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Original Article

Hit-and-runs more common with pedestrians lying on the road: Analysis of a nationwide database in Japan

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ABSTRACT

Purpose: To determine the trends with fatally or otherwise injured pedestrians lying on the road and the relationship to hit-and-run incidents in Japan.
Methods: We extracted data for 2012–2016 from the records of the Institute for Traffic Accident Research and Data Analysis, Japan, a nationwide traffic accident database. All the injured and fatally injured pedestrians were selected. We examined the levels of pedestrian injury, vehicle speed immediately before the collision, whether or not the pedestrian was lying on the road, and hit-and-run incidents. Chi-square test was employed to make a statistical comparison between the two groups.
Results: The database contained data on 286,383 pedestrian casualties and 7256 fatalities; 8.3% of fatalities (602 persons) and 0.6% of casualties (1827 persons) involved pedestrians lying on the road. The rates of fatalities and severe injuries were significantly higher for pedestrians who were lying on the road than for those who were not. Hit-and-run incidents were evident in 4.0% of casualties and 7.3% of fatalities. The rate of hit-and-run cases was also significantly higher among pedestrians who were lying on the road. Among fatally injured pedestrians not lying on the road, the rates with speeds of ≥30 km/h did not differ significantly between hit-and-run and other cases. However, when the pedestrians were lying on the road, the rate was significantly increased in hit-and-run cases.
Conclusion: This is the first report to focus on pedestrians lying on the road and being involved in hit-and-run incidents. In addition to preventing hit-and-run incidents, prevention of pedestrians lying on the road could also decrease fatalities.

Introduction

Road traffic injuries are a major public health issue. According to the World Health Organization, the number of road traffic death continues to climb, having reached as high as 1.35 million worldwide in 2016.[1] The overwhelming majority of traffic deaths and injuries involve vulnerable road users, such as pedestrians and bicyclists. Especially for pedestrians, the fatalities accounted for 23% of all road users' deaths because most roads do not have separate lanes or adequate crossing for pedestrians and allow a high speed for motor vehicles in many countries.[1] Particularly in low- or middle-income countries, pedestrians have been considered as a high-risk group among road users.[2] Therefore, greater efforts by all countries are recommended to decrease the pedestrian fatalities. The value of setting a target to improve the road safety performance was acknowledged in the Paris-based Organisation for Economic Co-operation and Development report, Safety on the Road, in 2002.[3] Target-setting is recommended for all countries attempting to reduce road fatalities. In Japan, the government established the Traffic Safety Measures Basic Law in 1970. With this law, the Traffic Safety Basic Plan set goals for every 5 years from 1971; traffic safety measures were promoted comprehensively and systemically. The essential goal is to achieve a society with no traffic accidents. For the period 2011–2015, the target was fewer than 3000 fatalities and 700,000 casualties. The goal for casualties was achieved by the end of 2015 (670,140); however, the goal for fatalities was not (4117). In 2016, the government established a new set of objectives to reduce the number of fatalities to under 2500

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and casualties to under 500,000 by 2020. These goals necessitate the ongoing elimination of traffic fatalities in Japan.

In Japan in 2018, the most common element in traffic fatalities was pedestrians, accounting for 35.6%, which increased from 28.0% in 2000.[4] This figure in Japan differs from that in other developed countries: it is greater than the proportion in France and the United States (16.1% each), Germany (15.4%), and Sweden (15.6%).[5] To reduce traffic fatalities and achieve the objectives of the Traffic Safety Basic Plan in Japan, more in-depth investigations of vehicle-pedestrian collisions are required.

For pedestrian fatalities, some victims had been lying on the road and suffered from the accident. In these types of accident, hit-and-run incidents are often occurred. However, there have been no comprehensive reports about traffic accidents involving pedestrians who are lying on the road.

The Institute for Traffic Accident Research and Data Analysis (ITARDA), Japan maintains a huge, all-inclusive database of traffic accidents using data provided by Japan's National Police Agency (NPA). Investigation on accidents in great detail at ITARDA aids in establishing preventive measures or revising previous official guidelines. In the cases of vehicle-pedestrian collisions, details of the kinematics of pedestrians were widely distributed. As a result, the classification related to the pedestrian's action was revised in 2012: subsequently, the situation of a pedestrian who was "lying on the road" appeared on the ITARDA database. Hitherto, however, a detailed investigation about such pedestrians (lying on the road) has not been undertaken.

To provide a better understanding of the trends associated with fatally or otherwise injured pedestrians lying on the road in the context of hit-and-run accidents, we analyzed the nationwide traffic accident data in Japan.

Methods

We extracted data from ITARDA records. Founded in 1992, ITARDA contributes to reducing road traffic accidents and casualties through research and analysis of such accidents with respect to human factors, vehicular factors, and the road traffic environment. A unique feature of Japan's traffic accidents data is that without exception, the police investigate all fatal and injury traffic accident cases and record all cases.

Using this database, we chose vehicle-pedestrian collisions during 2012–2016. We examined the following items:

(1) Injury levels

According to the diagnosis of medical doctors, the pedestrians' injury levels were classified as death, severe injury, or mild injury. Death was defined as the pedestrian died within 24 h of the accident. The injured pedestrian that needs a treatment of $\geq$30 days was defined as severe and that treated <30 days as mild injury.

(2) Vehicle speed

In each case, we examined the vehicle speed immediately before the collision. The vehicle speed had been determined by the police.

(3) Lying on the road

We investigated the action of the pedestrian immediately before the accident. Pedestrians' actions in vehicle-pedestrian collisions were classified as follows: walking in the same direction as the vehicle was travelling; walking in the opposite direction; crossing the road; playing on the road; working on the road; standing on the road; lying on the road, and others. We then decided whether or not the victim had been lying on the road.

(4) Hit-and-run incidents

We determined whether or not the accident was a hit-and-run case. We defined such a case as follows: the driver of the offending vehicle escaped after striking the pedestrian without offering any aid.

Chi-square test was employed to make a statistical comparison between the two groups, and data were analyzed by using the Statcel 3 for Windows (CMS, Saitama, Japan). A p value less than 0.05 was considered statistically significant.

This study was performed with the approval of the NPA. The draft of the manuscript was also reviewed by the NPA, and we received their permission for submission (April 26, 2019).

Results

Lying on the road

During the 5-year period, the database registered contained 286,383 pedestrian casualties (44,784 severe injuries, 234,343 mild injuries) and 7256 fatalities; 8.3% of fatalities (602 persons) and 0.6% of casualties (1827 persons) involved pedestrians who had been lying on the road. Among the non-fatalities, pedestrians lying on the road accounted for 1.3% of severe injuries (563 persons) and 0.3% of mild injuries (662 persons). The fatality rate (number of deaths/numbers of casualties) and severely injured rate (number of severely injured/number of casualties) for pedestrians lying on the road were 33.0% and 30.8%, respectively. The rates of fatalities and severe injuries were significantly higher for pedestrians who had been lying on the road than for those who had not (33.0% versus 2.3%, 30.8% versus 15.5%, respectively, $p < 0.001$).

We compared the distribution of the collision speed between cases where the pedestrians had been lying on the road and those who had not with respect to the levels of injuries. In both groups, the distribution showed a similar pattern: in fatal cases, there was a peak with the vehicle speed of 41–50 km/h; in severely injured cases, the peak was a vehicle speed of $\leq$10 km/h or 11–20 km/h, gradually decreasing with an increasing speed; in mildly injured cases, the peak was a speed of $\leq$10 km/h, dramatically decreasing with an increasing speed (Figs. 1–3).

Hit-and-run cases

Hit-and-run incidents were evident in 11,387 persons, accounting for 4.0% of all casualties and 7.3% of fatal incidents. Hit-and-run incidents were significantly higher among pedestrians who were lying on the road than those who were not in fatal (27.1% versus 5.5%, $p < 0.001$), severely injured (16.0% versus 3.0%, $p < 0.001$), and mildly injured (10.1% versus 4.0%, $p < 0.001$) cases (Fig. 4).

We dichotomized vehicle speed as $\geq$30 km/h or less. We examined cases where the collision speed was $\geq$30 km/h in terms of the pedestrians lying on the road and in hit-and-run incidents (Table 1). Among fatally injured pedestrians not lying on the road, we observed no significant difference between hit-and-run cases and others with respect to the speed being $\geq$30 km/h. However, with pedestrians lying on the road, the rates significantly increased in hit-and-run cases. When pedestrians were not lying on the road, hit-and-run cases were significantly higher with non-fatal incidents ($p < 0.001$).

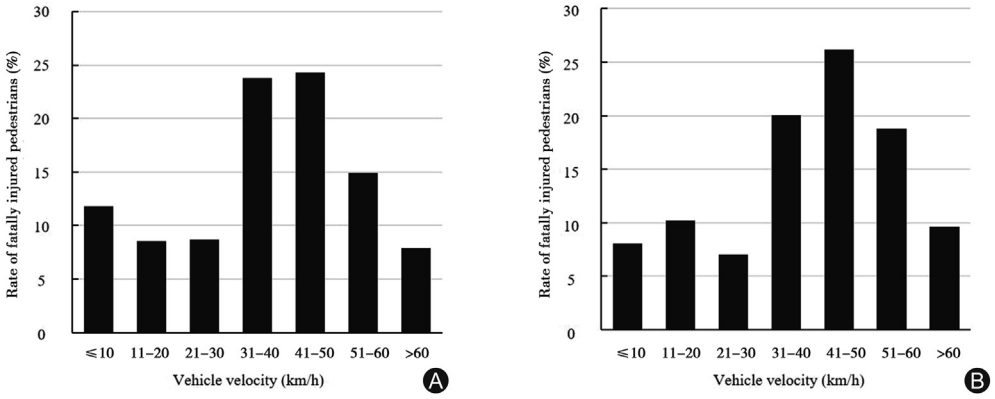

Fig. 1. Distribution of fatally injured pedestrians lying on the road (A) or not (B) at different vehicle speed immediately before the collision.

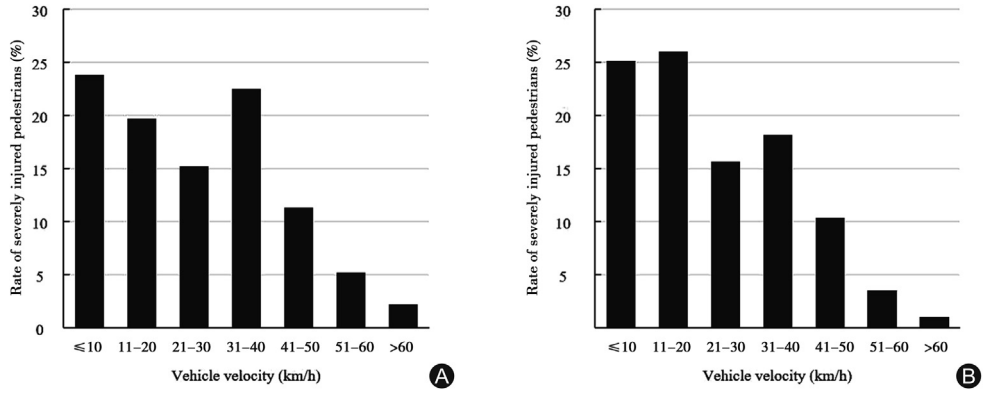

Fig. 2. Distribution of severely injured pedestrians lying on the road (A) or not (B) at different vehicle speed immediately before the collision.

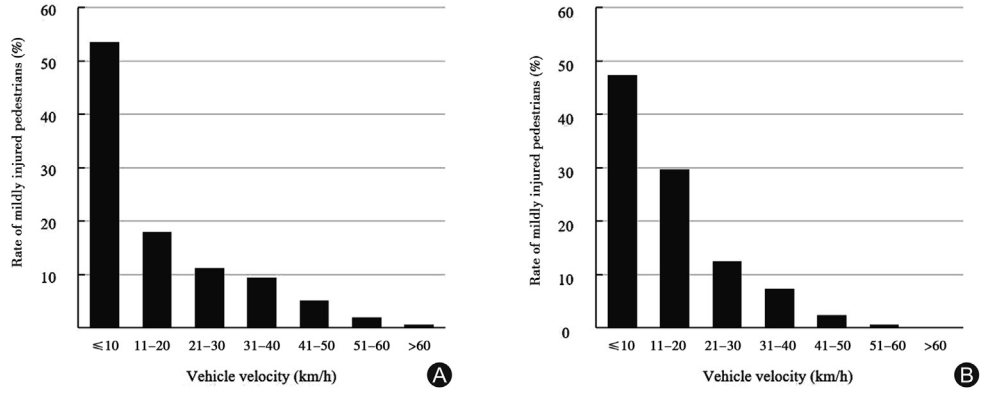

Fig. 3. Distribution of mildly injured pedestrians lying on the road (A) or not (B) at different vehicle speed immediately before the collision.

Discussion

In Japan, police investigations always include on-the-scene examinations and collection of medical information about the victims; thus, an investigation about collisions in which pedestrians had been lying on the road before the accident could be performed using the ITARDA database. The data employed in the present study are not widely available and could be examined only with the permission of the NPA. To our knowledge, there are no other comprehensive reports about vehicle collisions involving pedestrians lying on the road. The relationship between such collisions and hit-and-run incidents has also not previously been examined. Therefore, this is the first report to focus on pedestrians lying on the road and being involved in hit-and-run incidents.

First, we determined that among the vehicle-pedestrian collisions, 0.6% of casualties and 8.3% of fatalities involved pedestrians who had been lying on the road. Reducing pedestrian fatalities is vital in preventing traffic fatalities, so it is necessary to make efforts to prevent such collisions. In addition to hit-and-run incidents, collisions involving low-speed vehicles are a serious problem.[6] In Australia, accidents caused by low-speed vehicles are the second-largest cause of death after pool drowning among unintentional

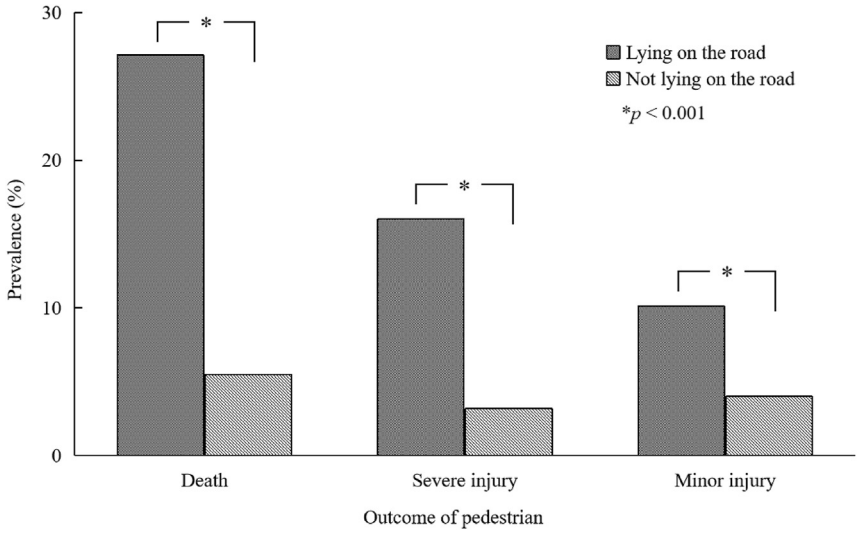

Fig. 4. Prevalence of hit-and-run cases between pedestrians lying on the road and not.

Table 1
The rates (%) of cases with the vehicle velocity immediately before collision of ≥30 km/h according to the occurrence of lying on the road or hit-and-run.

Outcome	Lying on the road			Not lying on the road		
	Hit-and run	Not hit-and run	*p* value	Hit-and run	Not hit-and run	*p* value
Death	84.6	71.0	0.001	74.7	74.7	0.993
Severe injury	63.9	38.0	<0.001	56.8	32.7	<0.001
Minor injury	39.3	16.2	0.002	19.3	10.0	<0.001

injuries for children aged 1–4 years.[7] Thus, further in-depth analysis of collisions involving pedestrians lying on the road is required.

Next, we found that the rates of fatalities and severe injuries were significantly higher for pedestrians who were lying on the road than among those who were not. In both groups, the distribution of the collision speed showed similar patterns. Accordingly, the higher rates of fatalities and severe injuries depended on differences in the kinematics of the pedestrian at the time of collision. Recent developments in vehicle safety measures have contributed to the prevention of pedestrian fatalities. According to a study based on real-world accident data for pedestrians crossing the road, the frequency of fatalities and serious injuries was less than 5% and 27%, respectively, when the incident involved sedan-type vehicles travelling at 30 km/h.[8] If the pedestrian was hit by the centre of the front end of a sedan or light passenger vehicle, the frequency decreased further. According to an analysis using a finite element model, the frequency of severe injuries when the collision involved the centre of a sedan or light passenger vehicle was 5.0% and 4.0%, respectively.[9] Therefore, pedestrians crossing a road would be less likely to be severely injured or suffer fatal injuries than ones who are lying on the road. We were surprised that although the victims had been lying on the road and been involved in collisions, some of them suffered only minor injuries. However, addressing that problem using the comprehensive data in the present study would be difficult. In future, in-depth investigations should be conducted, involving detailed information, such as the road environment, victim's age and stature, primary injuries, type of offending vehicle, vehicle speed, and part of the vehicle causing the injury.

For severely and mildly injured pedestrians, the prevalence was markedly decreased when increasing the collision speed for cases both lying on the road or not. Especially for mildly injured pedestrians, nearly half of them were included in a collision speed of <10 km/h for both cases. Therefore, decreasing the collision speed would contribute to reduced injury severity of the pedestrians even if they are lying on the road.

In the present study, we observed the hit-and-run cases among 4.0% of casualties and 7.3% of fatalities. Those data are similar to previous results obtained approximately 10 years earlier in Japan.[10] The hit-and-run proportion in Japan is lower than in the United States (18.1% of fatalities) and Ghana (7.7% of casualties).[11,12]

Our study suggests that hit-and-run cases occurred more frequently when the pedestrians were lying on the road than not. That trend was also more evident among fatal or severely injured cases. Furthermore, in fatal cases, a vehicle speed of ≥30 km/h was higher in hit-and-run cases than in other incidents when the pedestrians were lying on the road. However, we did not observe that trend in cases when pedestrians were not lying on the road. It was previously found that a driver who perceived that the victim was dead or severely injured might be more likely to leave the accident scene.[10] Aideo et al.[13] also found that drivers were more likely to leave fatally injured pedestrians. Our results are thus well in accordance with those findings.

Previous studies have found that drivers were more likely to leave an accident scene in situations where they recognized a lower probability of being witnessed, when accidents occurred in the early morning, when there were no accompanying passengers, when they lacked a valid licence, when they were drunk, and in the case of younger drivers.[10,11,14] In addition to both driver and pedestrian characteristics, the effect of road and environment characteristics, such as lighting and road surface conditions, may contribute to hit-and-run tendencies. In some fatal hit-and-run accidents, the victim died as a result of the driver leaving the pedestrian at the scene of the accident. In addition to death as a result of the primary collision or being run over, there are cases of later death due to failure to receive immediate trauma care or being struck again by another vehicle. Therefore, preventing hit-and-run

cases can decrease pedestrian fatality. The effectiveness of increasing the number of checkpoints for drunk driving and driving without a licence has been confirmed.[15] Our results also suggest that preventing pedestrians from lying on the road might be effective. Future investigations should examine the situation in which pedestrians come to be lying on the road (i.e. with respect to area and time) to identify such individuals and save them from harm.

This study has some limitations. First, it was performed with the approval of the NPA, and the data are limited. Other data, such as information about the drivers and victims and the accident sites, were not included. However, this is the first study to focus on pedestrians lying on the road and being involved in hit-and-run incidents. Thus, we obtained novel results. Second, this study was based on information from the national database of the ITARDA, i.e. macro-data, and detailed information about each accident was not examined. Therefore, we could not undertake a multivariate analysis using detailed information, such as about the road environment, the victims, and the type and characteristics of the offending vehicles. Accordingly, an in-depth investigation collecting above detailed information, i.e. micro-data, is required in future.

To reduce the incidence of this type of accident, first, the education to aware the risk of lying on the road is required. Both in developed and developing countries, lying on the road should be prevented through proper education with current results. Next, as the variety kinds of warning system for drivers have been considered, the development of the safety system detecting lying person on the road and avoiding the collision would be expected. We believe that the results of this study could be useful for health care providers, researchers and engineers who are trying to reduce vehicle collisions.

Funding

Nil.

Ethical statement

This study was performed with the approval of the National Police Agency (NPA), Japan. The draft of the manuscript was also reviewed by the NPA and permitted for submission at April 26, 2019.

Declaration of competing interest

The authors declare that they have no conflicts of interest.

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