.A., Sia, I.G., Wieland, M.L., 2021. The disproportionate impact of COVID-19 on racial and ethnic minorities in the United States. Clin. Infect. Dis. 72, 703–706. https://doi.org/10.1093/cid/ciaa815.
Wallace, R., Hughes-Cromwick, P., Mull, H., Khasnabis, S., 2005. Access to health care and nonemergency medical transportation: two missing links. Transport. Res. Record 1924 76–84. https://doi.org/10.1177/0361198105192400110.
Whittle, R.S., Diaz-Artiles, A., 2020. An ecological study of socioeconomic predictors in detection of COVID-19 cases across neighborhoods in New York City. BMC Med. 18, 271. https://doi.org/10.1186/s12916-020-01731-6.
Wolfe, M.K., McDonald, N.C., Holmes, G.M., 2020. Transportation barriers to health care in the United States: findings from the national health interview survey, 1997–2017. Am. J. Publ. Health 110, 815–822. https://doi.org/10.2105/AJPH.2020.305579.
Yang, S., Zarr, R.L., Kass-Hout, T.A., Kourosh, A., Kelly, N.R., 2006. Transportation barriers to accessing health care for urban children. J. Health Care Poor Underserved 17, 928–943. https://doi.org/10.1353/hpu.2006.0137.
Yehia, B.R., Winegar, A., Fogel, R., Fakih, M., Ottenbacher, A., Jesser, C., Bufalino, A., Huang, R.-H., Cacchione, J., 2020. Association of race with mortality among patients hospitalized with coronavirus disease 2019 (COVID-19) at 92 US hospitals. JAMA Netw Open 3, e2018039. https://doi.org/10.1001/jamanetworkopen.2020.18039.
Zou, G., 2004. A modified Poisson regression approach to prospective studies with binary data. Am. J. Epidemiol. 159, 702–706. https://doi.org/10.1093/aje/kwh090.