



Knowledge and Beliefs About Pedestrian Safety in an Urban Community: Implications for Promoting Safe Walking

Elizabeth D. Nesoff^{1,5} · Keshia M. Pollack Porter² · Maryanne Bailey^{3,5} · Andrea C. Gielen⁴

Published online: 24 July 2018
© Springer Science+Business Media, LLC, part of Springer Nature 2018

Abstract

As more people walk for transport and exercise, it is possible to avoid a concomitant increase in the number of pedestrian injuries. Understanding how the public views pedestrian safety can help inform the development of prevention strategies that support national efforts to promote walking and walkable communities. As part of the formative research for a community pedestrian safety health promotion campaign, we administered an online questionnaire to employees and students at a large urban medical campus, along with residents in the neighboring communities, to determine their knowledge, attitudes, and behavior regarding pedestrian safety; awareness of relevant traffic safety laws; and effective strategies that could improve pedestrian safety. Pearson Chi square Test of Independence was used to investigate differences between individuals who mainly traveled as drivers versus those who mainly traveled as pedestrians. Statistical significance was established at $p < .05$. A total of 3808 adults completed the online survey. More drivers than pedestrians reported that pedestrian safety was an important problem (73 and 64%, respectively; $p < .001$). A large proportion of respondents incorrectly reported the existing state laws addressing right of way, fines, and enforcement, with significant differences between drivers and pedestrians ($p < .001$). Significantly more pedestrians than drivers supported changing traffic signals to increase crossing time ($p = .001$), while more drivers than pedestrians supported creating structures to prevent midblock crossing ($p = .003$). Effective interventions to improve pedestrian safety need to tailor messages for both drivers and pedestrians, increase awareness of the laws, and implement comprehensive strategies.

Keywords Pedestrian safety · Injury prevention · Health promotion · Formative research · Health communication

At the time of this research, Elizabeth D. Nesoff and Maryanne Bailey were affiliated with The Johns Hopkins Center for Injury Research and Policy.

✉ Elizabeth D. Nesoff
EN2408@columbia.edu

¹ Present Address: Department of Epidemiology, Columbia University Mailman School of Public Health, 722 W 168th St, 5th Floor, New York, NY 10032, USA

² Department of Health Policy and Management, Johns Hopkins Bloomberg School of Public Health, The Johns Hopkins Center for Injury Research and Policy, 624 N. Broadway, 5th Floor, Baltimore, MD 21205, USA

³ Present Address: Department of Nursing, The Johns Hopkins Hospital, 600 N. Wolfe St, Baltimore, MD 21287, USA

⁴ Department of Health, Johns Hopkins Bloomberg School of Public Health, Behavior, and Society, The Johns Hopkins Center for Injury Research and Policy, 624 N. Broadway, 7th Floor, Baltimore, MD 21205, USA

⁵ The Johns Hopkins Center for Injury Research and Policy, Baltimore, MD, USA

Introduction

In 2015, the U.S. Surgeon General issued a “Call to Action” to promote walking and walkable communities across the country [1], and numerous studies have documented how walking improves physical, mental, and emotional health [2–5]. At the same time, injuries and fatalities to pedestrians have steadily increased over the past decade. In 2015, 5376 pedestrians were killed—a 9.5% increase over 2014—and an estimated 70,000 were injured in the United States [6]. Over three-quarters of these fatalities occurred in urban areas [6].

The benefits of walking do not have to come at the expense of safety, and many pedestrian injuries are preventable. Comprehensive pedestrian safety interventions that include strategies that emphasize engineering, education, and enforcement (i.e., the “three Es” of injury prevention) can effectively improve pedestrian safety [7–9]. Understanding how the public views pedestrian safety can help to inform the development of targeted prevention strategies

that ultimately support national efforts to promote walking and walkable communities for everyone. Previous research has focused on attitudes towards walking itself and the environments where walking takes place [10–13]. There has been less research exploring community knowledge of, and beliefs about, pedestrian safety, including relevant laws and possible interventions. Knowing this information could help tailor community-level pedestrian safety interventions and serve as baseline measures for post-intervention evaluations.

As part of the formative research to create a multi-faceted intervention to address pedestrian safety on and around a large urban university medical center campus, we conducted a survey to determine the community's (1) knowledge of the applicable pedestrian-related laws; (2) beliefs about the importance of the problem and contributors to it; and (3) beliefs about the effectiveness of specific pedestrian safety interventions. We also explored differences between drivers and pedestrians and men and women, both of which could have important implications for prevention efforts.

Methods

This cross-sectional study occurred on an urban university medical center campus that includes three professional schools (medicine, nursing, public health) and a large hospital system ("the community"). As the campus is located in the center of a major mid-Atlantic city, multiple mode users travel the arteries that pass through the community. Estimated average daily vehicle volume in 2015 was approximately 28,720 [14].

In response to increasing incidents of pedestrian injuries among individuals affiliated with the university and hospital, a multidisciplinary task force was assembled consisting of university administrative leadership and employees from multiple divisions within the university and medical center. Other key stakeholders included representatives from the municipal department of transportation, the state motor vehicle administration, and the regional organization for transportation planning. Further details on the creation and implementation of the resulting health promotion campaign can be found in the campaign guide [15].

Sample

To reach potential respondents, the study team partnered with leadership from each of the schools on the campus, who in turn distributed the survey using multiple email distribution lists. The survey was also distributed through the campus community relations office so that individuals not affiliated with the university, but who lived in the surrounding areas, could have an opportunity to complete it. The researchers did not have access to the complete list of

names associated with each listserv, and potential respondents could be on multiple listservs (e.g., staff and student and community resident). To ensure anonymity—and because of the difficulty in matching email addresses across listservs—we did not track names or affiliations of participants who clicked on the link associated with each email. These constraints precluded calculating a completion rate for the survey. Based on the number of students and faculty, we estimate that at least 20,000 people received an email to complete the survey. Invitations were sent out at three time points from August 16, 2013, to September 7, 2013. Data were collected using the online survey tool Qualtrics.

If participants chose to click the link in the invitation, they were first asked if they were 18 years old or older; if not, they were directed to a message thanking them for their interest in the study. Upon completion of the survey, participants were offered the opportunity to enter a raffle for a free iPad. This research was approved by the Institutional Review Board at the Johns Hopkins Bloomberg School of Public Health.

Measures

The survey was developed by the study team after reviewing the existing literature for surveys exploring pedestrian behavior, attitudes, perceptions, subjective norms, and injury [16, 17]. We were guided by Fishbein and Ajzen's Theory of Planned Behavior to understand the behaviors of crossing against the light (for pedestrians) and turning right on red without stopping (for drivers) [18]; results from this portion of the survey are in preparation for publication elsewhere. While these analyses were informative for providing a theoretical understanding of specific pedestrian-related behaviors to be targeted in a safety campaign, it was important to also understand several other psychosocial characteristics of the campaign's target audience that could be helpful to developing interventions. Specifically, we sought to understand whether the audience was knowledgeable about pedestrian safety, what their beliefs were about the importance of the problem and contributors to it, and how effective they thought specific interventions would be in their community. Items to measure these constructs were created by the study team.

Knowledge of pedestrian- and driver-safety laws in Maryland were created using an informational handout developed by the area Metropolitan Planning Organization. Survey items included three true–false questions: "Pedestrians always have right of way in the crosswalk," "Pedestrians can be fined up to \$500 for jaywalking," and "Drivers can be ticketed for failing to stop for pedestrians." "Don't know" was also allowed as a response to these items.

To evaluate beliefs about the importance of the pedestrian safety problem, respondents were asked to rate "How

important a problem is pedestrian safety” around the university campus on a four-point Likert scale of very important to very unimportant. Responses to this question were recoded to a binary item of “important” versus “unimportant” for data analysis.

To evaluate beliefs about contributors to the problem, respondents were also asked to assess “who contributes the most to this problem,” with response options of “only drivers, mostly drivers, mostly pedestrians, only pedestrians, both drivers and pedestrians equally, or don’t know/no opinion.”

Respondents were also asked their beliefs about the effectiveness of a variety of engineering, enforcement, and educational strategies to improve pedestrian safety on and around the campus. Each item was assessed on a four-point Likert scale of “very effective” to “very ineffective.” Responses from these questions were collapsed to a binary scale of “Effective” (very effective and effective) and “Ineffective” (very ineffective and ineffective) for data analysis.

Respondents were asked to report their age, sex, university affiliation if any, frequency of driving on the campus, and whether they had ever been struck as a pedestrian or struck a pedestrian as a driver. Respondents were categorized as drivers or pedestrians by their response to the question: “Do you drive around East Baltimore, including the [medical center] campus?” Those who answered “no” would be considered pedestrians only; those who answered “yes” were considered drivers, although they could have also been pedestrians.

Data Analysis

To answer the study questions, we first present descriptive results for the entire sample. We then use Pearson Chi square Test of Independence to investigate differences in knowledge and beliefs between drivers and pedestrians, between male and female respondents, and between male and female drivers and male and female pedestrians. We performed post hoc testing on statistically significant measures with more than two categories to determine which cells contributed most to a statistically significant omnibus test by comparing the significance levels of adjusted standardized residuals for each cell to Bonferroni-corrected p-values [19, 20]. Analyses were performed using SPSS 20.

Results

Overall Sample

A total of 3902 respondents met the inclusion criteria. Because the number of non-university affiliates who completed the survey was only 77, we excluded these responses

and 17 missing responses for a final sample of 3808 participants. Of the 3808 respondents, over 80% ($n = 3079$) reported they drove to campus and were coded as “drivers” in subsequent analyses (Table 1). The average age of respondents was 40 years old, and 76.2% were women ($n = 2900$). Involvement in pedestrian-involved traffic accidents in any location was rare in this sample. Only 5.4% ($n = 205$) reported ever being struck by a motor vehicle, and < 2% ($n = 50$) had ever struck a pedestrian. Near misses, however, were more common. Approximately 35% ($n = 1329$) of the sample reported almost being struck by a car while walking, and 16% ($n = 623$) reported almost striking a pedestrian while driving.

Knowledge of Pedestrian Safety Laws

Of the three knowledge items, the highest percent correct response (84.9%, $n = 3232$) was seen for knowing that drivers could be ticketed for failing to stop for a pedestrian (Table 2). Only 48.2% ($n = 1836$) of respondents knew that pedestrians could be fined up to \$500 for jaywalking, and

Table 1 Description of survey sample ($n = 3808$)

Demographics	Mean (SD) or n (%)
Age	40 (13.3)
Sex	
Men	892 (23.4)
Women	2900 (76.2)
University affiliation	
Student	625 (16.4)
Employee	2833 (74.4)
Both	344 (9.0)
Do you drive around East Baltimore, including the [medical center] campus?	
Yes (coded as “Driver”)	3079 (80.9)
No (coded as “Pedestrian”)	729 (19.1)
Frequency of travel to East Baltimore	
Once a week or less	396 (10.4)
Two to three times a week	368 (9.7)
Four or more times a week	3036 (79.7)
Ever been struck by a vehicle when walking? ^a	
Yes, injured	75 (2.0)
Yes, not injured	130 (3.4)
No, but near miss	1329 (34.9)
No, never	2267 (59.5)
Ever struck a pedestrian when driving? ^a	
Yes, injured	17 (0.4)
Yes, not injured	33 (0.9)
No, but near miss	623 (16.4)
No, never	3125 (82.1)

^aLifetime

Table 2 Knowledge and beliefs about pedestrian safety among pedestrians compared to drivers (n = 3808)

	Total N (%)	Drivers N (%)	Pedestrians only N (%)	p-Value
Pedestrians always have right of way in crosswalk				< .0001
True	2404 (63.1)	1990 (64.6)	414 (56.8)	
False ^a	205 (5.4)	155 (5.0)	50 (6.9)	
Don't know	1199 (31.5)	934 (30.3) ^c	265 (36.4) ^c	
Pedestrians can be fined up to \$500 for jaywalking				.461
True ^a	1836 (48.2)	1499 (48.7)	337 (46.3)	
False	1856 (48.7)	1486 (48.3)	370 (50.8)	
Don't know	115 (3.0)	94 (3.1)	21 (2.9)	
Drivers can be ticketed for failing to stop for pedestrians				< .0001
True ^a	3232 (84.9)	2662 (86.5) ^c	570 (78.3) ^c	
False	524 (13.8)	378 (12.3) ^c	146 (20.1) ^c	
Don't know	51 (1.3)	39 (1.3)	12 (1.6)	
How important a problem is pedestrian safety in East Baltimore?				< .0001
Unimportant	1082 (28.4)	817 (26.6)	265 (36.4)	
Important	2723 (71.5)	2259 (73.4)	464 (63.6)	
Who contributes most to the problem?				< .0001^b
Only drivers	16 (0.4)	13 (0.4)	3 (0.4)	
Mostly drivers	497 (13.1)	376 (12.2) ^c	121 (16.6) ^c	
Mostly pedestrians	355 (9.3)	299 (9.7)	56 (7.7)	
Only pedestrians	0 (0)	0 (0)	0 (0)	
Both equally	2823 (74.1)	2309 (75.0)	514 (70.5)	
Don't know/no opinion	116 (3.0)	81 (2.6) ^c	35 (4.8) ^c	
How effective would each of the following be to improve pedestrian safety in East Baltimore?				
Changing traffic signals to give pedestrians more time to cross				.001
Ineffective	1505 (39.5)	1259 (41.0)	246 (34.0)	
Effective	2292 (60.2)	1814 (59.0)	478 (66.0)	
Police ticket drivers who don't yield to pedestrians				.446
Ineffective	891 (23.4)	713 (23.2)	178 (24.5)	
Effective	2910 (76.4)	2362 (76.8)	548 (75.5)	
Creating structure so that pedestrians can't cross in middle of block				.003
Ineffective	1377 (36.2)	1079 (35.1)	298 (41.1)	
Effective	2419 (63.5)	1992 (64.9)	427 (58.9)	
Communication campaign to educate pedestrians and drivers about traffic laws				.668
Ineffective	1964 (51.6)	1584 (51.5)	380 (52.4)	
Effective	1835 (48.2)	1490 (48.5)	345 (47.6)	
Communication campaign to educate pedestrians and drivers how to stay safe				.861
Ineffective	1681 (44.1)	1358 (44.2)	323 (44.6)	
Effective	2117 (55.6)	1715 (55.8)	402 (55.4)	
Having police ticket pedestrians who jaywalk				.001
Ineffective	1372 (36.0)	1071 (34.9)	301 (41.5)	
Effective	2424 (63.7)	2000 (65.1)	424 (58.5)	
Community leaders make statements about pedestrian safety				.800
Ineffective	2435 (63.9)	1973 (64.2)	462 (63.7)	
Effective	1362 (35.8)	1099 (35.8)	263 (36.3)	
University leaders make statements about pedestrian safety				.962
Ineffective	2376 (62.4)	1922 (62.5)	454 (62.6)	
Effective	1423 (37.4)	1152 (37.5)	271 (37.4)	

Bold values indicate statistical significance at $p < 0.05$

^aCorrect answer according to Maryland law

^bOne or more cells have expected count < 5

^cStatistically significant compared to Bonferroni-corrected p-value

only 5.4% ($n = 205$) knew that pedestrians do not always have the right of way in a crosswalk.

Knowledge about pedestrian safety laws varied between those who drove around campus and those who only walked (Table 2). There was a statistically significant difference in the proportion of responses to whether the statement “pedestrians always have the right of way” was true or false ($p < .0001$). Sixty-three percent of all respondents ($n = 2404$) incorrectly reported that pedestrians *always* have the right of way in a crosswalk, and only 5% ($n = 205$) selected the correct response. Over 30% ($n = 1199$) of all respondents did not know whether the statement was true or false, and 36% ($n = 265$) of pedestrians did not know. When asked if pedestrians could be fined for jaywalking (which was true in the state), half of the participants responded with the correct answer, while half did not. There was no statistically significant difference in the responses to this question between pedestrians and drivers ($p = .46$). There was a clearer consensus regarding penalties for drivers, with 85% ($n = 3232$) of the total sample and 87% ($n = 2662$) of drivers correctly reporting that drivers could be ticketed for failing to yield to pedestrians; slightly fewer pedestrians thought this was true ($n = 570$, 78.3%), and this difference was statistically significant ($p < .001$).

Beliefs About the Importance of the Problem and Contributors to It

Almost 72% ($n = 2723$) of all respondents said that pedestrian safety was an important problem on campus (Table 2). By mode, 73% of drivers ($n = 2259$) and 64% ($n = 464$) of pedestrians thought pedestrian safety was an important problem; this difference was statistically significant ($p < .001$). Significantly more women than men thought pedestrian safety was an important issue in the area, both among drivers ($p < .001$) and pedestrians ($p < .001$) (Table 3).

When asked if drivers or pedestrians were more responsible for the problem, almost three-quarters ($n = 2823$) of participants responded that both contributed equally to the problem. The second most common choice was “mostly drivers” ($p < .001$); both drivers and pedestrians alike shared this perspective.

Beliefs About Effectiveness of Interventions

Of the eight survey items on strategies to improve pedestrian safety, police ticketing drivers who do not yield to pedestrians was the most popular with 76.4% ($n = 2910$) of the total sample endorsing this intervention as effective (Table 2). Approximately two-thirds of respondents reported that creating structures to prevent midblock crossing, police ticketing jaywalkers, and changing traffic signals to increase crossing time were effective interventions to improve pedestrian

safety. About half of respondents considered communication campaigns for traffic laws or for safe crossing behavior effective, while two-thirds thought that university or community leaders making statements about pedestrian safety would be ineffective.

Significantly more pedestrians than drivers supported changing traffic signals to increase crossing time ($p = .001$), while more drivers than pedestrians supported creating structures to prevent midblock crossing ($p = .003$) (Table 2). Significantly more drivers also supported having police ticket jaywalkers ($p = .001$). Preference for interventions also varied by sex. Significantly more male drivers than female drivers thought communication campaigns of either type would be ineffective ($p < .001$), while significantly more female pedestrians thought a communication campaign to educate pedestrians and drivers how to stay safe would be effective compared to male pedestrians ($p = .021$) (Table 3).

Discussion

Based on recent epidemiologic trends indicating an increase in pedestrian-related traffic fatalities [6], improving pedestrian safety warrants continued focus. In this study, a majority of respondents from an urban environment were either unaware of pedestrian safety laws or misunderstood pedestrian safety laws. Only half correctly knew if pedestrians could be fined for jaywalking, and less than half knew that pedestrians do not always have the right of way. In contrast, almost 85% knew that drivers could be fined for failing to yield to pedestrians. These findings are supported by similar studies reporting that pedestrians and drivers often do not know pedestrian safety laws [21–23].

These findings support a need for more education on pedestrian safety laws. Determining how best to educate people on the laws is challenging. While driver education programs discuss pedestrian safety laws, new strategies are needed to reach the growing number of individuals, particularly among younger age groups, who do not obtain drivers licenses and do not participate in driver education programs [24]. There is an opportunity for health promotion campaigns to disseminate messages about the rules of roads, with messages specific for drivers and pedestrians.

Nearly three-fourths of our sample reported that pedestrian safety was an important problem in the community. The importance of this issue was reported by both individuals who drove and those who only walked, although more drivers than pedestrians perceived pedestrian safety to be an important problem. We could find no studies in the peer-reviewed literature that compared driver and pedestrian perceptions of the importance of pedestrian safety, which suggests a need for more research to understand if pedestrian safety is viewed as an important public health problem in

Table 3 Knowledge and beliefs about pedestrian safety among pedestrians compared to drivers stratified by sex (n = 3808)

	Men			Women			Men vs. women	
	Drivers N (%)	Pedestrians only N (%)	p-Value	Drivers N (%)	Pedestrians only N (%)	p-Value	Drivers p-value	Pedestrians p-value
Pedestrians always have right of way in crosswalk			.096			.001	.229	.657
True	447 (62.1)	93 (54.1)		1539 (65.5) ^c	316 (57.4) ^c			
False ^a	37 (5.1)	14 (8.1)		116 (4.9)	36 (6.5)			
Don't know	236 (32.8)	65 (37.8)		694 (29.5) ^c	199 (36.1) ^c			
Pedestrians can be fined up to \$500 for jaywalking			.997			.297	<.0001	.152
True ^a	295 (41.0)	71 (41.3)		1199 (51.0)	265 (48.2)			
False	396 (55.0)	94 (54.7)		1085 (46.2)	273 (49.6)			
Don't know	29 (4.0)	7 (4.1)		65 (2.8)	12 (2.2)			
Drivers can be ticketed for failing to stop for pedestrians			.295 ^b			<.0001	.034	.071
True ^a	636 (88.3)	145 (84.3)		2019 (86.0) ^c	420 (76.4) ^c			
False	71 (9.9)	24 (14.0)		304 (12.9) ^c	121 (22.0) ^c			
Don't know	13 (1.8)	3 (1.7)		26 (1.1)	9 (1.6)			
How important a problem is pedestrian safety in East Baltimore?			.079			<.0001	<.0001	<.0001
Unimportant	249 (34.6)	70 (40.7)		567 (24.2)	193 (35.0)			
Important	471 (65.4)	102 (59.3)		1779 (75.8)	358 (65.0)			
Who contributes most to the problem?			.076 ^b			.009 ^a	<.0001	.035
Only drivers	6 (0.8)	1 (0.6)		7 (0.3)	2 (0.4)			
Mostly drivers	110 (15.3)	40 (23.3)		264 (11.2)	78 (14.2)			
Mostly pedestrians	93 (12.9)	16 (9.3)		206 (8.8)	40 (7.3)			
Only pedestrians	0 (0)	0 (0)		0 (0)	0 (0)			
Both equally	485 (67.4)	106 (61.6)		1817 (77.4)	406 (73.7)			
Don't know/no opinion	26 (3.6)	9 (5.2)		54 (2.3) ^c	25 (4.5) ^c			
How effective would each of the following be to improve pedestrian safety in East Baltimore?								
Changing traffic signals to give pedestrians more time to cross			.046			.002	<.0001	.019
Ineffective	353 (49.0)	71 (41.5)		899 (38.4)	174 (31.8)			
Effective	367 (51.0)	100 (58.5)		1444 (61.6)	374 (68.2)			
Police ticket drivers who don't yield to pedestrians			.698			.462	.092	.420
Ineffective	183 (25.4)	46 (26.9)		525 (22.4)	131 (23.9)			
Effective	537 (74.6)	125 (73.1)		1820 (77.6)	418 (76.1)			

Table 3 (continued)

	Men			Women			Men vs. women	
	Drivers N (%)	Pedestrians only N (%)	p-Value	Drivers N (%)	Pedestrians only N (%)	p-Value	Drivers p-value	Pedestrians p-value
Creating structure so that pedestrians can't cross in middle of block			.011			.032	.853	.230
Ineffective	250 (34.8)	76 (44.7)		825 (35.2)	217 (39.5)			
Effective	468 (65.2)	94 (55.3)		1519 (64.8)	332 (60.5)			
Communication campaign to educate pedestrians & drivers about traffic laws			.340			.311	<.0001	.113
Ineffective	427 (59.4)	98 (57.3)		1151 (49.1)	276 (50.4)			
Effective	292 (40.6)	73 (42.7)		1194 (50.9)	272 (49.6)			
Communication campaign to educate pedestrians & drivers how to stay safe			.339			.359	<.0001	.021
Ineffective	390 (54.2)	89 (52.0)		961 (41.0)	230 (42.0)			
Effective	330 (45.8)	82 (48.0)		1382 (59.0)	318 (58.0)			
Having police ticket pedestrians who jaywalk			.011			.008	.002	.012
Ineffective	285 (39.6)	85 (49.7)		780 (33.3)	213 (38.9)			
Effective	434 (60.4)	86 (50.3)		1562 (66.7)	335 (61.1)			
Community leaders make statements about pedestrian safety			.352			.433	<.0001	.120
Ineffective	505 (70.2)	117 (68.4)		1461 (62.4)	339 (61.9)			
Effective	214 (29.8)	54 (31.6)		882 (37.6)	209 (38.1)			
University leaders make statements about pedestrian safety			.148			.306	<.0001	.446
Ineffective	499 (69.4)	111 (64.9)		1416 (60.4)	338 (61.7)			
Effective	220 (30.6)	60 (35.1)		929 (39.6)	210 (38.3)			

Bold values indicate statistical significance at $p < 0.05$

^aCorrect answer according to Maryland law

^bOne or more cells have expected count < 5

^cStatistically significant compared to Bonferroni-corrected p-value

other communities. For those planning interventions, it is beneficial that in this community at least, individuals are already aware of the issue and consider it important. With this knowledge, a resulting campaign in this community could bypass messaging that aims to convince people that pedestrian safety is a problem and move on to messaging that better targets specific behavior changes.

Most respondents said that pedestrians and drivers were equally responsible for pedestrian safety problems, and a

substantial proportion reported that driver behavior contributed most to the problem. This perspective was shared by both drivers and pedestrians. These opinions contradict several studies that show pedestrians are more often at fault for pedestrian-involved crashes than drivers [25–28]. Understanding how driver and pedestrian behavior affect injury risk is important for community-specific health promotion interventions that aim to change behavior. Messages can be appropriately tailored based on the perceptions of the target

audiences, and these data suggest that different messages should be developed for drivers and pedestrians.

Endorsement of strategies for improving pedestrian safety varied by respondent group. Significantly more pedestrians than drivers supported increasing crossing time at signalized intersections, while more drivers than pedestrians supported creating structures to prevent midblock crossing and police enforcement of jaywalking. In each case, the respondent endorsed a safety solution that would facilitate their own behavior. This suggests that perceived behavioral control (perceptions of the ease of performing some preventive behavior) [18] is important in influencing pedestrian safety-related behaviors of both drivers and pedestrians.

Respondents were relatively equally split on the perceived effectiveness of health education communication campaigns, regardless of whether it was to be focused on the relevant laws or on how to stay safe more generally. Although health education on its own may not change behavior, there is a wealth of evidence demonstrating the important role of education as part of comprehensive interventions [29–31]. Educating drivers and pedestrians, coupled with engineering changes and enforcement to reinforce behaviors, could create sustained behaviors that promote safe walking in urban settings.

Despite the insights gained from this study, there are some limitations. First, because of our inability to assemble a sampling frame, we cannot be sure that the entire population of potential respondents received our survey, thus raising possible issues of selection bias. Second, surveys often raise concerns about social desirability bias; however, this survey was focused on knowledge and opinions without an obvious correct answer, and not on the respondent's own safety-related behaviors. Finally, while we had a large number of responses to the survey, the generalizability of these findings to other populations is limited. Despite these limitations, these data reveal a new perspective and generate data relevant to other academic urban institutions visited by a large number of pedestrians and vehicles, which exist in many places across the United States.

Conclusions

Understanding how the public views pedestrian safety can help inform the development of tailored prevention strategies that support national efforts to promote walking and walkable communities. Our results suggest that substantial numbers of drivers and pedestrians view pedestrian safety as an important public health problem and value engineering, enforcement, and educational approaches to solutions. Effective interventions to improve pedestrian safety need to tailor messages for both drivers and pedestrians, increase awareness of the laws, and implement comprehensive strategies.

Acknowledgements The authors would like to thank the Maryland Highway Safety Office (MHSO), Johns Hopkins University, and the Baltimore Metropolitan Council (BMC) for providing funding and resources. Additional thanks are extended to survey participants; Bala Akundi at BMC; Ernie Lehr at MHSO; Mark Beisser, graphics designer from the Johns Hopkins Center for Communication Programs; Sue Baker, Eileen McDonald, Jim Williams, Nasir Mohd Ismail, Basant Motawi, and Xia Ma from the Johns Hopkins Center for Injury Research and Policy.

Funding Funding for this work was made possible through multiple sources: Maryland Highway Safety Office; the Johns Hopkins University; and a Grant from the National Center for Injury Control and Prevention, Centers for Disease Control and Prevention (Grant Number 1R49CE002466).

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no conflict of interest.

References

1. U.S. Department of Health & Human Services. (2015). *Step it up! The surgeon general's call to action to promote walking and walkable communities*. Washington, D. C. Retrieved from <http://www.surgeongeneral.gov/library/calls/walking-and-walkable-communities/call-to-action-walking-and-walkable-communities.pdf>.
2. Hamer, M., & Chida, Y. (2008). Walking and primary prevention: A meta-analysis of prospective cohort studies. *British Journal of Sports Medicine*, 42(4), 238–243.
3. Robertson, R., Robertson, A., Jepson, R., & Maxwell, M. (2012). Walking for depression or depressive symptoms: A systematic review and meta-analysis. *Mental Health and Physical Activity*, 5(1), 66–75.
4. Murphy, M. H., Nevill, A. M., Murtagh, E. M., & Holder, R. L. (2007). The effect of walking on fitness, fatness and resting blood pressure: A meta-analysis of randomised, controlled trials. *Preventive Medicine*, 44(5), 377–385.
5. Roe, J., & Aspinall, P. (2011). The restorative benefits of walking in urban and rural settings in adults with good and poor mental health. *Health & Place*, 17(1), 103–113.
6. National Center for Statistics and Analysis. (2017). *Pedestrians: 2015 data (traffic safety facts. Report No. DOT HS 812 375)*. U.S. Department of Transportation. Washington, D.C.: National Highway Traffic Safety Administration.
7. Sleet, D. A., Pollack, K. M., Rivara, F., Frattaroli, S., & Peek-Asa, C. (2010). It wouldn't hurt to walk: Promoting pedestrian injury research. *Injury Prevention*, 16(3), 211–212.
8. Pollack, K. M., Kercher, C., Frattaroli, S., Peek-Asa, C., Sleet, D. A., & Rivara, F. P. (2012). Toward environments and policies that promote injury-free active living—It wouldn't hurt. *Health & Place*, 18(1), 106–114.
9. Martin-Diener, E., Brügger, O., & Martin, B. (2010). *Physical activity promotion and injury prevention: Relationship in sports and other forms of physical activity*. Berne. Retrieved from http://www.bfu.ch/sites/assets/Shop/bfu_2.068.08_bfu-report_no.64%25E2%2580%2593PhysicalActivityPromotionandInjuryPrevention.pdf.
10. Lorenc, T., Brunton, G., Oliver, S., Oliver, K., & Oakley, A. (2008). Attitudes to walking and cycling among children, young

- people and parents: A systematic review. *Journal of Epidemiology and Community Health*, 62(10), 852–857. <https://doi.org/10.1136/jech.2007.070250>.
11. Blacksher, E., & Lovasi, G. S. (2012). Place-focused physical activity research, human agency, and social justice in public health: Taking agency seriously in studies of the built environment. *Health and Place*. <https://doi.org/10.1016/j.healthplace.2011.08.019>.
 12. Rossen, L. M., Pollack, K. M., Curriero, F. C., Shields, T. M., Smart, M. J., Furr-Holden, C. D. M., & Cooley-Strickland, M. (2011). Neighborhood incivilities, perceived neighborhood safety, and walking to school among urban-dwelling children. *Journal of Physical Activity & Health*, 8(2), 262–271.
 13. Sisiopiku, V., & Akin, D. (2003). Pedestrian behaviors at and perceptions towards various pedestrian facilities: An examination based on observation and survey data. *Transportation Research Part F*, 6(4), 249–274.
 14. Maryland State Highway Administration. (n.d.). GIS Traffic count data. Traffic monitoring system. Retrieved June 24, 2016, from <http://www.roads.maryland.gov/Index.aspx?PageId=251>.
 15. Johns Hopkins Center for Injury Research and Policy. (2015). *Be alert, don't get hurt: A pedestrian safety campaign on an urban, academic campus*. Baltimore, Maryland. Retrieved from https://www.jhsph.edu/research/centers-and-institutes/johns-hopkins-center-for-injury-research-and-policy/_docs/materials/pedestrian-safety-campaign/pedestrian-safety-brochure.pdf.
 16. Granié, M.-A., Pannetier, M., & Guého, L. (2013). Developing a self-reporting method to measure pedestrian behaviors at all ages. *Accident Analysis & Prevention*, 50, 830–839. <https://doi.org/10.1016/j.aap.2012.07.009>.
 17. Zhou, R., Horrey, W. J., & Yu, R. (2009). The effect of conformity tendency on pedestrians' road-crossing intentions in China: An application of the theory of planned behavior. *Accident Analysis & Prevention*, 41(3), 491–497.
 18. Ajzen, I. (1991). The theory of planned behavior. *Organizational Behavior and Human Decision Processes*, 50(2), 179–211.
 19. Beasley, T. M., & Schumacker, R. E. (1995). Multiple regression approach to analyzing contingency tables: Post Hoc and planned comparison procedures. *Journal of Experimental Education*, 64, 79–93.
 20. García-pérez, M. A., & Núñez-antón, V. (2003). Cellwise residual analysis in two-way contingency tables. *Educational and Psychological Measurement*, 63(5), 825–839.
 21. Sarkar, S., & Andreas, M. (2004). Drivers' perception of pedestrians' rights and walking environments. *Transportation Research Record*, 1878, 75–82. <https://doi.org/10.3141/1878-10>.
 22. Mitman, M., & Ragland, D. (2007). Crosswalk confusion: More evidence why pedestrian and driver knowledge of the vehicle code should not be assumed. *Transportation Research Record*, 2002, 55–63. <https://doi.org/10.3141/2002-07>.
 23. Hebert Martinez, K. L., & Porter, B. E. (2004). The likelihood of becoming a pedestrian fatality and drivers' knowledge of pedestrian rights and responsibilities in the Commonwealth of Virginia. *Transportation Research Part F: Traffic Psychology and Behaviour*, 7(1), 43–58. <https://doi.org/10.1016/j.trf.2003.11.001>.
 24. Sivak, M., & Schoettle, B. (2011). Recent changes in the age composition of U.S. drivers: Implications for the extent, safety, and environmental consequences of personal transportation. *Traffic Injury Prevention*, 12(6), 588–592. <https://doi.org/10.1080/15389588.2011.605817>.
 25. Lee, C., & Abdel-Aty, M. (2005). Comprehensive analysis of vehicle-pedestrian crashes at intersections in Florida. *Accident Analysis & Prevention*, 37(4), 775–786.
 26. Preusser, D. F., Wells, J. K., Williams, A. F., & Weinstein, H. B. (2002). Pedestrian crashes in Washington, D.C., and Baltimore. *Accident Analysis & Prevention*, 34(5), 703–710.
 27. Kim, J.-K., Ulfarsson, G. F., Shankar, V. N., & Kim, S. (2008). Age and pedestrian injury severity in motor-vehicle crashes: A heteroskedastic logit analysis. *Accident Analysis & Prevention*, 40(5), 1695–1702.
 28. Ulfarsson, G. F., Kim, S., & Booth, K. M. (2010). Analyzing fault in pedestrian–motor vehicle crashes in North Carolina. *Accident Analysis & Prevention*, 42(6), 1805–1813.
 29. Gielen, A. C., & Sleet, D. A. (2003). Application of behavior-change theories and methods to injury prevention. *Epidemiologic Reviews*, 25(1), 65–76.
 30. Frieden, T. R. (2010). A framework for public health action: The health impact pyramid. *American Journal of Public Health*, 100(4), 590–595. <https://doi.org/10.2105/AJPH.2009.185652>.
 31. Gielen, A. C., & Green, L. W. (2015). The impact of policy, environmental, and educational interventions: A synthesis of the evidence from two public health success stories. *Health Education & Behavior*, 42(1 Suppl), 20S–34S.