Who is willing to take transit in the future? Older adults' perceived challenges and barriers to using public transit across Canada

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A B S T R A C T

Offering public transit services that meet the needs of older adults can contribute to their independence and well-being. Based on the Aging in Place survey conducted in March 2023 (N = 3,551), this research explores the barriers preventing older Canadians (65 and older) from using public transit in their area of residence. Specifically, we use factor and cluster analysis to identify non-transit user profiles (N = 491) based on survey participants' perceptions of public transit and their stated willingness to use it in the next year. We find four distinct groups, including transit inclined, transit is a last resort, transit is not for now, and transit averse. Each group shows variation in the extent to which they are willing to use public transit in the future. To add nuances to our segmentation findings, we conduct a thematic analysis of an open-ended question pertaining to barriers to using public transit in each region. Access to public transit, frequency, travel time, reliability, safety, infrastructure, and convenience are defined as areas for potential improvement, though the prevalence of the concerns did vary between the non-user profiles. The findings from this research can be of interest to decision-makers and public transit agencies as accounting for the heterogeneity of non-transit users can help in directing strategies promoting public transit adoption among older adults in the future.

1. Introduction

Older adults' level of mobility can decrease due to age-related challenges and life events. They tend to make fewer and shorter trips and rely more heavily on private vehicles to get around, especially in the North American context (Newbold et al., 2005; Spinney et al., 2009; Wasfi & Levinson, 2007). As driving cessation becomes more prevalent with age, older populations can experience loss of independence (Choi & DiNitto, 2016; Kandasamy et al., 2018; Mezuk & Rebok, 2008; Musselwhite & Shergold, 2013; Public Health Agency of Canada, 2023; Qin et al., 2020). Convenient and affordable public transit options can increase community participation, the usage of public amenities as well as physical and emotional wellbeing among older adults (Freeland et al., 2013; He et al., 2018; He et al., 2020; Hess, 2012; Wasfi et al., 2013). Representing an increasingly significant proportion of our population (World Health

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Organization, 2021), addressing their transport concerns is of particular importance. Encouraging them to reduce their dependence on private vehicles and increase their use of sustainable modes can have positive effects on their lives. However, changing life-long behaviours, such as sustained car use, is not straightforward (Bamberg et al., 2003a; Ravensbergen et al., 2022a; Siren & Haustein, 2013).

Travel behaviours and preferences are often developed over time and become habitual (Fujii et al., 2001; Gärling & Garvill, 1993). Behavioural modification, such as switching modes, tends to be spurred by significant personal (i.e., retirement, moving) or contextual (i.e., free fare, new infrastructure) disruptions. Maintaining this new habit demands that the chosen mode continue to be an adequate travel alternative and provide a certain level of travel satisfaction (Bamberg et al., 2003a; De Vos & Witlox, 2017). For older adults, though age can further cement certain habits, the life transitions which accompany this stage of life can result in the adoption of new travel behaviours. This could not only ease the switch to sustainable modes but contribute to older adults' long-term health and well-being. It is therefore important to identify who among older adults are able and willing to make these changes and what are the policies need to be implemented to help in this change.

Drawing on the results of the 2023 Aging in Place survey conducted across six Canadian cities (N = 3,551), this paper seeks to answer the following research questions: (i) What profile of older adult are willing to start using public transit in the future? and (ii) What is making them apprehensive about using public transit? To answer these questions, our study applies a combination of factor, cluster, and thematic analysis to a sample of older adults who reported not having used public transit in the past year (N = 491). We apply factor and cluster analysis to derive a set of non-user profiles based on their perceptions of public transit as well as their behavioral intentions towards it (i.e., willingness to use and to recommend). For each non-user profile, we analyze open-ended comments through a thematic analysis, which aims to identify the concerns that are deterring each older adult identified sub-group from using public transit.

2. Literature review

Older adults tend to be concerned about the various aspects of travelling by public transit, starting from planning to reaching their destination (Shrestha et al., 2017). The number and location of transit stops as well as the ease of reaching them on foot are defined as deterrents to public transit use among older adults (Dabelko-Schoeny et al., 2021; Shrestha et al., 2017). Older adults tend to favour shorter access to public transit stops (Moran et al., 2014), which is especially relevant for those who experience frailty or other health conditions related to aging (Gimie et al., 2022; Ravensbergen et al., 2021). In this sense, perceived walking time is significantly related to transit use and ridership among this population (Hess, 2012). Previous research has found that to promote walking among the elderly, a combination of factors is relevant (Van Cauwenberg et al., 2012). Van Cauwenberg et al. (2012) state that while the basic is to provide well-maintained walking infrastructure, such as sidewalks, crossings, and benches, ensuring they feel safe from traffic and crime is also necessary.

The quality of transit services is another challenge. Services that are not perceived as reliable, convenient, and comfortable are likely to discourage older adults from using them (Habib et al., 2011; Ravensbergen et al., 2023; Redman et al., 2013). Older adults tend to have lower levels of accessibility (i.e., ease of reaching destinations) by transit than other segments of the population (Ravensbergen et al., 2022b), which is likely to lead to lower levels of perceived convenience and of transit's ability to meet their travel needs. Other considerations are the difficulties of boarding and alighting vehicles, the complexity of navigating the transit network, personnel behaviour, and the availability of clear information (Dabelko-Schoeny et al., 2021; Lamanna et al., 2020; Ragland et al., 2019; Shrestha et al., 2017). Older adults wish for more off-peak service frequency, including evenings and weekends (Ravensbergen et al., 2023). Safety concerns can contribute to transit avoidance both in terms of fear from crime and from falling and getting injured (Shrestha et al., 2017). More recently, many older adults stopped using transit due to fear of infection during the COVID-19 pandemic have yet to return to use the public transit systems (Long et al., 2023).

Preconceived opinions regarding transit may discourage older adults from using it. Many perceive transit services as inefficient, unreliable, and difficult to access (Panahi et al., 2022), thus preferring to keep driving, to use other services (e.g., taxi) (Panahi et al., 2022), or rely on family and friends to get around (Lehning et al., 2017). In fact, personal car use is found to be negatively associated both with intention to use and actual use of public transit (Şimşekoğlu et al., 2015). Encouraging a switch from car use to public transit use requires ensuring highly reliable and comfortable transit service in addition to policies that make car use substantially more expensive and inconvenient compared public transit (Bamberg et al., 2003b; Redman et al., 2013). Other common negative perceptions of transit may prevent older adults from using transit, such as it being dirty or unsafe (Shrestha et al., 2017). Those who have never used transit or stopped a long time ago may feel reluctant to do so as they may have to develop or renew transit-specific abilities, such as trip planning (i.e., navigating the network) (Ravensbergen et al., 2022a). Due to the tie between driving cessation and adoption of public transit, some older adults may also associate public transit with a loss of independence, making them more reticent to use the mode before it becomes "necessary".

General challenges and barriers to transit adoption by older adults are being explored in the literature. However, given the age group's unique challenges and their increasing need for public transit as they age to enable them to travel independently, studying potential older users separately could aid in better addressing the challenges faced by them to encourage their use of public transit. To the best of our knowledge, no previous study has looked at the profile and needs of older non-transit users based on their willingness to start taking transit in the future while considering their perceptions of transit, behavioral intentions, socio-demographic characteristics and their perceived challenges and concerns to transit adoption. Even within the general transit market literature, non-riders' input is not readily available, and the segment of non-users is rarely addressed (Krizek & El-Geneidy, 2007). In this study, we combine quantitative survey data and qualitative free short-form responses, allowing us to gain a more profound understanding of older adults'

self-described barriers to public transit use, all while accounting for their receptivity to taking transit in the future.

3. Data

This study draws from the Aging in Place Survey, a bilingual online survey conducted by the Transportation Research at McGill (TRAM) group. The survey focuses on the travel needs and experiences of older adults (65 years and older) across six metropolitan regions in Canada, namely Toronto, Montréal, Vancouver, Halifax, Victoria, and Saskatoon. As proposed by Dillman et al. (2014), multiple recruitment strategies were employed to ensure a large and representative sample, such as the distribution of flyers at senior and community centers, social media advertising, senior center mailing lists, newspaper and radio interviews, and recruitment through Léger, a market research and analytics company specialized in public opinion surveys. Data collection was completed in Winter 2023, and out of the 5,964 responses received, 3,551 were deemed complete and valid after a thorough cleaning process. For more detailed information on the data collection and cleaning procedures see Alousi-Jones et al. (2024).

To identify profiles of older adults willing to use transit and the issues preventing them from doing so, we select respondents who meet the following three criteria (i) those who have not used public transit within the past year (N = 751), (ii) who have suitably gave their opinion on the quality of public transit service (N = 541), and (iii) answered the following optional open-ended question: "Is there anything that would make you choose to take transit in your region?" (N = 491). For each respondent, we explore perceptions (i.e., reliability, convenience, affordability, comfort, and safety) and behavioral intentions towards transit (willingness to use and to recommend transit services). Both sets of variables are measured on a 4-point Likert scale. Neutral is not included in the scale, yet respondents were allowed to select "I don't know" as a response. For the analysis, these variables were recoded on a −2 to 2 scale, where zero represents "I don't know". Those who indicated "Does not apply" for any of the statements were excluded from the analysis. We use these variables to identify profiles of non-transit users through a combination of factor and cluster analyses. The profiles are further characterized by sociodemographic characteristics (age, gender, immigration status, household income, reported disability status, and access to a car) as well as by the results of a thematic analysis derived from the above-mentioned open-ended question, uncovering the challenges and barriers that are preventing respondents from using public transit.

4. Methods

4.1. Exploratory factor analysis

Factor analysis recognizes the smallest number of single underlying latent constructs (i.e., factors) based on the covariance structure among a set of variables (Hair et al., 2014). We apply this technique to reduce the number of variables with a minimum loss of information, focusing on variables reflecting perceptions and behavioral intentions toward transit. The attitudinal questions included in the factor analysis are:

- Public transit in my region is a reliable way of travelling
- Public transit in my region is a convenient way of travelling
- Public transit in my region is a comfortable way of travelling
- Public transit in my region is a safe way of travelling

To do so, we conduct a principal components exploratory factor analysis using both *psych* and *factoextra* packages in R based on Pearson correlation matrices. The number of factors extracted was defined based on latent root criterion (eigenvalue ≥1) and parallel analysis, which has been found to perform better than scree plots in determining the number of components to be retained (Zwick & Velicer, 1986). To reduce the likelihood of variables loading highly in more than one factor and facilitate the replicability of the results, varimax was applied as the rotation method (Hair et al., 2014). Only variables with loadings greater or equal to 0.5 were retained to ensure statistical significance (Hair et al., 2014) and those not meeting this criterion were removed from the analysis. Factorability of the samples was assessed prior to the analyses by confirming that all variables correlate significantly to at least one other variable (r ≥ 0.3), by ensuring their levels of sampling adequacy (KMO ≥ 0.7), and by observing that the found correlation matrix is not the identity matrix (a significant result for the Bartlett's Test of Sphericity).

4.2. Clustering

We cluster the sample in two stages. First, we apply k-means clustering to identify groups with similar current attitudes toward transit use. K-means clustering aims to minimize the differences within groups while maximizing the differences between them. Based on a centroid method algorithm, clusters are redefined every time a new observation is grouped leading to new centroid to be derived. Centroids are based on the mean values of the responses for the variables being assessed (Hair et al., 2014). To cluster the sample at hand, we combine factor scores, calculated in the previous step, with two unfactored, yet relevant variables taken from the survey:

- Public transit in my region is an affordable way of travelling
- I would recommend public transit in my region to a friend or family member

To define the number of clusters, we use transit-specific criteria as proposed by Krizek and El-Geneidy (2007), which include

assessing cluster characteristics, relevance and transferability to transport policy, previous studies, and common sense and intuition. Complementarily, we use silhouette analysis, which can help identify the optimal number of clusters based on the separating distance between them. To evaluate the consistency of the cluster solution, we redid the analysis three times while randomly omitting 10 % of the observations to ensure the stability of the clusters.

All identified clusters in the first stage were further segmented based on their ridership potential according to their willingness to use transit within the next year. This second stage aims to differentiate groups based on whether respondents have a near-term or longer-term potential to use public transit, guiding timelines for the implementation of policies that encourage ridership among older adults. We characterize each cluster based on sociodemographic variables and shared challenges, concerns, and barriers to public transit adoption as resulted from a thematic analysis.

4.3. Thematic analysis

To deepen our understanding of the respondents' barriers to using transit, we use thematic analysis to analyze the following open-ended question:

> Is there anything that would make you choose to take public transit in your region?

The goal was to find repeated patterns of meaning across the qualitative data at a semantic (explicit) level (Braun & Clarke, 2006), which were grouped by cluster. We follow the approach laid out by Guest et al. (2012) termed Applied Thematic Analysis (ATE). This approach has an inductive nature, which is well suited to exploratory research. Data-familiarization was undertaken by at least two researchers, who examined the responses and defined emerging themes as proposed by Nowell et al. (2017). There was a high level of agreement among the researchers in terms of the identified themes, and further peer-debriefing was used to ensure the soundness of the patterns found in the raw data and their classification into common themes. A codebook was kept with the aim of categorizing the data systematically and consistently. We quantified themes based on their frequency, which allowed us to compare themes across cluster groups.

5. Results

5.1. Exploratory factor analysis

Table 1 denotes the factors extracted from the exploratory factor analysis. The first factor combines perceptions of transit reliability and convenience in their region while the second one focuses on perceptions of comfort and safety. Initially, perceptions of affordability, willingness to recommend and to reuse transit were added. However, they did not load significantly in any factor and were removed from the analysis to later be reintroduced independently at the clustering stage.

5.2. Defining cluster segments

Initially, two cluster segments were found in the k-means clustering analysis. The first was characterized by positive perceptions of transit while the second held respondents who felt negatively about it. Each cluster was split into two based on the respondent's willingness to use public transit within the next year. The positive cluster resulted in the *transit-inclined* (cluster 1, 25 %) and the *transit is not for now* (cluster 3, 16 %) groups. The negative cluster was split into the *transit is a last resort* (cluster 2, 21 %) and the *transit averse* (cluster 4, 37 %) clusters. The *transit-inclined* and the *transit is a last resort* groups are classified as near-term prospective adopters as they are either willing to use public transit or are unsure about whether they will do so within the next year. The remaining groups, *transit is not for now* and *transit averse*, are defined as future potential adopters as they do not see themselves using public transit in the near future. Fig. 1 illustrates the cluster solution. The cluster shares were consistent even when randomly omitting 10 % of the sample.

Fig. 2 reports on the perceptions of public transit in the respective regions among the four clusters while Fig. 3 focuses on their behavioral intentions toward public transit. Table 2 reports on the sociodemographic characteristics of each cluster.

5.2.1. Transit-inclined (cluster 1)

This cluster gathers those who feel the most positively towards public transit and who are the most willing to use it in the near future. Most respondents believe that transit services in their region are affordable (87.2 %), safe (81.6 %), reliable (78.4 %), and comfortable (72.8 %). To a lesser extent, they report transit as being convenient (61.6 %). They would be willing to recommend transit

Table 1
Factor loadings for the sample of older adults who currently do not take transit.

| Factor	Variable	Loading	Cronbach's Alpha
Reliability and convenience	Public transit in my region is a *reliable* way of travelling	0.678	0.73
	Public transit in my region is a *convenient* way of travelling	0.756	
Comfort	Public transit in my region is a *comfortable* way of travelling	0.543	0.73
and safety	Public transit in my region is a *safe* way of travelling	0.831	
Variance explained (53.4 %); KMO (0.780); Bartlett's Test of Sphericity ($\chi^2 = 695.90$, d.f. = 10, p-value = 0)			
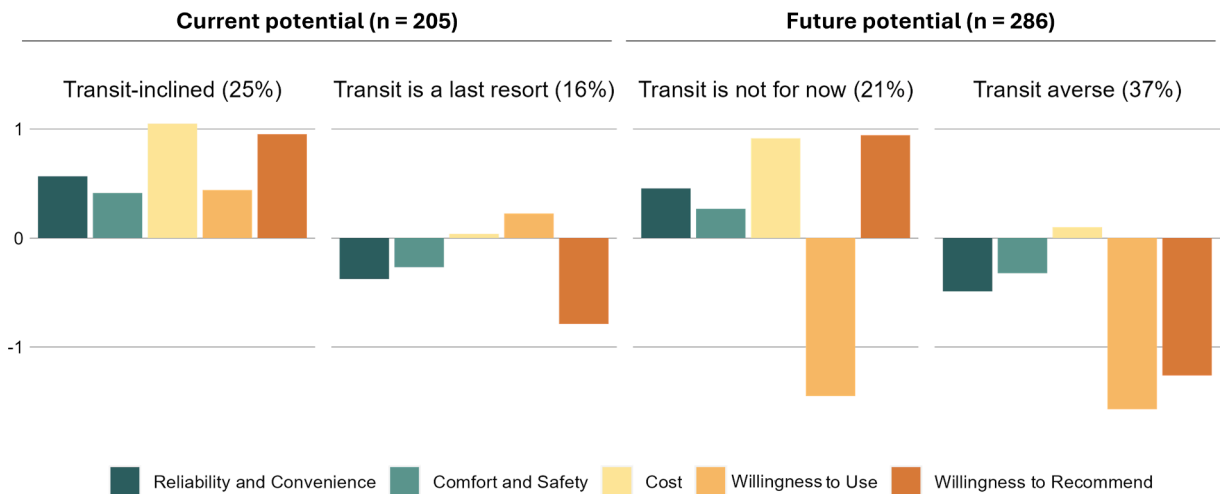
Fig. 1. Cluster analysis for the sample of older adults who currently do not take transit.
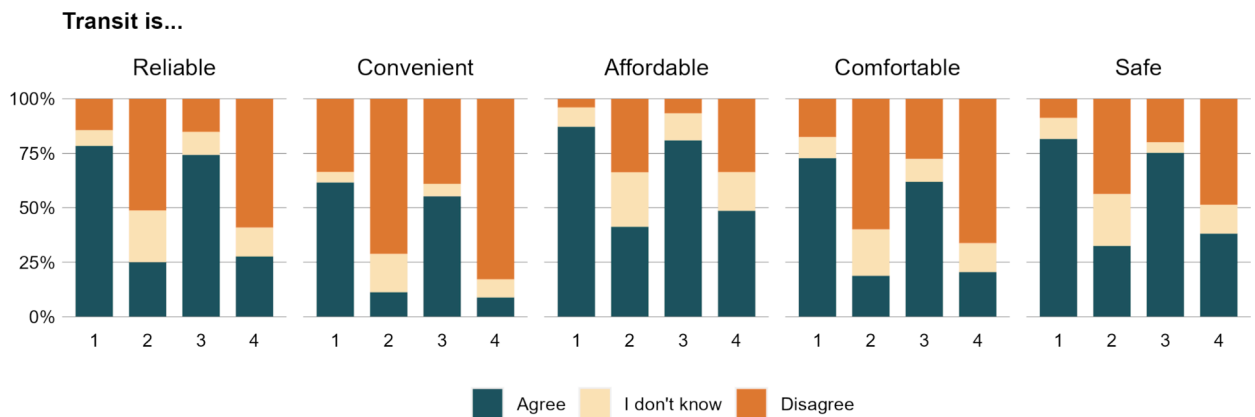
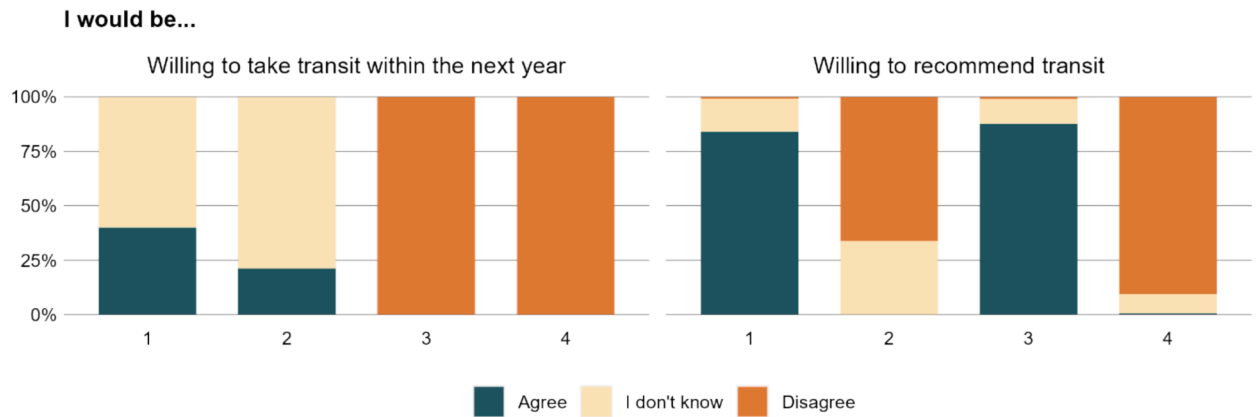**Fig. 2.** Perceptions of transit by cluster group.

services to friends and family members (84 %). When compared to the full sample, this group has a higher share of respondents from the Montreal region (+9.6 %), those born in Canada (+6.1 %) and of men (+4.8 %).

5.2.2. Transit is a "last resort" (cluster 2)

Even though respondents in this group would be willing to use public transit in the next year, they perceive it as a last resort. Differently from those in the *transit-inclined* cluster, they mostly believe that transit services in their region are inconvenient (71.3 %) and uncomfortable (60.0 %). To a lesser extent, they do not believe that public transit is reliable (51.3 %) or safe (43.8 %). Most would not recommend transit services to friends and family members (66.3 %). When compared to the full sample, this group has a higher share of respondents who are women (+11.1 %), immigrants (+13.1 %), lower-income respondents (+8.1 %), and who do not have access to a car (+6%). Most respondents do not have a disability that limits their mobility (58.8 %).

5.2.3. Transit is not for now (cluster 3)

Respondents in this group have a positive perception of public transit services in their region, however they are not interested in using public transit in the near future. In this sense, most agree that public transit in their region is affordable (81.0 %), safe (75.2 %), and reliable (74.3 %). To a lesser extent, they believe that transit is comfortable (61.9 %) and convenient (55.2 %). Most would recommend public transit services to friends and family members (87.6 %). When compared to the full sample, this group has a higher share of respondents from the smaller regions (i.e., Halifax, Victoria, Saskatoon) (+14.3 %). Most respondents are women (58.1 %), born in Canada (81.0 %), and have access to a car (96.2 %).

I would be...

Fig. 3. Behavioral intentions toward transit by cluster group.

Table 2
Sociodemographic characteristics by cluster group.

Variable	Category	Near-term prospective		Future potential		
		1 (n = 125)	2 (n = 80)	3 (n = 105)	4 (n = 181)	Sample (n = 491)
Region	Greater Toronto	16.8 %	17.5 %	16.2 %	23.8 %	19.3 %
	Greater Montreal	41.6 %	36.3 %	21.9 %	29.3 %	32.0 %
	Greater Vancouver	15.2 %	21.3 %	16.2 %	17.7 %	17.3 %
	Greater Halifax	8.0 %	5.0 %	9.5 %	9.9 %	8.6 %
	Greater Victoria	13.6 %	16.3 %	25.7 %	13.3 %	16.5 %
	Greater Saskatoon	4.8 %	3.8 %	10.5 %	6.1 %	6.3 %
Age	Mean in years (s.d.)	75 (6)	73 (6)	75 (6)	73 (5)	74 (6)
Gender	Man	49.6 %	33.8 %	41.9 %	48.1 %	44.8 %
	Woman	50.4 %	66.3 %	58.1 %	51.9 %	55.2 %
Immigration status	Immigrant	12.0 %	31.3 %	19.0 %	16.0 %	18.1 %
	Canadian	88.0 %	68.8 %	81.0 %	84.0 %	81.9 %
Household income	Less than $60 k	44.0 %	51.3 %	46.7 %	37.0 %	43.2 %
	$60 k to $90 k	30.4 %	32.5 %	26.7 %	29.8 %	29.7 %
	$90 k and over	25.6 %	16.3 %	26.7 %	33.1 %	27.1 %
Disability	No	53.6 %	58.8 %	58.1 %	52.5 %	55.0 %
	Yes	46.4 %	41.3 %	41.9 %	47.5 %	45.0 %
Car access	No car access	4.0 %	11.3 %	3.8 %	4.4 %	5.3 %
	Access to a car	96.0 %	88.8 %	96.2 %	95.6 %	94.7 %

Near-term prospective adopters: 1 = Transit-inclined, 2 = Last resort.
Future potential adopters: 3 = Transit is not for now, 4 = Transit averse.

5.2.4. Transit averse (cluster 4)

This cluster is composed of those who feel the most negatively towards public transit services in their regions. Most state that transit is inconvenient (82.9 %), uncomfortable (66.3 %), and unreliable (59.1 %). Regarding safety and affordability, opinions are split. Overall, 48.6 % disagree that transit is safe while 38.1 % agree. Meanwhile, 48.6 % agree that transit services are affordable while 33.7 % disagree. They would also not recommend transit services to friends or family members (90.6 %). When compared to the full sample, a higher share of transit-averse respondents have higher-level incomes (+6.1 %). Moreover, this group has the highest share of people who have reported a disability that limits their mobility (47.5 %). Most respondents in this group are women (51.9 %), born in Canada (84.0 %), and have access to a car (95.6 %).

5.3. Thematic analysis

Table 3 provides an overview of commonly mentioned topics found through application of the thematic analysis. The themes that were retained were brought up by at least 10 % of the respondents in each cluster or in the total sample and are bolded in the table. This benchmark was chosen to focus the analysis given the broadness of answers in the open-ended question. Directionality is indicated by a (+) for improvements or circumstances that would make respondents consider using public transit, and by (−) for barriers to public

Table 3

Thematic analysis by cluster group.

Themes	Sub-Themes	Near-term Prospective		Future Potential		Sample
		Transit-inclined (1)	Transit is a last resort (2)	Transit is not for now (3)	Transit averse (4)	
		N = 125	N = 80	N = 105	N = 181	N = 491
Access and Egress	*Access and Egress*It's challenging/too far for me to walk to and from transit (−)	10.4 %	18.8 %	14.3 %	12.7 %	13.4 %
Transit Service	*Reliability*Transit is not reliable/on time (−)	4.8 %	7.5 %	1.9 %	10.5 %	6.7 %
	*Frequency*Increase frequency, especially off-peak (weekdays and weekends) (+)	4.0 %	17.5 %	4.8 %	14.4 %	10.2 %
	*Routes*Transit does not go where I need it to (−)	2.4 %	8.8 %	4.8 %	10.0 %	6.7 %
	Offer increased/better routes to more destinations (+)	8.0 %	10.0 %	5.7 %	7.2 %	7.5 %
	*Travel Speed*Transit takes too long (−)	3.2 %	10.0 %	3.8 %	13.8 %	8.4 %
	*Safety*Transit is dangerous/I feel unsafe taking transit (−)	3.2 %	11.3 %	2.9 %	10.0 %	6.9 %
	*Crowding*Transit is too crowded/I'm not guaranteed a seat (−)	2.4 %	6.3 %	1.9 %	4.4 %	10.0 %
	*Waiting*Wait times are too long (−)	3.2 %	12.5 %	7.6 %	5.0 %	6.3 %
	*Transfers*I have to transfer/transfers are numerous and inefficient (−)	2.4 %	13.8 %	7.6 %	11.0 %	8.6 %
	*Transit Infrastructure*New infrastructure would encourage me to take transit (+)	2.4 %	7.5 %	4.8 %	10.5 %	6.7 %
Comparisons to Driving	*Convenience*Driving is more convenient for me (−)	14.4 %	12.5 %	14.3 %	12.2 %	13.2 %
	*Can't drive*I would consider transit if/when I can't drive (+)	17.6 %	7.5 %	21.9 %	7.7 %	13.2 %
External Factors	*Weather*Poor weather makes taking transit unpleasant (−)	4.0 %	11.3 %	6.7 %	7.2 %	6.9 %
	*COVID-19*I am concerned about catching COVID/illness on transit (−)	9.6 %	11.3 %	5.7 %	2.8 %	6.5 %
	*Built Environment*My area is not conducive to public transit (−)	7.2 %	2.5 %	3.8 %	11.0 %	7.1 %
Disability	*Disability*Reduced mobility/disability makes travelling by transit difficult (−)	10.4 %	12.5 %	14.3 %	12.7 %	12.4 %

transit use as identified by the respondents. We include direct quotes in the results of the analysis to illustrate the themes and their prevalence.

5.3.1. Access and Egress

A main barrier to transit use across all four clusters is access to and from transit stops or stations: "*The transit system itself is good, but getting to it and then to my destination from it at the other end are a challenge*" (Cluster 3 respondent). Transit-inclined and last resort respondents suggest closer and more numerous stops in their residential area, or convenient shuttle services to larger public transit hubs to eliminate the long walks needed to reach transit. Respondents who have reduced mobility are particularly concerned about accessing transit, as even the characteristics of their residential environment can cause challenges: "*I cannot walk up the steep hill to get to the bus stop for our feeder bus*" (Cluster 3 respondent).

5.3.2. Transit service

Insufficient frequency of public transit services represents an important barrier to older adults' transit use: "*Because of the lack of*

trains during the day, I end up driving to the hospital as it is easier" (Cluster 1 respondent). Providing increased frequency especially during the off-peak periods of weekdays and weekends is suggested by last resort and transit averse respondents as vital for them to consider taking public transit.

In addition to perceiving transit as too infrequent, transit averse respondents believe it to be unreliable: "*Buses are early or late and don't appear sometimes or they are full and drive by you*" (Cluster 4 respondent). Moreover, they are reticent to take public transit since the routes available in their region do not get them to their desired destinations. Last resort respondents suggest that better service to more areas could make them consider using public transit: "*If we had better crosstown and more frequent transit I might use it*" (Cluster 2 respondent).

Last resort and transit averse respondents explain that the length of public transit trips often exceeds their desired travel times. This can explain their choice of private vehicle over public transit, as car trips are generally speedier: "*I can travel to my destination in 7 min by car but takes 45 min by public transit*" (Cluster 4 respondent). Last resort respondents dislike long waits for public transit, especially in inclement weather: "*I do not like waiting in the cold during the winter*" (Cluster 2 respondent). They suggest shelters and seating to be provided at transit stops to make waiting less unpleasant. Moreover, poor coordination between routes and schedules makes transfers undesirable and lengthen transit trips, particularly for last resort and transit averse respondents: "*Several connecting bus routes are not in sync, as one arrives to the next bus, the driver just takes off, leaving people waiting long periods*" (Cluster 2 respondent). Some respondents in Montreal and Toronto also mention the inconvenience of transferring between regions run by different transit agencies, calling for a "*better integration of transit between the jurisdictions […]*" (Cluster 4 respondent).

Many transit averse respondents stress the importance of supportive transit infrastructure such as providing seating and shelters at stops, and park-and-ride facilities: "*There is no parking available to use public transportation!*" (Cluster 4 respondent). Expanding the current network, such as adding new lines and reserved bus lanes, are often mentioned as desirable. In Montreal in particular, some respondents state their intention to start using the new LRT network (*Réseau express métropolitain*) once it becomes operational: "*Waiting for the REM Deux-Montagnes to be operational*" (Cluster 4 respondent).

5.3.3. Comparisons to driving

Across all four clusters, the car's convenience was overwhelmingly stated as a reason for not using public transit: "I am not prepared to stand in the rain to wait for a bus that is late, then to have to change buses or modes of transport, and take longer to get there when there is a quicker, safer and more comfortable alternative; my car" (Cluster 4 respondent). Respondents explain that public transit is unsuitable for certain travel purposes, such as having to "lug the groceries home" or "doing a number of errands". Using public transit seems conceivable only post-driving cessation or when preferable modes are not available: "Only when I am no longer able to drive or own my own vehicle, will I then explore other options" (Cluster 1 respondent).

5.3.4. External factors

An important concern for transit-inclined and last resort respondents is the possibility of disease transmission when using public
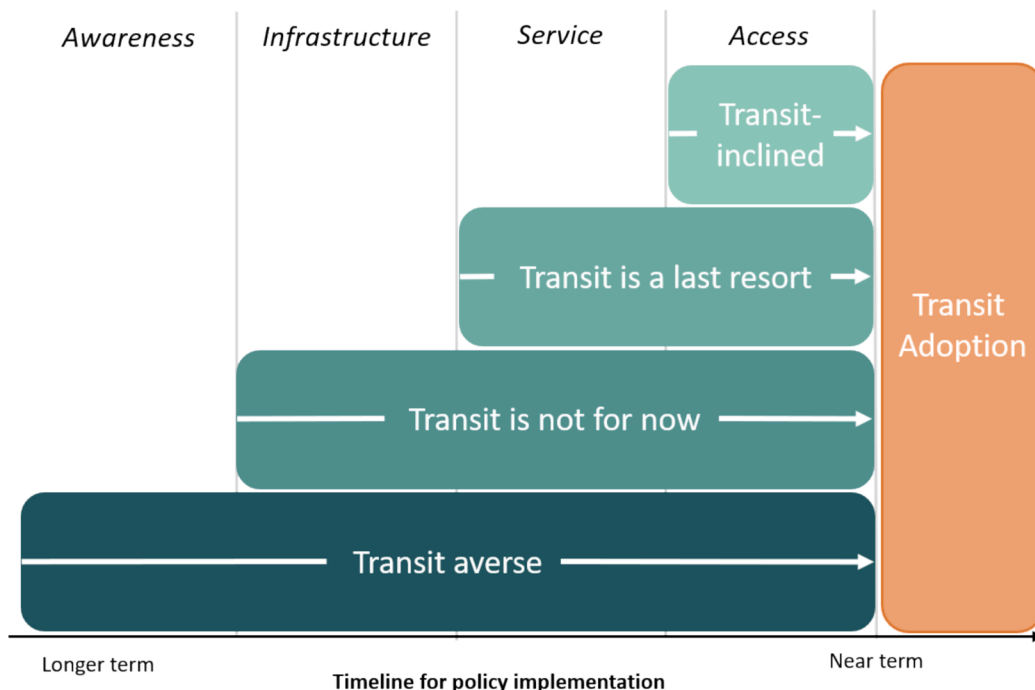

Fig. 4. Summary of implementation strategies for each non-user profile.

transit. In fact, some of these respondents are previous transit users who stopped using it due to the COVID-19 pandemic: "*I used to take rapid transit downtown to go to art galleries, meet friends for lunch, etc. The pandemic changed that and I have not used public transit in three years*" (Cluster 2 respondent). Some respondents state that if mask mandates were reinstated, they would return to public transit.

Other respondents perceive their region's built environment to be unable to support efficient public transit. Transit averse respondents in particular are of the opinion that the area or region they live in is not conducive to public transit, especially in more suburban or rural areas: "*We should not wonder why people don't use transit: our suburbs aren't designed for it*" (Cluster 4 respondent).

5.3.5. Disability

People living with a disability state that public transit is not well-adapted to their needs and/or mobility devices: "*Public transit is not an option for someone with limited mobility*" (Cluster 4 respondent). Paratransit is not considered an adequate solution, as the eligibility requirements can be quite strict or people may feel apprehensive to use the specialized services: "*I am in a mobility device and I am not able to use public transportation and [paratransit] is too scary*" (Cluster 3 respondent).

Moreover, respondents mentioned the lack of truly universally accessible stops and stations with functioning escalators and elevators, parking, bathrooms, and vehicles properly adapted to older adults' needs (e.g., lowering to onboard passengers, adequate step height, etc.): "*I had to stop volunteering because I had such a hard time negotiating the stairs [in public transit stations]*" (Cluster 1 respondent).

6. Discussion and conclusion

The reasons for which older adults do not use public transit are numerous and depend on their individual perceptions, preferences, and characteristics. To encourage transit adoption among this age group, it is important that this diversity is understood. This study offers insight into the reasons behind older adults' non-use of public transit across 6 cities in Canada. A typology of older non-users was proposed, augmented with participants' willingness to use transit in the following year, and a thematic analysis of their short-form responses suggesting transit improvements that would encourage their transit use.

Understanding these different types of non-transit users can help guide policy targeting broader transit adoption among older adults. Fig. 4 summarizes the four identified profiles based the types of strategies and the implementation timeline that might best encourage them to use transit.

Near-term prospective adopters, i.e., *transit-inclined* and *transit is a last resort* segments, would likely respond well to more immediate transit service improvements. For *transit-inclined* participants*, increasing the number of available stops may remove a significant barrier to their transit use. Regarding the *transit is a last resort* segment, they are challenged by the access to the stops as well as the service characteristics, which can be alleviated by employing service improvement strategies. These improvements could include increasing frequency on existing transit routes, especially off-peak during the week and on weekends to better meet older adults' travel needs. The *transit is a last resort* group is particularly sensitive to waiting, transfers and travel time. Ensuring transit is more efficient and minimizing their wait times could encourage them to take public transit and improve their perception of the mode. Both types remain concerned about their chance of catching COVID-19 and other diseases onboard, so continuing to provide masks at stops and stations could help mitigate some of these apprehensions.

Longer-term strategies could be more compelling for future potential adopters, i.e., *transit is not for now* and *transit averse* older adults. Implementing the above-mentioned access- and service-focused strategies is important to improve their perception of public transit. However, by combining these strategies with longer term goals, their path toward transit adoption could be expedited. This means ensuring new transit infrastructure and projects are well-executed and reliable, and address the needs of non-users. For the *transit averse*, in addition to all the suggested strategies above, it is also important to widely advertise improvements to existing transit and new projects to make sure users and non-users alike are aware of the changes. Ensuring older adults are well-informed about the public transit services available in their region could increase their willingness to use the mode. Implementing these strategies will hopefully help older adults reduce their driving and improve their impression of public transit's convenience.

Finally, to encourage transit use among all types of non-user profiles, it is important to ensure universal accessibility. As was made clear in the thematic analysis, older adults living with reduced mobility or with disabilities are hesitant to use public transit as they do not consider it to meet their needs. Some of these concerns could be quelled by providing adequate seating and shelters at stops and stations, ensuring escalators and/or elevators are available through the network and are functional, and providing parking near transit stations to encourage at least part of older adults' trips be made using transit.

Some themes and barriers to transit use identified by older non-users in this paper resemble those found previous studies that looked at a more general population of older adults (Shrestha et al., 2017), and older immigrant populations (Dabelko-Schoeny et al., 2021). However, our segmentation of older non-users of public transit according to their attitudes towards public transit and their near-term willingness to use it leads to a deeper understanding of the concerns of this subgroup. Our profiling of non-users and subsequent thematic analysis of the group-specific barriers to using public transit allows for the needed tailoring of strategies aiming to introduce older non-riders to transit, rather than considering non-users as a homogenous group.

This mixed-method analysis of older adults' firsthand accounts of the challenges and barriers to their public transit use is key for more successfully increasing the age group's ridership. Moreover, the detailed understanding of the non-users needs can help in designing a public transit system that is more welcoming to this age group. It is also likely that some of the identified challenges are experienced by current transit users as well, and these improvements could increase the general user satisfaction. For example, increasing the number of available stops and stations and ensuring universal accessibility across the network could benefit users and non-users alike. Other more specific strategies could be applied to specific non-user types, such as reducing the need for transfers or

improving overall perceptions of the transit system in less urban areas.

A few notable limitations to the study are firstly, that the data used is cross-sectional, capturing the attitudes, behaviours and intentions of older non-public transit users at one moment in time. Though valuable, panel or longitudinal data could provide richer insight into how barriers to transit use identified by older adults change over time, following changes in public transit service or personal life circumstances. For example, the impact of new transit infrastructure on ridership, which we found to be desirable by certain non-users, is best captured using panel data. Secondly, though we tried to account for external factors that could impact older adults' non-use of transit, the survey questions used for the PCA, cluster analysis and thematic analysis were mainly focused on transit-related factors. Personal and societal values, land use characteristics and other influential variables, which we could not fully account for could contribute to older adults' reasons for not using public transit.

Further research could study the impact of specific policies on ridership increase among non-user older adults. Programs and strategies such as reduced or free transit fares, and one-on-one training programs to enhance older adults' public transit skills and wayfinding could be important catalysts. Measuring the short- and long-term effectiveness of such programs, especially for non-riders, could provide valuable insights for both research and public transit operations. Secondly, further studies could account for non-transit users' travel behaviour, as their preference for personal vehicles, walking and/or cycling could provide valuable insight into their attitudes towards public transit and their willingness to start using it. Finally, further segmentation of non-users by region, income level, status of disability and other factors might point certain inequities in older adults' barriers to public transit use. Further exploration of this topic would therefore help guide decision-makers and transit agencies in encouraging older adults to use public transit, with the ultimate goal of reducing their automobile dependence and contributing to their well-being.

7. Author contribution statement

The authors confirm contribution to the paper as follows: Study conception and design: Alousi-Jones, Carvalho, Zhang, Jimenez & El-Geneidy; Data collection: Alousi-Jones, Carvalho, Zhang, Jimenez & El-Geneidy; Analysis and interpretation of results: Alousi-Jones, Carvalho, & El-Geneidy; Draft manuscript preparation: Alousi-Jones, Carvalho, Zhang, Jimenez & El-Geneidy. All authors reviewed the results and approved the final version of the manuscript.

CRediT authorship contribution statement

Meredith Alousi-Jones: Writing – review & editing, Writing – original draft, Visualization, Validation, Project administration, Methodology, Data curation, Conceptualization. **Thiago Carvalho:** Writing – review & editing, Writing – original draft, Visualization, Validation, Formal analysis, Data curation, Conceptualization. **Merrina Zhang:** Writing – review & editing, Writing – original draft, Project administration, Investigation, Funding acquisition, Data curation, Conceptualization. **Isabella Jimenez:** Writing – review & editing, Writing – original draft, Project administration, Data curation, Conceptualization. **Ahmed El-Geneidy:** Writing – review & editing, Writing – original draft, Visualization, Validation, Supervision, Software, Resources, Project administration, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The authors do not have permission to share data.

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