ORIGINAL ARTICLE

Risk perception, road behavior, and pedestrian injury among adolescent students in Kathmandu, Nepal

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Objective: To examine the relationship between the perceived safety of specified road behaviors, self-described road behaviors, and pedestrian injury among adolescent students in Kathmandu, Nepal.
Methods: A cross-sectional study was conducted among 1557 adolescents in grades 6–8 across 14 schools in Kathmandu using a self-administered questionnaire in 2003. A multiple logistic regression analysis was used to analyze the data.
Results: Adolescents were more likely to suffer from pedestrian injury when they did not always ''wait for green signals to cross the road''. There were no significant associations between road behaviors such as ''looking both ways along the road before crossing'' or ''playing in the road or sidewalks'' and pedestrian injury. Adolescents who ''perceived it safe to cross the road from any point'' or ''did not perceive it to be safer to cross the road at a zebra crossing'' were less likely to ''look both ways'' or ''wait for green signals'' before crossing the road. Adolescents who ''perceived it to be safe to play in the road'' were more likely to play in the road or sidewalk. Similarly, this study showed a positive association between road safety education and adolescents' road crossing behaviors.
Conclusion: Adolescents' road behaviors, except for compliance with green signals, were not significantly associated with pedestrian injury. This suggests that a behavioral approach without modification of the traffic environment (such as provision of crossing signals) might not effectively prevent the occurrence of pedestrian injury in developing countries with poor traffic conditions.

Adolescents show different risky behaviors around the road. Such behaviors might put them at risk of pedestrian injury. Te Velde *et al*[1] reported that adolescents spend no more time waiting on the curb before crossing than do young children. They are often seen running across the road instead of walking[2] and do not check for oncoming traffic[2 3] forcing traffic to change its trajectory.[3] Moreover, Joly *et al*[4] reported that one third of adolescents who were injured crossing the street had disobeyed pedestrian traffic rules. Another study found that most injured adolescents routinely use the streets and sidewalks as play areas.[5] However, the role of adolescents' road behaviors in pedestrian injury has not been investigated.

Road crossing, a typical road behavior, is not an easy task in developing countries. The roads in such countries have limited pedestrian facilities and have heavy mixed traffic traveling at different speeds.[6 7] This complex road environment complicates the judgment needed to cross the road safely, as humans cannot visually track more than four objects at a time.[8] Thus, we investigated whether adolescents' road behaviors are associated with their risk of pedestrian injury.

Theoretically, adolescents' perceptions of road safety behavior can affect their road behaviors. This follows from the health belief model.[9 10] People are more likely to engage in healthy behaviors if they perceive (*a*) a threat to health and (*b*) that treatment or taking preventive measures will be effective. On the basis of this model, we would expect that the perceived safety of one's behavior around roads would affect road behavior, which could indirectly influence pedestrian injury. However, this indirect relationship has received little attention in injury prevention research.

Previous research on risk perception has focused on perception towards the causes of injuries among children and adults. Children aged 8–10 years believe that bad luck results in injuries,[11] whereas people aged 15 and above perceive that driver intoxication and recklessness are the leading causes of traffic injuries.[12 13]

In Nepal, children and adolescents are vulnerable to pedestrian injury. One hospital-based study revealed that 94% of children and adolescents (0–15 years) were dead due to pedestrian injury of total traffic deaths of that age group. In another hospital-based study, adolescents (12–18 years) accounted for 49% of the total number of road traffic injuries among children and adolescents (0–18 years), and 51% of the road traffic injuries were to pedestrians.[15] Beyond these studies, little is known about pedestrian injuries in Nepal.

Therefore, we examined the relationship between perceived safety of specific road behaviors, self-described road behaviors, and pedestrian injury among adolescent students in Kathmandu, Nepal.

METHODS

The study procedures have been reported in detail elsewhere.[16 17] This study was conducted in 14 of 30 program schools of World Vision International in two (Kathmandu and Lalitpur) of the three districts of Kathmandu Valley. All students in grades 6–8 who were present on the survey date were included in the study.

Data were collected using a pre-tested questionnaire in the classroom, anonymously and independently. The questionnaire covered injury episodes, road behaviors, road safety perception, attitudes towards injury prevention, road safety education, and sociodemographic variables. It was developed on the basis of published literature.[18 19] The research committee of the Institute of Medicine, Tribuvan University, Nepal, approved the study.

For this study, pedestrian injury was defined as injury that occurred as a result of being hit by any type of vehicle while on the road, regardless of where the collision took place. This study included injuries that resulted from being hit by a vehicle while performing any kind of activities on the road such as crossing,

Table 1 Bivariate and multivariate logistic regression analysis of predictor variables of pedestrian injury (n = 1557)

Characteristic	Total	Number injured	Unadjusted OR	95% CI	Adjusted OR	95% CI
Sex						
Male	725	215 (29.7)	2.04	1.61 to 2.60	1.98	1.52 to 2.58
Female	832	142 (17.1)				
Residence						
Urban	216	81 (37.5)	2.31	1.70 to 3.14	2.32	1.65 to 3.26
Semi-urban	1341	276 (20.6)				
Television ownership						
No	186	57 (30.6)	1.58	1.13 to 2.21	1.44	0.99 to 2.08
Yes	1371	300 (21.9)				
Distance to school						
More than 10 min	828	205 (24.7)	1.25	0.98 to 1.58	1.26	0.96 to 1.66
Up to 10 min	729	152 (20.9)				
Road crossing for school						
One or more crossing	858	227 (26.4)	1.57	1.23 to 2.01	1.52	1.15 to 2.01
No crossing	699	130 (18.6)				
Father's education*						
Illiterate	169	49 (29.0)	1.44	1.01 to 2.06	1.35	0.92 to 1.99
Literate	1304	288 (22.1)				
Mother's occupation*						
Housewife	1254	265 (21.1)	0.61	0.46 to 0.82	0.69	0.50 to 0.95
Some employment	290	88 (30.3)				
Looking both ways before crossing road						
Not always†	633	162 (25.6)	1.28	1.01 to 1.63	1.19	0.91 to 1.57
Always	924	195 (21.1)				
Waiting for green signal before crossing a road						
Not always†	877	214 (24.4)	1.41	1.10 to 1.80	1.51	1.14 to 1.99
Always	680	139 (20.4)				
Playing in the road						
Ever‡	534	141 (26.4)	1.34	1.05 to 1.71	1.10	0.82 to 1.49
Never	1023	216 (21.1)				
Playing on the sidewalk						
Ever‡	758	203 (26.8)	1.53	1.20 to 1.94	1.25	0.94 to 1.66
Never	799	154 (19.3)				

Values in parentheses are percentages.
*Participants whose fathers or mothers had died have been excluded.
†The category ''not always'' included responses from ''never'' to ''frequently''.
‡The category ''ever'' included responses from ''rarely'' to ''always''.

walking, or playing. Injuries were excluded if they occurred during travel in any type of vehicle or when getting on or off or in or out of the vehicle. Participants in the study area were not injured when using equipment such as wheelchairs or rollerblades as roads in the study area do not have facilities that would allow the use of such equipment.

We included injuries that limited school participation for at least 1 h, because the more typical 1-day limitation criterion can miss minor injuries. For example, adolescent students are likely to sustain a pedestrian injury when they are away from school for lunch.[4 20] Students who are injured during this time are likely to return to school the following day, having rested overnight, unless the injury is very severe. We chose to include only injury episodes that occurred in the 3 months preceding the survey—that is, we used a short recall period (1–3 months) as recommended by previous studies.[21 22] We considered only one injury per participant, whichever had the most notable effect on school participation.

Road behaviors were evaluated with four questions: how frequently did participants (*a*) look both ways before crossing roads, (*b*) wait for a green signal before crossing the road, (*c*) play in the road, and (*d*) play on the sidewalk. Those who had not encountered zebra crossings (n = 10) or green signals (n = 73) were excluded from the analysis of specific questions. Within the Kathmandu and Lalitpur districts, 14 intersections have traffic lights and 72 intersections have zebra crossings. The participants indicated the frequency of performing these behaviors on a five-point Likert scale ranging from 1 (never) to 5 (always). These responses were recoded dichotomously: ''always'' for road crossing and ''never'' for road playing behaviors, versus all other responses. This is because we defined ''safe behavior'' for road crossing as always looking both ways or always waiting for a green signal before crossing the road, and for road playing as never playing in the road or on the sidewalk. These responses were categorized as ''always'' and ''not always'' for road crossing and ''never'' and ''ever'' for road playing behaviors.

Adolescents' perception of road safety behavior was measured with four questions: how safe did participants think it was to (*a*) cross the road from any point, (*b*) cross in relatively little traffic (fewer cars), (*c*) cross at a zebra crossing, and (*d*) play on the road? Attitudes towards road traffic injury prevention were measured with one question: can road traffic injury be prevented? The five-point Likert-scale responses were re-coded into either ''not at all'' for perceived road safety and ''not at all'' to ''moderately'' for attitudes, versus all other responses. Then, these responses were categorized into dichotomous ''no'' and ''yes'' to reduce the influence of random error.

Road safety education was measured with three questions: how often had participants' parents, teachers, and friends talked to them about how to cross the road safely? The textbooks of grades 6–8 in Nepal do not include safety education. The five-point Likert-scale responses were re-coded into ''quite often'' or ''very frequently'' versus all other responses. Then, these responses were

Table 2 Multiple logistics regression analysis for factors associated with pedestrian injury, stratified by sex

	Female (n = 742)		Male (n = 653)	
Characteristic	**Adjusted OR**	**95% CI**	**Adjusted OR**	**95% CI**
Residence				
Urban	1.86	1.13 to 3.05	3.09	1.89 to 5.05
Semi-urban				
Television ownership				
No	1.15	0.63 to 2.12	1.78	1.09 to 2.89
Yes				
Distance to school				
More than 10 min	1.43	0.95 to 2.17	1.14	0.78 to 1.65
Up to 10 min				
Road crossing for school				
One or more crossing	2.00	1.32 to 3.02	1.19	0.82 to 1.75
No crossing				
Father's education*				
Illiterate	1.28	0.72 to 2.29	1.48	0.87 to 2.53
Literate				
Mother's occupation*				
Housewife	0.75	0.45 to 1.23	0.66	0.43 to 1.01
Some employment				
Looking both ways before crossing road				
Not always†	1.01	0.67 to 1.53	1.39	0.96 to 2.01
Always				
Waiting for green signals to cross the road				
Not always†	1.74	1.12 to 2.69	1.41	0.97 to 2.05
Always				
Playing in the road				
Ever‡	0.97	0.60 to 1.56	1.25	0.85 to 1.85
Never				
Playing on the sidewalk				
Ever‡	1.32	0.86 to 2.04	1.19	0.81 to 1.75
Never				

*Participants whose father or mother had died have been excluded.
†The category ''not always'' included responses from ''never'' to ''frequently''.
‡The category ''ever'' included responses from ''rarely'' to ''always''.

categorized into ''frequently'' and ''not frequently'' to reduce the influence of random error.

For data analysis, we used multiple logistic regression analysis to examine the relationship between road behaviors and pedestrian injury including sociodemographic characteristics, which were significantly associated with pedestrian injury in the bivariate analysis. We added distance to school to the model, as it is known to be a risk factor for pedestrian injury.[23] The multicollinearity test was performed to assess possible collinearity among covariates. We used SPSS software V11.0 (SPSS Inc, Chicago, Illinois, USA) for analysis.

RESULTS

The mean (SD) age of the 1557 participants was 13.8 (1.3) years. The proportion of boys and girls was nearly equal. A more detailed description of the participants has been published elsewhere.[16 17]

Factors associated with pedestrian injury

The sociodemographic factors that were significantly associated with pedestrian injury included: being male, residing in an urban area, not having a television at home, crossing one or more roads on the way to school, and having illiterate fathers or housewife mothers (table 1).

Regarding road behaviors, participants who acknowledged that they ''do not always look both ways'' or ''do not always wait for green signals'' to cross the road were more likely to sustain a pedestrian injury than participants who claimed that they always ''look both ways'' or ''wait for green signals''. Participants who played in the road or on the sidewalk were more likely to sustain a pedestrian injury than those who never played in the road or on the sidewalk.

In the multiple logistic regression analysis, the adolescents who did not always ''wait for green signals'' to cross the road were more likely to have a pedestrian injury than those who waited for a green light. Similarly, male adolescents, adolescents who ''reside in urban areas'' and ''who cross one or more roads on their way to their school'' were more likely to incur a pedestrian injury than their respective counterparts.

In the stratified analysis by gender, female adolescents were more likely to have a pedestrian injury when they ''resided in urban areas,'' ''crossed one or more roads on their way to school,'' and when they ''did not always wait for green signals to cross the road'' (table 2). Similarly, male adolescents were more likely to have a pedestrian injury if they ''resided in urban areas'' and ''did not have television at home'', than their respective counterparts. Although the difference was not statistically significant, male adolescents ''who do not always wait for green signals'' to cross the road were more likely to sustain a pedestrian injury than those ''who always wait for green signals.''

Road safety perception, education, attitudes towards road traffic injury prevention, and road crossing behaviors

When adjusted by gender, the participants who perceived it to be ''safe to cross the road at any point'' were less likely to ''look both ways'' or ''wait for green signals'' before crossing the road (table 3). The result was the same for the participants who did not perceive it to be ''safer to cross at zebra crossings''. The participants who were less frequently educated on road crossing by their parents were less likely to ''look both ways'' or ''wait for green signals'' before crossing. The participants who think that ''road traffic injury is not preventable'' were

Table 3 Relation between road safety perception, education, attitudes to road traffic injury prevention, and road crossing behaviors, adjusted by gender (n = 1557)

	Looking both ways before crossing road (less frequently)			Waiting for green signals before cross the road (less frequently)		
	Total	%	Adjusted OR (95% CI)	Total	%	Adjusted OR (95% CI)
Road safety perception						
Perceived safety of crossing road from any point						
Yes*	820	47.1	1.55 (1.24 to 1.94)	777	64.9	2.30 (1.84 to 2.89)
No	737	33.5		707	42.2	
Perceived safety of crossing road from relatively less traffic						
Yes†	912	41.8	1.00 (0.79 to 1.25)	862	58.0	1.11 (0.88 to 1.39)
No‡	645	39.1		622	48.9	
Perceived safety of crossing road at zebra crossing§						
Yes	575	26.3	2.52 (2.01 to 3.17)	554	44.9	1.60 (1.28 to 2.00)
No¶	972	49.1		923	59.6	
Education on safe road crossing						
Education by parents						
Less frequently**	546	47.4	1.49 (1.19 to 1.86)	513	62.0	1.53 (1.21 to 1.92)
Frequently††	1011	37.0		971	50.1	
Education by teachers						
Less frequently**	689	41.8	0.92 (0.74 to 1.15)	648	59.0	1.23 (0.99 to 1.54)
Frequently††	868	39.7		836	50.5	
Interaction with friends						
Less frequently**	1023	43.8	1.39 (1.11 to 1.75)	967	57.8	1.37 (1.09 to 1.72)
Frequently††	534	34.6		517	47.4	
Attitudes to road traffic injury prevention						
Road traffic injury can be preventable						
Yes‡‡	584	34.2	1.54 (1.24 to 1.90)	558	48.2	1.48 (1.20 to 1.83)
No**	973	44.5		926	57.8	

*The category ''yes'' included responses from ''a little bit'' to ''always''.
†The category ''yes'' included responses from ''moderately'' to ''always''.
‡The category ''no'' included response of ''not at all'' or ''a little bit''.
§Those who were unfamiliar with zebra crossings have been excluded.
¶The category ''no'' included responses from ''quite a bit'' to ''not at all''.
**The category ''less frequently'' and ''no'' included responses from ''moderately'' to ''not at all''.
††The category ''frequently'' included response of ''quite often'' or ''frequently''.
‡‡The category ''yes'' included responses of ''quite a bit'' or ''always''.

more likely to cross the road without ''looking both ways'' or ''waiting for green signals''.

Road safety perception, attitudes towards road traffic injury prevention, and road playing behaviors

When adjusted by gender, the participants who perceived it to be ''safe to play on the road'' were more likely to play on the road or sidewalk (table 4). Likewise, the participants who think that ''road traffic injury is not preventable'' were more likely to play on the road or sidewalk.

DISCUSSION

The study shows a weak association between adolescents' road behaviors and pedestrian injury in the bivariate analysis. In the

Table 4 Relation between road safety perception, attitudes to road traffic injury prevention, and road playing behaviors, adjusted by gender (n = 1557)

	Playing in the road (ever)			Playing on the sidewalk (ever)		
	Total	%	Adjusted OR (95% CI)	Total	%	Adjusted OR (95% CI)
Road safety perception						
Perceived safe to play on the road						
Yes*	615	50.9	3.22 (2.58 to 4.01)	615	66.8	3.30 (2.65 to 4.09)
No	942	23.5		942	36.8	
Attitudes to road traffic injury prevention						
Road traffic injury can be preventable						
Yes†	584	24.8	2.01 (1.60 to 2.53)	584	40.9	1.64 (1.33 to 2.03)
No‡	973	40.0		973	53.3	

*The category ''yes'' included responses from ''a little bit'' to ''always''.
†The category ''yes'' included responses of ''quite a bit'' or ''always''.
‡The category ''no'' included responses from ''moderately'' to ''not at all''.

multivariate analysis, we found that this weak association did not yield significant results, except for compliance with green signals, because of small reductions in odds ratios of behaviors.

In adolescents, the behavior ''looking both ways before crossing roads'' was not significantly associated with their risk of pedestrian injury. This could be due to the difficulty of judging when to cross the mixed-traffic roads of Kathmandu Valley, which have limited crossing facilities.[24] In Kathmandu Valley, only 72 intersections have zebra crossings and they are often discolored, in our observation. As a result, people typically cross the roads wherever they like, as observed in Pakistan.[3]

Adolescents' habit of playing in the road was not significantly associated with their risk of pedestrian injury. During our field observation, we noticed that adolescents commonly play on the side roads near their homes or schools, where motor vehicles pass frequently. Most such roads in Kathmandu Valley are muddy[25] and unpaved or marred with potholes.[24] Playing in such roads might not increase the risk of pedestrian injuries, as the poor road conditions result in slower vehicle speeds, making pedestrians much safer.[7]

In contrast, adolescents' compliance with green signals was significantly associated with their low risk of pedestrian injury. This suggests that safety behaviors alone cannot reduce risk without appropriate traffic environments. It is possible that green signals help adolescents to make road-crossing judgments more easily. The result thus supports the system-oriented approach, which questions over-reliance on education and aims to reduce crashes by designing a traffic environment with behavioral limitations in mind.[7 26]

Our study showed a positive association between road safety perception and road behaviors, and attitudes toward road traffic injury prevention and road behaviors. This result suggests that safety education programs can improve the safety behaviors of adolescents. However, as discussed above, we found a lack of association between adolescents' road behaviors and their pedestrian injuries. This suggests that safety education programs alone might not be effective in preventing pedestrian injuries.

In this study, we found a gender difference in the relationship between the number of roads that adolescents must cross en route to school and their risk of pedestrian injuries. This difference might be due to gender differences in road behaviors. Girls are significantly slower than boys in crossing the road.[27 28] They are also less active than boys.[29] The longer they take to cross, the longer they are exposed to risk.

Some limitations of the study should be noted. Firstly, as the survey relies on self-reported road behavior, there might be concern about measurement validity. However, Stevenson[30] found no significant difference between children's reported exposure to the road environment and either observed exposure or exposure reported in pedestrian diaries. If adolescents over-report safe road behavior, the extent is likely to be similar for all participants and unlikely to bias study results.

Secondly, we considered only one injury per participant that had limited school activity for at least 1 h. The recall of injuries that only interfered with their participation in school for a few hours might diminish over the 3-month period. However, we believed that such recall bias would be less in this study. This is because rates of injuries that cause the loss of a school day show higher stability throughout recall periods from 1 to 12 months.[21] In addition, studies have recommended shorter recall periods of 1–3 months in surveys of non-fatal injuries.[21 22]

Thirdly, our study might have underestimated the effects of behaviors on injury as injury experience can improve some adolescents' behaviors. However, it is unlikely to distort the results, as boys are more likely to repeat the injury risk behavior even if they had previously been injured performing the activity.[11]

Finally, this study used a convenience sample to select the school adolescents residing in the marginalized areas. However, the traffic situation in the study sites is not very different from other areas of Kathmandu Valley. Thus, the exposure to risk as pedestrians may not be very different for other adolescent populations living in Kathmandu Valley.

Despite such limitations, we have incorporated several aspects of the phenomenon under study such as road behaviors, perceptions of road safety, attitudes towards injury prevention, and road safety education by reviewing the literature to ensure content validity. Moreover, our results, such as a positive association between perception and behavior, and education and behavior, confirm theoretical concepts of the entity under study, which might ensure construct validity.[31]

Implications for prevention

This study suggests that a behavior approach without modifying the traffic environment (such as providing more signaled crossings) might not effectively reduce pedestrian injury risk in developing countries with poor traffic conditions. The 10th plan of Nepal (2002–2007) identified the need of constructing road infrastructure but it did not mention road safety specifically. This study result, therefore, will be useful in encouraging the Nepalese government to install more traffic signals. Simultaneously, education by schoolteachers and parents should aim to improve adolescents' safety perceptions and attitudes, as improved perceptions and attitudes in this study were associated with increased compliance with green signals.

Key points

- Adolescents who ''perceived it to be safe to cross the road from any point'' or ''did not perceive it to be safer to cross the road at a zebra crossing'' were less likely to ''look both ways'' or ''wait for green signals'' before crossing the road.
- Adolescents who ''perceived it to be safe to play in the road'' were more likely to play in the road or sidewalk.
- Adolescents' road crossing or playing behaviors, except for compliance with green signals, were not significantly associated with their risk of pedestrian injury.
- Adolescents who did not always ''wait for green signals to cross the road'' were more likely to sustain a pedestrian injury.

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Greece puts brakes on its racy billboards

According to Greek authorities, up to 10% of traffic crashes are caused by drivers distracted by billboards, and the nation's courts are trying to do something about it. Giant billboards that feature nude or scantily-clad models, and others that are designed to look like official road signs distract and confuse drivers. Billboards commonly block road signs and traffic lights, and many are illegal, resulting from bribes by advertising agencies to planning authorities. An estimated 15 000 illegal billboards can be found in the Athens area alone. Athanasios Tsokos, an Athens lawyer, is suing the country for the death of his son in a crash allegedly caused by a provocative roadside advertisement. Earlier this year, an Athens court upheld Tsokos' claim that the Greek government was obliged to keep the road sides clear of illegal signs. Local councils are being ordered to enforce the law curtailing billboards. Motorways in Greece are becoming safer, ostensibly because the country's drivers are taking care of their many new cars, but it is believed that the opening of new roads has invited more illegal billboards.

From *The Times* (London, UK). Contributed by Anara Guard.