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Bus Stops and Pedestrian-Motor Vehicle Collisions in Lima, Peru: A Matched Case-Control Study

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Abstract

Objective—To evaluate the relationship between bus stop characteristics and pedestrian-motor vehicle collisions.

Design—Matched case-control study where the units of study were pedestrian crossing.

Setting—Random sample of 11 police commissaries in Lima, Peru. Data collection occurred from February, 2011 to September, 2011.

Participants—97 intersection cases representing 1,134 collisions and 40 mid-block cases representing 469 collisions that occurred between October, 2010 and January, 2011 and their matched controls.

Main Exposures—Presence of a bus stop and specific bus stop characteristics.

Main Outcome—Occurrence of a pedestrian-motor vehicle collision.

Results—Intersections with bus stops were three times more likely to have a pedestrian-vehicle collision (OR 3.28, 95% CI 1.53-7.03), relative to intersections without bus stops. Both formal and informal bus stops were associated with a higher odds of a collision at intersections (OR 6.23,

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95% CI 1.76-22.0 and OR 2.98, 1.37-6.49). At mid-block sites, bus stops on a bus-dedicated transit lane were also associated with collision risk (OR 2.36, 95% CI 1.02-5.42). All bus stops were located prior to the intersection, contrary to practices in most high income countries.

Conclusions—In urban Lima, the presence of a bus stop was associated with a three-fold increase in risk of a pedestrian collision. The highly competitive environment among bus companies may provide an economic incentive for risky practices such as dropping off passengers in the middle of traffic and jockeying for position with other buses. Bus stop placement should be considered to improve pedestrian safety.

Keywords

Pedestrian Safety; Accidents; Traffic; Peru; Transportation; Bus Stops

Introduction

In 2008, pedestrian-motor vehicle collisions (referred to as collisions hereafter) contributed to 78% of all traffic fatalities and 38% of all traffic injuries in Peru.[1] In 2006, bus and foot traffic were the primary modes of transport in Lima where more than half the 12 million daily trips occur on public transit vehicles and a quarter on foot.[1] Sustaining a public transportation system that considers pedestrian safety as a fundamental element is a critical component of urban and economic vitality. Structural design factors, however, may also contribute to pedestrian collision risk in Lima as well as other low- and middle-income countries.[12] As of 2010, public transit was largely operated by the unregulated private sector creating a highly competitive atmosphere between bus operators and companies to board and discharge passengers, often in the middle of traffic flow.[3] These practices could place pedestrians and bus riders in danger of collision. Pedestrian risk may be further aggravated by design features of bus stops in Lima, which allow buses to block a competitor before rushing through the warning light at an intersection in order to collect waiting passengers.

Bus stops generate larger pedestrian volumes and the frequency of collisions will likely be higher in their vicinity.[4] This could be exacerbated by a poorly designed system. Other factors that can lead to a higher risk of a collision at bus stops may include their reduced pedestrian visibility due to transit vehicles, risky bus driver behaviors, and risky pedestrian behaviors to board or alight a bus at transit stops.[4-12]

The objective of this study was to evaluate the relationship between pedestrian-motor vehicle collisions and the built environment features of the bus transit system in Lima, Peru. We examined the presence of formal and informal bus stops, bus bays, painted bus stop areas, and dedicated bus lanes.

Methods

Design

This was a matched case-control study to measure risk and protective factors in the pedestrian environment. The primary unit of analysis was a pedestrian crossing area at an intersection or a mid-block, similar to a US study conducted by Koepsell and colleagues.[13]

Study methods are described in greater detail in a previous publication.[14] Each case was a pedestrian crossing area where there had been a police reported pedestrian-motor vehicle collision. Each control was a pedestrian crossing area in the same neighborhood as the case area where no police-reported pedestrian-motor vehicle collision had occurred during the same 24-hour period.

Context

Bus transit in Lima was primarily managed by private companies as of 2010. In, 2008 there were 322 transportation companies operating nearly 30,000 buses on 424 bus routes.[15] A 1991 national law essentially legalized any operator of a vehicle with more than two wheels to offer public transportation whether as a bus or taxi service.[3] Since then the Metropolitan Municipality of Lima (MML) has imposed additional restrictions: they required bus companies to propose and apply for desired routes, designated official (authorized) transit stops and mandated adherence to several safety regulations (e.g., speed limits and passenger occupancy), though enforcement may be lacking. Some transport companies leased routes to independent bus owners who in turn leased their vehicle(s) to independent drivers and fare collectors. Other companies managed their own routes and buses.[316] The pay for drivers and fare collectors was typically linked to route completion time and collected fares, though some are salaried. These incentives created a highly competitive, disorganized and potentially dangerous atmosphere, even within the same companies and routes.[3]

Study Population

Due to the frequency of pedestrian in collisions in Lima (over 13,000 annually), we randomly sampled cases for study using two-stage cluster sampling. In the first stage we randomly sampled police commissaries. The probability of selection was proportional to the number of collisions they reported in 2006.[117] After receiving permission from the Peruvian National Police, commissaries were visited during January and February 2011 to record data on pedestrian collisions occurring from October 1, 2010 to January 15, 2011. After visiting 11 commissaries we estimated that we had a sufficient number of cases recorded to meet study size requirements. In the second stage we took a simple random sample of the recorded collisions. Before sampling collisions at the second stage we excluded cases where the injured person was not a pedestrian (e.g. a cyclist), the pedestrian was not struck within the roadway (e.g., on the sidewalk), the collision occurred outside the jurisdiction of the commissary, information on the location was incomplete, the time of the incident was not recorded, or the collision was deemed intentional. Sites in areas with high criminal activity and incidents that occurred from 8 PM to 6 AM were excluded due to the safety risks for study staff.

For each case, one matched control was randomly selected from a risk set of potential matched controls.[1318-20] Controls were matched to cases based on proximity (<1000 meter radius), road type, number of lanes, and the type of secondary road intersecting the primary road if the case occurred at an intersection or the types of the roads intersecting the primary road at both ends of the block if the case occurred at a mid-block.

We assumed a bus stop would be prevalent on 25% of arterial street blocks in Lima. Based on that prevalence and assuming an intraclass correlation coefficient of 0.3 we would need at least 88 pairs to detect an odds ratio of 3.0 with an 80% power and 5% significance.

Data Collection

We visited each case and control site within a one hour timeframe before or after the original time of the incident (case), which could be on either a weekday or weekend depending on the day of the week of the incident occurred on. The index crossing (Figure 1) corresponded to the area where the police indicated the incident had occurred for cases, and a similar location within the matched control site was selected. We video recorded 10 minutes of vehicle and pedestrian flow, photographed the site, and recorded vehicle speeds for 10 minutes or until at least 25 vehicles in each direction were recorded using a portable speed gun. Physical characteristics of the road were recorded, measured and sketched. Field workers were blinded to whether a site was a case or control. Videos of the pedestrian and vehicle flows were coded for the total number of vehicles passing through the index crossing and the number of pedestrians using the index crossing area.

Data Elements

The primary outcome was the presence of a pedestrian-motor vehicle collision reported to the police. The primary exposures were the presence of a bus stop, the type of bus stop (authorized or unauthorized, Figure 2), whether there were any bus-dedicated traffic lanes (Figures 3a and 3b), the presence of a painted stop area for buses (Figure 3c) and the presence of a bus bay area for boarding and alighting passengers (Figure 3d). Unauthorized stops were identified as any location where an observed bus picked up or dropped off passengers where no municipal bus stop sign was present. Some of the bus-dedicated traffic lanes were part of a bus rapid transit system in Lima (*El Metropolitano*).

We collected data on pedestrian and vehicle flow, and potential confounders including mean vehicle speed, presence of crosswalk markings, crosswalk marking condition, number of crossing segments (road subdivisions created by pedestrian refuges, median barriers, median dividers, or other physical structures separating lanes of vehicular traffic), number of radiating roads, vehicle signalization and crossing distance. Pedestrian flow may be both a confounder and a mediator in terms of the relationship between bus stops and the risk of a collision. Bus stops tend to be placed on busy streets, but once installed they also serve to attract pedestrians. Since eliminating bus stops is not a viable or desirable option, the focus was on the design features that make a bus stop safe or unsafe. For this reason, pedestrian flow was treated as an adjustment variable in order to understand the effects of bus stops and bus stop features on pedestrian safety apart from their being pedestrian magnets. We did not measure or assess road condition due to weather (wetness or visibility) because they would likely have been similar at the time of the incident due to the proximity of cases and controls.

Data Analysis

To account for case-control matching, we used conditional logistic regression to calculate odds ratios (OR) and 95% confidence intervals (CIs). We examined the association between a police-reported collision and the site characteristics related to bus transport. Confounding was assessed for *a priori* covariates (pedestrian and vehicle flow, vehicle speed). We also assessed confounding for other covariates (e.g., crossing distance, median presence, etc) in multivariable models to determine the degree of change between the primary exposures of interest and case status. Using fractional polynomial models for continuous covariates (pedestrian volume, vehicle volume, mean vehicle speed and crossing distance) we determined that a single linear term for each of these variables provided the most appropriate fit. We tested the significance of an interaction term between an exposure and whether a site was a mid-block or intersection. This analysis showed that intersection risk estimates significantly differed from mid-block sites, and results were therefore presented separately.

All analyses were performed with Stata 11 (STATA Corp, College Station, TX, USA). Survey weights and cluster sampling[21] was accounted for using the *svy* command in Stata. The study protocol was approved by the University of Washington and *Universidad Peruana Cayetano Heredia* institutional review boards.

Results

Site Characteristics

We collected data for 97 intersection and 40 mid-block cases representing 1134 pedestrian-motor vehicle crashes at intersections and 469 at mid-blocks throughout metropolitan Lima. There were no significant differences between cases and controls for most road characteristics (Table 1). The mean vehicle speed at mid-block case sites was somewhat lower than the speed at control sites (32.7 KPH vs. 34.6 KPH).

Bus Stop Characteristics

At intersection sites, cases and controls differed on several bus stop characteristics (Table 2). Cases were more likely to have any bus stop present (80% vs. 66%) and to have unauthorized stops (43% vs. 30%). Case sites were also more likely to have a painted bus stop area (18%) and to have a bus bay (8%). At mid-block sites, cases and controls were similar on most transit characteristics, though cases had more unauthorized stops than controls.

Bus Stops at Intersection Sites

There was evidence of an association between the presence of any type of bus stop (authorized or unauthorized) at intersections and collisions (OR 3.28, 95% CI 1.53-7.03) when adjusted for pedestrian and vehicle flow, mean vehicle speed and total crossing width (Table 3). When examining the type of bus stop at an intersection (formal or informal), this significant relationship persisted compared to sites with no stops. Pedestrians were three times as likely to be struck at sites with an unauthorized bus stop (OR 2.98, 95% CI 1.37-6.49) and were six times more likely to be struck at sites with an authorized bus stop (OR 6.23, 95% CI 1.76-22.0). Bus stops which were not co-located on bus lanes were four times as likely to be associated with a pedestrian collision, compared to sites with no bus stop (OR 4.00, 95% CI 1.94-8.26). Pedestrian collisions were more common in the presence of a painted bus stop area or bus bay (Table 3).

Bus Stops at Mid-Block Sites

Bus stops were not significantly associated with pedestrian collision risk at mid-block sites, though the sample was relatively small (Table 3). Contrary to our findings at intersections, at mid-block sites, bus stops with a bus bay were significantly less likely to have a collision compared to mid-block sites with no bus stop (OR 0.16, 95% CI 0.03-0.96).

Discussion

Bus stops were associated with increased pedestrian collisions at intersections, even when adjusting for pedestrian and vehicle volumes. This association may be indicative of the negative public health consequences to pedestrians of a poorly regulated and disorganized transport system in rapidly growing middle-income country. This study suggests that in Lima, some bus stop features may actually increase pedestrian risk of being involved in a collision in lieu of providing a safe loading area. While we did not study pedestrian or driver behaviors specifically in this study, it is possible that the manner they interact with these features may contribute to this risk rather than reduce it.

Several studies have hypothesized similar relationships between pedestrian safety and bus transit in other settings, though they did not explicitly explore the association of bus stops with the risk of a pedestrian collision.[9101222-25] The association between bus bays and painted bus stop areas with pedestrian collisions had not been reported in previous peer-reviewed literature. Bus bays are recommended for roads with speed limits over 40 MPH, vehicle volume over 250 vehicles per peak hour, high bus volumes, high transit rider volumes, and other road features.[6] Most of the sites in this study with a bus bay would likely not meet all these criteria. As described above, observers frequently witnessed episodes where the bus bays were not used as a means to safely leave and enter traffic as intended by city planners. Increased risk for pedestrians may be an unintended consequence of dedicated bus areas when there are strong economic incentives for picking up passengers wherever possible and limited enforcement.

The discordant findings between intersections and mid-blocks could relate to the positioning of the bus stop relative to the intersection. At intersections, bus stops in Lima are nearly always located on the near-side approaching the intersection rather than being positioned on the far-side of the intersection. Previous research has found placing bus stops on the far-side of the intersection can improve pedestrian safety and traffic flow.[626-28] This configuration may reduce conflicts between turning traffic and transit vehicles and may increase the visibility of pedestrians when crossing behind the bus.

Bus-dedicated lanes are meant to enhance traffic flow and lessen non-transit vehicle conflicts with public transit.[4] The effect of transit-dedicated lanes (usually in the context of a bus rapid transit system) on pedestrian safety is unknown, though they have significant benefits for improving traffic flow.[2729-31] In this study, this feature could not be fully examined due to a limited number of sites with any transit-dedicated lanes. Bus lanes may have offered some benefit to pedestrians at intersections, but were associated with a higher likelihood of pedestrian collisions at mid-block sites, where they may encourage unsafe mid-block crossing conditions. The crossing distance is much larger when bus lanes are present, and pedestrians may be more exposed to vehicle traffic, especially if there is no traffic control in place, though we did attempt to control for these factors.

Bus drivers in Peru and similar settings appear to be under pressure to complete their routes quickly, pick up as many passengers as possible, and to work long hours with few and short rest periods. These conditions may lead to negative health consequences for them, their passengers and other road users.[332-34] Bus drivers have been noted to use many strategies to improve their economic return such as quick, unsafe passenger pick-ups and drop-offs, preventing competitors from overtaking them by blocking traffic, and using phased signal timing to maximize stops. Even if drivers or companies are fined for illicit behaviors on the road, there are few legal consequences to not paying or accumulating fines.

Pedestrians who use public transit in Peru are at times complicit with the dangerous behaviors of bus drivers. Pedestrians place themselves at higher risk when catching a bus if they cross the road against a phased signal, cross unsafely between stopped vehicles, or try to board or leave a bus while it is pulling away from a stop. This latter behavior can be worsened by buses that exceed passenger capacity, making it difficult for a passenger to disembark in time or to fully enter the bus before it starts moving.

This study had a number of limitations. Police-reported data are not always optimally suited for research due to data collection priority differences,[3536] but use of police records did permit retrospective identification of pedestrian collision cases irrespective of injury severity. One quarter of the collisions were excluded as they occurred at nighttime or in dangerous areas, thus we cannot generalize results to those sites or nocturnal conditions. Our sample size was modest, but several associations observed were statistically significant, suggesting that the associations may be large. The unique structure of public transportation in Lima may also limit the generalizability of these results to other cities, but this study should at least provide useful information about potential risk factors in other settings.

We collected vehicle and pedestrian flow and vehicle speed for 10 minutes; it is possible that longer observation time or repeated measurements may have been needed in order to have appropriately adjusted for these important covariates. We also collected data up to 10 months after an incident occurred, with the risk that observed physical conditions may no longer represent the conditions under which the incident collision took place. We used Google Earth archival satellite imagery to assess observable changes in 10% of the sites and found few observable changes except newer or older paint markings compared to the satellite image. We recorded data on de facto unauthorized bus stops with observed boarding and drop-off of passengers, though this may not have reflected practices at the time of the incident, though it is known such stops are quite common.[316]

In conclusion, certain features of bus stops may play a role in putting pedestrians in danger of a motor vehicle collision. Future studies should examine how pedestrians and bus drivers interact at bus stops in the presence and absence of these features. If these features are truly harmful, designs that reduce or prevent these behaviors may need to be developed. Increased risk may result from the interaction between design features and behavioral incentives which favor competitive jockeying for passengers and rapid disembarkation over rider and pedestrian safety. Some of risk may also be due to the unregulated public transit system that existed at the time of the study. Improving it could have not only beneficial economic consequences, but also improve public health. These findings may be useful for providing direction for future research in similar dense urban settings.

A well-functioning public transportation network is crucial to urban health via economic health, active living, and environmental sustainability.[37] Road users in cities come from diverse social backgrounds and groups that may not often intersect except in the shared urban space and a desire to arrive at their destinations quickly, efficiently and safely. This can lead to conflicts which need a well-managed public transportation and road system. Many wealthier nations aspire to improve the saturation of public transportation already operating in cities like Lima, where 52% utilize the bus system.[1] Nonetheless, the results of this study and others[14] may point to opportunities to improve pedestrian safety and efficiency while supporting a vibrant public transportation system. Affordable and efficient access to public transport is critically important to road users in low- and middle-income countries. Public transit users also wish to feeling safe during their travels.[38] In order to have both efficient and safe public transport in settings such as Peru, innovative approaches are needed that include pedestrian safety as fundamental component. These strategies include the regulation and enforcement of transit practices to support the safety of public transit users while balancing and maintaining equitable transportation solutions for all.

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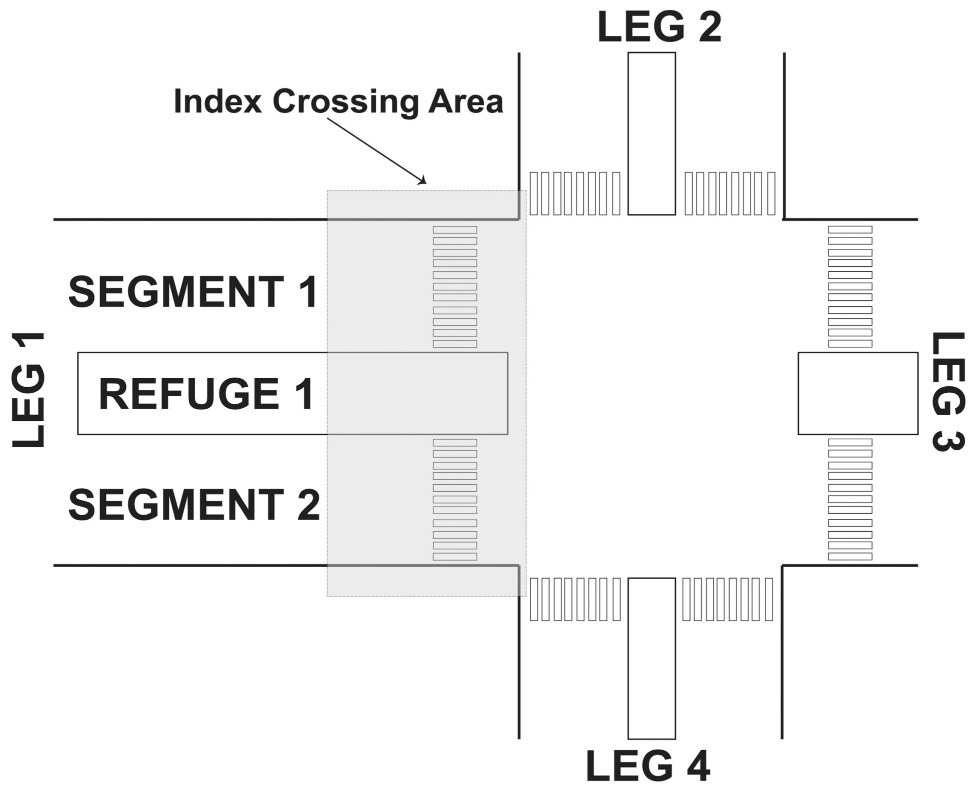
What is already known on this subject

- Bus stops placed on the far-side of intersections in the direction of traffic can reduce pedestrian-motor vehicle collisions.
- Bus stops may be associated with risky pedestrian behaviors and a higher frequency of pedestrian-motor vehicle collisions.

What this study adds

- Sites with bus stops had a three times the risk of pedestrian-motor vehicle collisions, even when controlling for pedestrian and vehicle volumes.
- Bus stops with design modifications (bus pullout and painted bus stop area) meant to improve traffic safety had a higher odds of pedestrian-motor vehicle collisions.


LEG 2
Index Crossing Area
SEGMENT 1
LEG 1
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LEG 4

Figure 1.

Figure 2.

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Figure 3.

Table 1

Descriptive characteristics of intersection and mid-block sites by case or control status, unweighted and weighted proportions or means and standard deviations (as indicated). P-value was a test for null hypothesis of equal odds ratios between categories.

	Intersection Sites						Mid-Block Sites					
	Unweighted			Weighted			Unweighted			Weighted		
	Cases N=97 %	Controls N=97 %	P-value[c]	Cases N=1134 %	Controls N=1134 %	P-value[c]	Cases N=40 %	Controls N=40 %	P-value[c]	Cases N=469 %	Controls N=469 %	P-value[c]
No. of Crossing Segments			0.39			0.37			1.00			1.00
1	31	28		32	29		48	43		32	28	
2	54	57		58	62		48	50		58	62	
3	8	7		8	7		3	3		8	7	
4	7	8		2	3		3	5		2	3	
No. of Lanes, Mean (SD)	4.4 (2.1)	4.5 (2.0)	0.55	4.2 (2.0)	4.4 (1.9)	0.32	3.7 (2.0)	3.4 (1.9)	0.45	3.2 (1.8)	3.7 (2.2)	0.49
Crossing Width (Meters), Mean (SD)	21.2 (13.4)	20.9 (13.3)	0.77	17.9 (10.1)	18.8 (10.7)	0.52	16.3 (11.1)	17.0 (12.6)	0.62	14.2 (9.0)	16.9 (12.5)	0.11
Any Pedestrian Refuge			0.33			0.58			N/A			0.09
No	33	30		40	44		48	43		52	44	
Yes	67	70		59	56		52	57		48	56	
Pedestrian Refuge Width (Meters), Mean (SD)	8.3 (7.7)	8.5 (7.3)	0.38	5.2 (4.5)	5.7 (5.2)	0.68	5.1 (3.6)	6.5 (5.2)	0.53	4.6 (3.2)	6.0 (5.3)	0.09
Road Surface Material			0.48			0.45			N/A			N/A
Asphalt	95	93		88	87		90	85		93	88	
Concrete or Brick	5	7		12	13		15	10		7	12	
Road Surface Condition			0.71			0.99			0.17			0.15
Good	58	58		57	58		48	65		50	61	
Fair	32	29		33	33		27	22		35	24	
Poor	10	13		10	9		15	12		15	15	
Marked Crosswalk			0.34			0.07			0.34			0.67
No	39	44		35	41		83	88		83	86	
Yes	61	56		65	59		17	12		17	14	
Crosswalk Marking Visibility			0.57			0.35			0.46			0.89
Unmarked	39	44		35	41		83	88		83	86	
Visible	24	21		19	22		5	2		6	2	

	Intersection Sites						Mid-Block Sites					
	Unweighted			Weighted			Unweighted			Weighted		
	Cases N=97 %	Controls N=97 %	P-value[c]	Cases N=1134 %	Controls N=1134 %	P-value[c]	Cases N=40 %	Controls N=40 %	P-value[c]	Cases N=469 %	Controls N=469 %	P-value[c]
Faded	37	35		46	37		12	10		12	12	
Vehicles Per Hour, Mean (SD)	1715 (967)	1553 (1001)	0.05	1677 (951)	1429 (868)	0.11	1359 (1050)	1341 1077)	0.89	1227 (999)	1335 (1034)	0.38
Pedestrians Per Hour, Mean (SD)	436 (505)	305 (404)	0.01	360 (396)	285 (378)	0.33	190 (255)	123 (173)	0.14	169 (222)	103 (132)	0.27
Mean Speed (KPH), Mean (SD)[a]	33.7 (6.1)	34.0 (6.0)	0.44	31.9 (5.8)	33.8 (5.7)	0.23	33.0 (6.6)	35.1 (8.5)	0.13	32.7 (6.5)	34.6 (8.0)	0.02
Max Speed (KPH), Mean (SD)[b]	55.9 (28.2)	54.4 (10.2)	0.08	50.0 (9.8)	53.3 (9.4)	0.94	51.0 (12.2)	52.7 (13)	0.4	50.4 (12.3)	51.7 (11.6)	0.18

[a]Mean of the mean speed recorded at each site

[b]Mean of the maximum speed recorded at each site

[c]P-value was a test for null hypothesis of equal odds ratios between categories.

Table 2

Univariate analysis of the relationship between bus stop characteristics and a pedestrian-vehicle motor vehicle collision at intersections and mid-blocks, both unweighted and weighted. All numbers are proportions except where noted.

	Intersection						Mid-Block					
	Unweighted			Weighted			Unweighted			Weighted		
	Cases N=97 %	Controls N=97 %	P-value[b]	Cases N=1134 %	Controls N=1134 %	P-value[b]	Cases N=40 %	Controls N=40 %	P-value[b]	Cases N=469 %	Controls N=469 %	P-value[b]
Any Type of Bus Stop			**0.02**			**0.02**			0.71			0.49
No	23	35		20	34		62	65		56	60	
Yes	77	65		80	66		38	35		44	40	
Type of Bus Stop			**0.03**			0.09			0.47			0.58
None	23	35		20	34		62	65		56	60	
Authorized	39	30		37	36		15	20		23	26	
Unauthorized[a]	38	35		43	30		23	15		21	13	
Any Bus-Dedicated Lanes			0.57			0.21			0.57			0.51
No	81	80		86	85		92	95		91	92	
Yes	19	20		14	15		8	5		9	8	
Type of Bus-Dedicated Lanes			1.00			<0.01			1.00			<0.01
None	81	81		86	85		92	95		91	92	
Interior	16	16		9	9		5	5		1	8	
Exterior	3	3		5	6		3	0		8	0	
Any Painted Bus Stop			**0.04**			**0.03**			N/A			N/A
No	67	86		82	92		92	90		84	83	
Yes	23	14		18	8		8	10		16	17	
Any Bus Bay Area			0.07			0.39			0.45			0.45
No	86	92		92	97		95	92		96	93	
Yes	14	8		8	3		5	8		4	7	

[a] Unauthorized stops were those with no bus stop sign present, but where passengers were observed entering or exiting buses

[b] P-value was a test for null hypothesis of equal odds ratios between categories

Table 3

Weighted multivariable analysis of the relationship between bus stop characteristics and a pedestrian-vehicle motor vehicle collision. All bus stops at intersection sites were proximal to the intersection in the direction of vehicle traffic.

	Intersection		Mid-Block	
	OR (95% CI)	**P-value[f]**	**OR (95% CI)**	**P-value[f]**
Any Bus Stop Present				
No	Ref[a]		Ref[a]	
Yes	3.28 (1.53-7.03)[a]	**<0.01**	0.15 (0.005-4.21)[b]	0.22
Type of Bus Stop				
None	Ref[a]		Ref[a]	
Unauthorized	2.98 (1.37-6.49)		0.80 (0.06-11.2)	
Authorized	6.23 (1.76-22.0)	0.27	0.22 (0.02-2.03)	0.06
Any Bus Lanes				
No Bus Stop	Ref[a]		Ref[a]	
Any Bus Stop without Bus Lanes	4.00 (1.94-8.26)		0.23 (0.01-6.82)	
Any Bus Stop with Bus Lanes	0.58 (0.23-1.48)	**<0.01**	2.36 (1.02-5.42)	0.14
Bus Stop Painted Area				
No Bus Stop (including unauthorized)	Ref[c]		Ref[d]	
Bus Stop without Painted Area	0.51 (0.06-4.34)		0.27 (0.08-0.97)	
Bus stop with Painted Area	14.6 (1.30-165)	0.07	*e*	**<0.01**
Bus Stop Bay/Pullout Area				
No Bus Stop	Ref[a]		Ref[b]	
Bus Stop with No Bay	3.30 (0.52-20.8)		0.64 (0.04-11.1)	
Bus Stop with Bay	40.7 (4.70-352)	0.07	0.16 (0.03-0.96)	0.37

[a]Adjusted for vehicles per hour, pedestrians per hour, mean vehicle speed, and total crossing width of Leg A

[b]Adjusted for vehicles per hour, pedestrians per hour, and total crossing width of Leg A

[c]Adjusted for vehicles per hour, pedestrians per hour, and mean vehicle speed

[d]Adjusted for vehicles per hour and pedestrians per hour

[e]Term was perfectly correlated with control status

[f]The P-value is the hypothesis test of no difference between subgroups.