

Biking to Ride: Investigating the Challenges and Barriers of Integrating Cycling with Regional Rail Transit

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ABSTRACT

Integrating bicycling with public transport can potentially benefit cyclists and transit operators. Successfully coordinating these transport modes, however, can be a difficult task when so little is known about the social and environmental barriers to this type of multi-modal travel in the North American context. Using data derived from a survey of regional train service patrons in the Greater Toronto and Hamilton Region of Ontario, Canada, this study examines the challenges faced by those who cycle to/ from the train, the barriers that keep passengers from commuting to/ from the train by bicycle, and the socio-demographic characteristics of those cycling – and not cycling – to/ from the train. Safety concerns, worries about bicycle security, and rules restricting when bicycles are permitted on trains were among the top challenges identified by individuals currently cycling to and/or from train stations. Among those who do not cycle to or from the train, appearance and comfort were the two primary concerns. Results also indicate that certain groups were more likely to cycle to/ from the train than others. Notably, a large gender gap exists, approximately two thirds (67%) of those cycling to their local train station were male. Results from this study may inform policy makers on how to successfully, and equitably, integrate cycling with regional rail transit.

INTRODUCTION

In recent years, the bicycle has received increasing attention from planners, decision makers, and researchers (1). Due to the bicycle's associated efficiency, environmental and health benefits, it is promoted as a potential key transport mode in producing sustainable urban mobility (2). Transportation research tends to focus on single transport modes independent from others. For example, while most research on city cycling focuses solely on trips that begin and end by bike, cyclists often exhibit multi-modal travel behaviour combining the bicycle with other modes such as buses or trains (2). In a study of Danish travel behaviour, it was found that few cyclists used a bicycle as their sole travel mode; the majority combined bicycle trips with other modes (3). Furthermore, scholars have argued that bicycles and public transit can be allies with their joint use potentially competing with the private car (4,5). Planning for sustainable transport could mean taking a closer look at multi-modal passenger travel, including cycle-transit integration.

Integrating cycling with public transit can be a mutually beneficial combination. Bicycles can extend the catchment area of transit stations far beyond the pedestrian range (6,7,8) and at a lower cost than cars, which require expensive parking facilities (6). Access to public transit not only allows cyclists to make longer trips that are difficult to make by bike alone, but can also provide alternatives when cyclists encounter bad weather, mechanical problems, or gaps in the bicycle network (7). While cycling rates remain low in many US and Canadian cities, cycling levels, public transit use, and the integration of bicycles with public transit have grown over the past decade (7).

This paper focuses on the challenges and barriers to bicycle-rail integration of the GO Transit system in the Greater Toronto and Hamilton Area in Ontario, Canada. GO Transit is a division of Metrolinx, a transportation planning agency of the Government of Ontario, and consists of an extensive network of commuter train lines and bus routes serving 65 million passengers a year (9). The system's rail network, the focus of this study, encourages cycling by providing bicycle parking facilities at each station and by allowing passengers to bring their bicycles on trains during off-peak hours. However, the number of individuals reaching the service by bicycle remains low, averaging approximately 1% across the network of stations (10). This study answers the following research questions through an analysis of a survey distributed to passengers of GO's train service: What challenges do integrated riders report? What barriers keep rail passengers from biking to rail? And what is the demographic profile of those who do - and those who do not - cycle to a regional train station? The paper begins with a brief review of articles examining bicycle-train integration. Sections detailing methods, results, and a concluding section with policy recommendations follow the review.

LITERATURE REVIEW

Previous research has found that few studies explore bicycle-public transport integration (2, 8, 11). One article identified five main approaches to aid in promoting bicycle-public transit integration in US and Canadian cities including: provision of bicycle parking facilities at bus stops and rail stations; multi-function bike stations providing a range of services such as bicycle rental, repairs, lockers; bicycle racks on buses; allowing bicycles on board public transit vehicles; and coordinating the bicycle network with public transit (7). In a study of bike-and-ride trip characteristics and user profiles in the UK, Netherlands, and Germany, the authors found that more people cycled to faster, higher-order types of public transit, e.g. trains or inner-city buses, than

1 slower types of public transport, e.g. local buses or streetcars (4). Research out of the Netherlands
2 suggests that two improvements could potentially increase ridership: the quality of bicycle routes
3 and bicycle parking (6). Additionally, a countrywide program that upgraded bicycle parking at
4 train stations in the Netherlands reported increased use and greater user-satisfaction (12). Finally,
5 through the examination of the effect of passenger attitudes on the decision to commute by public
6 transport and bicycle, it has been found that those who commute solely by public transport have
7 more positive attitudes toward commuting by car and less positive attitudes towards commuting
8 by bike, than those who combine bicycle and public transport for commuting (11). Bicycle-rail
9 integration has not been studied extensively, especially in the North American context. Given that
10 Europeans cities tend to differ greatly from North American ones regarding their planning and
11 political histories, built form, and transit, car, and bicycle networks and ridership, research on
12 bicycle-train integration in North America is needed. Furthermore, we could not locate work
13 examining, as this study does, the challenges faced by those currently combining bicycle and train
14 travel, nor the barriers preventing rail passengers from doing so.

15 In addition, mode choice, trip purpose, and social characteristics have been found to
16 influence travellers' needs, desires, and priorities when it comes to their transport journey (13).
17 For example, punctuality and reliability are important to rush hour commuters while safety,
18 reliability, and service frequency have been found to be more important to female commuters (13).
19 A substantial literature on the social characteristics of different kinds of travellers exists. For
20 example, we know that approximately two thirds of commuter cyclists are men in Canada, the
21 USA, the UK, and Australia (14). While less studied than the gender gap in cycling, discrepancies
22 between other demographic groups have been observed as well. For instance, in a study set in
23 London, England, most cyclists identified as white, male, and came from more affluent social
24 groups (15). In the City of Toronto, utilitarian cyclists are predominantly male (65%), between the
25 ages of 25 and 44 (58%), of higher income and educational standing, and maintain a downtown
26 address (16).

27 Few studies have assessed the social characteristics of those who combine cycling and train
28 travel. Research set in Nanjing, China found that women, older commuters, and low-income
29 commuters were more likely to use a private bicycle, and less likely to use public bicycle/ bike
30 share, to access rail transit. Given that there is little accessible data on how bicycles combine with
31 transit in most countries (2, 4), especially countries with low cycling rates such as Canada (4), the
32 lack of knowledge on the social characteristics of multi-modal travelers is not surprising. This
33 paper explores the challenges faced by those who combine bicycle and rail, the barriers preventing
34 people from doing so, and the social characteristics of those who do, and those who do not,
35 combine cycling with rail in the Greater Toronto and Hamilton Area, Canada. In doing so, this
36 paper addresses two research gaps identified in this literature review: a lack of studies on the
37 challenges and barriers to bicycle-rail integration in the North American context, and limited data
38 on the social characteristics of multi-modal travelers.

39 40 **DATA AND METHODS**

41 42 **Sample Characteristics**

43
44 A Bike Policy Survey was administered to GO Train passengers between November 17th and 30th
45 2014. It was sent to 6483 panelists of Metrolinx's online customer advisory community called the
46 'Let GO Know' panel. Panelists are recruited annually through advertisements on many channels

(e.g.: newspaper ads, website, train posters, train schedule departure screens, etc.). ‘Let GO Know’ panelists are compared to a larger system wide GO transit rail survey, with approximately 17,000 respondents, to validate its member make-up against the population of passengers. Non-panelists were also requested to participate in the survey through postcard invitations at specific stations (i.e. small printed invitations with links to the survey were distributed by hand to passengers during rush hour) and through a link posted to a Toronto-based cycling advocacy group’s newsletter. Survey respondents were not directly compensated, but were automatically entered in a draw to win credit on the GO Transit system.

The survey was completed by 1323 ‘Let GO Know’ panelists (19.87% panelist response rate). Of those, 1247 had ridden a GO Train in the past year. Furthermore, 33 non-panelists successfully completed the survey, resulting in a sample of 1280 individuals. The primary goal of the study was to understand passengers’ knowledge and use of the train system’s bike policy, i.e. the restriction of bicycles on GO Trains traveling through the most central and connecting station in the network during rush hour. However, the survey also asked the participants about their cycling behaviors and attitudes as well as their age, gender, and income.

Most participants owned a bicycle (62.54%) (Table 1). One in five survey respondents stated that they have biked to or from a train station that year. Approximately one third (27%) of the sample indicated they were somewhat to very interested in riding a bicycle to their home train station. Few respondents were under 18, older than 65, or earned less than \$25,000 yearly.

Variables and Units of Analysis

The survey included multiple-choice and open-ended questions. Responses were assessed through quantitative analysis and qualitative reporting. Specifically, to answer the first research question, “what challenges do those who combine cycling with rail face?”, responses to the open question “What are some of the challenges you experience combining cycling and GO Transit travel?” (n=237) were assessed. Recurrent themes were then identified. To answer the second research question, “what barriers keep rail passengers from reaching train stations by bicycle?”, responses to the multiple-choice question “What are the main reasons you don’t ever ride your bicycle to the GO station” were examined. Participants could select more than one option resulting in 1416 responses from the 641 participants. Finally, to answer the last research question, “what is the demographic profile of those who do – and those who do not – cycle to reach the regional train station?”, the gender, age, and income profiles of those who combine biking and rail were established. Then, responses to the questions: “What are the main reasons you don’t ever ride your bicycle to the GO station?” And “How interested are you in riding a bicycle to [your home station]?” were compared across income, age, and gender categories. Chi-Squared tests were performed to check for statistically significant differences between male and female responses to these two questions. The names of train stations were removed to preserve respondent anonymity.

RESULTS

What Challenges Do Those Who Combine Cycling With Rail Face?

Most passengers who had biked to GO at least once in the past year, specifically 237 of the 256, responded to the open question “What are some of the challenges you experience combining cycling and GO Transit travel?”. Four factors were consistently cited by the respondents: unsecure

1 and inconveniently designed bicycle parking at stations, travel safety concerns for the cycle part
2 of the trip, unclear and restrictive rules regarding when bicycles are allowed on trains, and
3 impracticality of navigating stations with bicycles. Other reported challenges included weather
4 (n=16), and lack of changing rooms at stations (n=3).

5 6 *Bicycle Parking at Stations* 7

8 The most frequently mentioned challenge - identified by 33.76% of cyclists (80 out of 237) – was
9 station bicycle parking. Two types of bicycle parking issues emerged: the security of locked
10 bicycles and poor/inconvenient bicycle parking design. Regarding the inconvenience of the bicycle
11 parking at stations, reported difficulties included distance between racks and station platforms,
12 inadequate shelter for locked bicycles, and proximity between smoking and bicycle parking areas.

13 As one participant explained:

14
15 “[some] bike racks [...] are only accessible if you get off your bike IN THE ROAD and
16 lift it onto a curb. You cannot bike from the sidewalk because a bench is in the way. These bike
17 racks were not placed with a biker in mind.” (emphasis original)

18
19 Multiple participants described their own or acquaintances’ experiences of bike theft:

20
21 “I’ve had my bike vandalized (and/or parts stolen) at the train station on a couple of
22 occasions. During the day, thieves have a good, long window between trains when there is nobody
23 around.”

24 25 *Safety Concerns Cycling to/from Stations* 26

27 Following bicycle parking concerns, the most frequently cited issue was traffic safety while riding
28 to/from train stations (22.36%). Many cyclists blamed this lack of perceived safety risk on driver
29 behaviors; others expressed their desire for dedicated bicycle lanes to attenuate conflict.

30
31 Many cyclists vividly described these safety issues:

32
33 “Where to start? Have you actually tried to bike from the road to where the bike parking
34 is at a GO Station? There are no bike lanes. I’m fighting for space with drivers trying to park. We
35 need dedicated lanes! You have the space.”

36
37 Another expressed the need for infrastructure:

38
39 “Very limited bicycle lanes to and from the GO station at [X station] make for a VERY
40 dangerous ride.” (emphasis original)

41 42 *GO Train Bicycle Policy* 43

44 Bicycles are not allowed on regional trains during rush hour (due to potential overcrowding) if the
45 train travels through the downtown station, called Union Station. Many individuals, however, still
46 carry their bicycle on board during this period. Almost a quarter (specifically 22.36% or 53 out of

237) of cycling respondents identified the rush hour policy as a key challenge to integration. Folding bicycles are permitted on regional trains at all times.

The rules/policies were perceived as restrictive and lacking clarity:

“The hours and rules are too restrictive. Sometimes going against rush hour traffic (e.g., on [X] line), there is no need to restrict bikes during rush hour. Also, until recently there were no trains outside of rush hour on the [Y] line, so it wasn't even possible to use a bike on some lines.”

With regard to clarity:

“The policy about bicycles ON the train is not clear at all. SOME GO employees say it's only on peak hours; SOME others say I can take my bike with me at any time. Then to make things more confusing, almost ALL GO train coaches have a sign by the door clearly showing that IT IS ALLOWED to take up to two bike on the train. I looked for clear rules on the GO website or on the stations and there's nothing in writing that can tell the user what the real policy is.” (emphasis original)

Train Station and Rolling Stock Design Issues

Approximately 15% of people who cycled (35 out of 237) reported encountering difficulties navigating the stations with their bicycles. Identified issues included: lack of space for bicycles on train cars, awkwardness when using elevators, and difficulty getting onto train cars. Many participants listed issues they have encountered:

“Handlebars getting caught on the vertical post in the doorway, carrying bicycle up and down stairs at the stations, no dedicated bicycle car [...]”

Another stated:

“No obvious elevators in stations to facilitate bringing the bike to and from the platform. No ramp into the trains to facilitate bringing in a bike (accessibility ramp could be used for this purpose). [...] The doors have almost closed on my bike several times because it took me some time to lift it in.”

The responses made clear that the train stations and coach designs were not designed with cyclists in mind. These qualitative observations suggest that bicycle parking at train stations, perceived traffic risks, restrictive and unclear bicycle policy, and the station and train's bicycle-unfriendly designs are key service integration challenges.

What are the Barriers Keeping Rail Passengers From Reaching Train Stations by Bicycle?

Respondents who didn't cycle to the train were asked, “What are the main reasons you don't ever ride your bicycle to the train station?”. Appearance and comfort were the majority concerns with 42% of patrons who do not cycle to the train indicating concern about maintaining a professional appearance and 38% reporting they feared they would be sweaty during their train ride (Figure 1).

Thirty-three percent of those who do not cycle indicated that train stations were too far from their home to bike. After distance, key reported barriers included: personal safety concerns while cycling to/from stations (27%), concerns about bicycle security at stations (25%), finding cycling impractical due to the amount of equipment they carry to/from the train (24%), and bike policy (15%) (Figure 1). While only 25% of passengers who do not bike to/from the train station identified bicycle parking as a barrier, 44% of those who do not cycle to/from the train, but who indicated being somewhat to very interested in biking to/from the train, cited concerns about the security of their parked bicycles as a main deterrent. Finally, 15% of respondents selected “other” responses including: living close enough to walk ($n=40$), coordinating commutes with household responsibilities ($n=8$), weather concerns ($n=4$), medical reasons ($n=3$), and a lack of lockers/storage at stations ($n=2$).

What are the social characteristics of those who do, and those who do not, combine cycling with rail?

Gender

Consistent with North American bicycle commuting trends, the data suggest that two thirds of regional rail cyclists are men (67% male vs. 33% female). A “female” risk aversion hypothesis has been suggested as an explanation for this type of gender gap in cities with low cycling rates (18, 19, 20). This study, however, does not support the gendered safety risk hypothesis (p -value > 0.1) (Table 2). It has also been hypothesized that women cycle less than men due to the greater social pressures women face to look feminine and attractive (14). However, while women indicated concern about professional appearance more than men, this observation was not statistically significant (p -value $> .01$). Men more frequently cited not wanting to be sweaty during the train ride than women (p -value < 0.1).

Others have suggested that women may not like cycling as much as men (14). This study suggests that women are equally interested in cycling to/from the train (p -value > 0.1). Previous work has found that women are more likely to trip chain than men due to greater household responsibilities (14, 21). This disproportionate unpaid household-serving burden limits their time available for other activities and makes it more difficult to commute by bicycle. Of those who selected “other” as a response, six women, compared to two men, specified that household duties, specifically picking up their children ($n=5$) or running errands ($n=1$) were among the main reasons they do not bike to/from the train. One woman stated:

“[I] need to pick up my children at the end of the day and can't do that with a bike”.

Furthermore, women in this survey indicated carrying too much equipment as a barrier to cycling to/from the train more frequently than men (p -value < 0.1) (Table 2). While the survey did not specify, this extra equipment may also relate to trip chaining (i.e., extra equipment for groceries, childcare, etc.). Survey questions did not directly investigate trip chaining.

Income

Most current cyclists to the train earn more than \$150,000 yearly (Figure 2a). Looking within each income category, a greater proportion of lower-income respondents cycle to the train. In fact, intra-income category rates decline as income increases and then rise within the highest income category (Figure 2b). Those earning \$25,000- \$49,999 yearly are most interested in cycling to the train (39% were somewhat to very interested).

Many barriers to cycling vary by income. Respondents within the lowest income group reported greater concern about their safety while cycling to the station as well as bicycle parking security more than all other income groups. Furthermore, those in the middle-income bracket (i.e. earning \$50-\$74,000 yearly) cite the system's bicycle policy as a deterrent more frequently than other income groups (Figure 3).

Finally, a positive correlation between income and both concerns over maintaining a professional appearance and wanting to avoid being sweaty was found (Figure 4).

Age

Most respondents currently cycling to/from the train station are between the ages of 25 and 44 (Figure 5a). However, a greater proportion of young passengers cycle to/from the train. In fact, these rates decline with age (Figure 5b).

Before the age of 35, similar proportions of commuters are somewhat to very uninterested and somewhat or very interested in cycling to/from the train station (approximately 40%). This interest drops dramatically from 35 until 64 (Figure 6).

DISCUSSION AND CONCLUSION

This study examined the challenges and barriers reported by those who currently do and do not combine cycling with rail travel. Limitations include potential self-selection bias of survey respondents. This study did not consider how these challenges and barriers vary by season. Future work is needed to consider potential seasonal variation, particularly in the winter months, in rider participation in bicycle-rail integration programs. Furthermore, this case study focused on bike-rail integration in the context of the Greater Toronto and Hamilton Area. Therefore, while the study contributes to the broader discussion on bicycle-rail integration, the policy recommendations emerging from this research may not be transferrable to other rail networks. This concluding section includes a discussion of key findings and policy recommendations.

Both cyclists (34%) and those not cycling to the train (25%) identified station bicycle parking as a barrier. Transit agencies wanting to encourage cycling, particularly the one studied here, should provide secure and convenient bicycle parking at every station. The majority of cyclists (69%) stated that they were interested in using a shared bicycle parking area with key access only, if such facilities were available at train stations. This type of infrastructure, which can be found at select stations on the Caltrain service in California (22) and in Melbourne, Australia (23), takes up the space of three parking spots, but can fit 26 bicycles while costing less than half the price of a single parking space (23). One in four cyclists also stated that video surveillance would encourage them to park their bicycle at the train station. Given that 44% of passengers who do not bike to the train, but are interested in doing so, cited concerns about bicycle security, solving the bicycle parking security challenge could weaken the impact of this key barrier.

Of course, improved bicycle parking would encourage cycling for only one side of the multi-modal trip: their bikes cannot be used at their destination stations. Previous work has found

1 that public transit users are more likely to use their own bicycles to get from their (often suburban)
2 home to their origin station than to their final destination (often downtown) from their destination
3 station (24). Given that destination stations may be at or near the city center, ensuring adequate
4 bike share programs at stations in the city center may facilitate cycle-train integration. Downtown
5 Toronto is served by 270 public bicycle stations (25). The fares for this Bike Share service and the
6 regional rail service are not integrated, however, GO Train passengers who own a PRESTO Card,
7 the electronic fare payment system available across many transit agencies in the Greater Toronto
8 and Hamilton Area, receive a 40% discount on annual Bike Share memberships (25). While some,
9 of course, prefer the convenience of bringing their own bicycle on the train to use it for both the
10 first and last mile of their trip, coordinating Bike Share and rail systems could still encourage
11 cycling to/from train stations. Indeed, others have similarly recommended that rail agencies
12 provide multimodal offers such as access to shared bicycle systems, or integrated multimodal fare
13 cards, to encourage cycle-train integration (26). Future research could specifically examine how
14 best to coordinate public bicycle sharing systems with rail.

15 Approximately one quarter of those who combined bikes and rail, and 27% of those who
16 do not bike to/from the train station cited safety concerns as a challenge or barrier. This result
17 highlights the need for cycling infrastructure to provide cyclists with safe access to train stations
18 across the transit network. Dedicated bicycle lanes within the train station property, with clear
19 orientation to bike parking, as well as lanes connecting train stations to the municipalities they
20 serve are recommended. Improving cyclist safety while accessing stations is also in line with the
21 2016 GO Rail Station Access Plan that includes the guideline to “create safe and direct pedestrian
22 and cycling routes to transit stations that are complemented with clear way-finding and potential
23 bike share programs within the station area” (10). Given that the lowest income group of this study
24 was most concerned with their personal safety while cycling to/from train stations as well as station
25 bicycle security, policies aimed at improving rider safety and bicycle security could be particularly
26 beneficial to lower-income train commuters. Safety concerns are not necessarily limited to those
27 associated with traffic; future work could explore the different sources of cycling-related safety
28 concerns such as fear of being mugged, assaulted, or harassed in general.

29 Navigation within the station envelope was also reported as a barrier. New stations should
30 be designed and built with all passengers, including cyclists, in mind. For stations that have already
31 been built, modifications can be made to accommodate cyclists. For example, stairways in stations
32 can be modified to include a ramp to roll bicycles up and/or down, bicycle stickers can be placed
33 on elevators to indicate that cyclists and their bicycles are invited to use these facilities, and a
34 dedicated train car for bicycles would also make it easier for cyclists to navigate train stations.
35 Within the train coaches, a more flexible design of the bike area (e.g.: folding seats, more spacious
36 standing zone) may also support bikes on trains, and could also be used for strollers, luggage, etc.

37 The GO system’s bike policy was also identified as a challenge or barrier for both cyclists
38 (22%) and those who do not cycle to/from the train (15%). The two main critiques from cyclists
39 were that the policy lacked clarity and that it was restrictive. Bicycle-related policies should be
40 simple and easy to follow. Many respondents (including those who do or do not cycle) support the
41 bike policy and expressed some acrimony toward the idea of letting bicycles onto rush hour trains.
42 Adding a separate car dedicated to bicycles during rush hour periods, as suggested above, could
43 allow cyclists to incorporate cycling into their daily commute without inconveniencing other
44 passengers. For example, Caltrain includes bike cars that can accommodate up to 24-72 bicycles
45 (23). Rail operators must also weigh the benefits of increased bicycle capacity against the costs of

increased dwell times, initial capital investment, maintenance, and other ongoing costs when deciding to implement this policy (8).

The two main barriers preventing passengers from combining bike and train integration were concerns about maintaining a professional appearance and comfort. This result may have to do with perception around cycling; some see biking as a high intensity sport that should be “performed” while wearing specialized clothing. Utilitarian cycling, however, does not need to involve heavy exertion resulting in sweating or an unprofessional appearance. Even the frame geometry of many utilitarian bikes enables a more relaxed riding position and pace. In many places, people of all ages and fitness levels cycle for transport. Other than providing showers or lockers at train stations, or in the workplace, little can be done in the short term to encourage people with these concerns to cycle, but over the long term, a change in the culture of mobility could attenuate such concerns.

Other than identifying key policies that could encourage bicycle-train integration, this study also contributes knowledge on the social characteristics of those combining cycling with train travel. Specifically, approximately two thirds (67%) of those cycling to the train were male. Furthermore, this study does not offer evidence supporting gendered hypotheses regarding risk, appearance, or a general dislike of cycling, as an explanation for the reported gender gap in cycle rates. Some evidence points to women cycling less due to the need to trip-chain in support of unpaid household labor. However, further research is needed to investigate this hypothesis. It is important to note that while this study identified behavioral and perception-based patterns across social groups, why these patterns and rates exist was not studied in detail. Further research should investigate how the transportation behaviors, needs, and experiences of people of different ages, genders, and incomes are shaped by, and shape, the context within which they live.

The authors confirm contribution to the paper as follows: study conception and design: Léa Ravensbergen, Meaghan Mendonca, Naren Garg; data collection: Meaghan Mendonca, Naren Garg, Ron Buliung; analysis and interpretation of results: Léa Ravensbergen; draft manuscript preparation: Léa Ravensbergen, Ron Buliung, Meaghan Mendonca. All authors reviewed the results and approved the final version of the manuscript.**

REFERENCES

1. Börjesson, M. and Jonas, E. The Benefits of Cycling: Viewing Cyclists as Travelers Rather than Non-Motorists. In *Cycling and Sustainability* (J. Parkin, S. Ison, J. Shaw, ed.), Biggleswade: Turpin Distribution Services Limited. Published online, 2012, pp. 83-108.
2. Kuhnimhof, T., B. Chlond, P.C. Huang. Multimodal Travel Choices of Bicyclists. *Transportation Research Record: Journal of the Transportation Research Board*, No. 2190, 2010, pp. 19–27.
3. Olafsson, A. S, T.S. Nielsen, T.A. Carstensen. Cycling in Multimodal Transport Behaviours: Exploring Modality Styles in the Danish Population. *Journal of Transport Geography*, No. 52, 2016, pp. 123-130.
4. Martens, K. The Bicycle as a Feeder Mode: Experiences from Three European

- 1 Countries. *Transportation Research Part D: Transport and Environment*, No. 9, 2004, pp. 281–
2 294.
- 3
- 4 5. Keijer, M. J. N., P. Rietveld, P. How do People Get to the Railway Station? The Dutch
5 Experience. *Transportation Planning and Technology*, No.23(3), 2000, pp. 215–235.
- 6
- 7 6. Geurs, K.T., L. La Paix, S. Van Weperen. A Multi-Modal Network Approach to Model Public
8 Transport Accessibility Impacts of Bicycle-Train Integration Policies. *European Transportation*
9 *Research Review*, 8(25), 2016, pp. 1-15.
- 10
- 11 7. Pucher, J., R. Buehler. Integrating Bicycling and Public Transport in North America, *Journal*
12 *of Public Transportation*, No. 12(3), 2009, pp. 79- 104.
- 13
- 14 8. Krizek, K. J., Stonebraker, E. W. Bicycling and Transit: A Marriage Unrealized.
15 *Transportation Research Record: Journal of the Transportation Research Board*,
16 No. 2144, 2010, pp. 161–167.
- 17
- 18 9. Metrolinx. Go Transit, 2015. <http://www.gotransit.com/publicroot/en/default.aspx>. Accessed
19 October 2017.
- 20
- 21 10. Metrolinx. GO Rail Station Access Plan, p. 5, 2016.
22 [http://www.metrolinx.com/en/regionalplanning/projectevaluation/studies/GO_Rail_Station_Ac](http://www.metrolinx.com/en/regionalplanning/projectevaluation/studies/GO_Rail_Station_Access_Plan_EN.pdf)
23 [ss_Plan_EN.pdf](http://www.metrolinx.com/en/regionalplanning/projectevaluation/studies/GO_Rail_Station_Access_Plan_EN.pdf). Accessed July 2017.
- 24
- 25 11. Heinen, E., W. Bohte. Multimodal Commuting to Work by Public transport and Bicycle:
26 Attitudes Toward Mode Choice. *Transportation Research Record: Journal of the Transportation*
27 *Research Board*, No. 2468, 2014, pp. 111–122.
- 28
- 29 12. Martens, K. Promoting Bike-and-Ride: The Dutch Experience. *Transportation Research Part*
30 *A*, No. 41, 2007, pp. 326-338.
- 31
- 32 13. Susilio, Y.O., O. Cats. Exploring Key Determinants of Travel Satisfaction for Multi-Modal
33 Trips by Different Traveler Groups. *Transport Research Part A*, No. 67, 2014, pp. 366-380.
- 34
- 35 14. Garrard, J., S. Handy, J. Dill (2012). Women and Cycling. In *City Cycling* (J. Pucher and R.
36 Buehler, eds.), MIT Press, Cambridge, MA, 2012, pp. 211-234.
- 37
- 38 15. Steinbach, R., J. Green, J. Datta, P. Edwards. Cycling and the City: A Case Study of How
39 Gendered, Ethnic and Class Identities Can Shape Healthy Transport Choices. *Social Science and*
40 *Medicine*, No. 72(7), 2011, pp. 1123-1130.
- 41
- 42 16. City of Toronto (2015). Toronto Cycling Statistics.
43 [http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=caa5970aa08c1410VgnVCM100000](http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=caa5970aa08c1410VgnVCM10000071d60f89RCRD)
44 [71d60f89RCRD](http://www1.toronto.ca/wps/portal/contentonly?vgnextoid=caa5970aa08c1410VgnVCM10000071d60f89RCRD). Accessed October 2015
- 45

17. Yi, Y., Y. Fan, A. Ermagun, X. Cao, W. Wang, K. Das. Public Bicycle as a Feeder Mode to Rail Transit in China: The Role of Gender, Age, Income, Trip Purpose, and Bicycle Theft Experience, *International Journal of Sustainable Transportation*, No. 11(4), 2017, pp. 308-317,
18. Agarwal, A., A. North, A. Encouraging Bicycling Among University Students: Lessons from Queen's University, Kingston, Ontario. *Canadian Journal of Urban Research*, No. 21(1), 2012, pp. 151-168.
19. Garrard, J., G. Rose, S. Lo. Promoting Transportation Cycling for Women: The Role of Bicycle Infrastructure. *Preventive Medicine*, No. 46, 2008, pp. 55-59.
20. Heesch, K. C., S. Sahlqvist, J. Garrard. Gender Differences in Recreational and Transport Cycling: A Cross-Sectional Mixed-Methods Comparison of Cycling Patterns, Motivators, and Constraints. *International Journal of Behavioral Nutrition and Physical Activity*, No. 9(106), 2012, pp. 1-12.
21. Heinen, E., B. van Weeb, K. Maat. Commuting by Bicycle: An Overview of the Literature, *Transport Reviews: A Transnational Transdisciplinary Journal*, No. 30 (1), 2010, pp. 59-96.
22. Caltrain. Bicycle General Info, 2017. http://www.caltrain.com/riderinfo/Bicycles/Bicycle_General_Info.html. Accessed October 2017.
23. Bicycle Network. Parkiteer, 2016. <https://www.bicyclenetwork.com.au/general/programs/370/>. Accessed January 2017.
24. Pucher, J., R. Buehler. Cycling for Everyone: Lessons from Europe. *Transportation Research Record: Journal of the Transportation Research Board*, No. 2074, 2008, pp. 58–65.
25. Bike Share Toronto. Bike Share Toronto, 2016. <https://www.bikesharetoronto.com/>. Accessed October 2017.
26. Bachand-Marleau, J., J. Larsen, A. El-Geneidy. Much-Anticipated Marriage of cycling and Transit. *Transportation Research Record: Journal of the Transportation Research Board*, No. 2247, 2011, pp. 109–117.

List of Tables and Figures

Table 1 Summary Statistics of the Survey Sample

Table 2 Survey Responses by Gender

Figure 1 Primary Reasons Passengers do not Ride Their Bicycle to the Train Station

Figure 2 Income Profile of Those Who Cycle to the Train

Figure 3 Reasons Not to Bike to/from the Train Station Organized by Income

Figure 4 Relationship Between Concerns Over Maintaining a Professional Appearance and Sweating and Annual Income

Figure 5 Age Profile of those Combining Cycling with Rail

Figure 6 Interest in Cycling to the Train Station Across the Life Course

1 **TABLE 1 Summary Statistics of the Survey Sample**

Sample Characteristics		%	n
Own a bicycle (n=1025)		62.54	641
Have biked to the train in the past year (n= 1280)		20.00	256
Very interested in cycling to the train (n= 641)		5.62	36
Somewhat interested in cycling to the train (n= 641)		21.84	140
Neither interested or uninterested in biking to the train (n= 641)		11.54	74
Somewhat uninterested in cycling to the train (n= 641)		16.69	107
Very uninterested in cycling to the train (n= 641)		44.31	284
Gender (n=1,280)	Male	46.80	599
	Female	53.20	681
Age Group (n= 1,280)	Under 18	0.47	6
	18-24	7.34	94
	25-34	17.34	222
	35-44	23.28	298
	45-49	14.69	188
	50-54	17.58	225
	55-64	17.27	221
	65+	2.03	26
Annual Income (n= 1,247)	Under \$25,000	3.29	41
	\$25,000 - \$49,999	6.26	78
	\$50,000 – \$74,999	10.67	133
	\$75,000 - \$99,999	12.99	162
	\$100,000 - \$124,999	12.11	151
	\$125,000 – \$149,999	7.70	96
	\$150,000 or more	14.11	176
	Prefer not to answer	32.88	410

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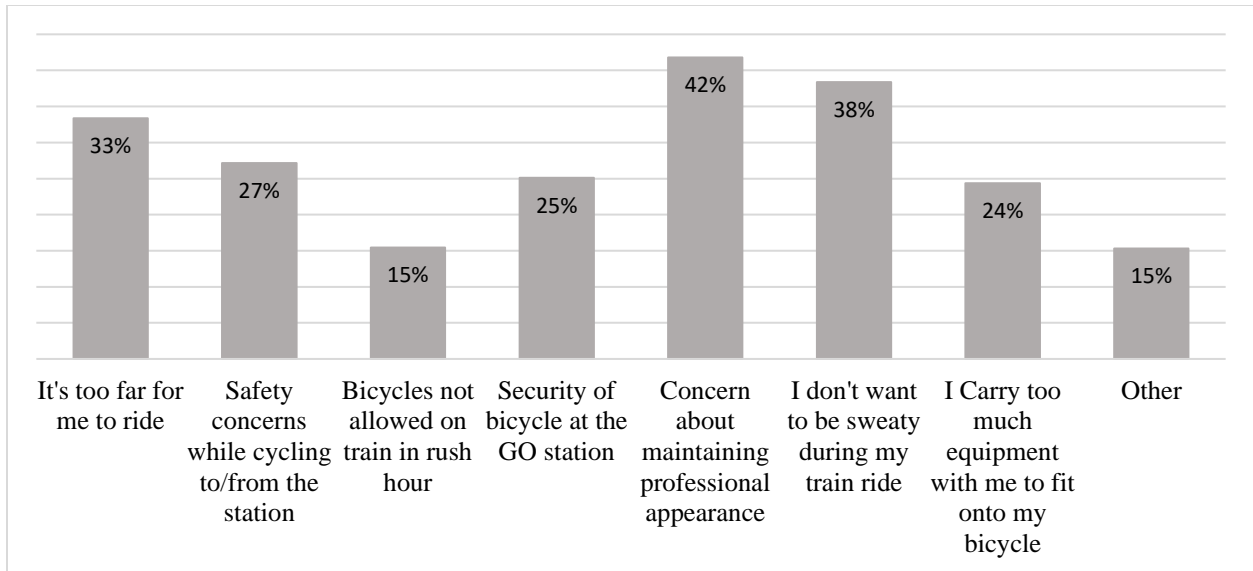


FIGURE 1 Primary Reasons Passengers do not Ride Their Bicycle to the Train Station*

*Respondents could select multiple options

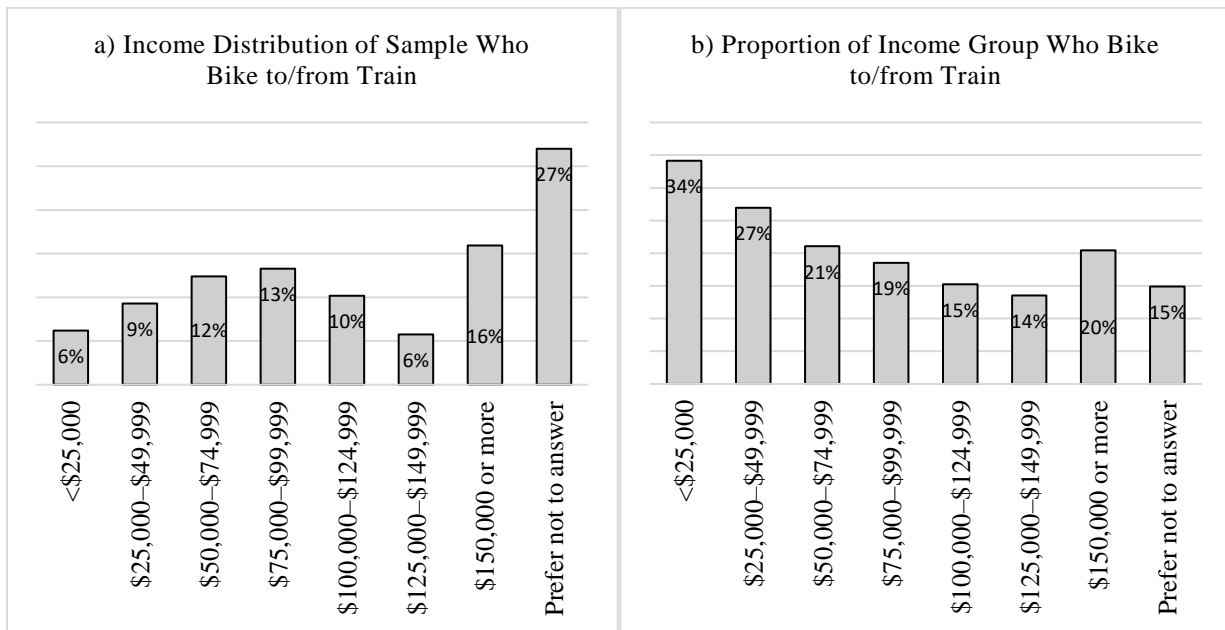
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1 **TABLE 2 Survey Responses by Gender**

	Men (n= 302)	Women (n = 339)
What are the main reasons you don't ever ride your bicycle to the train station? (multiple choice)		
It's too far for me to ride	108	106
Safety concerns while cycling to/from the station	77	97
Bicycles not allowed on the train in rush hour	59***	40
Security of bicycle at the GO Station	84	77
Concern about maintaining a professional appearance	117	151
I don't want to be sweaty during my train ride	127*	119
I carry too much equipment with me to carry onto my bicycle	61	95*
How interested are you in riding a bicycle to the train station? (multiple choice)		
Very interested in riding a bike to the train station	18	18
Somewhat interested in riding a bike to the train station	63	77
Neither interested nor interested in riding a bike to the train station	39	35
Somewhat uninterested in riding a bike to the train station	58	49
Very uninterested in riding a bike to the train station	124	160

***p-value < .01, **p-value < .05, *p-value < .1

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3 **FIGURE 2 Income Profile of Those Who Cycle to the Train**
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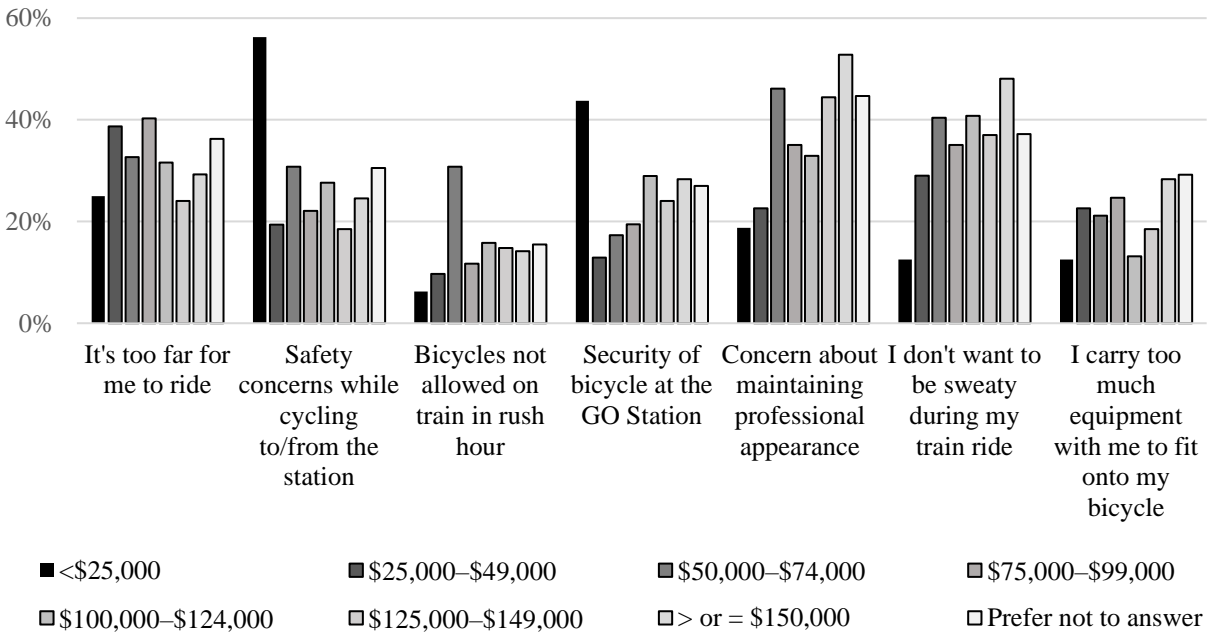


FIGURE 3 Reasons Not to Bike to/from the Train Station Organized by Income

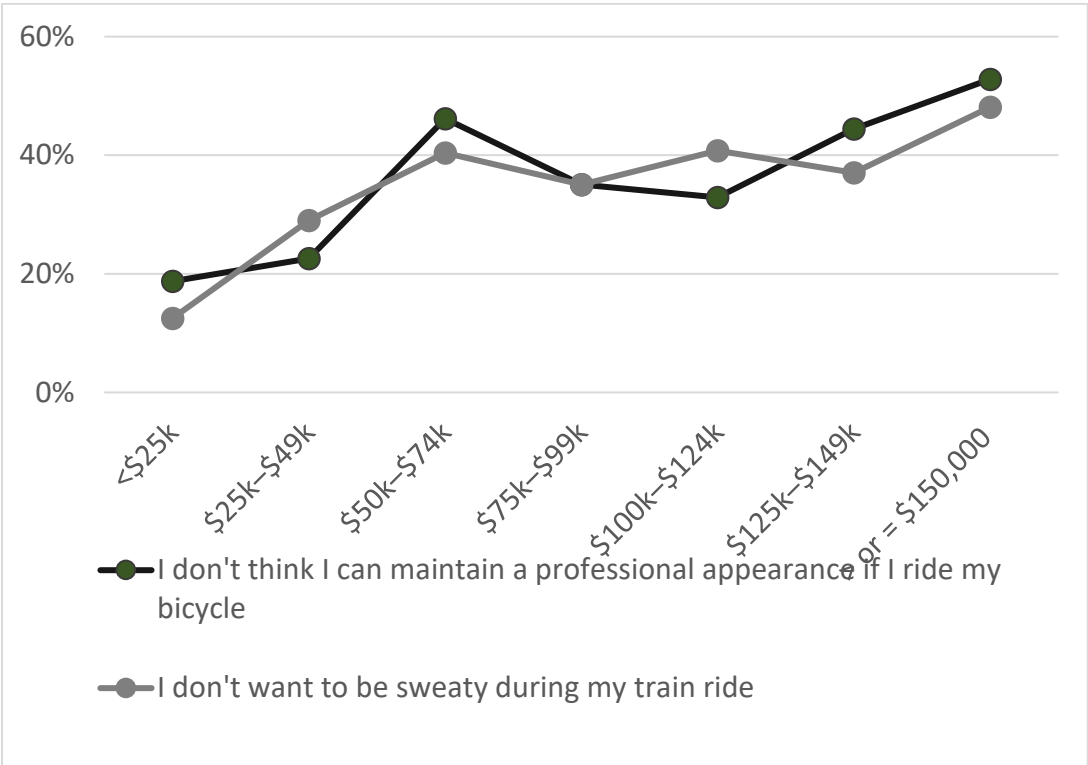


FIGURE 4 Relationship Between Concerns Over Maintaining a Professional Appearance and Sweating and Annual Income

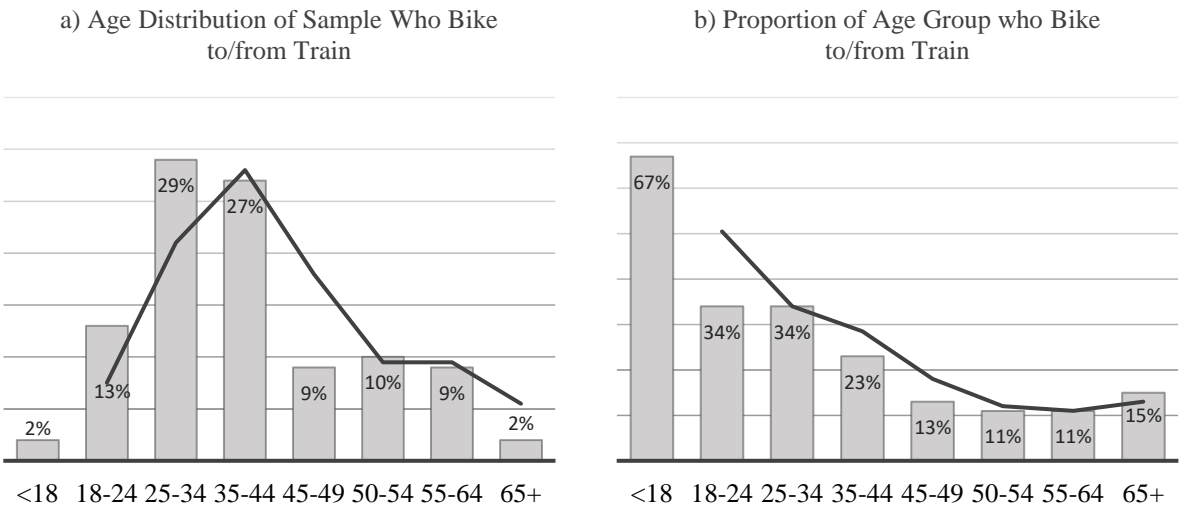


FIGURE 5 Age Profile of those Combining Cycling with Rail

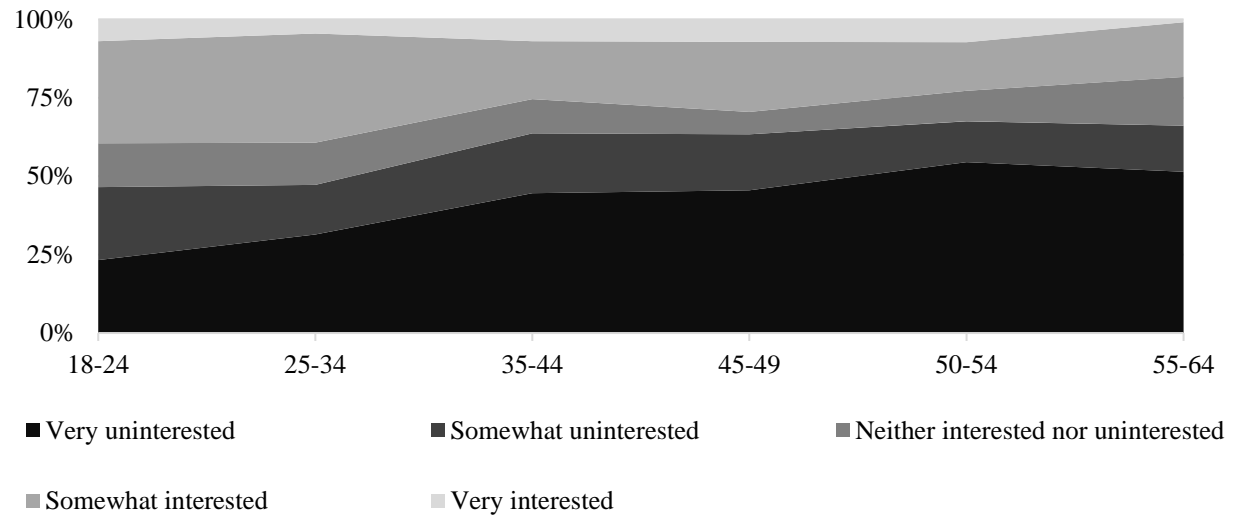


FIGURE 6 Interest in Cycling to the Train Station Across the Life Course