Who does light rail serve? Light-rail transit and gendered mobilities in Montreal

Julian Villafuerte-Diaz
McGill University
Email: julian.villafuertediaz@mail.mcgill.ca
orcid: 0000-0001-6543-7105

Rodrigo Victoriano-Habit
McGill University
Email: rodrigo.victoriano@mail.mcgill.ca
orcid: 0000-0001-6328-0722

Aryana Soliz
McGill University
Email: aryana.soliz@mcgill.ca
Orcid: 0000-0001-5172-4947

Ahmed El-Geneidy
McGill University
Email: ahmed.elgeneidy@mcgill.ca
orcid: 0000-0002-0942-4016

July 27th 2022

Word count: 6851 words + 2 tables (2 x 250 words) = 7351 words

For Citation please use: Villafuerte, J., Victoriano-Habit, R., Soliz, A., El-Geneidy, A. (2023). *Who does light rail serve? Light-rail transit and gendered mobilities in Montreal.* Paper accepted for presentation and publication at the 102nd Transportation Research Board Annual Meeting.

ABSTRACT

Investment in light rail transit (LRT) has been one of the main strategies of large metropolitan areas in the last decade to tackle environmental, economic, and social issues. In Montreal, Canada, a CAD$6.9 billion LRT system is currently under construction and is expected to significantly impact mobility patterns across the metropolitan region. It is crucial to identify the ways in which the impacts of such large public investment vary across societal groups to assess whether the distribution of benefit is fair and equitable. Using data from an online survey and a binary logistic modelling approach, we investigate the ways in which intentions to use this new LRT system differ across gender identities. First, we found that women are less likely to have an intention to use LRT compared to men. Our modelling results show that there are statistically significant differences across gender identities in the effect of certain sociodemographic and travel-behavior characteristics that explain the intention to use the LRT system. In terms of trip purpose, whilst women and men intend to use LRT for work trips to the same extent, men intend to use LRT for leisure and discretionary travel more than women. Our findings can help in guiding further research into gender gaps in transport studies and inform practitioners on how gender can be considered in LRT policy decisions so that the benefits of major public-transport investments are more equitably distributed.

INTRODUCTION

Given the pressing need for sustainable-transport transitions (*1*), policy makers are increasingly working to invest in Light Rail Transit (LRT). The *Réseau Express Métropolitan* (REM), a CAD$6.9B, 67-km LRT system currently under construction in Montreal, Canada, is one of the largest infrastructural interventions currently being built in North America. As a monumental public-transport investment, the REM aims to significantly alter the way that people move within the metropolitan area by reducing car dependency and increasing public-transit ridership (*2*). In addition to delivering environmental benefits, transport-infrastructure projects of this scale also promise to significantly enhance local neighbourhoods and provide substantial economic benefits to residents through increased access to opportunities (*3*).

Beyond these environmental and economic goals, LRT projects should also strive to foster equitable transport systems, which means ensuring that the social and economic benefits of major infrastructure investments are fairly distributed across society (*4-7*). There are major gaps, however, in knowledge about how these public-transport investments serve the wants and needs of different segments of society, particularly with regards to LRT and gender (*8*). While gender-disaggregated information on LRT ridership remains scare, some studies have found that women have less propensity to use LRT than men (*9*). Additional research is needed to understand how gender differences in intended LRT ridership change across diverse geographical contexts as well as to characterize the phenomena that generate these gender differences.

To address this gap, this research draws from survey data from Montreal to examine residents' intentions to use the REM, how these intentions vary across genders, as well as factors that generate gaps in perceived utility. Our study poses the following research question: to what extent and in what ways do women's intentions to use light-rail transit vary from men's?

LITERATURE REVIEW

Studies on gendered mobilities have long revealed that transport systems are not gender neutral (*10-13*). For example, urban-planning decisions that prioritize infrastructure for car travel, or that relate to bus routes and street lighting, often have immense gender consequences (*14; 15*). Feminist research has revealed that men tend to travel at a faster pace (relying more on car travel) in comparison to women, whose mobilities have often been restricted to slower speeds, especially when travelling with children (*16*). Because gender-differentiated roles place a higher burden on women for family-care activities (*17; 18*), women's mobilities tend to be much more complex, often encompassing multiple travel modes (*16; 19; 20*). Although women's trips are often shorter than men's (*12*), on average, women make significantly more trips (*21; 22*), and engage in more non-work related travel (*21*). As for travel patterns, the literature finds that women tend to walk more than men do (*21*) and that they rely more heavily on public transport (*22; 23*).

While the literature on light-rail transit (LRT) has vastly increased in recent years (*3*), discussions on the gendered dimensions of LRT ridership remain limited, and at times lack consensus. For example, a study from Flanders, Belgium (*9*) found that women were less inclined than men to use LRT, whereas a study from Huston Texas (*24*) found that gender was not been associated with more or less intention to use LRT when controlling for other variables. In their research on how gender-specific factors mediate different mode choices, Hsu et al. (*25*) found that safety concerns were more negatively associated with the number of LRT trips for women than for men.

The limited reach of studies on gender and LRT is of course reflective of wider trends in transport studies and planning, which often neglect to incorporate discussions on gender, or that engage with these questions in only limited ways (*11; 15*). Although feminist research has brought attention to women's and girl's unique travel patterns and safety concerns, these considerations have only been sparsely integrated in urban transport planning (*14*). While this neglect can be related to such issues as gender-based barriers in urban-planning professions and wider power relations (*15*), there is also a great need for more comprehensive data about women's lives, mobilities, and travel preferences (*14*). With the rapid implementation and expansion of LRT in cities across the globe, this paper addresses the urgent need for more detailed research on the gendered dimensions of light rail.

STUDY CONTEXT

The REM is an automated LRT system currently under construction in Montreal, Canada that is expected to begin operations progressively in phases between 2022 and 2024. When complete, the REM will connect Montreal's downtown, its international airport, and suburban destinations with high-frequency service (**Error! Reference source not found.**). With a predicted initial ridership of 190,000 passengers per day (*26*), the REM has the potential to radically alter mobility and land-use and transport patterns across the Greater Montreal Area, as LRT projects have done elsewhere (*27*). The impacts of the REM on social wellbeing are potentially significant as well, as the project may have broad public health, environmental, and economic impacts within the metropolitan area (*28; 29*).

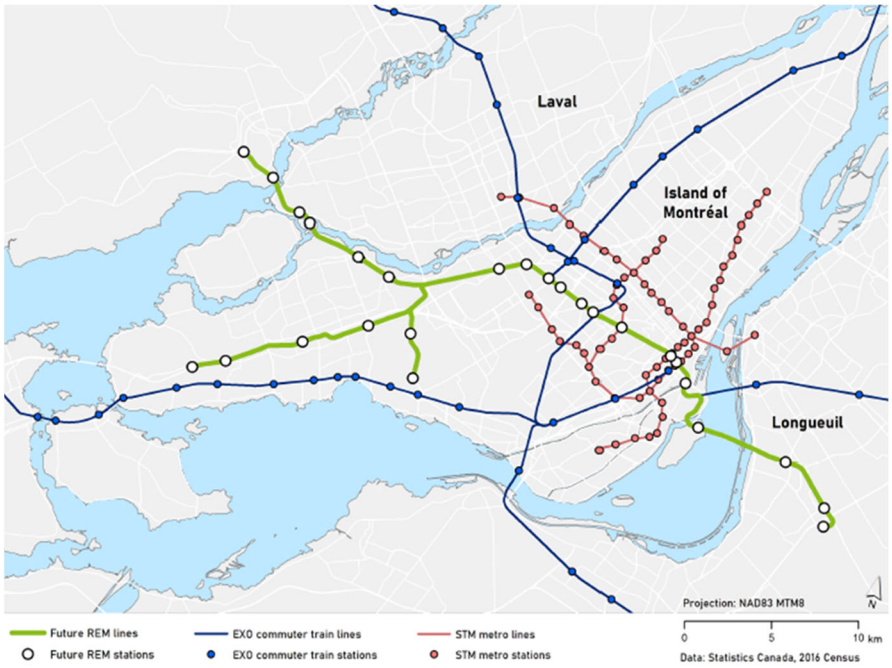

Figure 1. Map of Montreal's rapid transit and commuter rail system, including the REM.

At the same time, LRT investments of that scale will need to pay careful attention to local household realities and gender dynamics if they are to support social-equity goals. For example, recent quantitative research on travel patterns in Montreal has found that women disproportionately bear the burden for care mobilities, including such activities as grocery

shopping, escorting children, and other forms of travel associated with unpaid care labour (*18*). Other studies have revealed that single-parent households and elderly individuals in Montreal have more geographically limited travel patterns (*30; 31*). Low-income groups in Montreal have also been found to travel less than higher income groups (*32*). These findings underscore the importance of accounting for socio-demographic differences in sustainable-transport planning, including gender. In this context, it is highly relevant to study the differing perceptions and intended uses of the REM between genders, both for this LRT project in Montreal, as well as for future LRT projects elsewhere.

DATA AND METHODS

This study's primary data source is an online bilingual (English-French) survey conducted between October and November 2019. This survey was administered in the Greater Montreal Area to participants of 18 years of age and older to collect data on people's intention to use the REM for different purposes, to study the project's potential impact on travel patterns and wellbeing. The survey collected data on respondents' sociodemographic characteristics, attitudes towards the REM and transit in general, current and past travel behaviour, and physical activity levels. Additionally, the survey collected residential choice factors, which allow us to control for residential self-selection.

To ensure the representativeness of the sample, we employed various recruitment techniques recommended by Dillman, Smyth and Christian (*33)*, including the distribution of flyers at various residences and downtown transport hubs, as well as targeted online recruitment through paid and un-paid advertisements on various social media platforms. Incentives were included in the survey such as the possibility of winning a prize based on a draw. A public opinion survey company was also hired to help in recruiting part of the sample.

We collected a total of 4,148 complete answers, to which we applied a thorough filtering validation process. We removed responses that were filled too quickly to be considered reliable, excluding the fastest 10% from the sample depending on the number of questions answered. It must be noted that different groups of respondents, depending on their answers, were presented different sets of questions. Each of these groups were validated according to their own respective top 10% speed. We also filtered out unrealistic responses, including birth years before 1920 and reporting spending more than 200 minutes per day commuting by walking or bicycle. Furthermore, respondents who had not heard about the REM project before were not asked whether they intended to use the REM and were therefore excluded. We also excluded survey responses if the home location the respondent provided was outside the Montreal Census Metropolitan Area. Following this exclusion process, we retained a sample of 2,778 responses for our analysis.

To calculate regional accessibility to jobs by transit, and travel distance through the city network to REM stations, we used the r5r package in R (*34*). Job location data was acquired through Statistics Canada, from the 2016 Census, in the form of commute trips for the Montreal Census Metropolitan Area (CMA). Using the projected travel times for the REM, we calculated the improvement in job accessibility that will be brought by the project. To account for local accessibility, we used WalkScore data, which focuses on the number and diversity of activities that can be reached within walking distance. This measure has been tested repeatedly in the land use and transport literature (*35*), showing reliability as a walkability indicator (*36*).

To analyze this dataset and achieve this work's goal, we estimated a weighted multi-level binary logistic regression model using the lme4 R package (*37*). Using this model, we estimate the probability of intending to use the REM as a function of several independent variables that may affect this intention. These variables include a series of sociodemographic characteristics, distance to the nearest REM station, local and regional accessibility levels, current physical activity levels, past and current transit use, and current access to different transport modes. Additionally, we control by attitudes towards the REM and transit in general, as well as for residential self-selection.

In order to investigate the gendered effects that our studied factors have on the probability of using the REM, we tested interactions between the independent variables and gender, and included those that were statistically significant in the final model. Finally, to inquire into gendered differences in the intention to use the REM depending on trip purpose, we conducted three Welch two-sample t-tests. The three tested trip purposes were going to work, leisure, and going to the airport. For this, we only considered the sample of women (n = 699) and men (n = 791) who indicated that they intended to use the REM in general.

For the multilevel model, we considered the census tract of the home location as the higher level to control for shared characteristics in a neighborhood that are otherwise unaccounted for. The weightings in the model were calculated for all valid responses using the anesrake R package (*38*). The weights were calculated to match our sample to census tract information of age, income, and gender from Statistics Canada 2016 census (*39*), retrieved through the cancensus R package (*40*). This weighting process is key to ensure that model results are not affected by biases from the survey sampling.

RESULTS AND DISCUSSION

Descriptive statistics

The descriptive statistics of the cleaned and validated sample that we retained for our analysis (n = 2,778) is presented in Table 1. Around 54.2% of this sample indicated that they intended to use the REM. Whilst 50.2% of respondents in this sample identified as a man, 48.4% identified as a woman, and 1.4% (38 individuals) identified as another gender. A smaller proportion of women than men indicated that they intended to use the REM: 50.1% of women compared to 58.8% of men. A two-sample Welch t-test confirms that this difference is statistically significant ($p < 0.001$).

Gendered factors influencing intention to use LRT

The results of our model estimating the probability of intending to use the REM are presented in Table 2. We found several factors that have a significantly different effect for women than men by identifying statistically significant interactions between gender and other independent variables. First, we found that intention to use the REM for women is less negatively affected by increased age than men. While men's probability of intending to use the REM is reduced by 2% for each additional year of age, for women this effect is less than 1%. In other words, women's intention to use the LRT declines less with age, and the gender gap between intended use is narrower for older individuals than for younger individuals.

Second, immigrating to Canada within the last 5 years has a strongly positive effect on intention to use the REM for women, but does not have this effect for men and other respondents. All else held equal, recent immigrant women are 2.4 times more likely of intending to use the REM than

women who are not recent immigrants. This effect could be partially explained by higher public transit use by women in other countries (*41*), but merits further research.

Table 1. Descriptive statistics of the sample

			Total (n = 2778)		Female (n = 1395)		Male (n = 1345)	
Category	**Variable name**	**Description**	**Mean**	**St. Dev.**	**Mean**	**St. Dev.**	**Mean**	**St. Dev.**
	Dependent variable							
Dependent variable	Intends to use REM	Intends to use REM	0.542	0.498	0.501	0.5	0.588	0.498
	Independent variables							
Socio-demographic characteristics	Female	Gender [female]	0.502	0.5				
	Non-binary	Gender [other]	0.014	0.116				
	Age	Age (in years)	45.527	15.898	44.394	15.689	46.997	16.024
	Employed	Employed	0.685	0.464	0.689	0.463	0.685	0.465
	New immigrant	Immigrated to Canada in the last 5 years	0.042	0.201	0.036	0.186	0.048	0.215
	under $30K	Household income [under $30K]	0.104	0.305	0.097	0.296	0.106	0.308
	$30K to $60K	Household income [$30K - $60K]	0.214	0.41	0.23	0.421	0.198	0.398
	$60K to $90K	Household income [$60K-$90K]	0.191	0.393	0.196	0.397	0.187	0.39
	$90K to $120K	Household income [$90K-$120K]	0.167	0.373	0.166	0.372	0.169	0.375
	over $120K	Household income [$120K+]	0.228	0.42	0.192	0.394	0.271	0.445
	Used transit in childhood	Used public transit in childhood	0.684	0.465	0.599	0.49	0.774	0.418
	Raised urban	Grew up in an urban environment	0.394	0.489	0.352	0.478	0.438	0.496
	Raised suburban	Grew up in a suburban environment	0.454	0.498	0.481	0.5	0.427	0.495
	Raised rural	Grew up in a rural environment	0.152	0.359	0.167	0.373	0.135	0.342
Spatial characteristics	AccessDist	Access network distance between home and REM station (km)	6.325	6.989	6.183	6.751	6.543	7.299
	Sq of AccessDist	Square of network distance between home and REM station	88.833	217.589	83.774	210.202	96.048	227.523
	Accessibility by transit	Number of jobs (10,000s) accessible within 45 minutes by transit (May 2019)	27.079	26.088	26.865	26.129	26.729	25.956
Physical activity characteristic	Transport physical activity	Hours of active transport physical activity in past week	2.788	3.229	2.68	3.03	2.872	3.373
Mobility characteristics	Access to vehicle	Access to a vehicle	0.751	0.433	0.75	0.433	0.76	0.427
	Bixi member	Has a bixi membership	0.089	0.285	0.072	0.258	0.107	0.309
	Weekly transit rides	Number of transit rides in the previous week	2.912	3.375	2.9242	3.397	2.893	3.359
Attitudinal characteristics	Transit positive attitude	Would like to ride public transit more often	0.334	0.472	0.309	0.462	0.366	0.482
	REM bad for Montreal	Believes the REM will be bad for Montreal	0.071	0.257	0.069	0.253	0.073	0.26
	REM bad for n'hood	Believes the REM will be bad for neighbourhood	0.179	0.384	0.177	0.382	0.181	0.386
Residential selection characteristics	Having a large home	Residential self-selection [having a large home]	0.571	0.495	0.573	0.495	0.577	0.494
	Near work/school	Self-selection [being near my primary work/school location]	0.568	0.495	0.581	0.494	0.554	0.497
	Parks	Self-selection [presence of parks and green spaces]	0.808	0.394	0.83	0.376	0.788	0.409
	Near public transit	Self-selection [being near public transportation]	0.806	0.396	0.816	0.388	0.796	0.403

Table 2. Model for intention to use the REM including interactions with gender.

Predictors	Odds Ratios	Confidence interval	*p*
(Intercept)	12.08 ***	5.79 - 25.19	**<0.001**
Gender (ref cat: man)			
Woman	0.27 ***	0.14 – 0.51	**<0.001**
Non-binary	0.52	0.22 - 1.25	0.141
Factors with gender interactions			
Age	0.98 ***	0.98 – 0.99	**<0.001**
Woman x Age	1.01 *	1.00 – 1.03	**0.01**
New immigrant	0.97	0.55 – 1.77	0.925
Woman x New immigrant	2.45 *	1.00 – 5.99	**0.049**
Used transit in childhood	0.94	0.71 – 1.26	0.675
Woman x Used transit in childhood	1.55 *	1.05 – 2.29	**0.026**
Weekly transit rides	1.07 **	1.03 – 1.11	**0.001**
Woman x Weekly transit rides	0.95 ·	0.90 – 1.00	0.058
Socio-demographic characteristics			
Employed	0.74 **	0.60 – 0.91	**0.005**
Income (ref cat: over $120K)			
under $30K	0.58 ***	0.43 – 0.78	**<0.001**
$30K to $60K	0.63 ***	0.49 – 0.81	**<0.001**
$60K to $90K	0.61 ***	0.47 – 0.80	**<0.001**
$90K to $120K	1.01	0.76 – 1.35	0.944
Childhood environment (ref cat: suburban)			
Raised urban	0.79 *	0.65 – 0.96	**0.018**
Raised rural	0.92	0.71 – 1.20	0.535
Spatial characteristics			
Accessdist	0.82 ***	0.78 – 0.85	**<0.001**
Sq of Accessdist	1.00 ***	1.00 – 1.01	**<0.001**
Accessibility by transit	0.98 ***	0.98 – 0.99	**<0.001**
Walkscore of home location (ref cat: <50)			
Walkscore 50-69	0.92	0.68 – 1.23	0.564
Walkscore 70+	0.66 *	0.48 – 0.91	**0.011**
Physical activity characteristics			
Transport physical activity	1.07 ***	1.04 – 1.10	**<0.001**
Mobility characteristics			
Access to vehicle	0.8 ·	0.63 – 1.01	0.058
Bixi member	1.56 **	1.12 – 2.17	**0.009**
Attitudinal characteristics			
Transit positive attitude	2.16 ***	1.78 – 2.62	**<0.001**
REM bad for Montreal	0.42 ***	0.28 – 0.63	**<0.001**
REM bad for n'hood	0.35 ***	0.27 – 0.45	**<0.001**
Self-selection characteristics			
Having a large home	0.81 *	0.68 – 0.98	**0.029**
Near work/school	0.73 **	0.61 – 0.88	**0.001**
Parks	1.38 **	1.10 – 1.74	**0.005**
Near public transit	2.38 ***	1.86 – 3.05	**<0.001**
Random Effects			
σ^2	3.29		
$\tau_{00\ CT\_UID}$	0.13		
ICC	0.04		
N_{CT_UID}	674		
Observations	2767		
Marginal R^2 / Conditional R^2	0.303 / 0.330		

*· p<0.1 * p<0.0 ** p<0.01 *** p<0.001*

Third, according to our results, experience of having used public transit regularly in childhood had a positive and statistically significant association with intended use of LRT for women, but did not have an effect on intended use for men. All else held equal: women who used public transit regularly in childhood had 55% greater odds of intending to use the REM than women who did not have this experience in childhood. This finding points to a gendered effect of life course on mode choice and builds on an emerging understanding of how life events affect individuals' travel patterns differentially by gender (*42*). A potential explanation for the lack of effect of men's childhood transit use may be related to differences in travel socialization across gender identities while growing up (*43*).

If women's mode choice is distinctly more affected by personal childhood mobility experiences, as our model results suggest, there could be a case for prioritizing exposure to public transport in childhood, for example through public education, in order to contribute to reducing gender gaps in light-rail transit use and better understanding women's unique travel needs. However, given that women already depend more heavily on public-transit, a case could be made for finding other strategies to better foster public-transit use for boys and men, such as programs that help to discourage car use.

Finally, we found differences in terms of how existing transit use affects intention to use the REM differently for women. Overall, our model results suggest that more frequent current transit use is positively associated with intended use of LRT, which is supported by previous research (*24; 44*). For men and non-binary respondents, every additional transit ride in the previous week contributes to a 7% increase in the probability of intending to use the REM. Multiplying the odds ratio of the interaction term and the non-interaction term gives us the contribution to odds of intending to use the REM for women, which is around 2% increase. Thus, intended use of the REM is far less sensitive to additional current transit use for women than it is for men. In other words, while childhood use of transit is more deterministic of future LRT use for women, their current use of public transit predicts their future LRT use less.

The coefficient associated to non-binary people's dummy variable indicates that their intention to use the REM is not significantly different from people who identify as men. Since the model includes several interaction effects for women, the coefficient associated with women's dummy variable cannot be interpreted on its own. To integrally understand the gendered results from our logit model, Figure 2 presents two sensitivity analyses. In these analyses, we calculated the probability of intending to use the REM for men and women by fixing every independent variable to the sample's mean, except for key variables which were sensitized. In the case of the first sensitivity analysis, shown in Figure 2.a, the probability for intending to use the REM was calculated for men and women as a function of varying age. Additionally, for women, the analysis was subdivided into women who are new immigrants and those who are not. Since for men, immigration status was not a significant factor, this subdivision was not calculated for them.

Figure 2.a shows the significant difference between recent immigrant women and other women in terms of their intention to use the REM. When keeping every other variable fixed at its mean, women that are non-new-immigrants have a probability of 45% to 48% of using the REM, while new-immigrant women have a probability between 68% to 70%. Additionally, Figure 2.a shows that age has a considerably smaller effect on women than men. When keeping all else constant, women of 80 years of age have less than a 2% reduction in probability of using the REM compared to women of 20 years of age, regardless of immigration status. On the other hand, older men are

considerably less likely to use the REM when compared to their younger counterparts. While men of 20 years of age have a 69% likelihood to use the REM, for 80-year-old men this likelihood decreases to 48%, when keeping all other variables constant. This figure demonstrates how the gender gap in intention to use the REM is greatest among younger individuals.

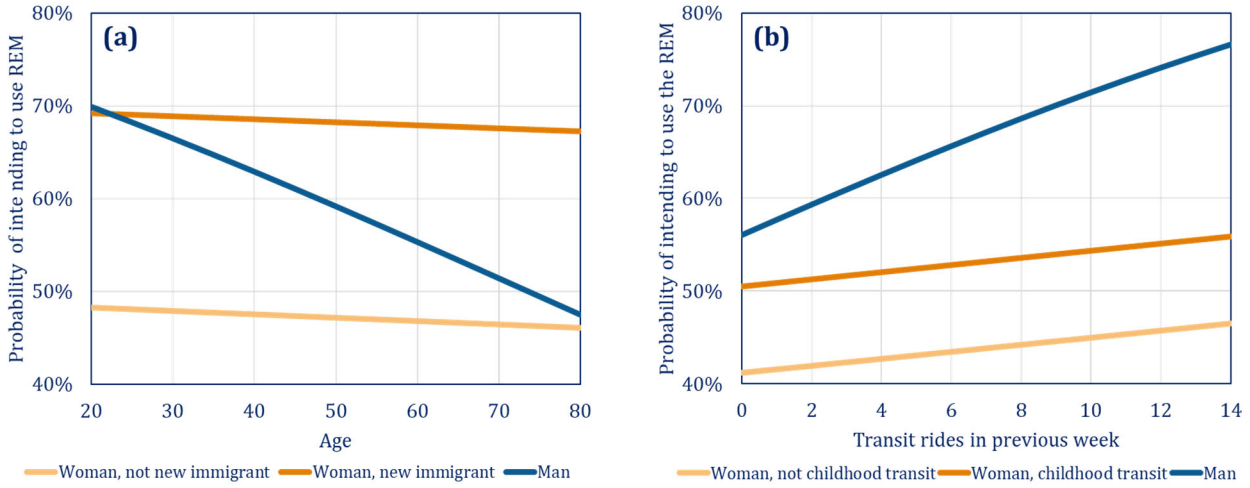

Figure 2. Sensitivity analysis of (a) age and immigrant status, and (b) current and childhood transit use.

For the second sensitivity analysis (Figure 2.b), similarly to the first analysis, the probability for intending to use the REM was calculated for men and women while sensitizing key variables. In this case, the probability was calculated while varying the number of current weekly transit rides. Additionally, we subdivided women into those who regularly used transit during their childhood and those who did not. We did not apply this distinction for men, as this variable was not significant for them.

This analysis shows that, when keeping all else fixed at its mean, women who used transit regularly during their childhood have a probability of using the REM approximately 9% larger than women who did not, regardless of current transit use. Additionally, women who have a current transit use of two daily trips have a 5% increase in probability to use the REM compared to those who currently do not use transit, when keeping all else constant. This effect is small when compared to men. For men who currently use transit twice a day, their probability of using the REM is 21% more than for men who have no current transit use, when fixing all other variables.

Non-gendered factors

Our model of intention to use the REM included several independent variables that showed not to have a significantly different effect depending on the person's gender. These include sociodemographic, life history, spatial, mobility, attitudinal, and residential self-selection independent variables. According to the model results, employed people are 26% less likely to intend to use LRT than those who are not, all else held equal. Individuals in yearly-income groups of less than $90,000 are 33% to 42% less likely to use the new LRT than those in higher income groups, which goes in line with previous research (*25*). Respondents raised in rural environments

had a 21% lower probability for intending to use the REM, in comparison to individuals who were raised in a suburban environment have a higher to use the REM.

As expected, increasing the access distance to the closest REM station reduces the odds of intending to use the REM. The statistical significance and positive odds ratio of the square term indicates that there is a non-linear effect of access distance on the intention to use the REM, which is illustrated in Figure 3. The probability that a person living at a distance of 3.7km from their closest REM station intends to use the REM is half of a person living in the immediate vicinity of the REM. While previous research has found that the effect of access distance to the closest LRT station on realized use differed significantly between men and women (*25*), we did not find a significant gendered difference in this relationship. Higher existing transit accessibility at the respondent's home location generates less intention to use the REM. Similarly, higher local accessibility, as measured through WalkScore, also results in lower intention to use the REM. These results indicate that the REM caters to individuals who live in areas where there are currently fewer mobility and destination options, and thus the project may fill important gaps in the transport system and change behaviour.

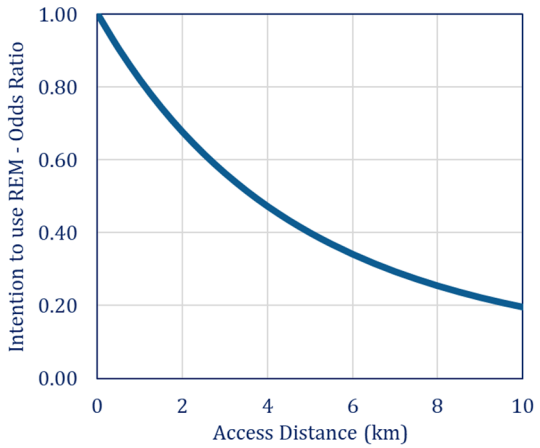

Figure 3. Effect of access distance on intention to use the REM odds

Corroborating findings by Sener et al. (*24)*, we found that individuals who reported doing more physical activity for transport in the previous week were more likely to intend to use the REM compared top those who reported doing less. Each additional hour of transport physical activity per week increases the likelihood to intend to ride the REM by 7%. Respondents with access to a car are 20% less likely to intend to use LRT, all else held equal. This finding is consistent with findings in previous research (*24; 44*). Members of Montreal's public bike share system, Bixi, have higher odds of intending to use the REM. We understand this as a proxy for willingness or openness to adopt new behaviours in general. Consistent with other studies on the determinants of LRT and rail use, we found that attitudes were very strongly deterministic, even when accounting for socio-demographic, environmental, and mobility characteristics (*24; 45-47*). Pro-transit attitudes, indicated by desire to use public transit more often, had a strongly positive association on intention to use the REM, while negative attitudes towards the impact of the REM on the respondent's neighbourhood and on the city had a strongly negative association.

Use of REM by gender and trip purpose

By analyzing intended use of the REM for specific purposes, we further inquire into other important ways in which use of LRT differs for women. Considering the subset of respondents who indicated that they intended to use the REM (n = 1490), we compare intended use for three specific trip purposes between people who identify as women and those who identify as men (Table 3), other genders were excluded due to small sample size. The results of this analysis show that there is no statistically significant gender gap for travel to work by LRT. In contrast, there is a statistically significant gender gap for intention to use the REM for leisure activities and for going to the airport. These results suggest that the REM is less useful to women than it is for men, as it does not fill women's travel needs for non-discretionary travel. We propose two explanations to this that could be investigated in future research. The first is that women may conduct different activities to fulfill leisure needs that require LRT less. This could be the case if, for example, leisure activities are conducted closer to the household for women than for men, which could be partially explained by the greater burden placed on women for household responsibilities, hindering the possibility of long-distance leisure activities. The second explanation would be that women generally have fewer opportunities to conduct non-discretionary trips, due to enduring gender inequities, such as the uneven distribution of care mobilities (*18; 19*).

Table 3. Intended trip purpose using the REM by gender, and t-test results, for respondents who intend to use the REM.

Intended trip purpose with REM	Women (n = 699)	Men (n = 791)	*p*-Value
Going to work	44.20%	44.10%	0.973
Recreation and leisure activities	54.50%	62.60%	0.002
Going to the airport	61.20%	66.60%	0.031

6 CONCLUSIONS

Large public transit infrastructure, such as LRT, has the potential to make transformative impacts on urban environments and the wellbeing of local populations. It is crucial to identify the ways in which these impacts vary across society, to examine whose needs are being fulfilled by LRT, and to assess whether the distribution of benefit across groups is fair and equitable. Our study examining how intended use of LRT in Montreal differs across gender builds on previous research that has illuminated gender differences in travel behaviour and public transit use in general (*10; 23; 25*). Studies on realized and intended LRT use in other context have found differences across gender categories (*9; 24*), but require greater attention to the causes of gender gaps, which our paper has tried to explain.

Using a weighted multi-level logistic regression, we analyzed a survey conducted in Montreal, Canada, to understand the gender differences in factors affecting the intention to use the REM, an LRT system currently under construction in the metropolitan area. We found five major ways in which intention to use the REM differs across gender. First, and most broadly, is that women intend to use the REM significantly less than men. Second, intention to use the REM for women declines slower with their age relative to men, and thus the gap in intended LRT use is greater among young people. Third, women who recently immigrated to Canada intend to use the REM far more than non-immigrant women, whereas there is no effect of being a new immigrant on

men's intention to use the REM. Thus, the gap in intended REM use is greater among people who are not recent immigrants. Fourth, increased current use of public transit contributes less to intention to use the REM for women, whereas use of public transit in childhood contributes positively to intention to use the REM for women, but not for men.

Lastly, among future REM users' intention, there is no discernable gap in intention to use the REM for work, less discretionary travel purpose. However, there are large and statistically significant gaps in intention to use the REM for leisure, with women intending to use the REM far less for this purpose. These differential intentions regarding discretionary travel could be attributed to a variety of gender dynamics discussed in the mobilities literature, from the feminization of household labour, to differential care mobilities, to issues of unequal pay (*11; 13; 14; 18; 19*). Our study brings greater attention to the potential impact of these gender inequities on travel for leisure, meriting further research and analysis.

Particularly in light of the COVID-19 pandemic, which widened the income gap and led to an increase in women's household care responsibilities (*48*), greater attention is needed to how these dynamics impact women's access to leisure activities and other benefits associated with major public-transit investments. These inequities also underscore the need for transport planning to not only be gender responsive, but also work in alignment with calls for gender-transformative planning processes that support women and other underrepresented groups in challenging oppressive gender roles and inequities (*20; 49*). To design transport systems that include LRT and serve people with diverse gender identities, policy makers can target their efforts on specific sub-groups and travel purposes where the gender gaps in intended LRT use are widest: younger individuals, non-immigrants, and for non-work travel purposes. The findings of our study can be used to prioritize and design behaviour change efforts.

Our study is limited in that we were not able to control for or investigate how varying perceptions of light-rail transit in general, especially with regards to personal safety on LRT, affect intention to use the REM, as our survey dataset lacked questions on this point. Additionally, as our survey dataset only included 38 non-binary individuals, we were not able to make any conclusive remarks about how the intention to use LRT for non-binary individuals might vary relative to people who identify as men and women.

Future research could inquire deeper into the social and economic phenomena that create the specific patterns that we identified with women's intentions to use LRT. Specifically, further investigations can investigate how perceived barriers, attitudes, specific travel intentions, and other factors vary for women by age cohort and immigration status. What our study revealed about how childhood experience affects intended mode choice in adulthood merits further investigation as part of a broader effort to understand how life-course events have gendered effects on mode choice (*42*). In particular, we suggest research on the role of gender-differentiated socialization on travel behaviour. Future research can build on our study by applying qualitative approaches, such as in-depth interviews, that can triangulate and detail the phenomena that generate the gender gaps in mode choice that we identified. Eventually, we hope that improved understanding of the interactions between gender and public transit technology, including LRT, will guide interventions that target the design of transport infrastructure and the de-construction of gender roles that produce inequities in order to realize transport systems that advance social wellbeing equitably.

Acknowledgements
The authors would like to thank James DeWeese, Rania Wasfi, Boer Cui, Lea Ravensbergen and Manuel Santana Palacios for their help in designing, building, and cleaning the survey data. This research was funded by The Canadian Institutes of Health Research (CIHR) and The Natural Sciences and Engineering Research Council of Canada (NSERC) Collaborative Health Research Projects (CHRP) Program (CIHR CPG-170602 and CPG-170602 X- 253156, NSERC CHRPJ 549576-20). It was also funded by the Social Sciences and Humanities Research Council of Canada and Fonds de Recherche du Québec- Société et culture (FRQSC).

References
[1] Sovacool, B. K., and J. Axsen. Functional, symbolic and societal frames for automobility: Implications for sustainability transitions. *Transportation Research Part A: Policy and Practice,* Vol. 118, 2018, pp. 730-746.

[2] Dent, N., L. Hawa, J. DeWeese, R. Wasfi, Y. Kestens, and A. El-Geneidy. Market-Segmentation Study of Future and Potential Users of the New Réseau Express Métropolitain Light Rail in Montreal, Canada. *Transportation research record,* Vol. 2675, No. 10, 2021, pp. 1043-1054.

[3] Ferbrache, F., and R. D. Knowles. City boosterism and place-making with light rail transit: A critical review of light rail impacts on city image and quality. *Geoforum,* Vol. 80, 2017, pp. 103-113.

[4] Pereira, R. H., T. Schwanen, and D. Banister. Distributive justice and equity in transportation. *Transport reviews,* Vol. 37, No. 2, 2017, pp. 170-191.

[5] Manaugh, K., and A. El-Geneidy. Who benefits from new transportation infrastructure? Using accessibility measures to evaluate social equity in public transport provision.In *Accessibility analysis and transport planning*, Edward Elgar Publishing, 2012. pp. 211-227.

[6] Manaugh, K., M. G. Badami, and A. M. El-Geneidy. Integrating social equity into urban transportation planning: A critical evaluation of equity objectives and measures in transportation plans in North America. *Transport policy,* Vol. 37, 2015, pp. 167-176.

[7] DeWeese, J., M. S. Palacios, A. Belikow, and A. El-Geneidy. Whose express access? Assessing the equity implications of bus express routes in Montreal, Canada. *Journal of Transport and Land Use,* Vol. 15, No. 1, 2022, pp. 35-51.

[8] Mandhani, J., J. K. Nayak, and M. Parida. Establishing service quality interrelations for Metro rail transit: Does gender really matter? *Transportation Research Part D: Transport and Environment,* Vol. 97, 2021, p. 102888.

[9] Creemers, L., M. Cools, H. Tormans, P.-J. Lateur, D. Janssens, and G. Wets. Identifying the determinants of light rail mode choice for medium-and long-distance trips: Results from a stated preference study. *Transportation research record,* Vol. 2275, No. 1, 2012, pp. 30-38.

[10] Hanson, S., and P. Hanson. Gender and urban activity patterns in Uppsala, Sweden. *Geographical Review*, 1980, pp. 291-299.

[11] Uteng, T. P., and T. Cresswell. *Gendered mobilities*. Routledge, London, 2016.

[12] Crane, R. Is there a quiet revolution in women's travel? Revisiting the gender gap in commuting. *Journal of the American planning association,* Vol. 73, No. 3, 2007, pp. 298-316.

[13] Walsh, M. Gender and travel: mobilizing new perspectives on the past.In *Gendered Journeys, Mobile Emotions*, Ashgate, 2009. pp. 5-18.

[14] Gauvin, L., M. Tizzoni, S. Piaggesi, A. Young, N. Adler, S. Verhulst, L. Ferres, and C. Cattuto. Gender gaps in urban mobility. *Humanities and Social Sciences Communications,* Vol. 7, No. 1, 2020, pp. 1-13.

[15] Kern, L. *Feminist city: claiming space in a man-made world*. Verso Books, 2021.

[16] Soto Villagrán, P. Repensar el hábitat urbano desde una perspectiva de género. Debates, agendas y desafíos. *Andamios,* Vol. 13, No. 32, 2016, pp. 37-56.

[17] Jirón, P. Planificación urbana y del transporte a partir de relaciones de interdependencia y movilidad del cuidado.In *¿Quién cuida en la ciudad?*, CEPAL, 2017. pp. 403-430.

[18] Ravensbergen, L., J. Fournier, and A. El-Geneidy. Exploratory Analysis of Mobility of Care in Montreal, Canada. *Transportation Research Record*, 2022, p. 03611981221105070.

[19] Plyushteva, A., and T. Schwanen. Care-related journeys over the life course: Thinking mobility biographies with gender, care and the household. *Geoforum,* Vol. 97, 2018, pp. 131-141.

[20] Soliz, A. Gender and cycling: Reconsidering the links through a reconstructive approach to Mexican history. *Mobilities,* Vol. 16, No. doi.org 10.1080/17450101.2021.1939109, 2021.

[21] Miralles-Guasch, C., M. M. Melo, and O. Marquet. A gender analysis of everyday mobility in urban and rural territories: from challenges to sustainability. *Gender, Place & Culture,* Vol. 23, No. 3, 2016, pp. 398-417.

[22] Nosal Hoy, K., and S. Puławska-Obiedowska. The Travel Behaviour of Polish Women and Adaptation of Transport Systems to Their Needs. *Sustainability,* Vol. 13, No. 5, 2021, p. 2693.

[23] Preston, V., and S. McLafferty. Revisiting gender, race, and commuting in New York. *Annals of the American Association of Geographers,* Vol. 106, No. 2, 2016, pp. 300-310.

[24] Sener, I., K. Lee, C. Durand, A. O. Oluyomi, and H. Kohl III. Intention to use light-rail transit in Houston, Texas, United States: Findings from the travel-related activity in neighborhoods study. *International journal of sustainable transportation,* Vol. 14, No. 12, 2020, pp. 944-955.

[25] Hsu, H., M. Boarnet, and D. Houston. Gender and rail transit use: Influence of environmental beliefs and safety concerns. *Transportation research record,* Vol. 2673, No. 4, 2019, pp. 327-338.

[26] Steer Davies Gleave. Sommaire des prévisions d'achalandage du REM.In, 2017.

[27] Lee, R. J., and I. N. Sener. The effect of light rail transit on land use in a city without zoning. *Journal of Transport and Land Use,* Vol. 10, No. 1, 2017, pp. 541-556.

[28] Wali, B., L. D. Frank, D. R. Young, R. T. Meenan, B. E. Saelens, J. F. Dickerson, and S. P. Fortmann. Causal evaluation of the health effects of light rail line: A natural experiment *Journal of Transport & Health,* Vol. 24, 2022, p. 101292.

[29] Topalovic, P., J. Carter, M. Topalovic, and G. Krantzberg. Light Rail Transit in Hamilton: Health, Environmental, and Economic Impact Analysis. *Social Indicators Research,* Vol. 108, No. 2, 2012, pp. 329-350.

[30] Roorda, M. J., A. Páez, C. Morency, R. Mercado, and S. Farber. Trip generation of vulnerable populations in three Canadian cities: a spatial ordered probit approach. *Transportation,* Vol. 37, No. 3, 2010, pp. 525-548.

[31] Morency, C., A. Paez, M. J. Roorda, R. Mercado, and S. Farber. Distance traveled in three Canadian cities: Spatial analysis from the perspective of vulnerable population segments. *Journal of transport geography,* Vol. 19, No. 1, 2011, pp. 39-50.

[32] Páez, A., R. Gertes Mercado, S. Farber, C. Morency, and M. Roorda. Relative accessibility deprivation indicators for urban settings: Definitions and application to food deserts in Montreal. *Urban Studies,* Vol. 47, No. 7, 2010, pp. 1415-1438.

[33] Dillman, D., J. Smyth, and L. Christian. *Internet, phone, mail, and mixed-mode surveys: The tailored design method (Fourth ed.)*. Wiley, Hoboken, New Jersey, 2014.

[34] Pereira, R. H. M., M. Saraiva, D. Herszenhut, C. K. V. Braga, and M. W. Conway. r5r: Rapid Realistic Routing on Multimodal Transport Networks with R5 in R. *Findings,* Vol. 21262, 2021.

[35] Hall, C. M., and Y. Ram. Walk score (R) and its potential contribution to the study of active transport and walkability: A critical and systematical review. *Transportation Research Part D,* Vol. 61, 2018, pp. 310-324.

[36] Manaugh, K., and A. El-Geneidy. Validating walkability indices: How do different households respond to the walkability of their neighbourhood? . *Transportation research Part D: Transport and Environment,* Vol. 16, No. 4, 2011, pp. 309-315.

[37] Bates, D., M. Mechler, B. Bolker, and S. Walker. Fitting Linear Moxied-Effects Models Using lme4. *Journal of Statistical Software,* Vol. 67, No. 1, 2015, pp. 1-48.

[38] Pasek, J. anesrake: ANES Raking Implementation. *R package version 0.80*, 2018.

[39] Statistics Canada. Census Tract Boundary Files, Census Year 2016. *Statistics Canada Catalogue no. 92-168-X2016001*, 2016.

[40] von Bergmann, J., D. Shkolnik, and A. Jacobs. cancensus: R package to access, retrieve, and work with Canadian Census data and geography. *R package version 0.4.2*, 2021.

[41] Uteng, T. P., and K. Lucas. *Urban mobilities in the global south*. Routledge London, 2018.

[42] Scheiner, J. Gendered key events in the life course: effects on changes in travel mode choice over time. *Journal of transport geography,* Vol. 37, 2014, pp. 47-60.

[43] Baslington, H. Travel Socialization: A Social Theory of Travel Mode Behavior. *International journal of sustainable transportation,* Vol. 2, No. 2, 2008, pp. 91-114.

[44] Yazdanpanah, M., and M. Hosseinlou. The role of personality traits through habit and intention on determining future preferences of public transport use. *Behavioral Sciences,* Vol. 7, No. 8, 2017, pp. 1-15.

[45] Kitamura, R., P. Mokhtarian, and L. Laidet. A micro-analysis of land use and travel in five neighborhoods in the San Francisco Bay Area. *Transportation,* Vol. 24, No. 2, 1997, pp. 125-158.

[46] Lai, W., and C. Chen. Behavioral intentions of public transit passengers—The roles of service quality, perceived value, satisfaction and involvement. *Transport policy,* Vol. 18, No. 2, 2011, pp. 318-325.

[47] Şimşekoğlu, Ö., T. Nordfjærn, and T. Rundmo. The role of attitudes, transport priorities, and car use habit for travel mode use and intentions to use public transportation in an urban Norwegian public. *Transport policy,* Vol. 42, 2015, pp. 113-120.

[48] Fortier, N. COVID-19, gender inequality, and the responsibility of the state. *International Journal of Wellbeing,* Vol. 10, No. 3, 2020.

[49] Ortiz Escalante, S., and B. Gutiérrez Valdivia. Planning from below: using feminist participatory methods to increase women's participation in urban planning. *Gender & Development,* Vol. 23, No. 1, 2015, pp. 113-126.