Evaluating methods for measuring daily walking to public transport:
Balancing accuracy and data availability

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INTRODUCTION

Quantifying physical activity accumulated through daily commuting is challenging due to the scarcity of detailed data, especially for public transport trips.

Using Montreal, Canada as a case study, this paper measures and compares an individual's daily amount of walking to and from public transport in their regular commute to work using two datasets and two methods.

The **first method** uses urban level detailed **origin-destination microdata.**

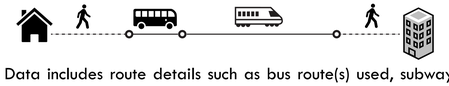
The **second method** uses open-source data including **commuting flows** obtained from census data and GTFS data.

This study is of relevance to professionals from municipalities of all sizes who are wishing to measure the relationship between physical activity and public transport use in areas where access to detailed travel survey microdata is limited.

DATA

1 Origin-Destination Microdata

The Montreal, Canada, OD survey is conducted every five years by the Agence Métropolitaine de Transport (AMT).

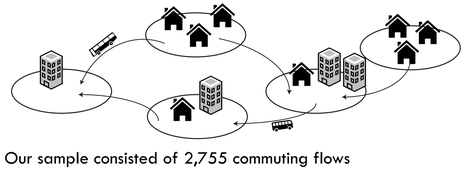


Data includes route details such as bus route(s) used, subway or train station of access and egress, and subway.

Our sample consisted of 9,588 public transport trips.

2 Commuting flows

Census data including commuting modes and patterns collected by Statistics Canada at the Census Tract (CT) level.

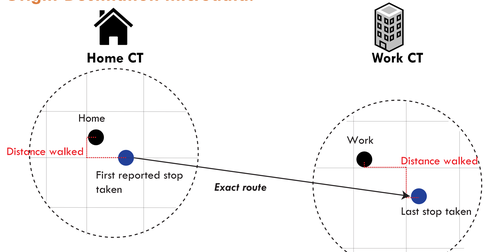


Our sample consisted of 2,755 commuting flows

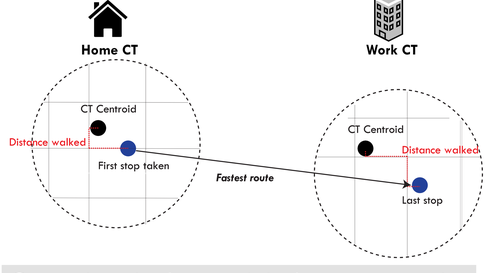
METHODS

Extracting walking distances

Origin-Destination microdata:



Commuting flows method:



Comparing trip characteristics between scenarios

	OD microdata scenario	Commuting flows scenario
First mode taken (home-work trip) (%)		
Train	6	1
Subway	30	27
City bus	45	51
Suburban bus (STL and RTL)	14	15
Peripheral bus (CIT)	5	6
Number of transfers taken (home-work trip) (%)		
0 transfers	41	10
1 transfer	37	24
2 transfers	19	35
3 or more transfers	4	31
Average daily walking distance by first mode taken (m) †		
Train	4,632	2,932
Subway	2,255	2,113
City bus	1,519	2,010
Suburban bus (STL and RTL)	1,681	2,499
Peripheral bus (CIT)	2,471	4,410
Proportion of individuals meeting recommended 30 minute daily walking target (%)		
Train	71	58
Subway	24	18
City bus	10	17
Suburban bus (STL and RTL)	13	31
Peripheral bus (CIT)	32	68

RESULTS

Multilevel mixed-effect regression modeling

Multilevel mixed-effect regression modeling is employed to:

1. Uncover the key determinants of daily walking to public transport according to OD microdata - **MODEL 1**
2. Explore how the two approaches differed in their estimation of walking levels - **MODEL 2**

Results of the multilevel mixed-effect regression modeling total walking distance

	MODEL 1				MODEL 2			
Variable	Coeff.	Sig.	95% Conf. interval		Coeff.	Sig.	95% Conf. interval	
Male	10.6		-24	45.2				
Age	-2.5	***	-3.9	-1.1				
Medium income ($20K - 79K)	-18.9		-80.1	42.3				
Low income (< $20K)	16.6		-21.2	54.3				
Headway of first route used (min)	0.1		-1	1.1				
In vehicle distance (km)	14.1	***	9.8	18.5	10.3	***	6.4	14.1
First mode taken (ref = city bus)								
Subway	580.6	***	524.7	636.6	580.6	***	531	630.1
Train	1307.5	***	1162.3	1452.7	1351.8	***	1254.7	1448.9
Suburban bus	-186.4	***	-295.8	-77	-109.7	*	-204.9	-14.5
Peripheral bus	-253.8	**	-428	-79.5	-82.0		-216.9	52.8
Commuting flows * First mode: subway					-243.5	***	-321.6	-165.5
Commuting flows * First mode: train					-836.4	***	-1198.3	-474.6
Commuting flows * First mode: suburban bus					150.3	**	56.5	244.2
Commuting flows * First mode: peripheral bus					820.4	***	683	957.9
One transfer	-186.4	***	-228.9	-143.2	-195.4	***	-233.3	-157.5
Two transfers	-325.7	***	-381.2	-270.2	-346.7	***	-394	-299.5
Three or more transfers	-435.9	***	-538.9	-333	-399.7	***	-467.9	-331.4
Percent of population with a university degree	-3.5	*	-6.9	-0.1	-3.1	*	-6	-0.2
Population density (1000 km²)	-10.9		-22.4	0.7	-14.5	**	-24	-5
Number of bus stops	-5.7	***	-7.6	-3.8	-4.4	***	-5.9	-3
Commuting flows Scenario					365.6	***	316	415.2
Constant	1573	***	1402.5	1743.6	1420.8	***	1288.6	1553.1
AIC	156,718				198,864			
BIC	156,854				199,012			
Observations	9,549				12,220			
Log likelihood	-78,340				-99,412			
Groups	No. Groups		Intraclass correlation		No. Groups		Intraclass correlation	
CT origin	830		0.3		822		0.2	
CT flow					7,377		0.5	

* 95% significance level | ** 99% significance level | *** 99.9% significance level

Adjustment table

A **sensitivity analysis** is used to derive an **adjustment table** for practitioners and researchers who wish to use open data to estimate walking. Adjustment values are presented in the following table.

First mode taken	OD microdata scenario walking distance (m)	Commuting flows scenario walking distance (m)	Adjustment (m) †
Commuter train	2327.83	1856.98	470.85 (20%)
Subway	1556.60	1678.64	-122.04 (-8%)
City bus	976.01	1341.57	-365.57 (-37%)
Suburban bus	866.30	1382.20	-515.91 (-60%)
Peripheral bus	893.96	2079.96	-1186.00 (-133%)

CONCLUSIONS

Our results indicated that walking distances estimated using the commuting flows scenario closely resemble actual walking distances derived from origin-destination microdata.

Mean walking distances:
OD microdata scenario: 1007.31m
Commuting flows scenario: 1034.63 m

Accordingly, the commuting flows method underestimated average walking distances by **only 3%**.

However, the accuracy of the commuting flows method varied depending on the first mode of public transport used for each trip.

Adjustments:
For **commuter train users** **471 meters must be added** to walking estimates obtained from the commuting flows data, while **negative adjustments are required** for **subway users** **(122 meters)**, **city bus users** **(366 meters)**, **suburban bus users** **(516 meters)**, and **peripheral bus users** **(1186 meters)**.

Policy implications:

The commuting flows method provides professionals **without access to detailed travel survey data** with a method to accurately use **open data** to estimate total walking accumulated by public transport users.

This knowledge provides an understanding of **baseline physical activity levels** of a population, which is vital for setting goals for **future public health interventions**.

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