Use of a New Public Bicycle Share Program in Montreal, Canada

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Background: Cycling contributes to physical activity and health. Public bicycle share programs (PBSPs) increase population access to bicycles by deploying bicycles at docking stations throughout a city. Minimal research has systematically examined the prevalence and correlates of PBSP use.

Purpose: To determine the prevalence and correlates of use of a new public bicycle share program called BIXI (name merges the word BIcycle and taXI) implemented in May 2009 in Montreal, Canada.

Methods: A total of 2502 adults were recruited to a telephone survey in autumn 2009 via random-digit dialing according to a stratified random sampling design. The prevalence of BIXI bicycle use was estimated. Multivariate logistic regression allowed for identification of correlates of use. Data analysis was conducted in spring and summer 2010.

Results: The unweighted mean age of respondents was 47.4 (SD=16.8) years and 61.4% were female. The weighted prevalence for use of BIXI bicycles at least once was 8.2%. Significant correlates of BIXI bicycle use were having a BIXI docking station within 250 m of home, being aged 18–24 years, being university educated, being on work leave, and using cycling as the primary mode of transportation to work.

Conclusions: A newly implemented public bicycle share program attracts a substantial fraction of the population and is more likely to attract younger and more educated people who currently use cycling as a primary transportation mode.

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Public bicycle share programs (PBSP), widely implemented in Western Europe,[1] increase population access to bicycles by deploying bicycles at docking stations throughout an area within a city.[1] Grey literature suggests that PBSP are well used and have the potential to increase cycling for transportation.[2] Bicycle use was reported to have increased by 80% in Lyon since the implementation of Vélo'v.[3] However, minimal research has examined the prevalence and correlates of PBSP use.

North American cities have been slower to adopt PBSP.[1] The largest PBSP in North America is BIXI (named from BIcycle and taXI) in Montreal, Canada. Launched in 2009, BIXI made available 5000 bicycles at 450 docking stations from May through November (see Figure 1). Individuals aged ≥14 years can check out and drop off bicycles for a subscription fee of CAD$5 for 24 hours, CAD$28 for 1 month, or CAD$78 for a season. After paying the subscription fee, users can access bicycles as many times as they wish, within the subscription period, for usage periods of 30 minutes or less at no additional charge. Any single usage period beyond 30 minutes costs approximately CAD$1.50 per 30 minutes. Of interest, the BIXI PBSP was extended to Washington DC and Minneapolis in 2010.[4] This study examines the prevalence and correlates of PBSP use during the first season of implementation in Montreal, Canada.

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Methods

Design

A stratified random sampling design was used. The sampling frame was individuals residing on the Island of Montreal. To sample within contacted households, the individual to next celebrate a birthday and aged ≥18 years was invited to respond. The sampling frame was stratified according to the presence or absence of BIXI docking stations. In the stratum without BIXI docking stations, the

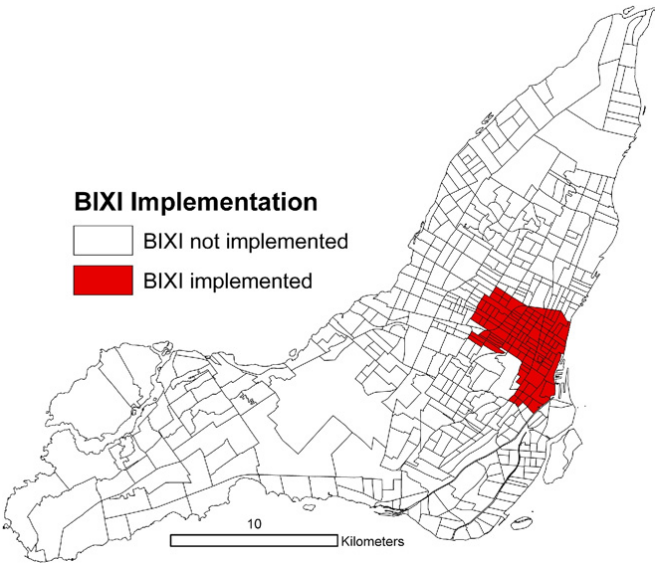

Figure 1. Spatial distribution of BIXI stations on the Island of Montreal in 2009 by census tract
Note: For detailed station information, see montreal.bixi.com/the-stations.
BIXI, a blend of the words BIcycle and taXI

sampling used random-digit dialing to landlines. In the stratum with BIXI docking stations, a 25% oversampling was conducted by randomly selecting landlines with Montreal postal codes matched to areas with BIXI docking stations. People having moved in the previous year were excluded. Ethical approval was obtained from the ethics committee of Centre de Recherche du Centre Hospitalier de l'Université de Montréal. Participants provided verbal informed consent and could respond to the survey in French or English.

Measures

The outcome variable was self-reported use of BIXI bicycles. Participants indicated whether or not they had ever used BIXI and estimated the total number of BIXI uses since implementation. Use of BIXI was operationalized in two ways: a dichotomous indicator of use (*Yes, had tried BIXI bicycles* vs *No, had not tried*) and a dichotomous indicator of regular (≥10 usages) or nonregular (<10 usages) BIXI bicycle use in the first season.

The main exposure was a count of the number of BIXI docking stations within a 250-m road network buffer from participants' home postal code.[5] The 250-m buffer was chosen as an indicator of exposure because it is a walkable distance and because BIXI docking stations were installed approximately 300 m apart. Exposure at work, a secondary exposure, was operationalized as a dichotomous variable indicating whether or not an individuals' primary occupation was in a neighborhood where BIXI docking stations were available.

Sociodemographic variables included age, gender, education, employment status, and usual mode of transportation to work. Education was categorized as high school or less, trade school or college, and university. Employment/student status was categorized as employed full-time, employed part-time, student, retired or other (e.g., work from home). Usual mode of transportation to work was categorized as cycling (not including BIXI); walking; public transportation; personal motor vehicle; and other (i.e., taxi, work at home, or skateboard).

Data Analysis

Data analysis was conducted to estimate the prevalence of BIXI use and to examine the correlates of BIXI use using SPSS, version 17. Weighting via inverse probability of selection (correction for oversampling) and poststratification for age and gender using data from the 2006 Canadian census (ensure representativeness to the

Table 1. Sociodemographic characteristics of 2133 survey respondents residing on the Island of Montreal, Canada, in 2009

Characteristic	Unweighted percentage (*n*)	Weighted percentage
Age (years)		
18–24	7.4 (158)	18.6
25–34	19.1 (407)	22.0
35–44	18.7 (399)	16.3
45–54	20.4 (436)	16.6
55–64	17.2 (367)	12.2
≥65	17.2 (366)	14.3
Transportation to work		
Cycle	5.2 (110)	4.8
Walk	13.5 (287)	13.0
Car	38.5 (821)	34.9
Public transportation	39.2 (837)	44.1
Other	3.7 (78)	3.2
Education		
High school or less	27.2 (581)	30.2
Trade school	6.4 (136)	7.1
College degree	14.4 (308)	15.4
University degree	51.9 (1108)	47.3
Employment		
Full-time	52.9 (1129)	48.4
Part-time	6.9 (148)	7.3
Student	9.8 (210)	18.8
Retired	19.4 (413)	15.6
Other	10.9 (233)	9.9
Gender		
Male	38.6 (824)	44.8
Female	61.4 (1309)	55.2
BIXI stations within 250 m		
0	79.3 (1691)	84.5
1	12.8 (273)	9.2
>1	7.9 (168)	6.3

BIXI, a blend of the words BIcycle and taXI

population residing on the Island of Montreal) was applied to prevalence estimates.[6] Logistic regression was used to examine correlates of BIXI bicycle use.[7,8]

Ancillary analyses compared sociodemographic characteristics across regular and nonregular BIXI bicycle users (n=152) and whether exposure to BIXI docking stations from home and work (in a subset of 1065 with worksite postcode) independently predicted BIXI use.

Results

The final sample included 2502 respondents, and the response rate was 34.6%. The current study was based on a subset of 2133 (85% of the final sample of 2502) respondents. Of 369 respondents excluded, 150 (6%) had moved in the previous year and 219 (9%) had missing data. The unweighted mean age of participants was 47.4 (SD=16.8) years; 61.4% of the sample was female (Table 1).

The unweighted prevalence of having used BIXI at least once for those aged ≥18 years was 7.1% (95% CI=4.1, 10.1), whereas the weighted prevalence estimate was 8.2% (95% CI=8.1, 8.3, n=125,626). Weighted estimates showed that 14.3% (95% CI=14.1, 14.5, n=53,934) and 6.0% (95% CI=5.9, 6.1, n=69,133) of residents living where BIXI docking stations, respectively, were and were not available had used BIXI at least once.

Table 2 shows the results from logistic regression on weighted data. Results show that having one station (OR=2.03, 95% CI=1.31, 3.16) or more than one station (OR=1.73, 95% CI=1.04, 2.88) within a 250-m road network buffer of home was related to greater likelihood of BIXI use. Compared to participants aged 18–24 years, those aged ≥35 years were less likely to use BIXI bicycles. Men and women did not differ in their likelihood of BIXI use and those cycling to work were more likely to have used BIXI at least once compared to walking, driving, and using public transit.

Ancillary analysis comparing regular and nonregular BIXI users indicated no difference between participants aged 18–24 years and those aged >24 years (OR=0.69, 95% CI=0.19, 2.47). Regular BIXI users were as likely to have a high school diploma or more than a high school education (OR=0.77, 95% CI=0.15, 4.08). Students and men were as likely to be regular BIXI users compared to nonstudents (OR=0.87, 95% CI=0.32, 2.41) and women (OR=1.91, 95% CI=0.91, 4.01), respectively. Exposure to BIXI stations at work (OR=1.56, 95% CI=1.01, 2.43) was related to BIXI use, once exposure at home was controlled.

Discussion

This study examined the prevalence and correlates of use of a PBSP in its first season, BIXI in Montreal, Canada. Results show that BIXI bicycles were used by approximately 125,626 inhabitants (8.2%) of the adult population

Table 2. Associations of BIXI use, presence of BIXI bicycle docking stations, and sociodemographic characteristics

Variable	Unadjusted OR (95% CI)[a]	AOR (95% CI)[b]
Stations within 250 m		
No stations (ref)	1.00	1.00
1 station	**3.68 (2.49, 5.43)**	**2.03 (1.31, 3.16)**
More than 1 station	**3.19 (1.96, 5.18)**	**1.73 (1.04, 2.88)**
Age (years)		
18–24 (ref)	1.00	1.00
25–34	1.11 (0.66, 1.88)	0.74 (0.44, 1.22)
35–44	0.73 (0.42, 1.26)	**0.41 (0.23, 0.75)**
45–54	**0.25 (0.13, 0.49)**	**0.14 (0.07, 0.29)**
55–64	**0.14 (0.06, 0.32)**	**0.11 (0.04, 0.29)**
≥65	**0.02 (0.02, 0.13)**	**0.02 (0.01, 0.36)**
Gender		
Female (ref)	1.00	1.00
Male	1.17 (0.84, 1.63)	1.26 (0.92, 1.72)
Education		
High school or less (ref)	1.00	1.00
Trade school	1.29 (0.35, 4.74)	0.31 (0.08, 1.17)
College degree	**2.52 (1.09, 5.81)**	**0.49 (0.26, 0.91)**
University degree	**7.33 (3.82, 14.06)**	**2.27 (1.49, 3.44)**
Employment		
Full-time (ref)	1.00	1.00
Part-time	0.69 (0.36, 1.37)	1.64 (0.96, 2.80)
Student	**1.67 (1.09, 2.57)**	0.63 (0.39, 1.01)
Retired	**0.05 (0.01, 0.19)**	**0.42 (0.06, 2.84)**
Other	**0.13 (0.04, 0.40)**	**0.09 (0.02, 0.36)**
Transportation to work		
Cycle (ref)	1.00	1.00
Walk	**0.22 (0.12, 0.40)**	**0.12 (0.06, 0.24)**
Car	**0.10 (0.06, 0.17)**	**0.12 (0.06, 0.23)**
Public transportation	**0.19 (0.12, 0.31)**	**0.23 (0.13, 0.41)**
Other	**0.29 (0.13, 0.67)**	0.45 (0.17, 1.17)

Note: Bolded values are significant at $p<0.05$.
[a]Unadjusted results are estimated using unweighted bivariate logistic regression.
[b]Adjusted results are estimated using weighted multivariate logistic regression.
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living on the Island of Montreal. Prevalence estimates of cycling for transportation in Montreal range from 1.6% to 8%.[8,9] In the first year of implementation, BIXI has been tried at a level comparable to that of cycling for transportation in Montreal. There are plausible reasons why people who own their own bicycle would use BIXI. For example, cyclists may be unwilling to leave their bicycle locked overnight or for longer periods for fear of theft. Using BIXI makes an overnight or long-term one-way trip possible without the danger of bicycle theft.

Prevalence estimates stratified by proximity to docking stations showed that approximately 53,934 (14%) of the population where BIXI bicycles were available had used them at least once compared to approximately 69,133 (6%) of residents where BIXI bicycles were not available. Although the prevalence of BIXI use was higher where docking stations were available, approximately two thirds of those reporting BIXI use at least once resided in areas where BIXI bicycles were not available.

Results also suggest that having a docking station within a 250-m road network buffer of an individual's home was related to greater likelihood of BIXI bicycle use. Being male and a student were not predictors of using BIXI bicycles, a result inconsistent with North American cycling literature.[10–14]

The present study creates a framework for studying the outcomes of implementation of PBSPs. Replication of findings is warranted in other cities as is examination of whether PBSPs can create a modal shift from motor vehicles to bicycles and thus result in population health benefits.

Limitations

Limitations include low power to examine differences between regular BIXI bicycle users compared to occasional or one-time users and potential self-selection of individuals who already cycle into neighborhoods where BIXI was implemented.

Conclusion

A proportion of the population similar to that already cycling for transportation has tried a newly implemented PBSP called BIXI in Montreal, Canada. Individuals residing in close proximity to BIXI docking stations had a higher likelihood of having tried BIXI; however, individuals residing where BIXI bicycles were not available contributed greatly to total usage.

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