Examining the relationship between transit use and active transportation in Canada: a time use approach of the active lifestyle of transit users

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ABSTRACT

The use of public transit has been positively associated with active transportation mainly because active transport is typically required to access and egress stations. Transit users may adopt a lifestyle that enables them to walk and bicycle more to destinations other than transit stops or stations. This study seeks to analyze the relationship between public transit use and active transportation in residents of larger urban areas of Canada. Using an urban sample of the time use module of Canada's General Social Survey (2005, n= 10,867, weighted to represent 15,298,948 Canadians), meeting Canadian physical activity guidelines of 30 minutes or more of moderate physical activity through walking on survey day was assessed using a logistic regression. Using public transit during the day was the main correlate, controlling for socio demographic characteristics and survey day. Transit users (8.5%) met physical activity guidelines (Adjusted Odds Ratio: 1.66 and 2.87 respectively for bus and subway/train) by walking to public transit or to other destinations. Additional analysis of walk time by purpose shows that trip duration do not vary significantly between transit users and non-users once an individual walks for a specific purpose, but a higher proportion of transit users walked for each studied purpose. Above and beyond the walks to public transit stops or stations, transit users perform more active transportation to destinations by taking more trips for various purposes. Promoting public transit use by developing infrastructure may provide health benefits beyond a reduction in travel related energy use and Greenhouse gas emissions.

Key words: Mass transportation, Walking, Travel, Time use, Physical activity guidelines

INTRODUCTION

Because of the important potential health benefits associated with physical activity (1,2), and the limited amount of Canadians being sufficiently physically active on a regular basis, the practice of active transportation (AT), walking or cycling for the purpose of reaching destinations, has been identified as a potentially important source of physical activity (3,4). In 2011, 54% of Canadians were considered active or moderately active (5), an increase compared to the 52% of active or moderately active Canadians in 2005 (6).

The total (direct and indirect) health care costs of physical inactivity in Canada in 2009 amounted to $6.8 billion, and represented 3.7% of overall health care costs (7). The Canadian Society for Exercise Physiology (CSEP) has established a set of guidelines for the practice of physical activity (PA) (1). On hundred and fifty minutes a week, or thirty minutes a day of brisk walking can improve adults' personal health, reduce the onset of disease, and help recover from poorer health. Coronary artery disease, stroke, hypertension, colon cancer, breast cancer (in women only), type 2 diabetes, and osteoporosis are some of the most common diseases associated with physical inactivity (7).

An abundance of research points to the relationship between the built environment and walking (8,9). Environments that are denser have more destinations within walking distance and have a variety of land uses tend to favor walking and have been empirically show to be associated with more frequent and longer bouts of active transportation.

Transit users are also walkers because most public transit trips require a walk trip at least on one end of a transit journey (10). Estimates for the percentage of transit users reaching PA guidelines by walking to and from transit range from 29% (11) to 35.3% (12) and 40% (13). Average total walk time to and from transit can be in the order of 12-49 minutes for work trips depending on transit types and need for transfer (14). Analyses are usually carried out at the level of a city or metropolitan region. Beyond transit access by active transportation, being a transit user increased the likelihood of walking to multiple other destinations both near their homes and workplace (15) but their data did not enable the calculation of time spent walking by purpose. Transit service tends to be associated with denser neighborhoods with more accessible destinations and certain trip may be accessed near the home without taking transit. Once at the destination side of a trip, transit users have no other means of transportation, and are more likely to walk to nearby destinations and services (15).

The higher level of active transportation of public transit users has also been associated to overweight and obesity (16-18), higher energy expenditure (19-21) and reduced health care costs (22,23).

This paper's objective is to explore how the Canadian General Social Survey (GSS) can serve to confirm these analyses at a national level. Specifically the paper aims to assess the relationship between meeting PA guidelines through walking depending on whether a person used different modes of transit, or not. A secondary objective is to identify

differences in engagement in walking for different purposes and average trip duration for users and non-users of public transit.

While a number of authors have used the GSS to assess the practice of physical activity (24), or overall transportation for the entire population (25,26) or for specific groups such as the elderly (27,28), none to this author's knowledge have analyzed the relationship between active transportation and public transit use. The GSS provides important qualities that can distinguish this analysis from others in its field. Namely, a nationally representative sample of urban Canadians, detailed socio-demographic characteristics, detailed information on trip purposes and on variation between days of the week.

METHODS

The analysis relies on the time use module of Statistics Canada's General Social Survey, Cycle 19 (2005, n= 19,597). The GSS is a Computer Assisted Telephone Interview of a random sample of non-institutionalized persons 15 years of age or older, living in Canada's ten provinces (excluding Yukon, Northwest Territories and Nunavut). The weighted sample is representative of the entire non-excluded population of Canada (29). Random Digit Dialing (RDD) methods were used to sample participants, and telephone interviews were conducted to retrieve voluntary information. Data was gathered in 2005 between January 12 and December 13. The overall response rate was 58.6%. The public use microdata files were used for this analysis.

This time use survey collects information on activities having taken place on the day prior to the survey call. The designated day begins at 04:00AM and ends 24 hours later. Participants are asked to provide a detailed list of all activities that took place during the 24-hour period. Types of activities are coded into episode files (nearly 200 activity codes), location where the activity took place (including 9 modes of transportation), start and end time, as well as duration. A person level file that includes information on socio demographic characteristics accompanies the episode file.

Because public transit is typically not available outside of larger urban centers, the analysis was restricted to participants living inside Census Metropolitan Areas (CMA) and Census Agglomeration (CA). One or more adjacent municipalities centered on a population core form a CMA and a CA. A CMA must have a total population of at least 100,000 of which 50,000 or more must live in the core. A CA must have a core population of at least 10,000 and a total population of at least 11,000 (29). The population of these 147 areas amounted in 2005 to 20,947,994, or 14,715 respondents. The final sample size (n=10,867) contained all relevant variables included in analysis. Most of the 3,848 missing cases were omitted because they did not report income.

Dependent Variables

Using a variable on the total walking duration for active transportation, two dummy variables were created: having walked at all and having walked 30 minutes or more on the diary day. Episode files were also used to create variables for participation and duration of

walk trips by purpose. The 24 different activity codes for walking were recoded into 7 purposes to combine similar activities with low participation rates. Upon inspection of the episode files, it was found that most respondents bundled walk access, transit wait time, trip time and egress time together as transit trips were not always preceded or followed by walk, bicycling, car or other transit trips. Estimates therefore underestimate the total amount of walking done by participants and should thus be considered as conservative estimates. Bicycle trips were also not included in measures of active transportation for the purpose of this study. Reported bicycling was however very low and preliminary tests showed that including them did not have a strong effect on results.

Independent Variables

The main independent variables of interest refer to the use of public transit. Public transit users were identified in a dummy variable as those participants that recorded at least one public transit trip during the survey day. Additional variables identified users of buses and users of subway/train separately.

Because both walking and transit use has been found to be associated with socio-demographic characteristics (30, 31), age (seven categories), household income (five recoded categories), and dichotomous variables of sex, having worked on survey day, having children under 14, being a recent immigrant (less than ten years) and currently receiving education were used as socio-demographic control variables. Canadian Census level analyses concluded that recent immigrants were more likely to commute by public transit (32).

Further contextual variables were used to describe the diary day (weekend days, vs. weekdays), and whether a person lived in a single family home. This last variable was used as a proxy for land use types surrounding a participant's home. The five large regions of Canada were also used in analyses to assess cross-Canada variations in meeting PA recommendations.

Analysis

The sample of users and non-users of transit was described using Chi squared tests for categorical variables. A multivariate logistic regression was used to test the hypothesis that using public transportation is associated with meeting physical activity recommendations through active transportation after controlling for covariates. Individual level survey weights were used to expand the survey population to the targeted Canadian population. Graphical analyses enabled the exploration of participation rates and episode specific duration of walking purposes contributing to total active transportation levels. Variation in duration by trip purpose was tested with ANOVA and variations in duration between users and non-users for each specific trip purpose was tested using two-tailed T-tests. Data analysis was carried out using Stata (Version 11.0, StataCorp, College Station, Texas).

RESULTS

A list of descriptive statistics for the survey sample and sub groups of transit uses and non-users is presented in Table 1. Compared to non-users of transit, transit users were younger, had lower incomes, were composed of a higher percentage of women, fewer families with children, more recent immigrants, fewer participants living in single family homes. There was less transit use on the weekends, and transit user had a higher proportion of students and participants who worked on the survey day (All reported differences were statistically significant at the $p<0.005$ level).

TABLE 1 Description of Studied Sample

	Did not use transit	Used transit	Total	Chi square test
Sample size n (%)	9,948 (91.54)	919 (8.46)	10,867 (100)	
	%	%	%	
Walked at all	14.6	38.4	16.9	0.000
Walked 30 min. or more	5.6	16.7	6.7	0.000
Minutes walking if walked (Mean)	28.9	27.9	28.7	
Used bus	-	77.0	6.7	
Used subway or train	-	28.9	2.5	
Women	55.7	56.0	55.8	0.010
Age groups (years)				0.000
15 to 24	25.1	42.2	28.4	
25 to 34	17.3	17.9	17.4	
35 to 44	16.4	16.1	16.4	
45 to 54	14.8	11.4	14.1	
55 to 64	12.1	5.0	10.8	
65 to 74	7.2	4.1	6.6	
75 and over	7.0	3.3	6.3	
Household income ($)				0.000
Less than 20 000	14.9	18.7	15.6	
20 000 to 39 999	21.7	20.6	21.5	
40 000 to 59 999	19.9	16.9	19.3	
60 000 to 99 999	25.1	22.3	24.6	
100 000 or more	18.4	21.6	19.0	
Has children under 14 years	22.0	17.0	21.1	0.000
Immigrated less than ten years ago	5.8	11.6	6.9	0.000
Lives in single familly home (vs. others)	57.5	45.3	55.2	0.000
Diary day				0.000
Weekday [ref.]	74.2	86.6	76.5	
Saturday	13.0	7.2	11.9	
Sunday	12.9	6.2	11.6	
Worked on survey day	40.5	54.5	43.1	0.000
Currently in educational institution	16.1	31.1	19.0	0.000

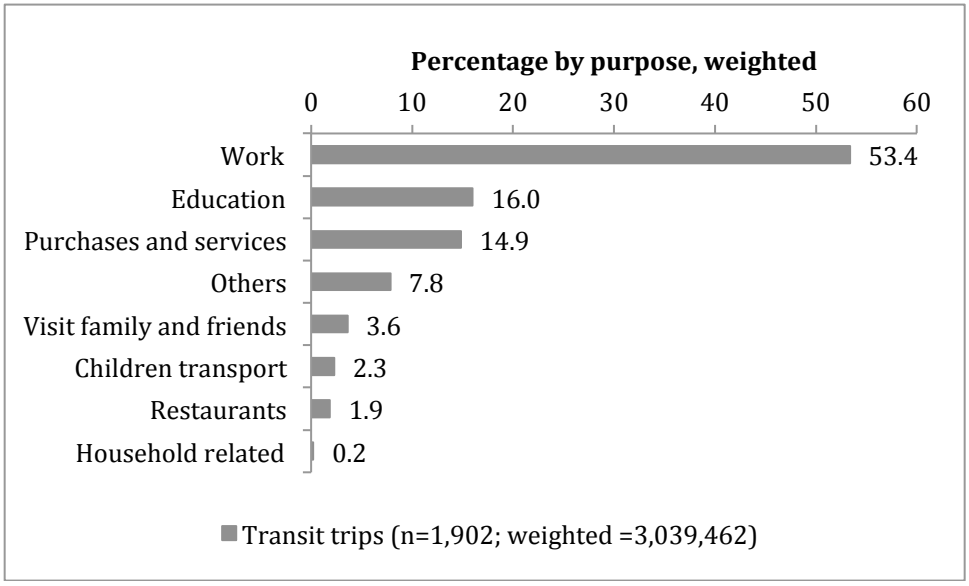
Region of Canada				0.000
Atlantic	9.2	3.6	8.1	
Quebec	21.6	24.3	22.2	
Ontario	38.8	48.1	40.6	
Prairies	15.6	10.5	14.6	
British Columbia	14.8	13.6	14.6	

214

Active transportation measures also differed across groups. A higher percentage of transit users walked at all, and reached PA guidelines during the reference day. Among transit users, 77% used buses and 28.9% used subway or trains (results do not add up to 100 because some users used both modes during one day).

As show in Figure 1, work trips were the main destination of reported transit trips by more than three times the second most popular destination, education related trips. Trips to purchases and services followed. The activity purposes where walking was accumulated are presented in Figure 2 for users and non-users of public transportation. Transit users' participation rates by trip types were usually nearly double or more those of non-users for each trip purpose. There were both significant differences (chi squared test) between trip purposes for users and non-users and between users and non-users by trip purposes. The ordered popularity of trip purposes between users and non-users of transit was quite similar.

FIGURE 1 Relative frequency of transit trip purposes for transit users



The average durations of trips by purpose depending on participants being transit users or not are presented in Figure 3. For those who performed active transportation trips, mean walk time per trip was not significantly higher for transit users (ANOVA test). Trip duration by purpose was similar for users and non-users (non significant T-test results) and hovered between 10 and 15 minutes. Both for users and non-users, duration was significantly different by trip purpose (using ANOVA test). For children transportation, the sample sizes were too small to produce reliable estimates, but were included to match information produced in other figures.

The results of the multivariate logistic regressions are presented in table 2. In a base model of meeting physical activity recommendations including only independent variables on transit use, the OR of using any form of transit on meeting the physical activity recommendation was of 2.78 (CI: 2.28-3.40).

FIGURE 2 Percentage of transit users and non-users engaging in walk trips by purpose

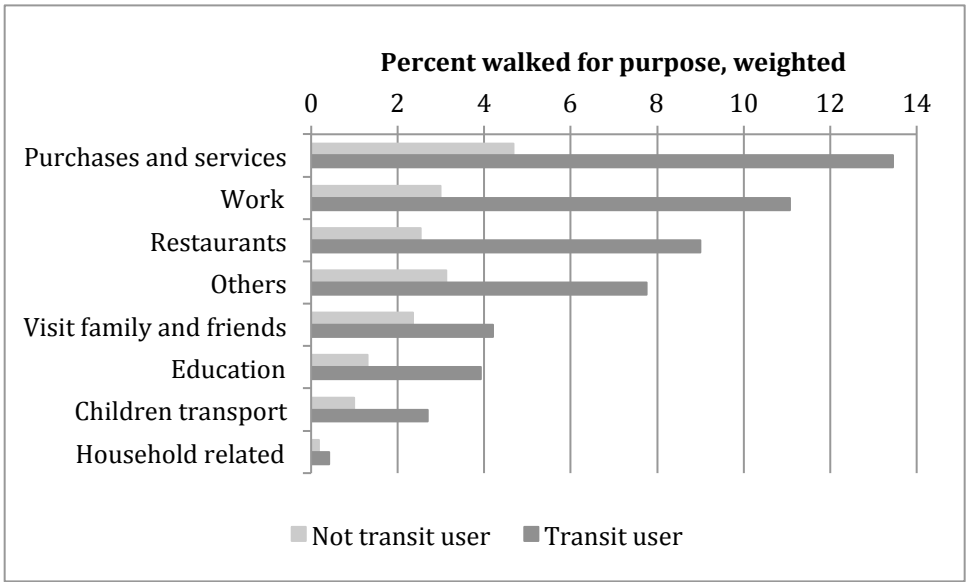
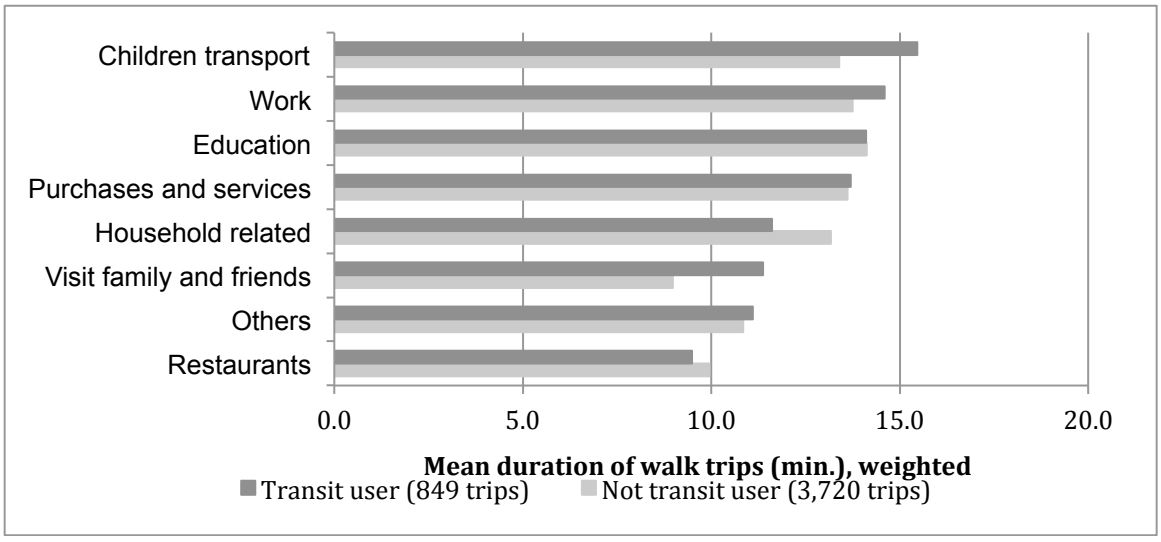


FIGURE 3 Trip level analysis of mean walk trip duration for walkers by transit use



These values were respectively 2.57 (CI: 2.06-3.22) and 3.11 (CI: 2.23-4.33) for using buses and the subway/train. When adding all other control variables (which presented significant differences between transit users and non-users in Table 1) to this model, the Adjusted Odds Ratio of using buses and subway/train respectively dropped to 1.66 and 2.87 but were still highly significant. Numerous socio demographic variables were also significantly associated with meeting the physical activity recommendation. There were no difference between men and women. As age and income increased, the likelihood of meeting the physical activity recommendation decreased. Living in a single family home decreased odds of meeting recommendations. Participants that were surveyed on the weekends were less

likely to meet physical activity recommendations. Participants living in the Atlantic Provinces, Ontario and British Columbia were more likely to meet physical activity recommendations than those in Quebec and the Prairies.

TABLE 2 Multivariate Logistic Regression of Meeting Physical Activity Recommendation Through Active Transportation

	Odds Ratio	P>z	[95% Conf.	Interval]
Used bus	1.66	0.002	1.21	2.29
Used subway or train	2.87	0.000	1.91	4.32
Women	1.07	0.503	0.88	1.30
Age groups (years)				
15 to 24 [ref.]				
25 to 34	0.58	0.002	0.41	0.82
35 to 44	0.64	0.012	0.45	0.90
45 to 54	0.50	0.000	0.34	0.72
55 to 64	0.50	0.001	0.33	0.77
65 to 74	0.55	0.004	0.36	0.83
75 and over	0.83	0.471	0.49	1.39
Household income ($)				
Less than 20 000 [ref.]				
20 000 to 39 999	0.63	0.002	0.47	0.84
40 000 to 59 999	0.44	0.000	0.32	0.60
60 000 to 99 999	0.55	0.000	0.40	0.75
100 000 or more	0.59	0.004	0.41	0.84
Has children under 14 years	1.08	0.535	0.85	1.37
Immigrated less than ten years ago	1.25	0.178	0.90	1.71
Lives in single family home (vs. others)	0.44	0.000	0.36	0.55
Diary day				
Weekday [ref.]				
Saturday	0.74	0.055	0.55	1.01
Sunday	0.65	0.005	0.48	0.88
Worked on survey day	0.94	0.618	0.74	1.19
Currently in educational institution	2.03	0.000	1.43	2.88
Region of Canada				
Atlantic	1.10	0.516	0.82	1.47
Quebec	0.72	0.009	0.56	0.92
Ontario [ref.]				
Prairies	0.74	0.030	0.56	0.97
British Columbia	0.95	0.750	0.71	1.28
Observations	10,867			
ll (base)	-3764000			
ll (model)	-3416000			
Chi-square	370.00			

Significance	0.000

DISCUSSION

The analysis of time use data shows that on a survey day, transit users did more active transportation, were more likely to walk for all trip purposes and achieved the physical activity recommendation of 30 minutes through AT more frequently than non-users of public transit. Transit users have socio demographic characteristics that differentiate them from non-users. For research purposes, these characteristics must be controlled for when assessing walking and the health benefits associated with walking. Failure to do so may create spurious relationships due to the socio-demographic characteristics themselves. Models that did not include socio-demographic covariates overestimated the impact of transit use on meeting physical activity recommendations.

These results correspond to the findings of analyses on the relationship between public transit use and active transportation (AT) not related to transit access (15, 33). The results also link transit users to more AT as other analyses that focus on the walk time needed to access public transit (11,12,14). The paper provides four original contributions: First, analyses were based on a time use survey instead of ad hoc surveys, health surveys or travel diaries. As such, the analysis carried out here can be replicated in many countries where such data is available. Second, time use diaries also have the advantage of not inciting certain response through the stated objective of the survey, and make it difficult for respondents to provide inaccurate time results since the sum of all time period must conform to a 24-hour day. Third, the paper provides estimates of the time spend in walking activity for multiple purposes and the percentage of transit users and non-users that engaged in these purposes. Fourth the paper provides socio-demographic comparison of users and non-users representative at a National level of the urban population.

Given that more walking converts to more energy expenditure, reduced obesity, other health benefits and reduced health care costs (18,20,22,23), there are clear public health benefits to the promotion of public transit use not only for its direct contribution to walking but also for the walking trips that the transit user lifestyle entails. Without proper access to public transit, most of the population needs to purchase a vehicle and is more likely to use it even when destinations are within walking distance (34). Walkable neighborhood design must likely include strong transit access to reach their objectives.

LIMITATIONS

Time use surveys provide incomplete information on walking trips to access public transit. Upon observation of activities preceding and following transit trips, it was founds that 5% and 4,3% of transit trips were respectively preceded or followed by walk trips and few transit trips were also preceded or followed by car, cycling or other transit trips. The data suggest that some transit users rather reported stop or station access and wait time as part of the overall transit trip time. For these 179 walk trips to or from transit, duration averaged 11.5 minutes. As participants having shorter transit access trips may be more

likely to not report walk access, these values are slightly higher than walk distance reported elsewhere. Because evidence points to this consistent source of walking for transit users (11,12,14), presented estimates of associations between transit use and meeting physical activity guidelines are conservative.

Because the GSS time use survey only reports on one specific day, it cannot be excluded that transit use on the survey day is not representative of all transit use and users. As some transit users potentially did not use transit on the survey day, results possibly underestimates the total proportion of transit users in the population and the extent of the benefits on walking. The clear link between transit use and all walk trips on a given day is however not affected.

The GSS 2005 did include other measures that could have been useful in this analysis such as car ownership, drivers license, perceived access to public transit, and use of public transit in the past year. This additional module was however only available for half of the survey population. The variables were not used in this analysis.

Bicycle trips were also excluded from the analysis because of their distinct characteristics and the low number of participants having reported cycling.

CONCLUSION

The use of public transit was associated with active transportation and with meeting physical activity recommendations through walking. Objectives to increase transit use among the Canadian population have the potential to increase population health, reduce health care costs, improve access and reduce car dependence not only because users walk to access transit, but because they also take more walk trips directly to destinations. Walk trips taken by transit users are typically not longer than the ones taken by non-users. Transit users just tend to take more of these trips for various purposes than their non-user counter parts. This result suggests that transit users preference for walking does not translate to longer walking distances per purpose, but rather to more frequent and varied walk trips. Providing land uses that enable short walking trips to destinations in areas with transit service is warranted.

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