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The Walking Environment in Lima, Peru and Pedestrian–Motor Vehicle Collisions: An Exploratory Analysis

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Objective: Pedestrians comprise 78% of the road fatalities in Peru. The objective of this study was to explore the relationship between the walking environment and pedestrian–motor vehicle collisions.

Methods: A matched case-control study was used to detect the odds of a pedestrian–motor vehicle collision at a pedestrian crossing location. Data were collected from 11 sampled police commissaries in Lima, Peru.

Results: In a multivariable model adjusting for vehicle and pedestrian flow, pedestrian collisions were less likely in the presence of a curb and sidewalk on both roadway sides (odds ratio [OR] = 0.19, 95% confidence interval [CI], 0.11–0.33) or a pedestrian barricade (OR = 0.11, 95% CI, 0.01–0.81). There was a greater risk of collisions for each street vendor present (OR = 2.82, 95% CI, 1.59–5.00) or whether any parked vehicles (OR = 3.67, 95% CI, 1.18–11.4) were present.

Conclusions: Improving or addressing these potentially modifiable features of the walking environment could improve pedestrian safety in Lima and in similar urban settings in low- and middle-income countries.

Keywords: pedestrian injury, built environment, less motorized countries, matched case-control study, Peru

Introduction

Pedestrians account for 78% of road fatalities in Peru (World Health Organization 2009). In 2010, over 60% of the pedestrian–motor vehicle collisions reported in 2010 to the Policía Nacional del Perú (National Police of Peru) occurred in the sprawling capital city of Lima. Pedestrians in Lima face a number of potential dangers in the walking environment: a high density of vehicle traffic, limited walking paths and spaces, street vendors blocking access, poor walking surfaces, visibility reduced by vehicle parking, and poorly maintained road markings (Secretaría Técnica del Consejo de Transporte de Lima y Callao 2009a, 2009b). A previous study on child

pedestrians in Lima found that at least 2 of these factors, street vendors and poor lane demarcation, were significantly associated with parent-reported child pedestrian injuries (Donroe et al. 2008).

One approach to improving pedestrian safety is modification of the walking environment (Agran et al. 1996; Ewing and Dumbaugh 2009; Mock et al. 2004; Pollack et al. 2012; Retting et al. 2003; Seibert Khulmann et al. 2009; Zegeer and Bushell 2012). Many design modifications (e.g., traffic calming, crosswalk signalization, marked crosswalks, stop lines, sidewalks) have been evaluated and have demonstrated effectiveness at preventing injury and fatalities or reducing pedestrian–vehicle conflicts (Bunn et al. 2003; Duperrex et al. 2002; Ewing and Dumbaugh 2009; Forjuoh and Li 1996; Gandhi and Trivedi 2007; Mohan 2008; Retting et al. 2003). With a few exceptions (Afukaar 2003; Damsere-Derry et al. 2007, 2008; Hidalgo-Solorzano et al. 2010; Hajar et al. 2003; Tiwari et al. 2007), most studies were conducted in high-income countries where traffic patterns, law enforcement practices, and commuting behaviors differ from those in low- and middle-income countries (LMICs). One Mexican study indicated that the

effectiveness of engineering interventions may be somewhat reduced relative to the effectiveness in high-income settings due to circumvention and misuse by road users (Hijar et al. 2003).

A number of traffic modifications and countermeasures to the built environment have been deployed in Lima to decrease the danger to pedestrians, though these modifications vary by municipal district and have not been evaluated. For example, some high-speed, vehicle-dense arterial roads have barricades to prevent pedestrian crossing except at specific areas. In addition, over 200 pedestrian footbridges are distributed along the Pan-American Highway and other major arterials throughout Lima (Secretaría Técnica del Consejo de Transporte de Lima y Callao 2008). At other sites, speed bumps have been placed near crossing areas to slow vehicle traffic. Pedestrian crossing signals have been added at some intersections (Secretaría Técnica del Consejo de Transporte de Lima y Callao 2009b). We previously evaluated the relationship between pedestrian crossing signals and pedestrian collisions and found paradoxically that pedestrian signals may be associated with an increased risk of pedestrian collision (Quistberg et al. 2014). Anecdotally, pedestrians and drivers in Lima often ignore signalization, thereby reducing their effectiveness (Secretaría Técnica del Consejo de Transporte de Lima y Callao 2009b). We also previously found that public transit stops may increase the risk of pedestrian–motor vehicle collisions even beyond pedestrian and vehicle volumes (Quistberg et al. 2013).

Though much of the central, older sectors of Lima received some of these modifications, few of the newer, outlying areas that are populated with new immigrants to the city had any such modifications, including basic design features such as sidewalks. This situation provided an opportunity to evaluate whether the presence or absence of these features of the built environment may have been associated with pedestrian collisions, thus potentially providing evidence for effectiveness of such modifications in an urban, middle-income setting. We evaluated these environmental features in an exploratory fashion with the intention of identifying possible improvements for pedestrian safety. We studied features that may reduce vehicle speed (e.g., speed bumps), features that improve pedestrian visibility (e.g., reduced street parking or marked crosswalks), and features that organize and separate pedestrian flow from vehicle flow (e.g., sidewalks or pedestrian barricades). We used multivariable modeling to determine which were significantly associated with reduced risk of pedestrian collision.

Methods

Design

We used a matched case-control design similar to a U.S. study (Koepsell et al. 2002). A pedestrian crossing area at an intersection or in a mid-block area was the unit of analysis. We defined a case as a pedestrian crossing area where the police reported a pedestrian–motor vehicle collision. A control was a similar pedestrian crossing area in the same neighborhood

as the case where no pedestrian–motor vehicle collision had been reported by the police during the same 24-h period. Detailed methods of this study have been previously published (Quistberg et al. 2013, 2014).

Setting and Study Population

We selected cases for study through 2-stage cluster sampling due to the high frequency of pedestrian collisions. The first stage used probability proportional to size to select police commissaries in metropolitan Lima where the probability of random selection was proportional to the number of pedestrian collisions reported in 2006. We visited commissaries in January and February of 2011 to identify and record any motor vehicle collisions involving a pedestrian. After visiting 11 commissaries we determined that a sufficient number of cases had been collected to meet sample size requirements. In the second stage, we randomly sampled reported incidents within each of the 11 commissaries. Before sampling, 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, sites in areas with high criminal activity, and any intentional collisions. Incidents that occurred from 8 p.m. to 6 a.m. were excluded due to safety risks posed to study staff.

We randomly selected one control for each case from a risk set of matched potential controls. Initial matches were made by searching for controls within a radius of up to 1,000 m of the case site within the commissary limits. Potential controls within this radius were matched to the case by the index road type (highway, arterial, arterial–collector, collector, or residential) and by the number of lanes of vehicle traffic. A final matching criterion was for the secondary road to be the same type as the secondary road at the case site at intersections or at mid-blocks for the 2 intersecting secondary roads on both ends of the segments to be the same road types as the case segment.

Data Collection

Cases were first identified at the selected police commissaries. After identifying and sampling case sites and selecting appropriate controls, we visited each site. Visits occurred on a weekday if the reported collision occurred on any weekday and similarly for weekend sites. Sites were visited within an hour of the time that the original incident occurred. At each site we recorded 10 min of video of vehicle and pedestrian flow and took pictures of the physical characteristics of the site. We measured vehicle speeds for 10 min or for 25 vehicles in each direction using a speed radar gun. We measured and sketched physical characteristics at each site. Fieldworkers were blinded to case and control status. Videos of the pedestrian and vehicle flows were viewed to count the total number of vehicles passing through the index crossing and the number of pedestrians using the index crossing area.

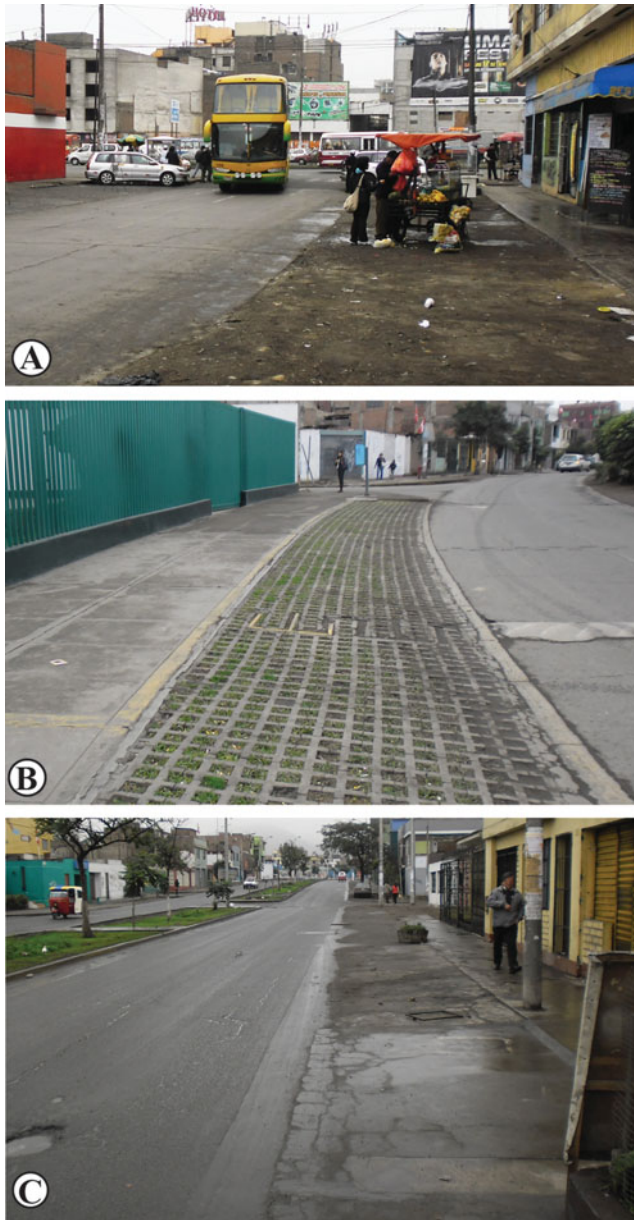


Fig. 1. Examples of sites without a hard-edged curb. (A) No curb, only dirt. (B) Angled transition for vehicle parking. (C) Mix of dirt and angled transition for vehicle parking.

Data Elements

The primary outcome was the presence of a pedestrian collision reported to the police. For this exploratory analysis, we examined environmental factors that could potentially affect the risk of pedestrian collisions. We classified these as roadside factors, crossing area factors, and potential confounders (Table A1, see online supplement). Roadside factors include features such as sidewalks and curbs (Figure 1) that are intended to separate pedestrians from vehicle traffic and factors that could affect their use of these areas such as the presence of street vendors (Figure 2). Crossing area characteristics were roadway features that facilitate or impede pedestrians' ability to cross vehicle traffic such as a marked crosswalk, pedestrian



Fig. 2. Example of street vendors. (A) Street vendors leave little room for pedestrians passing through. (B) Street vendors have completely blocked the sidewalk thoroughfare, causing foot traffic to use the roadway.

barricade (Figure 3A), or pedestrian bridge (Figure 3B) and obstructions that can affect their ability to see and be seen by drivers such as parked vehicles and traffic direction or that are meant to change vehicle flow near where pedestrians are expected to cross roadways such as speed bumps and stop lines. Based on published literature, we created a fourth group of potential confounding factors that could be strongly related to both the environmental exposures described above and the outcome (pedestrian and vehicle flow, mean vehicle speed, crossing width, and signalization).

Data Analysis

We initially evaluated the univariate relationship between each exposure in Table A1 and the outcome by examining unweighted and weighted proportions and means (if applicable) by case status. We calculated odds ratios (OR), 95% confidence intervals (CIs), and *P* values using conditional logistic regression to assess the associations between likelihood of a police-reported collision and characteristics of the walking environment. *P* values in unweighted analysis were based on the likelihood ratio and on the Wald test in weighted analysis. The *svy* commands in Stata 11 (STATA Corp, College Station, TX) were used to account for the 2-stage sampling design, including weighting. We determined that mid-block and intersection sites could be analyzed together after observing



Fig. 3. (A) Example of a pedestrian barricade. (B) Example of a pedestrian bridge.

that interaction terms between exposures and mid-block/intersection status indicated that odds ratio estimates did not differ significantly between site types. We evaluated the exposures and confounders together in a weighted multivariable model and eliminated factors from the model in a manual stepwise procedure. The starting model included variables that were statistically associated with the outcome in univariate analysis at P value $< .40$ and potential confounders (Table A1). One factor at a time was eliminated from the model based on its P value ($> .40$), its effect size, the relative change in F statistic, and whether the effect size of any remaining characteristics was importantly affected (greater than 10% change in estimate) by the removal of the factor. Because of the potential impact of vehicle and pedestrian flow as a priori confounders, they were included in every model. After reaching a parsimonious model of the statistically significant factors, other factors with a strong univariate relationship with case-control status were reentered into the model one by one to evaluate their fit and effect on other factors. We attempted to keep the final model to less than 10 terms and to limit those terms to factors with statistical significance in the multivariable model ($P \leq .05$). Fractional polynomial models were evaluated for the continuous covariates: vehicle flow, pedestrian flow, mean vehicle speed, total crossing width, and number of street vendors. A single linear term for each of these variables was determined to have the best fit.

The study protocol was approved by institutional review boards at the University of Washington and Universidad Peruana Cayetano Heredia.

Results

A total of 137 case sites had complete data (97 intersection sites and 40 mid-block sites), representing 1,603 pedestrian-motor vehicle crashes in Lima during the study period (1,134 at intersections and 469 at mid-blocks). In unweighted univariate analysis, sidewalks, curbs, street vendors, parked vehicles, pedestrian barricades, lane markings, pedestrian flow, and the maximum vehicle speed recorded were all significantly associated with case-control status when accounting for matching (Table 1 and Table A2, see online supplement). After adjusting for differential sampling probabilities, only curbs, street vendors, and pedestrian barricades of these factors remained statistically significant. Sites with curbs were less likely to have experienced a pedestrian collision, whether the curb was on only one side of the index road ($OR = 0.16$, 95% CI, 0.03–0.91) or both sides of the index road ($OR = 0.13$, 95% CI, 0.06–0.28). Pedestrian collisions were nearly twice as likely at sites where street vendors were present ($OR = 1.92$, 95% CI, 1.30–2.84). Some features that have demonstrated an association with pedestrian collisions in previous studies exhibited weak or no association, such as speed bumps ($OR = 1.37$, 95% CI, 0.15–12.7).

Many of the factors that were significantly associated with case-control status in univariate analysis maintained this relationship in the multivariable model (Table 2). Because curbs and sidewalks were strongly associated with each other, we created a composite, 3-category variable to model their joint effects (1 = No sidewalks or curbs/Sidewalks with no curbs [$n = 20$], 2 = Sidewalks with curbs on one side [$n = 28$], and 3 = Sidewalks and curbs on both sides [$n = 246$]). Compared to sites with sidewalks only, sites with curbs on one side and sidewalks were less likely to have had a pedestrian collision relative to sites without curbs ($OR = 0.42$, 95% CI, 0.12–1.49), whereas those with curbs and sidewalks on both sides were 81% less likely to have had a collision ($OR = 0.19$, 95% CI, 0.11–0.33). The presence of pedestrian barricades was also associated with lower risk, though the confidence interval was quite wide ($OR = 0.11$, 95% CI, 0.01–0.81).

Two factors were significantly associated with an increased chance of a pedestrian collision: the number of street vendors and parked vehicles. Each street vendor present was associated with a nearly 3-fold increase in the likelihood of a pedestrian collision ($OR = 2.82$, 95% CI, 1.59–5.00). Parked vehicles were associated with a nearly 4-fold increase, though the confidence interval was wide and approached the null on the lower bound ($OR = 3.67$, 95% CI, 1.18–11.4). We allowed the presence of a pedestrian footbridge to remain in the final model because it improved the model fit and affected the strength of association of other terms that were statistically significant. As expected, vehicle flow was significantly associated with collisions with a 10% increase in the odds of the outcome for every 100 vehicles passing through the crossing area. Pedestrian flow did not appear to be

Table 1. Descriptive and univariate statistics of features at case and control sites, unweighted and weighted

	Unweighted <i>N</i> = 137 Matched pairs				Weighted <i>N</i> = 1,603 Matched pairs			
	Cases %	Controls %	OR (95% CI)	<i>P</i> value	Cases %	Controls %	OR (95% CI)	<i>P</i> value
Sidewalk				.002				.051
Neither side	3	2	Reference		3	1	Reference	
One side	4	13	0.26 (0.04–1.78)		3	12	0.10 (0.02–0.55)	
Both sides	93	85	2.63 (0.37–18.6)		94	87	2.47 (0.51–12.1)	
Curb				.004				.001
Neither side	11	2	Reference		12	3	Reference	
One side	7	14	0.11 (0.02–0.54)		7	10	0.16 (0.03–0.91)	
Both sides	82	84	0.18 (0.04–0.82)		81	87	0.13 (0.06–0.28)	
Street vendors				<.001				.004
0	54	71	Reference		58	77	Reference	
1 to 2	32	24	2.65 (1.33–5.30)		28	20	2.95 (1.66–5.23)	
3 or more	13	4	11.2 (2.80–45.1)		14	3	24.4 (3.85–155)	
Mean, SD	1.3 (2.9)	0.5 (0.9)	1.85 (1.28–2.68)	<.001	1.5 (4.0)	0.4 (0.8)	1.92 (1.30–2.84)	.004
Any parking either side				.005				.386
No	50	64	Reference		43	52	Reference	
Yes	50	36	2.25 (1.25–4.05)		57	48	1.56 (0.52–4.68)	
Pedestrian barricades				.015				.144
No	82	75	Reference		81	74	Reference	
Yes	18	25	0.29 (0.09–0.87)		19	26	0.28 (0.05–1.68)	
Pedestrian bridge				.705				.976
No	96	96	Reference		97	97	Reference	
Yes	4	4	1.33 (0.30–5.96)		3	3	0.97 (0.11–8.69)	
Vehicles per hour, mean (SD)	1,596 (1,001)	1,464 (1,012)	1.04 (1.00–1.08)*	.072	1,545 (985)	1,401 (919)	1.04 (0.98–1.10)*	.141
Pedestrians per hour, mean (SD)	355 (455)	250 (366)	1.02 (1.01–1.03)*	<.001	304 (364)	232 (336)	1.01 (0.99–1.04)*	.247
Max speed (kph), mean (SD)	51.9 (11.3)	54.0 (11.1)	0.97 (0.95–1.001)	.048	50.1 (10.6)	52.8 (10.1)	0.96 (0.93–1.003)	.067

significantly associated with the occurrence of collisions in the final model.

Discussion

In this exploratory analysis of the walking environment for pedestrians in Lima, we found several features of the built environment that may have had a beneficial effect on pedestrian safety. The presence of hard-edged curbs was associated with a lower likelihood of a collision, as were pedestrian barricades. Hard-edged curbs are not consistently present in Lima. On some roads, especially more residential-type roads, there was not a curb separating the pedestrian walking area from the roadway; rather, the transition was a gently sloped dirt or concrete area. These sloped transitions allowed vehicles to park and block the pedestrian paths, forcing them to walk in the roadway. A high, hard-edged curb may eliminate illegally parked vehicles from encroaching on pedestrian paths but may cause more dangerous rollovers if the vehicle skids off the roadway (Sawalha and Sayed 2001).

Pedestrian barricades were also a potential beneficial feature. At mid-blocks, barricade structures prevented most pedestrians from crossing because the barriers were difficult to circumvent. At intersections, barricades channeled pedestrians toward the designated crosswalk area, perhaps reducing the incidence of crossings initiated outside the intersection in advance of a changing traffic light.

The presence of street vendors was strongly associated with the likelihood of a pedestrian collision. Our relative risk

estimate for each vendor present was twice as large as that observed by Donroe et al. (2008) in a study of child pedestrians. This may be due to differences in pedestrian populations, geographic area (all of Lima vs. one district), sample size (137 vs. 40 matched pairs), or sampling methodology. There are several dangers that street vendors may present to pedestrian safety. We observed that vendors tend to place themselves at street corners. This placement limited entry into the walking path area from the roadway, reduced the size of the waiting area to cross the roadway, and limited the ability of drivers to spot pedestrians attempting to cross. Though street vendors may draw foot traffic to an intersection, increasing pedestrian exposure, our study approach allowed us to separately control for pedestrian volume and thus to incorporate information about exposure as well as risk (Christie et al. 2007). Street vendors are an important component of the economy in countries like Peru where they may comprise 10–20% of employment (Herrera et al. 2012). Though eliminating street vendors is one possible solution, this would likely impose serious economic hardship for vendors and their clients. Another option could be to designate mid-block vendor areas, though this might require consistent enforcement. These results are exploratory; thus, it would be important to conduct further studies that examine how street vendors may be related to pedestrian safety and to seek specific solutions based on that evidence.

The presence of parked vehicles at a crossing area was associated with increased risk of pedestrian collision. Vehicles parked on the street can limit pedestrian and motorist views (Agran et al. 1996). Street parking in many fast-growing cities like Lima is costly and limited. Vehicle owners

Table 2. Final weighted multivariable model of environmental factors associated with pedestrian motor vehicle collisions

	OR (95% CI)	P Value
Sidewalks and curbs		
Sidewalks only/no curbs or sidewalks	Reference	
Curb on one side (any sidewalk present)	0.42(0.12–1.49)	0.157
Curb and sidewalks on both sides	0.19(0.11–0.33)	< 0.001
Number of street vendors	2.82(1.59–5.00)	0.002
Any parked vehicles	3.67(1.18–11.4)	0.029
Pedestrian barricades	0.11(0.013–0.81)	0.034
Pedestrian bridge	0.14(0.013–1.61)	0.103
Vehicle flow (per 100 vehicles per hour)	1.10(1.03–1.18)	0.011
Pedestrian flow (per 10 pedestrians per hour)	1.01(0.99–1.04)	0.334

sometimes parked cars in a lane of vehicle traffic or parked on the sidewalk. Traffic congestion and renegade parking will likely be exacerbated by growing auto ownership. A comprehensive planning approach will require focused attention on building walkable cities with accessible, affordable, and efficient public transportation. Limiting renegade parking also requires aggressive parking enforcement from the police or municipal authorities.

Some of the features we examined did not appear to benefit pedestrians. Sidewalks have demonstrated effectiveness at reducing pedestrian–vehicle conflicts and collisions in other studies (Boarnet et al. 2005; Poudel-Tandukar et al. 2007), but the relationship was not as clear in our study. Part of this difficulty could be due to our study having relatively few discordant pairs between cases and controls, because most sites had sidewalks. When modeled alone, sidewalks did not demonstrate a clear benefit to pedestrians, but when modeled as a composite variable with hard-edged curbs we found that sites with both had significantly lower odds of collisions than sidewalks alone. We observed (but did not record for this analysis) the condition or completeness of sidewalks. This variability may have made modeling a single indicator variable inadequate to account for these differences.

Speed bumps (or humps) did not appear to provide an observed benefit to pedestrians in our study, though they have been found to have a strong protective effect on pedestrian safety in other studies (Bunn et al. 2003; Tester et al. 2004), including several in developing countries (Afukaar 2003; Afukaar and Damsere-Derry 2010). In our study of congested urban streets, average vehicle speed was relatively low (32 kph at case sites and 34 kph at control sites). The few speed bumps observed were not uniform in construction, were generally in poor condition (missing pieces, faded paint markings, worn down, etc.), and were sometimes placed at uncontrolled crossings in areas of heavy vehicle and pedestrian traffic. These factors could have led to them being less effective at reducing vehicle speeds than previously reported. Confidence limits were also wide around our odds ratio estimate for speed bumps and did not rule out the possibility of a true protective effect.

Our analysis was exploratory in nature and, therefore, was limited by modest sample size and multiple comparisons. It is possible that environmental changes were made to sites in the interval between the incident date and visit date,

potentially in response to documented pedestrian risk, which might have modified the dynamic traffic characteristics. To assess this potential problem, we randomly selected 10% of the case sites and compared recorded data to archival satellite imagery from Google Earth. We observed no major physical changes to this sample of sites (addition of traffic lights, sidewalks, change to road layout, etc.). There were differences in paint markings, which may have been clearer or more faded than when sites were visited. For 5 sites we were able to collect vehicle and traffic flow data from 2 studies conducted in the year prior to our study (Secretaría Técnica del Consejo de Transporte de Lima y Callao 2010). For these 5 sites, observed vehicle and pedestrian flow was within the 24-h range of the previously measured values.

Pedestrian collision data were police reported and were not collected for the purposes of research (Secretaría Técnica del Consejo de Transporte de Lima y Callao 2011). These data may not include all collisions and there was limited data on the nature of pedestrian injury (typically reported as “multiple contusions”). Because of this limitation, we used the police data to identify collision locations but did not consider the severity of the injuries to the pedestrian. As noted in the Methods section, we excluded 38% of the police-reported collisions from sampling in the second stage. The majority of exclusions (26%) were due to their occurrence at night (19%) or occurring in an unsafe neighborhood (7%). Due to this nighttime exclusion, our results may not be applicable to these collisions, which may be influenced by additional factors such as poor visibility and alcohol use by drivers and pedestrians. The findings that are most likely affected by this exclusion are for parked vehicles and street vendors because both of these factors are dynamic and vary by time of day. Sites in residential areas will likely have a higher frequency of parked vehicles at night than in the day, whereas the reverse would likely be true for commercial areas. Street vendor presence would likely be affected similarly, especially for ambulatory vendors. Curbs and pedestrian barricades are stationary features of the environment that would not change but whose effectiveness may have uncertain variations under nighttime conditions. We speculate that the direction of our estimates may be similar for nighttime collisions but may have a differing magnitude of association. A small number of other reports were excluded (12%) because they were misclassified as pedestrian collisions, occurred outside the study area, lacked data crucial to observation, or were intentional collisions. It is possible that the presence of observers may have impacted behavior, though based on many illegal traffic and other behaviors observed, we felt that the impact was likely minimal.

Many LMICs have high rates of pedestrian commuting and utilization of public transportation. The challenge for urban planners is to help shape a safe walkable environment that will accommodate healthful demographic and economic growth and continue to encourage foot traffic (Jacobsen 2003; Pucher and Dijkstra 2003). Relative to wealthier nations, LMICs struggle with high levels of pedestrian risk and significant resource limitations. For burgeoning urban megacities such as Lima, there is an urgent need to explore the association between environmental modifications and pedestrian risk (Bunn et al. 2003; Forjuoh and Li 1996; Zegeer and Bushell 2012).

This work can identify promising interventions, redirect attention to traffic enforcement where needed, and, equally important, may suggest that some investments are wasteful and should not be replicated. Implementing interventions and addressing risks in the walking environment, such as those explored in this study, are necessary for LMICs to consider as their countries develop the economic resources and technical knowledge and ability to address their growing burden of road injury. Ecological studies examining country-level factors indicate that road injury and fatality increase linearly to economic development until reaching a certain level at which it is hypothesized that countries have the resources to address this growing epidemic (Kopits and Cropper 2005, 2008; Paulozzi et al. 2007).

This exploratory study identified potentially modifiable risk and protective factors associated with pedestrian collisions, including curb presence, pedestrian barricades, street vendors, and parked vehicles. These findings may provide lessons for improving the safety of the built environment for pedestrians in similar large, dense urban areas in other LMICs. Further field research is likely needed in other LMIC urban areas to develop, test, and disseminate promising interventions specific to their local context to curb the epidemic of pedestrian death and injury (Mock et al. 2004; Rydin et al. 2012). We hope, however, that these preliminary results may prove useful for researchers and policy makers to further enhance pedestrian safety in low- and middle-income settings.

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Supplemental Materials

Supplemental data for this article can be accessed on the publisher's website publisher's website.

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