

**TRANSPORT FINDINGS**

# The Impact of Implementing Public Bicycle Share Programs on Bicycle Crashes

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Keywords: difference in differences, crashes, natural experiment, bicycling safety, bicycle share

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**Transport Findings**

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A docked public bicycle share program (PBSP) makes bicycles available to the public. There is limited evidence on the impact of PBSPs on safety. We estimated the impacts of implementing a PBSP on the likelihood of bicycle crashes using a difference in differences approach with repeated cross-sectional survey data (self-reported crashes) collected in 8 Canadian and US cities, from 2012-2014. Relative to control cities (Detroit, Philadelphia, Vancouver), we found that the odds of reporting a bicycling crash did not change after implementing a PBSP (New York, Chicago) and were lower in cities that had existing PBSPs (Boston, Montreal, Toronto).

## Research Question

A docked public bicycle share program (PBSP) make bicycles available to the public throughout a service area, and can lead to increased bicycling within a population (Fishman 2016; Hosford et al. 2018, 2019). There is currently limited evidence on the population-level impacts of PBSPs in terms of bicycling crashes and injuries (Fishman, 2016; Fishman & Schepers, 2018; Martin et al., 2016). The International Bikeshare Impacts on Cycling and Collisions Study (IBICCS) collected data from over 20,000 participants in 8 major Canadian and US cities from 2012 – 2014 (Fuller et al., 2014). Here, we use the IBICCS data to estimate the impacts of implementing a PBSP on the likelihood of self-reporting a bicycling crash.

## Methods and Data

IBICCS is a quasi-experimental non-equivalent groups study designed to evaluate the health and traffic safety impacts of PBSPs. The study protocol is published elsewhere (Fuller et al. 2014). Residents (aged 18+ years) in cities that either had implemented a new PBSP in 2013 (Chicago, New York), had an existing PBSP (Boston, Montreal, Toronto), or had no PBSP during the study period (Detroit, Philadelphia, Vancouver) were sampled. Cities with existing PBSPs included Boston (implemented 2011), Montreal (implemented 2009), and Toronto (implemented 2011) (Hosford et al. 2019). Cross-sectional data were collected in each city in the fall of 2012, 2013, and 2014. Data collected included information on bicycling behaviour, bicycling crashes, sociodemographic characteristics, and residential location.

We used a difference in differences approach to evaluate the impact of implementing PBSPs on the likelihood of reporting a bicycling incident (Fuller et al. 2013). This analysis focuses on changes in self-reported bicycling crashes

over time for bicyclists in cities with a newly implemented PBSP, or an existing PBSP, compared to bicyclists in cities with no PBSP (control cities). We used census data to apply age and sex post-stratification weights to adjust the sample to better represent the general population. Survey weights were truncated at 0.2 and 10 (Hosford et al. 2019).

We used weighted logistic regression models to ascertain whether or not the likelihood of reporting a crash changed over time for bicyclists in a newly implemented or existing PBSP city, relative to those in control cities. To quantify the impact of implementing a PBSP on the likelihood of self-reporting a crash we used a model that includes year (2012 [baseline], 2013, 2014), city type (No PBSP [control], newly implemented PBSP, or existing PBSP) and additional covariates to adjust for characteristics of participants. We use an interaction term between year and city type to quantify the effect of PBSPs on the likelihood of a bicyclist self-reporting a crash within newly implemented or existing PBSP city, relative to those in control cities. We selected additional covariates based on bicyclist characteristic and environmental factors that have previously been identified as risk factors for a bicyclist crash (Branion-Calles et al. 2020; Degraeuwe et al. 2015; Fuller et al. 2013; Poulos et al. 2015; Tin Tin, Woodward, and Ameratunga 2013; Vanparijs et al. 2015). This included a measure of how much participants bicycle (average weekly bicycling hours in the past 30 days), age (18-24, 25-34, 35-44, 45-54, 55-64, 65+ years), sex (woman, man), educational attainment (high school or less, at least some college or university), perceived safety of bicycling (dangerous, neither safe nor unsafe, safe), and helmet use (never, seldom, often, always). We also used Walk Score® of a participants' neighbourhood as a proxy for favourability of within-city built environment conditions (Walk Score 2020).

## Findings

Across cities and survey periods there were 4,484 participants (weighted total) who indicated they bicycled at least once in the previous month and provided complete data. Of these, 934 participants (20.8%) reported at least one crash in the previous 3 months. Amongst the 934 participants who reported a crash, 38.6% indicated that the most recent crash resulted in injury and 18.6% involved a visit to the emergency room ([Table 1](#)). The number of participants who reported bicycling in the previous month increased from 1,074 at baseline in 2012 to 1,721 at two-year follow-up in 2014 ([Table 2](#)). There was a considerable change in the perception of bicycling safety with the proportion who view bicycling as dangerous in their city decreasing from 29.9% in 2012 to 23.5% in 2014.

In the logistic regression models, the interaction term (Year × City PBSP Status) is the estimated difference in the likelihood of a bicycling crash over time in cities that have a newly implemented or existing PBSP, relative to change over time in cities without a PBSP ([Table 3](#)). Relative to the change

**Table 1. Weighted characteristics of crashes in which a participant fell off their bike in the past 3 months, pooled.**

	Weighted n (%) <sup>a</sup>	
<b>Participants that have experienced a crashed in the past 3 months...</b>		
For any reason	934.0	(100.0)
Involving a car-door	299.4	(32.1)
Involving a motor vehicle	168.9	(18.1)
Involving another cyclist	195.0	(20.9)
Involving a pedestrian	186.9	(20.0)
Involving a road hazard (tracks, pothole, curb)	428.1	(45.1)
Involving personal distraction	330.1	(35.3)
Involving another reason not listed	185.9	(19.9)
<b>In their most recent collision, participants that ...</b>		
Were injured	360.7	(38.6)
Visited an emergency room	174.1	(18.6)
Riding a bike share bicycle	179.7	(19.2)

<sup>a</sup> Categories are not mutually exclusive, participants were able to select multiple reasons for a crash. As such categories will not add up to 100%.

in likelihood of a crash in cities without a PBSP (and after adjustment for bicycling exposure, sociodemographic characteristics, and Walk Score), there was no statistically significant difference in the odds of reporting a bicycling crash for cities with newly implemented PBSPs after 1-year (Odds Ratio [OR]: 1.09; 95% Confidence Interval [CI]: 0.57, 2.10), and after 2-years (OR: 1.33; 95% CI: 0.71, 2.50). Relative to the change in the likelihood of a crash in cities without a PBSP, for cities with existing PBSPs there was a significant decrease in likelihood of a crash after 2-year follow-up (OR: 0.49; CI: 0.25, 0.98). [Figure 1](#) illustrates the model-based estimates of changes in the predicted probability of a crash from 2012 to 2014 for participants across cities with existing, newly implemented, or no PBSPs.

In this study of population-level bicycling across 8 large cities, we observed that bicycle safety outcomes in cities with a newly implemented PBSP were no different from other cities in terms of safety. PBSPs may be associated with positive impacts on safety over longer time periods, as implied by the decreased odds of a crash in cities that had an existing PBSP at baseline. There are very few studies that evaluate the impact of PBSPs on bicycling safety outcomes. Bicycling crashes are vastly underreported in administrative data (Langley et al. 2003; Winters and Branion-Calles 2017). Although fatalities are consistently recorded, they are, fortunately, very rare (Beck, Dellinger, and O’Neil 2007; Teschke et al. 2013). The IBICCS study provided a large multi-city sample of self-reported bicycling crashes, overcoming data gaps in administrative data, and further, allowed for a quasi-experimental study. Confidence intervals were wide, limiting conclusive evidence on the impacts of implementing PBSPs on bicycling safety.

**Table 2. Weighted characteristics of bicyclists within the IBICCS sample, 2012-2014 (n weighted=4,484).**

	Fall 2012		Fall 2013		Fall 2014	
	(Baseline) weighted <i>n</i> (%)		(1-year follow-up) weighted <i>n</i> (%)		(2-year follow-up) weighted <i>n</i> (%)	
<b>Total</b>	1073.9	(100.0)	1689.2	(100.0)	1720.8	(100.0)
<b>Crash</b>						
No Crash	898.4	(83.7)	1297.5	(76.8)	1354.1	(78.7)
Crash	175.5	(16.3)	391.7	(23.2)	366.7	(21.3)
<b>City PBSP status</b>						
No PBSP (control)	385.6	(35.9)	603.3	(35.7)	658.7	(38.3)
Newly implemented PBSP	237.4	(22.1)	446.1	(26.4)	433.0	(25.2)
Existing PBSP	450.9	(42.0)	639.8	(37.9)	629.1	(36.6)
<b>Total weekly bicycling hours, mean (sd)</b>	2.9	(4.7)	4.2	(7.8)	3.9	(7.2)
<b>Walk Score, mean (sd)</b>	83.8	(19.9)	73.0	(26.4)	81.9	(21.6)
<b>Age</b>						
18-24	165.7	(15.4)	294.2	(17.4)	314.0	(18.2)
25-34	309.2	(28.8)	454.5	(26.9)	487.3	(28.3)
35-44	218.4	(20.3)	285.2	(16.9)	283.6	(16.5)
45-54	198.5	(18.5)	252.9	(15.0)	262.5	(15.3)
55-64	131.0	(12.2)	309.7	(18.3)	254.9	(14.8)
65+	51.1	(4.8)	92.7	(5.5)	118.4	(6.9)
<b>Sex</b>						
Women	453.9	(42.3)	688.3	(40.7)	717.8	(41.7)
Men	620.0	(57.7)	1001.0	(59.3)	1003.0	(58.3)
<b>Education</b>						
High school or less	77.4	(7.2)	208.0	(12.3)	183.5	(10.7)
College or University	996.5	(92.8)	1481.2	(87.7)	1537.3	(89.3)
<b>Helmet use</b>						
Never	212.6	(19.8)	310.9	(18.4)	326.6	(19.0)
Seldom	131.5	(12.2)	168.6	(10.0)	175.5	(10.2)
Often	136.5	(12.7)	288.5	(17.1)	259.4	(15.1)
Always	593.4	(55.3)	921.2	(54.5)	959.3	(55.7)
<b>Safety perception of bicycling</b>						
Dangerous	320.9	(29.9)	358.4	(21.2)	403.8	(23.5)
Neither safe nor unsafe	147.8	(13.8)	215.3	(12.7)	253.5	(14.7)
Safe	605.2	(56.4)	1115.5	(66.0)	1063.5	(61.8)

**Table 3. Weighted difference in differences logistic regression models**

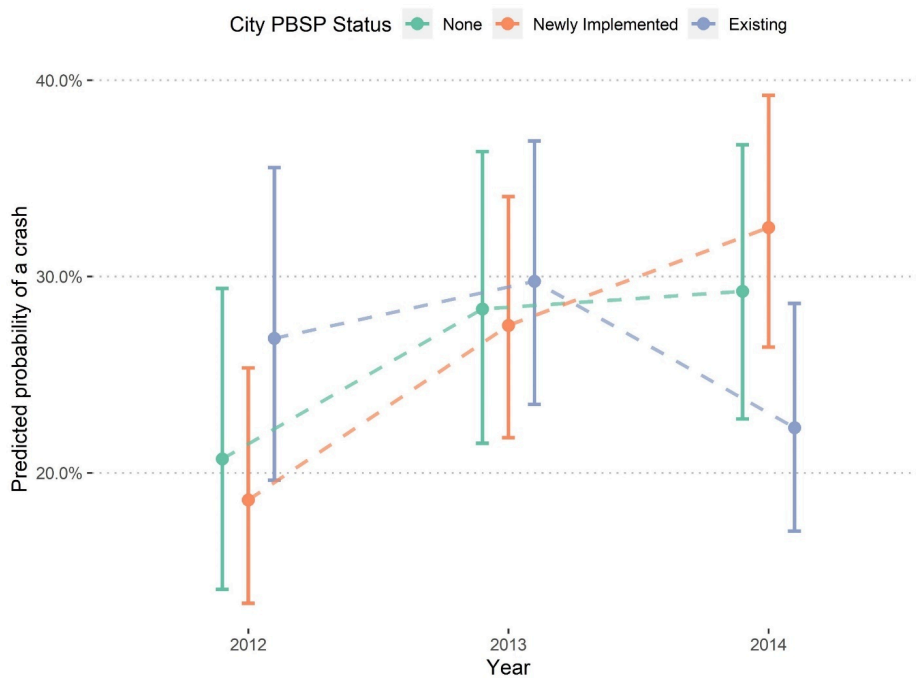
	Simple <sup>a</sup>			Adjusted <sup>b</sup>		
	OR (95% CI)	t	p-value	OR (95% CI)	t	p-value
<b>Year × City PBSP status<sup>c</sup></b>						
2013 × Newly Implemented	1.26 (0.68 - 2.32)	0.74	0.46	1.09 (0.57 - 2.10)	0.27	0.79
2013 × Existing	0.95 (0.50 - 1.80)	-0.16	0.87	0.76 (0.38 - 1.52)	-0.77	0.44
2014 × Newly Implemented	1.62 (0.89 - 2.93)	1.59	0.11	1.33 (0.71 - 2.50)	0.89	0.38
2014 × Existing	0.69 (0.36 - 1.32)	-1.13	0.26	0.49 (0.25 - 0.98)	-2.01	0.04
<b>Year</b>						
2013	1.42 (0.90 - 2.23)	1.50	0.13	1.52 (0.91 - 2.52)	1.60	0.11
2014	1.34 (0.87 - 2.08)	1.33	0.19	1.58 (0.97 - 2.58)	1.84	0.07
<b>City PBSP status</b>						
Newly Implemented	0.72 (0.44 - 1.18)	-1.32	0.19	0.88 (0.51 - 1.50)	-0.48	0.63
Existing	1.12 (0.67 - 1.89)	0.44	0.66	1.41 (0.79 - 2.49)	1.17	0.24

PBSP = Public bike share program; OR = Odds ratio; 95% CI = 95% Confidence interval

<sup>a</sup> Simple model examines interaction between Year and City PBSP status, adjusting for bicycling exposure

<sup>b</sup> Adjusted model examines interaction between Year and City PBSP status, adjusting for bicycling exposure, age, gender, educational attainment, helmet use, perceptions of bicycling safety, and Walk Score in residential neighbourhood

<sup>c</sup> Cities included in the “Newly Implemented” category include Chicago and New York (implemented PBSPs in 2013). Cities included in the “Existing” category are those that had PBSPs implemented prior to 2012 and include Boston, Montreal, and Toronto.



**Figure 1. Predicted probability of a crash for participant defined by median of continuous covariates and mode of categorical covariates but differ in City PBSP Status and Year. PBSPs were implemented in 2013 for “Newly Implemented” cities.**



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