Transportation (2024) 51:645–671
https://doi.org/10.1007/s11116-022-10344-2

Facing the future of transit ridership: shifting attitudes towards public transit and auto ownership among transit riders during COVID-19

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Accepted: 12 October 2022 / Published online: 29 October 2022

Abstract
Public transit agencies face a transformed landscape of rider demand and political support as the COVID-19 pandemic recedes. We explore people's motivations for returning to or avoiding public transit a year into the pandemic. We draw on a March 2021 follow-up survey of over 1,900 people who rode transit regularly prior to the COVID-19 pandemic in Toronto and Vancouver, Canada, and who took part in a prior survey on the topic in May 2020. We investigate how transit demand changes associated with the pandemic relate to changes in automobile ownership and its desirability. We find that pre-COVID frequent transit users between the ages of 18–29, a part of the so-called "Gen Z," and recent immigrants are more attracted to driving due to the pandemic, with the latter group more likely to have actually purchased a vehicle. Getting COVID-19 or living with someone who did is also a strong and positive predictor of buying a car and anticipating less transit use after the pandemic. Our results suggest that COVID-19 may have increased the attractiveness of auto ownership among transit riders likely to eventually purchase cars anyway (immigrants, twentysomethings), at least in the North American context. We also conclude that getting COVID-19 or living with someone who did is a positive predictor of having bought a car. Future research should consider how having COVID-19 transformed some travelers' views, values, and behaviour.

Keywords Public transit · COVID-19 · Generation Z · Immigrants · Vehicle ownership · Transportation

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Introduction

After decades of attempting to attract higher income, car owning 'choice riders' (Taylor and Morris 2015) and millennials (Sakaria and Stehfest 2013), North American transit agencies are serving a decimated ridership of mostly transit-dependent travelers due to COVID-19. The popularity of telecommuting and suppressed discretionary trip-making signal long term difficulties for transit agencies seeking to attract former riders (Loa et al. 2021; Salon et al. 2021). This presents a major crisis for transit agencies in countries like Canada, where over half of operating costs are traditionally covered by fares (CUTA-ACTU 2021), leading advocates to call for new means of transit finance to minimize service loss if ridership does not recover (McArthur et al. 2020). Transit riders' and lapsed riders' changing views of transit and alternative modes are thus important for decision-makers to understand.

We report on a follow-up survey of over 1,900 people who rode transit regularly prior to the COVID-19 pandemic in Toronto and Vancouver, Canada. The original survey took place in May 2020 (Palm et al. 2021a, 2021b; Zhang et al. 2020), and the follow-up occurred in March 2021. We asked these riders five main questions: (1) whether they returned to transit in the intervening period; (2) how often they ride transit now; (3) how the pandemic has changed their views on vehicle ownership; (4) whether they bought a car; (5) and whether they anticipate riding public transit less after the pandemic compared to before.

Our two wave survey adds to a rapidly growing literature on the effects of the COVID-19 pandemic on public transportation (Aaditya and Rahul 2021; Dong et al. 2021; Parker et al. 2021). It allows us to follow up on a survey conducted in the early stage of the pandemic and observe how travel behaviors and attitudes have changed over a ten-month period (Palm et al. 2021a, 2021b, 2020; Zhang et al. 2020). It also allows us to compare differences between socio-demographic groups on how they have continued to adapt to the crisis, and how they envision traveling in a post-pandemic future. Unlike broader surveys (Loa et al. 2021; Salon et al. 2021), we focus exclusively on formerly regular transit users and their shifting attitudes about transit and vehicle ownership, as a switch to vehicle ownership could have negative implications for sustainability (Basu and Ferreira 2021).

The article is structured as follows. The "literature" section provides a brief literature review on the intersection between transport disadvantage, mode choice, and the COVID-19 pandemic. The "data and methods" section details the data and methods used for the analysis. The "results" section presents findings. "Conclusions" provides the main conclusions around the choice-dependence dichotomy in the pandemic context and lays out future work to deepen our understandings based on our early findings.

Literature

The earliest research on public transit and COVID-19 emphasized disparities in who needed to continue using the mode despite possible health risks. The first wave of transit rider surveys and stop-level analyses of boardings revealed that residents working in essential jobs and those with low-incomes or without cars continued to ride to a much greater degree than others (Transit 2020; Wellington 2020). This constituted an equity concern as it meant these populations had no choice but to risk exposure to the COVID-19 virus via public transit despite public health agency advisories discouraging transit use. Subsequent academic literature refined these portraits. Telecommuting contributed to the class divide in who continued riding (Parker et al. 2021; Salon et al. 2021). Consistent with these findings, low-income riders did not reduce how often or how far they traveled by transit compared to other riders, despite the risks (Parker et al. 2021). Communities overrepresented in essential work sectors were more likely to keep riding, including Black, Indigenous, people of color, and immigrants (He et al. 2022; Liu et al. 2020; Palm et al. 2021a). Many riders with disabilities also had no alternative but to continue riding (Cochran 2020; Ravensbergen and Newbold 2020). These dynamics in turn influenced which alternative modes saw increased use, and by whom.

Mode shift and its wellbeing impacts

Transit riders who managed to stop riding adopted several different mobility strategies. Vehicle ownership strongly predicted changes in transit usage in both the U.S. and Canada (He et al. 2022; Palm et al. 2021a). In Toronto specifically, travelers that could be classified primarily as transit users pre-pandemic fell into one of three alternative mobility patterns: traveling strictly as drivers, mostly walking and occasionally driving, or as continued transit users who made more trips on foot (Loa et al. 2021). The study authors summarize these findings by stating that "among pre-pandemic transit users, those with alternative options for making non-mandatory trips are primarily turning to private vehicles and walking for their non-mandatory trips" (Loa et al. 2021, p. 80). In other cities, like New York, the collapse of transit ridership corresponded with increased use of bike sharing (Wang and Noland 2021). Bicycling volumes increased year-over-year in many cities (Buehler and Pucher 2021), and residents told public opinion pollsters that they planned to bicycle more after the pandemic (Ehsani et al. 2021). However, many residents who managed to stop riding transit faced difficulties switching modes for essential trips, including seniors struggling to walk or bike with groceries and parents chaperoning children (Palm et al. 2021a). In the U.S., the challenges of traveling without transit fell along racial lines, with Hispanic/Latinx respondents being more likely than others to report difficulty reaching essential destinations (He et al. 2022). Taken together, these findings highlight the limits of active travel as an alternative to transit for former riders from with diverse needs, comfort levels, and experiences, raising the question of whether those transit riders who can afford it may turn to the automobile instead.

Vehicle ownership

COVID-19 may have increased the appeal of vehicle ownership among carless households, although the limited evidence suggests that greater appeal may not translate into mass car buying too much beyond what would normally take place. Roughly 18% of respondents without cars in a Boston sample of 500 reported that the pandemic impacted their car purchase intentions (Basu and Ferreira 2021). The researchers noted, however, that half of those with 'enhanced intention' of purchasing a car were "willing to wait and watch developments over the next year," although those developments were not named (Basu and Ferreira 2021, p. 203). Notably, the authors managed to follow up with 10 households that purchased a vehicle in the following six months and found that both COVID-related concerns and non-COVID-19 issues like service reliability motivated the car buyers. The conclusions emphasize that car ownership increased in the region prior to the crisis, and that a spike in vehicle ownership due to the pandemic may only be short term. National trends buttress this caution. Cox Automotive reports that U.S. certified pre-owned vehicle purchases in the first half of 2021 increased 18% year-over-year, but only 4.8% compared to 2019 (Cox Automotive 2021). Similar analyses are not yet available for Canada, but a recent national survey of recent car buyers found 15% of respondents had purchased a vehicle to avoid riding public transit (CBB 2021). In Australia, younger adults tell researchers that COVID-19 did not alter their life plans vis-à-vis their mobility, but merely accelerated them, particularly car-buying (Delbosc and McCarthy 2021).

Telecommuting

The orientation of North American transit systems around commuting makes telecommuting a challenge to transit's post-COVID-19 recovery. Even before the pandemic, telecommuting correlated negatively with transit ridership across Canada (Diab et al. 2020). In the United States, researchers estimate that transit commuting may decline by roughly 40% after the pandemic, with half of this decline attributable to a reduction in commute frequency (Salon et al. 2021). Nearly 80% of Canadians who started telecommuting during COVID-19 told Statistics Canada that they hope to continue telecommuting for at least half of their hours post-pandemic (Statistics Canada 2021a). Employee preferences for telecommuting are just part of the reason for companies to embrace this change. A growing evidence base suggests that telecommuting increases productivity and has the potential to decrease costs like commercial rents in downtown cores (Barrero et al. 2021; Choudhury et al. 2021).

Understanding who will return

This rapidly emerging research offers a compelling picture of transit-related travel behavior changes during COVID-19: people are riding transit less and driving and telecommuting more. However, few of these studies focus specifically on regular riders of public transit, the likely base of ridership emerging out of the pandemic, and fewer still consider regular riders' views of the future, and investments in other options (i.e., car buying). This paper asks: which transit riders started returning to public transit and to what extent? It also asks: how has COVID-19 changed transit riders' perceptions of automobile ownership, and who anticipates riding less after COVID-19?

Data and methods

Data comes from waves 1 and 2 of the Public Transit and COVID-19 Survey. Wave 1 ran in May of 2020 in Toronto and Vancouver. Recruitment took place via community listservs and social media advertising. Participation was restricted to adults who took transit more than once a week in Toronto or Vancouver pre-pandemic, to establish a sample of regular transit riders. Details on the limitations and implications of initial data collection are available in prior publications and their technical appendices (Palm et al. 2021a; Zhang et al. 2020).

Wave 2 took place in March 2021 to capture changes in travel before an anticipated vaccination effort in late spring. Individuals were invited via an email with each respondent receiving a unique link to take the wave 2 survey. This Qualtrics survey was further protected by preventing multiple entries from the same IP address and requiring respondents to complete a captcha. Captcha stands for "Completely Automated Public Turing test to tell Computers and Humans Apart" and refers to tests that a web crawler would fail, such as presenting nine images and asking the potential survey taker to select all pictures with a crosswalk. The median respondent took 8.4 min to complete the wave 2 survey, which contained 38 questions separated into five sections. A copy of the survey is provided in the appendix.

Our methodological strategy is aimed at answering our primary research questions: who is planning on returning to transit and who is not, and what are the implications for an equitable transportation system after the pandemic? To assess this question, we derive from the data six quantitative measures of changes in attitudes and use of public transit, and changes in attitudes towards and ownership of a vehicle. Each of these outcomes is regressed on a set of variables including the rider's socio-demographics, wave 1 attitudes, travel resources, and built form context.

Dependent variables

We asked riders to respond to several statements about their travel attitudes and plans using a five-point Likert that ranged from strongly agree to strongly disagree. We converted each of these into a binary indicator where a 1 indicated agreement or strong agreement and modeled these outcomes using Poisson regression to approximate adjusted relative proportions, also known as incidence risk ratios (Zou 2004). We also explored ordered logistic models on the original variables using all five points on the Likert scale, but these models failed the Brant test for the assumption of proportional odds (Brant 1990). Binary logistic regression was inappropriate due to the high frequency of positive responses. The statements are summarized in Table 1. Two statements focused on anticipated changes to travel behavior after the pandemic, and two concerned attitudes about vehicle ownership. We also asked respondents if they bought a car in between survey waves, creating a fifth dependent variable where a 1 indicated a vehicle purchase. Finally, we asked respondents to report the number of times they boarded a transit vehicle in the last seven days. We modeled this variable using zero-inflated negative binomial logistic regression, as it is a count variable and it contained a high proportion of zeros (i.e., people who did not use transit at all in the prior week). Finally, we compared this variable of transit boardings in the last seven days to a similar question asked in wave 1 about a typical pre-pandemic week in March 2020. The change in weekly boardings is our sixth dependent variable, modeled using Ordinary Least Squares as it is numeric. Data analysis was conducted in R version 4.1.2.

All models are complemented by relative weights analysis implemented in R using the package *RWA* (Chan 2020). Relative weights analysis enables researchers to understand the contributions of each predictor variable in explaining an outcome from a multivariable model (Johnson 2000), as interpretation of estimates is complex due to interrelationships among predictor variables (Westreich and Greenland 2013). RWA involves the transformation of predictors such that they are orthogonal to each other so the analyst can recompute standardized beta coefficients (Tonidandel and LeBreton 2011). The method produces raw weights, or the contribution each variable makes in predicting the outcome, that can be interpreted as relative effect sizes for each predictor.

Table 1 Dependent variables

Survey question/input	Dependent variable	Model
"After the crisis ends, I will probably ride transit less than I did before COVID"	Binary. 1 = Strongly Agree or Agree; 0 = all other answers	Poisson regression with inverse probability attrition weighting (IPAW) weights & robust standard errors
Change in transit boardings in March 2021 (wave 2) compared to May 2020 (wave 1)	Numeric. Number of boardings for a week in March 2021 minus number of boardings in May 2021	Ordinary Least Squares with IPAW weights & robust standard errors
"How many public transit boardings have you made over the last seven days?"	Numeric. Number of boardings for a week in March 2021	Zero-inflated negative binomial regression
"COVID-19 has made owning a car more appealing"	Binary. 1 = Strongly Agree or Agree; 0 = all other answers	Poisson regression with IPAW weights & robust standard errors
"Because of COVID, I have looked into buying a car"	Binary. 1 = Strongly Agree or Agree; 0 = all other answers	Poisson regression with IPAW weights & robust standard errors
"Have you or your household purchased a car in the last 12 months?"	Binary. 1 = yes, 0 = no	Poisson regression with IPAW weights & robust standard errors

Predictors and covariates

We sought to understand how experiencing difficulties travelling without transit, or with minimal transit, influenced riders' attitudes and future travel plans. In wave 1, we asked respondents who had stopped riding completely in the early months of the pandemic whether avoiding transit made it more difficult to reach one of five different types of destinations (Palm et al. 2021a, 2021b). We coded respondents on a 0 to 5 scale that counted how many of these destinations they found it somewhat or much harder to reach without public transit. Respondents who were not asked the question in wave 1 because they continued to ride received a score of zero, and this is further controlled for with a nested indicator of whether the respondent stopped riding completely in wave 1.

Several demographic covariates were pulled from wave 1 of the survey, including gender (Male, Female, Non-Binary), ethnicity/race (aggregated to White, Black, Indigenous, other Persons of Color), 2019 income (numeric, in thousands), physical disability (yes/no), immigration to Canada in the last five years (yes/no), age (18–29, 30–50, 50–64, 65 +), and city (Vancouver, Toronto).

We also include several covariates from our wave 2 survey. We asked respondents whether they or a householder had tested positive for COVID-19 at any point during the pandemic and whether they had received a dose of a vaccine. Car ownership from wave 1 fell into three categories: respondent owned a car, had access to a car, or had no access at all. We also included a variable pertaining to the built environment, specifically a measure of transit accessibility to jobs. This measure was drawn from Allen & Farber (Allen and Farber 2019) and additionally accounts for competition to employment. It ranges from 0 to 1, where a one is the greatest possible accessibility accounting for competition, and zero is the least. This was linked to respondents based on their home Dissemination Area (DA) during wave 2. Dissemination Areas are the smallest geographic scales at which Statistics Canada releases detailed demographic information, and they generally contain between 400 and 700 people (Statistics Canada 2018). They are sometimes compared to American Census Block Groups. We then calculated the change in competitive transit access scores to account for people who moved: post-move competitive transit access minus pre-move, while keeping the value for non-movers at zero. We also included several variables on changing circumstances including change in employment (gained employment between the two waves, lost employment, or no change) and change in auto ownership between waves 1 and 2 (included only in our models on transit, as it is an outcome of interest in our models on the automobile).

Limitations

Wave 2 had a lower completion rate, with 55.5% of respondents with complete and valid wave 1 answers participating (1,954 out of 3,518). We address this attrition using inverse probability attrition weighting (IPAW). IPAW is a method that uses a set of variables (covariates) predictive of attrition to generate weights to create a pseudo-population that mimics the underlying cohort (including those who were lost to follow-up) (Cole and Hernan 2008). To apply the method to attrition, we select participation in the second wave as our exposure and develop weights which are the inverse of the probability of being a respondent in the second wave, to correct for attrition.

We generated IPAW weights using the predictors from wave 1 that are included in our models: city, ethnicity/race, 2019 income, age, recent immigrant indicator, essential worker indicator, having a disability, wave 1 vehicle access status, difficulty with physical distancing in wave 1, the competitive transit accessibility score, whether or not the respondent stopped riding transit in response to COVID-19 in wave 1, and the number of destinations the respond had trouble reaching without public transit in wave 1. Ideally, we would include wave 1 answers to our dependent variables in weight generation, but these were not asked in wave 1 so we could not do this.

Two major concerns with deploying this method include weights with extreme values or a mean that deviates significantly from one, which could indicate misspecification of the weight model (Cole and Hernan 2008). Our estimation, however, yielded weights averaging 1, with a minimum of 0.54 and a maximum just over 2.56 (Table 2). Unweighted models are provided in the technical appendix.

While these weights correct for attrition from our first survey wave, we cannot obtain population-level estimates of attitudes and changed behavior as the original wave was gathered as a large, online convenience sample through social media recruitment (Palm et al. 2021a). Wave 1 recruitment took place using targeted Facebook advertisements and emails to community list servs, and the sample is thus 'non-random.' It overrepresents women and people in the downtown cores of both cities. However, it is balanced along lines of income and age. The 'black box' aspect of Facebook recruitment makes any effort on our part to generalize results to the broader population speculative, and so our analytical strategy consciously avoids such claims and instead relies on differences between groups within our sample to offer new insights. However, our data reproduce known relationships between demographic, built form, and travel behaviour variables (Palm et al. 2021a; Zhang et al. 2020), lending confidence in the data to offer useful insights. Additionally, we note that our study does not consider uptake in active travel and telecommuting, although the unavailability of the latter for respondents is captured to some extent in our variable on essential workers. To minimize response burden and increase completion rates, we kept the wave 2 survey focused primarily on public transit. Finally, our overall modelling strategy contains limitations. We had to dichotomize our dependent variables. We did not ask our dependent variables in wave 1, information that would have provided more robust attrition weights.

Despite these limitations, this study offers value as one of the few large sample surveys in the literature dedicated exclusively to understanding public transit riders' attitudes and anticipated future behaviour. Few surveys have a large enough sample of regular transit riders to explore these dynamics along socio-demographic lines as we do, and even fewer of those are panels as our data is. Achieving such a large initial sample in the early days of a once-in-a-century pandemic inevitably necessitated these unconventional recruitment techniques.

The state of the pandemic during wave 2

The second wave ran in both cities from March 16 to April 6, 2021, a period of rapid increase in cases and severe restrictions on social gatherings in both places. This coincided with an increase in COVID-19 reported cases in Toronto, the weekly average of which rose from 0.4

Table 2 Distribution of weights

Minimum	1st quartile	Median	Mean	3rd quartile	Max
0.5411	0.8392	0.9460	1.0002	1.1180	2.5636

cases per 100,000 people the week of March 1st to 33.9 cases per 100,000 people on the week starting April 6th (City of Toronto 2021a). A week before the survey ran, Toronto moved into Ontario's 'Grey Zone,' after several months of strict lockdown in which all but essential businesses were closed (CIHI 2021). The Grey Zone meant that indoor gatherings of five people and outdoor gatherings of 24 could occur, and religious ceremonies could take place at 30% capacity. Non-essential services remained closed. In Vancouver, the weekly average case rate rose from about 13 per 100,000 the day the survey was released, to 27.4 per 100,000 the day the survey closed (BCCDC 2021). British Columbia had similarly remained under a state of emergency since November 2020, with residents asked to only socially gather or travel with people within the same household (CIHI 2021), although restaurants and other non-essential amenities were open at limited capacities.

Results

Overall, just 32% percent of pre-pandemic transit riders planned on riding transit less after the pandemic (see Table 3). However, 54% also agreed that the pandemic has made owning a vehicle more appealing. Still, this did not translate into mass car buying: only 26% reported looking into buying a vehicle, and 11% actually purchased one between survey waves. For context, this compares with 1.9 million vehicle purchases in Canada in 2019, equating to about 5% of the population buying cars in that year, suggesting that car purchasing rates in our sample are elevated compared to a pre-pandemic norm (Statistics Canada 2021b). In contrast, concurrent surveys on car purchase intention suggest 9% of Canadians intend to purchase a car within the next year (Turo and Leger 2021), while another suggests 44% intend to do so in the next two years, placing our survey of transit riders squarely in the average (CBB 2021). In sum, the share of our sample that purchased vehicles is higher than the population according to car sales statistics, but similar to or lower than would be expected given nationally representative surveys of car purchase intentions.

Respondents averaged 4.7 transit vehicle boardings over the past seven days, and this was 1.99 more boardings than in May 2020 but still 12.53 boardings less than before the pandemic, when respondents averaged 17.23 boardings per week. The average respondent found it harder to reach just under one out of five destination types while avoiding the mode. Notably, about 4% of riders either got COVID-19 or lived with someone who did. In contrast, total positive tests in Toronto equal 5.8% of the population (City of Toronto 2021b), and 3% in British Columbia (BCCDC 2021), where statistics are not reported at the city level.

The impact of the pandemic on vehicle ownership would be more important for transportation policy if it induced many zero-car households to purchase a vehicle. To assess this, we present in Table 4 our automobile-related outcome variables disaggregated by pre-pandemic car ownership status as reported in Wave 1, with 95% confidence intervals (in parenthesis). Roughly half of those who did not own a vehicle pre-pandemic find the crisis made vehicle ownership more appealing, versus two thirds of those who already owned a car. Those who could access but did not own a vehicle pre-pandemic were most likely to report looking into buying a car. Despite this, car purchases were highest among those who already owned a vehicle at 12.8%. In wave one we did not ask about the number of vehicles owned, so this 12.8% includes those who replaced a car as well as those in families that increased the number of vehicles they owned, and we cannot estimate the relative share of those two situations (Palm et al. 2021a).

Table 3 Summary statistics (n = 1954)

Variable	Min	Mean	Max
Dependent variables			
Agree/Strongly that "COVID-19 has made owning a car more appealing"	0	0.54	1
Agree/Strongly that "Because of COVID, I have looked into buying a car"	0	0.26	1
Bought a car between survey waves	0	0.11	1
Agree/Strongly that "After the crisis ends, I will probably ride transit less than I did before COVID"	0	0.32	1
Transit vehicle boardings in last 7 days	0	4.7	80
Change in transit vehicle boardings in March 2021 (wave 2) compared to May 2020 (wave 1)	-40	1.99	63
Demographic predictors			
City is Vancouver	0	0.48	1
Gender (ref: Female)	0	0.64	1
Male	0	0.28	1
Non-binary	0	0.08	1
Age (ref: 18–29 years old)	0	0.34	1
30–50 years old	0	0.44	1
50–64 years old	0	0.16	1
65 + years old	0	0.07	1
Immigrated in last five years	0	0.10	1
Essential worker (wave 1)	0	0.20	1
Employment Change (*ref: had a job in both waves*)	0	0.58	1
Gained employment between waves	0	0.20	1
Lost employment between waves	0	0.3	1
No employment either wave	0	0.19	1
Have a physical disability	0	0.03	1
Ethnicity/Race (ref: white)	0	0.66	1
Black	0	0.03	0
Indigenous	0	0.03	0
Non-Black or Indigenous POC	0	0.28	0

Table 3 (continued)

Variable	Min	Mean	Max
2019 income ($000 s)	0	72.84	150
Household size	1	2.53	13
Transportation & built form variables			
Wave 1 Vehicle Ownership (ref: no vehicle)	0	0.41	0
Had access	0	0.24	1
Owned a car	0	0.35	1
Hard to physically distance in my neighbourhood (wave 1)	0	0.39	1
Competitive transit access score	0.01	0.25	0.63
Change in competitive transit access score	-0.51	0.001	.48
Got COVID-19 or someone in household did	0	0.03	1

Table 4 Changes in automobility outcomes by pre-pandemic vehicle ownership

Pre-pandemic vehicle access	Agree/Strongly: "COVID-19 has made owning a car more appealing"	Agree/strongly: "Because of COVID, I have looked into buying a car"	Bought A Car Between Waves
No access	48.9% (45.2–52.4%)	23.8% (20.7–26.9%)	8.1% (6.0–10.0%)
Could access	56.8% (52.2–61.5%)	34.7% (30.2–39.1%)	11.5% (8.3–14.6%)
Owned a car	66% (65.7–69.3%)	21.9% (18.3–25.4%)	12.8% (10.1–15.4%)

Changes in transit travel and views on future transit use

Our modelling results on questions of transit travel behaviour suggest that the sociodemographic composition of transit ridership will continue to change as cities exit the pandemic. These findings are summarized in Table 5. The first column presents relative proportions (RPs) on agreement with the statement "After the crisis ends, I will probably ride transit less than I did before COVID-19." An RP of 0.57 can be interpreted as the independent variable reducing the likelihood of the outcome by 43%, while an RP of 1.05 can be interpreted as the variable increasing the likelihood of the outcome by 5%. The second column provides coefficients from an OLS model estimating the change in weekly vehicle boardings between March 2021 and May 2020. An OLS coefficient of 1.71 can be interpreted as stating that a one unit increase in the independent variable associated with a 1.71 unit increase in the dependent variable. Similarly, a -1.1 coefficient means that a one unit increase in the independent variable is associated to a 1.1 unit decrease in the dependent. The third column shows odds ratios predicting whether someone did not take a transit trip at all in March 2021, a step in the zero-inflated, negative binomial count model. An odds ratio of 1.50 can be interpreted as a one unit increase in the predictor variable being associated with a 1.50 times the odds of a positive case in the dependent variable (an increase). Similarly, an odds ratio of 0.56 means a one unit increase in the independent variable is associated with 0.56 time the odds of to the dependent variable being a positive case (a reduction). The fourth column presents the second step incident rate ratios for the count model. P-values across all models are included in parentheses. All models use inverse probability attrition weights and all but the negative binomial model report robust standard errors. Table 5 reports results from the relative weights analysis.

Who anticipates riding less after the pandemic? Living in a neighbourhood with strong transit accessibility pre-COVID-19 blunts respondents' likelihood of agreeing that they will ride transit less post-pandemic, as does gaining employment and being over the age of 65. In contrast, those who bought a car, who have trouble physical distancing in their neighborhoods, and those who gave up transit in wave 1 all planned on riding less in a post-pandemic future. The relative weight analysis points to car buying and giving up transit in the prior wave as explaining the greatest variance in anticipated future transit use, however, reflecting the 'stickiness' of some respondents' new travel habits (Salon et al. 2021). It also points to income as a positive predictor.

What predicts changes in transit boardings between March 2021 and May 2020? The second column of Tables 5 and 6 indicates that only a couple of factors mitigated against further decline in a rider's use of transit during the pandemic. This included gaining employment in between survey waves and experiencing difficulty without public transit in the early days of the crisis. Giving up transit in the early months of the pandemic is positively associated with an increase in trips between waves, suggesting that many riders returned to transit. In contrast, car buyers, car owners, and those who lost employment appear to have ridden less in March 2021 compared to the early months of the pandemic. Experiencing difficulty without public transit registers the greatest effect in the relative weight analysis, highlighting that many transit-dependent riders who could not make satisfactory use of other modes came back to transit.

What predicts the number of boardings per week in the middle of a pandemic? The third column in Table 5 presents the odds ratios of a binary model predicting that a respondent did not board transit at all in the prior week. Car owners and car buyers were

Table 5 Results from IPAW-weighted models with robust standard errors for predicting changes in transit usage, and views on post-pandemic transit use

	Agree/Strongly "After the crisis ends, I will probably ride transit less than I did before COVID-19"	Change in the number of weekly transit boardings March 2021 – Pre-COVID	Number of transit vehicle boardings in last seven days (March 2021)	
	RPs	Estimates	Odds Ratios- zero boardings	RPs-boarding counts
(Intercept)	0.24 (0.15, 0.38)***	0.41 (−2.11, 2.93)	0.50 (0.22, 1.14)^	3.86 (2.67, 5.59)***
Weekly boardings pre-COVID	1.01 (1.00, 1.01)	0.04 (−0.02, 0.09)	0.97 (0.96, 0.99)***	1.02 (1.02, 1.03)***
City is Vancouver (*ref: Toronto)*	0.94 (0.8, 1.10)	0.27 (−0.61, 1.14)	0.55 (0.41, 0.74)***	0.90 (0.79, 1.02)
Gender (ref: Female)				
Male	0.95 (0.80, 1.13)	−0.10 (−1.03, 0.84)	0.76 (0.56, 1.04)^	1.12 (0.98, 1.28)^
Non-binary	0.92 (0.69, 1.24)	0.19 (−1.39, 1.77)	0.90 (0.57, 1.41)	1.04 (0.84, 1.29)
Age (ref: 18–29 years old)				
30–50 years old	1.13 (0.95, 1.34)	0.42 (−0.56, 1.40)	1.43 (1.04, 1.96)*	1.14 (0.99, 1.32)^
50–64 years old	1.04 (0.80, 1.33)	0.99 (−0.30, 2.27)	1.06 (0.69, 1.64)	1.24 (1.02, 1.50)*
65 + years old	0.61 (0.37, 1.00)^	1.33 (−0.28, 2.95)	0.80 (0.42, 1.51)	1.44 (1.10, 1.88)**
Immigrated in last five years	1.08 (0.84, 1.39)	1.45 (−0.36, 3.25)	0.56 (0.35, 0.91)*	1.08 (0.90, 1.30)
Essential worker (wave 1)	0.83 (0.66, 1.04)	−0.06 (−1.41, 1.29)	0.59 (0.4, 0.87)**	1.76 (1.5, 2.07)***
Employment change (ref: had a job in both waves)				
Gained employment between waves	0.68 (0.55, 0.85)***	1.71 (0.42, 3.01)**	0.77 (0.54, 1.11)	1.57 (1.31, 1.87)***
Lost employment between waves	1.16 (0.75, 1.79)	−3.12 (−5.28, −0.96)**	0.78 (0.32, 1.88)	0.63 (0.46, 0.86)**
No employment either wave	0.82 (0.64, 1.06)	−0.81 (−1.91, 0.29)	0.95 (0.62, 1.44)	0.88 (0.72, 1.07)
Have a physical disability	0.83 (0.52, 1.32)	1.28 (−1.16, 3.72)	0.69 (0.32, 1.51)	1.22 (0.85, 1.76)
Ethnicity/Race (ref: white)				
Black	0.64 (0.34, 1.22)	1.25 (−1.09, 3.58)	1.20 (0.59, 2.44)	1.48 (1.09, 2.02)*
Indigenous	0.99 (0.66, 1.48)	0.47 (−2.47, 3.41)	0.82 (0.37, 1.81)	1.23 (0.93, 1.62)
Non-Black or Indigenous POC	0.97 (0.81, 1.16)	0.11 (−0.81, 1.03)	1.24 (0.90, 1.70)	1.07 (0.92, 1.24)
2019 income ($000 s)	1.00 (1.00, 1.00)	0.00 (−0.01, 0.01)	1.00 (1.00, 1.01)*	1.00 (1.00, 1.00)
Wave 1 vehicle ownership				
Had access	0.85 (0.68, 1.06)	0.01 (−1.07, 1.08)	1.21 (0.85, 1.73)	1.01 (0.86, 1.18)

Table 5 (continued)

	Agree/Strongly "After the crisis ends, I will probably ride transit less than I did before COVID-19"	Change in the number of weekly transit boardings March 2021 – Pre-COVID	Number of transit vehicle boardings in last seven days (March 2021)	
	RPs	Estimates	Odds Ratios- zero boardings	RPs-boarding counts
Owned a car	1.09 (0.90, 1.34)	−0.93 (−1.90, 0.04)^	2.28 (1.60, 3.26)***	0.86 (0.71, 1.04)
Bought a car between waves 1 and 2	1.65 (1.36, 2.01)***	−1.92 (−3.23, −0.62)**	2.2 (1.38, 3.52)***	0.88 (0.68, 1.13)
Hard to physically distance in my neighbourhood (wave 1)	1.24 (1.05, 1.45)**	−0.34 (−1.21, 0.52)	1.14 (0.86, 1.51)	0.96 (0.84, 1.09)
Competitive transit access score	0.40 (0.20, 0.79)**	0.91 (−2.83, 4.64)	0.44 (0.13, 1.48)	1.37 (0.76, 2.45)
Got COVID-19 or someone in household did	1.07 (0.71, 1.60)	0.15 (−1.87, 2.17)	0.73 (0.36, 1.50)	1.09 (0.79, 1.51)
Stopped riding when COVID began (wave 1)	2.18 (1.71, 2.78)***	0.97 (−0.01, 1.95)^	5.86 (4.04, 8.49)***	0.64 (0.53, 0.76)***
Experienced difficulty without transit (wave 1)	0.96 (0.90, 1.03)	0.32 (−0.01, 0.65)^	0.94 (0.84, 1.06)	1.04 (0.97, 1.12)
Household size (n)	0.96 (0.90, 1.02)	−0.11 (−0.48, 0.27)	0.88 (0.79, 0.98)*	1.03 (0.98, 1.08)
Degrees of freedom	1550	1550	1558	
Test Statistics	2004 (AIC)	0.03 (Adj R^2)	7003 (AIC)	

*^$p < 0.10$ * $p < 0.05$ ** $p < 0.01$ *** $p < 0.001$; did not use robust SEs*

Table 6 Relative Weights Analysis of transit models

	Agree/Strongly "After the crisis ends, I will probably ride transit less than I did before COVID-19"	Change in the number of weekly transit boardings March 2021 – Pre-COVID	Number of transit vehicle boardings in last seven days (March 2021)
Weekly boardings pre-COVID	0.017	0.076	0.264
City is Vancouver (*ref: Toronto*)	−0.06	−0.036	0.004
Gender (ref: Female)			
Male	−0.032	−0.015	0.042
Non-binary	−0.005	−0.001	0.025
Age (ref: 18–29 years old)	0	0	0
30–50 years old	0.09	−0.025	−0.009
50–64 years old	−0.015	0.015	0.035
65 + years old	−0.105	0.005	0.018
Immigrated in last five years	0.009	0.027	0.081
Essential worker (wave 1)	−0.074	−0.056	0.292
Employment change (ref: had a job in both waves)			
Gained employment between waves	−0.054	0.102	0.056
Lost employment between waves	−0.004	−0.035	0.01
No employment either wave	−0.068	−0.039	−0.068
Have a physical disability	−0.022	0.035	0.018
Ethnicity/Race (ref: white)			
Black	−0.03	0.022	0.061
Indigenous	0.006	0.009	0.101
Non-Black or Indigenous POC	−0.001	−0.022	0.023
2019 income ($000 s)	0.104	−0.032	−0.157
Wave 1 vehicle ownership			
Had access	0.104	−0.06	−0.209
Owned a car	−0.038	0.028	−0.029
Bought a car between waves 1 and 2	0.139	−0.071	−0.057

Table 6 (continued)

	Agree/Strongly "After the crisis ends, I will probably ride transit less than I did before COVID-19"	Change in the number of weekly transit boardings March 2021 – Pre-COVID	Number of transit vehicle boardings in last seven days (March 2021)
Hard to physically distance in my neighbourhood (wave 1)	0.072	0.029	−0.013
Competitive transit access score	−0.038	0.013	0.004
Got COVID-19 or someone in household did	0.008	0.003	0.004
Stopped riding when COVID-19 began (wave 1)	0.23	0.09	−0.397
Experienced difficulty without transit (wave 1)	0.071	0.122	−0.1
Household size (n)	0.019	−0.027	0.005

Relative weights produced on an OLS regression of boardings due to statistical package limitations statistically more likely to have made zero transit boardings despite the sample including only those who rode transit regularly pre-pandemic. People ages 30 to 50 were also more likely to have made zero boardings. Essential workers, immigrants, males, and residents of Vancouver were significantly less likely to have made zero boardings. The more someone boarded transit pre-COVID, the less likely they were to make zero boardings in March 2021. Conditional on these results, column 4 shows incidence risk ratios for a count model of boardings made in the reference week. Black respondents, essential workers, people over the age of 50 and those who gained employment were associated with boarding more transit vehicles in March 2021, while those who lost employment and those who stopped riding in the early months of the pandemic boarded less. Pre-COVID boardings are also a powerful explainer of variation in March 2021, as demonstrated by the RWA. In sum, demographic differences in responses to the pandemic have held among transit riders (He et al. 2022; Liu et al. 2020; Palm et al. 2021a). Some of these factors, such as higher transit use among immigrants and the negative relationship between transit usage and both incomes and vehicle ownership, mirror the findings of the ridership change literature from the decade prior to the pandemic (Blumenberg and Evans 2010; Manville et al. 2018a, b; Taylor and Fink 2013).

Modelling car-purchases and attitudes towards vehicles

Our second set of models suggest that immigrants and twentysomethings seem more attracted to vehicle ownership than other groups and are taking steps to purchase vehicles. Each dependent variable is modeled twice, once using the entire sample, and once using the subsample of respondents who did not own a vehicle in wave 1 (i.e. those who had other access to a vehicle or those with no access at all). This enables us to evaluate who among pre-pandemic non-car owners bought vehicles, allowing us to better discern the long-term implications of COVID-19 for sustainable transportation. All these results are presented as relative proportions derived from Poisson regression models in Table 6, 95% confidence intervals in parentheses. All models were calculated using IPAW weights and robust standard errors. Table 7 reports model results and Table 8 presents results from the relative weights analysis.

For whom has vehicle ownership become more appealing? Recent immigrants, those who had trouble with physical distancing in their neighbourhoods, car owners, and those who stopped riding transit when the pandemic began are more likely to find automobile more appealing in the wake of the crisis. These results hold when we repeat the model just among those who did not own a vehicle pre-pandemic. In contrast, men and older transit riders, including everyone over the age of 30, are significantly less likely to report that the pandemic has increased the appeal of vehicle ownership. Higher transit access is also associated with a lesser likelihood of finding vehicle ownership more appealing. Among all of these variables, the relative weight analysis points to age factors, prior vehicle ownership and giving up transit early on in the pandemic as indicators explain the greatest variation in the data. However, recent immigration is also a major factor when the analysis is limited to people who did not own pre-pandemic.

Who looked into buying a car because of the pandemic? Recent immigrants, people who had trouble maintaining physical distancing, and people who had trouble reaching destinations without public transit seemed more likely to have investigated buying a car. Notably, those who got COVID-19 or lived with someone who did were also more likely to have investigated buying a car. In comparison, people over the age of 50 are less

Table 7 Relative proportions on IPAW-weighted models with robust standard errors for vehicle purchase and attitudes towards vehicle ownership

	Agree/Strongly: "COVID-19 has made owning a car more appealing"		Agree/strongly: "Because of COVID, I have looked into buying a car"		Bought a car between waves	
	All	No car wave 1	All	No car wave 1	All	No car wave 1
(Intercept)	0.57 (0.46, 0.70)***	0.59 (0.44, 0.8)***	0.26 (0.17, 0.4)***	0.28 (0.17, 0.46)***	0.1 (0.05, 0.20)***	0.1 (0.04, 0.27)***
City is Vancouver (ref: Toronto)	0.95 (0.87, 1.04)	0.94 (0.82, 1.06)	0.96 (0.8, 1.15)	0.89 (0.72, 1.09)	1.22 (0.89, 1.66)	1.09 (0.72, 1.64)
Gender (ref: Female)						
Male	0.86 (0.78, 0.95)**	0.79 (0.68, 0.91)**	1.16 (0.97, 1.39)	1.11 (0.90, 1.37)	0.99 (0.71, 1.39)	1.2 (0.78, 1.86)
Non-binary	1.02 (0.88, 1.18)	1.07 (0.88, 1.30)	0.75 (0.51, 1.11)	0.74 (0.47, 1.15)	0.77 (0.39, 1.53)	0.64 (0.23, 1.74)
Age(ref: 18–29 years old)						
30–50 years old	0.86 (0.79, 0.94)***	0.82 (0.73, 0.93)**	0.89 (0.75, 1.07)	0.92 (0.75, 1.13)	0.71 (0.51, 0.99)*	0.68 (0.45, 1.05)^
50–64 years old	0.60 (0.5, 0.71)***	0.50 (0.37, 0.67)***	0.37 (0.24, 0.57)***	0.39 (0.23, 0.66)***	0.87 (0.53, 1.43)	0.91 (0.46, 1.80)
65 years and older	0.49 (0.37, 0.65)***	0.42 (0.26, 0.67)***	0.33 (0.16, 0.68)**	0.4 (0.17, 0.96)*	0.27 (0.08, 0.87)*	0.25 (0.03, 1.85)
Immigrated in the last five years	1.19 (1.05, 1.36)**	1.25 (1.06, 1.47)**	1.32 (1.05, 1.66)*	1.49 (1.17, 1.91)***	1.57 (1.00, 2.45)*	1.52 (0.89, 2.60)
Essential worker (wave 1)	0.94 (0.83, 1.07)	0.89 (0.75, 1.07)	1.12 (0.88, 1.42)	1.02 (0.77, 1.34)	1.3 (0.89, 1.89)	1.41 (0.88, 2.28)
Employment change (ref: had a job in both waves)						
Gained employment between waves	1.05 (0.95, 1.16)	1.02 (0.89, 1.18)	0.92 (0.73, 1.15)	0.91 (0.71, 1.17)	1.05 (0.71, 1.54)	0.93 (0.56, 1.56)
Lost employment between waves	1.17 (0.96, 1.42)	1.05 (0.8, 1.39)	1.05 (0.7, 1.58)	1.01 (0.64, 1.59)	1.14 (0.55, 2.34)	0.56 (0.17, 1.81)
No employment either wave	0.93 (0.81, 1.06)	0.9 (0.74, 1.10)	0.92 (0.69, 1.22)	0.86 (0.62, 1.20)	0.75 (0.45, 1.24)	0.49 (0.24, 0.99)*
Have a physical disability	1.04 (0.82, 1.32)	1.02 (0.72, 1.42)	0.78 (0.39, 1.58)	0.63 (0.24, 1.61)	1.19 (0.44, 3.18)	0.62 (0.08, 4.72)
Ethnicity/Race (ref: white)						
Black	1.16 (0.93, 1.45)	1.15 (0.88, 1.49)	1.2 (0.78, 1.85)	1.14 (0.71, 1.83)	1.05 (0.46, 2.37)	0.57 (0.16, 1.99)
Indigenous	0.95 (0.73, 1.23)	0.91 (0.64, 1.29)	1.24 (0.8, 1.93)	1.28 (0.76, 2.13)	1.65 (0.85, 3.21)	1.28 (0.47, 3.52)
Non-Black or Indigenous POC	1.04 (0.95, 1.14)	1.05 (0.92, 1.2)	1.21 (1.01, 1.47)*	1.19 (0.96, 1.48)	1.19 (0.84, 1.68)	1.23 (0.77, 1.95)
2019 income ($000 s)	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)	1.00 (1.00, 1.00)	1.00 (1.00, 1.01)^	1.00 (1.00, 1.01)
Wave 1 vehicle ownership						
Had access	1.44 (1.29, 1.61)***		0.97 (0.75, 1.25)		1.43 (0.92, 2.22)	
Owned a car	1.09 (0.97, 1.23)	1.1 (0.97, 1.25)	1.43 (1.15, 1.76)***	1.48 (1.19, 1.85)***	1.3 (0.85, 2.00)	1.33 (0.84, 2.10)

Table 7 (continued)

	Agree/Strongly: "COVID-19 has made owning a car more appealing"		Agree/strongly: "Because of COVID, I have looked into buying a car"		Bought a car between waves	
	All	No car wave 1	All	No car wave 1	All	No car wave 1
Hard to physically distance in my neighbourhood (wave 1)	1.17 (1.07, 1.28)***	1.2 (1.06, 1.35)**	1.33 (1.12, 1.57)***	1.37 (1.13, 1.67)**	1.07 (0.77, 1.49)	0.98 (0.63, 1.52)
Competitive transit access	0.69 (0.48, 0.98)*	0.73 (0.44, 1.23)	0.41 (0.2, 0.82)*	0.38 (0.17, 0.86)*	0.19 (0.06, 0.62)**	0.24 (0.04, 1.28)^
Got COVID or someone in household did	1.10 (0.92, 1.31)	1.02 (0.78, 1.34)	1.4 (0.99, 1.98)^	1.34 (0.9, 2.02)	1.93 (1.11, 3.36)*	2.51 (1.34, 4.69)**
Stopped riding in May 2020 (wave 1)	1.15 (1.02, 1.30)*	1.02 (0.87, 1.20)	1.19 (0.93, 1.52)	1.13 (0.86, 1.48)	1.07 (0.69, 1.66)	1.24 (0.73, 2.11)
Number amenities harder to reach without transit (wave 1)	1.02 (0.98, 1.06)	1.05 (1, 1.10)^	1.08 (1.00, 1.16)*	1.06 (0.98, 1.16)	1.09 (0.93, 1.27)	1.03 (0.84, 1.25)
Degrees of freedom	1751	1123	1531	1327	1577	1015
AIC	3021	1961	1845	1387	1075	671

^ $p < 0.10$* $p < 0.05$** $p < 0.01$*** $p < 0.001$

Table 8 Relative weights analysis of auto models

	Agree/Strongly: "COVID-19 has made owning a car more appealing"		Agree/strongly: "Because of COVID, I have looked into buying a car"		Bought a car between waves	
	All	Not prior owners	All	Not prior owners	All	Not prior owners
City is Vancouver (ref: Toronto)	−0.03	−0.071	−0.015	−0.027	0.033	0.021
Gender (ref: Female)						
Male	−0.047	−0.1	0.033	0.031	0.006	0.035
Non-binary	−0.037	0.044	−0.038	−0.04	−0.03	−0.048
Age (ref: 18–29 years old)						
30–50 years old	0.029	0.003	0.036	0.036	−0.022	−0.027
50–64 years old	−0.111	−0.169	−0.15	−0.152	−0.01	−0.018
65 years and older	−0.061	−0.137	−0.109	−0.105	−0.07	−0.068
Immigrated in last five years	−0.017	0.08	0.098	0.12	0.049	0.075
Essential worker (wave 1)	−0.075	−0.064	0.006	−0.013	0.032	0.042
Employment change (ref: had a job in both waves)						
Gained employment between waves	0.077	0.08	0.011	0.018	0.016	0.007
Lost employment between waves	0.028	0.01	0.017	0.011	0.024	−0.009
No employment either wave	−0.091	−0.103	−0.055	−0.073	−0.058	−0.084
Have a physical disability	−0.027	−0.032	−0.038	−0.058	−0.01	−0.039
Ethnicity/Race (ref: white)						
Black	−0.028	0.028	0.025	0.008	0.009	-0.022
Indigenous	−0.033	−0.029	−0.004	−0.017	0.041	0.007
Non-Black or Indigenous POC	−0.029	0.051	0.11	0.118	0.043	0.073
2019 income ($000 s)	0.103	0.028	−0.027	0.03	0.056	0.053
Wave 1 vehicle ownership						
Owned a car	0.143		-0.066		0.057	

Table 8 (continued)

	Agree/Strongly: "COVID-19 has made owning a car more appealing"		Agree/strongly: "Because of COVID, I have looked into buying a car"		Bought a car between waves	
	All	Not prior owners	All	Not prior owners	All	Not prior owners
Had access	−0.009	0.087	0.12	0.12	0.022	0.066
Hard to physically distance in my neighbourhood (wave 1)	0.071	0.133	0.077	0.089	−0.005	−0.021
Competitive transit access core	−0.022	−0.029	−0.065	−0.073	−0.086	−0.069
Got COVID-19 or someone in household did	0.044	0.028	0.067	0.069	0.06	0.075
Stopped riding in May 2020 (wave 1)	0.146	0.13	0.081	0.108	0.04	0.043
Number amenities harder to reach without transit (wave 1)	0.04	0.127	0.11	0.107	0.021	0.023

likely to have, at least relative to twentysomethings. The relative weights analysis mirrors these results, except in the case of non-Black people of colour, which shows as a relatively important factor.

Who bought a car? Recent immigrants and people in a household where someone got COVID-19 were both associated with a higher likelihood to have bought a car. In contrast, people over 30 seemed less likely to have bought a car. As with the other auto focused models, transit accessibility correlated negatively with car purchasing. Only presence of COVID-19 in the household retains significance in a model of those who did not own a vehicle pre-pandemic. The relative weight analysis, however, suggests that transit access, being a recent immigrant, and being a non-Black person of colour explain the most variance in the outcome.

Conclusions

COVID-19 forced many transit riders to choose between possible exposure to a new disease or having to give up a key mobility resource, and this choice was much easier for those who owned vehicles and lived in walkable neighbourhoods (Palm et al. 2021a). In this follow-up survey we find that the challenges associated with giving up transit may have increased the appeal of vehicle ownership among some transit riders, while inducing others to start riding again. Respondents who reported higher levels of difficulty reaching essential destinations while avoiding public transit, as first modeled in Palm et al. (2021a), were more likely to increase their transit boardings, and this was one of the strongest predictors in the relative weights analysis. Inequities in mobility thus remain at the forefront of understanding transit travelers' behaviour changes coming out of the COVID-19 pandemic. Groups more likely to use transit at the onset of the pandemic, such as people of color, essential workers, and recent immigrants (He et al. 2022; Liu et al. 2020; Palm et al. 2021a), continued to use transit at relatively higher rates nearly a year into the crisis. Vehicle owners have continued to stay away, and people who bought cars during the pandemic have joined them. Our results suggest that transit has lost many of its so-called 'choice' riders who had other alternatives (Taylor and Morris 2015), and they have much less desire to return than others.

Twentysomethings and recent immigrants are two rider segments that are consistently more turned off of public transit and more interested in vehicle ownership as a direct result of the pandemic. This does not necessarily mean that transit has lost a generation of potential riders, as these are also the riders most likely to transition into vehicle ownership as they age or, in the case of immigrants, as they begin to adopt the mobility patterns of North America (Blumenberg and Evans 2010; Farber et al. 2018). Our results on age may also reflect our unique sampling frame: those who ride transit regularly later in life are more dependent upon or more settled into a life of using the mode compared to younger frequent users, pandemic or no pandemic. We thus conclude that the pandemic merely hastened some rider's adoption of automobility, similar to conclusions drawn by Basu and Ferreira in their analysis of Boston (Basu and Ferreira 2021) and Delbosc and McCarthy in their interviews around Melbourne (Delbosc and McCarthy 2021). But our work shows that current twentysomethings, often referred to colloquially as "Gen Z," may not be as transit-friendly as Millennials were promised to be (Sakaria and Stehfest 2013). Our results underscore the enduring importance of vehicle ownership in daily life and wellbeing in North America, as some regular transit riders in Canada found buying a car a necessary and helpful response to the pandemic. Respondents articulated these sentiments despite the survey running at a time when supply chain shortages triggered historic inflation in automobile prices that may have pushed vehicle ownership out of reach for many (Foran 2021).

Our results demonstrate why maintaining high quality transit service should be the primary focus for policymakers hoping to recover transit ridership. In nearly all our models, those with greater transit accessibility are less likely to be attracted to vehicle ownership, are less likely to have bought a vehicle, and are less likely to anticipate riding transit less often post-pandemic. This variable may also be expressing the impact of the cost or lack of parking in transit rich urban cores where transit accessibility is high, but it nonetheless shows that those in areas with higher transit accessibility are more committed to using these services.

We find evidence that the experience of getting COVID-19, or living with someone who did, was associated with an increased likelihood of buying a car. This is consistent with the findings of Dong et al. (Dong et al. 2021), who mention that riders who perceive the virus as "close" have higher levels of anxiety and, as a consequence, may reduce their transit travel. Our other modeling suggests that the experience of COVID-19 in the household has changed attitudes towards auto-ownership. This topic merits further attention from researchers and decision-makers, as it is something that transit agencies will have to reckon with despite having no control over it.

Our analysis contains several limitations stemming mostly from a low completion rate of our second survey. We had to dichotomize our outcome variables and a few predictors, and we had to rely on weights to correct for significant attrition between survey waves. In addition, the interpretation of estimates from multivariable regression is complex due to interrelationships among predictor variables (Westreich and Greenland 2013). However, our findings point to clear hypotheses that further studies with causal design could evaluate further.

Our future work will be focused on text mining and content analysis of 1,400 comments from respondents on why they anticipate riding transit less often (or not) after COVID-19. This analysis is expected to give a better understanding on how people envision the post-pandemic era, the reasons behind their expected travel behaviour. Building on this work, cluster analyses will be performed to identify different user profiles considering their previous, actual, and expected travel behaviour. Finally, we aim to conduct a third wave in 2022 that will measure travel behaviour and attitudes in a Canada.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11116-022-10344-2.

Acknowledgements The lead author is supported by funding from the Social Sciences and Humanities Research Council's partnership grant: Mobilizing justice: towards evidence-based transportation equity policy. Partial financial support was also received from the University of Toronto School of Cities, the Ontario Research Fund and the Canada Research Chair in Transportation and Health.

Author contributions MP Conceptualization, Methodology, Software, Formal Analysis, Investigation, Data Curation, Writing—Original draft preparation, Writing- Review & Editing, Project Administration. JA: Conceptualization, Software, Investigation, Writing- Review & Editing. YZ: Conceptualization, Software, Investigation, Writing- Review & Editing. ITA: Validation, Formal Analysis, Writing- Review & Editing. BK: Conceptualization, Methodology, Writing—Review & Editing, Data Curation, Investigation. SF: Conceptualization, Reviewing and Editing, Methodology, Funding acquisition. MW: Conceptualization, Reviewing and Editing, Methodology, Funding acquisition.

Declarations

Conflict of interest The authors have no relevant financial or non-financial interests to disclose.

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