Investigation of Pedestrian Accidents and Primary Impact of Injury in Sub-Himalayan Area of Himachal Pradesh

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***Abstract**: Traffic related pedestrian injuries are a growing public health threat all over the world. When a vehicle strikes with any individual it causes injury. Severity of the injury depends upon the force of collision between the two. The shape and size of different vehicles are different so the impact of injury will be different. The findings of this study are mostly confined to hilly areas of Himachal Pradesh. The findings of this study show maximum number of pedestrian RTA (road side accidents) are not on weekends in contrary of earlier studies. On studying the impact from the body of victim we can tell the type of vehicle. It has great importance in forensic science and for the investigating team of the accident. It will ease the work of investigating officer and the forensic examiner. The present study will help in improving the knowledge of injury according to the impact. This study helps in understanding the cause of accidents and different preventing measures to avoid accidents. Senior citizens are mostly affected in pedestrian injury in our study. According to union transport ministry 62 pedestrian die daily in India.*

Keywords: RTA, primary impact, secondary impact, anti-slip technology, pedestrian

1. Introduction:

According to WHO report, 2015 nearly 1.2 million deaths have accounted due to traffic accidents all over the world and about 22% of road traffic accidents are consist of pedestrian but in some countries mostly developing and poor countries pedestrian fatalities are even more up to 67% (WHO, 2013). Every year more than 270,000 pedestrian die all over the world. In developed countries the rate of pedestrian casualties is decreasing [1] owing to the programs going on for the safety measures, but in developing nations the population growth is a major issue so the investments in other safety issues are in miserable conditions. Hence in developing countries the programs are more restricted towards improving roads making new highways and to improve safety operations for controlling traffic, little focus towards pedestrian safety. A substantial effort is required to identify the risk and plans to avoid pedestrian causalities in developing nations.

India accounts to have 1% of vehicle's present in the world. But 6% in road traffic accidents. In most of the cases the cause of accident is human error. According to Ministry of Road Transport & Highways Government of India, Road accidents continue to be a leading cause of death, disabilities and hospitalization in the country despite commitment and efforts. India ranks first in the number of road accident deaths across the 199 countries and accounts for almost 11% of the accident-related deaths in the World as per the WHO Global Report. A total of 4,49,002 road accidents have been reported by States and Union Territories (UTs) in the calendar year 2019, claiming 1,51,113 lives and causing injuries to 4,51,361 persons.

In recent years in India the attention for pedestrian safety is increasing and Transportation ministry is evaluating the cause and research is going on pedestrian risk management [2] [3]. But still in cities of

India where pedestrian fatalities rates are as high as 40% to 80% in records [4]. Although in cities pedestrian density are high but the infrastructure is often not present. The basic requirements like crosswalk, zebra crossing, traffic signals and adequate side walk facility is still lacking in most of the parts. Hence both the vehicle owner and pedestrian are sharing same road space for their daily requirement resulting in accident. It is also to be noted that behavior of pedestrian is also not disciplined every time, tendency to avoid traffic rules leads to accident. According to Ministry of Road Transport & Highways Government of India, fatalities rate per million of population has raised in most of the part of India except in north east part and union territories [5]. The study further reveals that increase was 300% to 40% in Himachal Pradesh, West Bengal, Rajasthan and Karnataka. Although Himachal Pradesh records less in terms of road traffic accidents but the number is of huge concern in terms of accident rate per thousand vehicles registered in state. Infrastructures present in metropolitan cities and villages are very different the life of people living there is different so is the case of road networks.

Most of the studies are done on metropolitan cities no study is earlier done on any state of India where majority of population lives in village. To achieve this aim, our study primarily focuses on the area covering town and villages.

The aim of this paper is to identify the risk factors associated with pedestrian accidents in hilly areas, to find out the role of weather and time on the number of pedestrian casualties. To study the primary impact of injury, severity of injury so that a set of directions can be suggested to avoid these accidents in future. In this study the focus is on the accidents involving single vehicle and pedestrians. There is a gap in studies where researches are focused on pedestrian accidents. In most of the cases the driver flew away after the accident as there is less probability of any injury to the driver as compare to pedestrian. This study will also help in filling the gap by providing knowledge of sub-Himalayan state first time. India is versatile in terms of its geographic area so it is important to do more studies from different geographical regions to overcome the biasness related to pedestrian accidents.

To study our aim the pedestrian accident record of year 2020 is taken of two districts of HP. The rest of the article is organized as follow- Literature review, Objectives, Data and Methodology, Geographical details of the area, Result, Conclusions and measures to avoid pedestrian accidents.

1.1 Literature Review:

Studies in past shows the importance of traffic and volume of pedestrian in pedestrian causalities [6], [7],[8]. Other studies also reveal the role of socio-economic status of the pedestrian in crash [9], [10], [11],[12]. Risk taking behavior of the pedestrian such as violation of traffic rules jumping or crossing in red light [13],[14],[15],[16] and risk-taking perception mainly by younger generation and mostly males are the main cause of pedestrian causalities [17], [18], [19]. Past researchers also shows that pedestrian is not using safety measures like crosswalks and thus developing risk during crossing [20]. Age is also an important variable in relation to behavior of pedestrian as with time speed, decision making ability and lower perception rate account for fatal injury in senior citizens [21]. In relation of road user pedestrian are called as vulnerable user and for their safety governments are paying attention. 2- Wheeler like motorcycle have great power in relation to its weight and thus morbidity and mortality are high due to lack of body structure in comparison to other vehicles. Most of the user of 2-wheeler are young people due to its cost effectivity so loss is great for any nation. The European Parliament in 2003 has forced automobile industry to design vehicles which will be more friendly with pedestrian and avoid fatal injuries during collision [22]. A study conducted shows the role of various factor in hit and run cases at California [23].

Limited researches are done in India in relation to pedestrian safety. Most of the studies are done in developed nations and the demographic area, drivers, road design are relevantly different as compare to India. In India also the studies which are conducted are done on metropolitan cities not in remote area or villages of India, where network of roads is not very strong and in case of hilly areas roads have curves and turns which are not there in metropolitan cities. There remains a significant research gap where a scientific approach is required to study the need, requirement of pedestrians crash fatalities and injuries in sub-Himalayan region of India. Further this study attempts to reveal the variable responsible pedestrian crashes and that can be helpful for the authorities to control pedestrian fatalities. Primary impact of injury may help in revealing the culprits as seen in most of the cases the driver run away from the crime scene and pedestrian are always not in the condition to note-down the details.

1.2 OBJECTIVE OF STUDY:

1: To find out which vehicle are most involved in hitting pedestrian people.

2: To know the primary impact of injury on the victim that is between victim and the vehicle.

3: To know at what time of day, day of the week road accident occur.

4: To suggest measures to reduce the road accidents in the Hilly region.

2. Data and Methodology:

This study is conducted in Himachal Pradesh a sub-Himalayan region of India. The material and data for the study has been collected from main police stations located at district Hamirpur and through RTI act 2005, for district Kangra. Details of injuries are provided by the department of police and from the department of forensic medicine, department of casualty located at govt. medical college Hamirpur and Kangra. Data is recorded in MS Excel 2019 and applying statical analysis table and charts are generated. Although number of accidents recorded at these police station is not a big numerical number it may be due the lock down of the state in result of COVID -19 pandemic in year 2020 but the percentage of pedestrian injuries is high.

2.1 Geographical details of the area:

Himachal Pradesh is hilly area. Topography of the state is dominant by mountains and hills with the total population of 6,85,6509 (census 2011) with 90% of the population living in villages [24]. Himachal Pradesh is a northern state of India. It experiences a pleasant climate throughout the year. There is great variation in climate due to variation in elevation. Winter season is the longest season as compare to summer and rainy in Himachal.

Our study is based on two districts of Himachal Pradesh that is Hamirpur and Kangra. District Hamirpur is located at south-west part of the state surrounded by shivalik range of hills between 76º 18′ to 76º 44’ East Longitudes and 31º 25′ to 31º 52′ North Latitude. It is the smallest district of the state. District Kangra is located at the southern cliff of Himalayas. lies between 31˚ 21′ to 32˚ 59′ N latitude and 75˚ 47′ 55″ to 77˚ 45′ E longitude.

According to census of India 2011

District	Hamirpur	Kangra
Area	1,118 Km^2	5,739 Km^2
Density	407 per Km^2	263 per Km^2
Population	454,768	1,510,075

Road accident in HP

Source: Police Department, HP/Deptt. Road Tpt. And Highways (HP)

Year	Road Accident	Killed	Injured
2015-16	3168	1271	5764
2016-17	3114	1203	5452
2017-18	3110	1208	5551
2018-19	2873	1146	4904
2019-20 (OCT 2020)	1791	671	2520

2.2 TYPES OF VEHICLES:

According to Regional Transport Authority (RTA) or Regional Transport Office (RTO). Motor vehicles are categorised into three major categories like LIGHT MOTOR VEHICLE, HEAVY MOTOR VEHICLE, HEAVY PASSENGER MOTOR VEHICLE OR HEAVY TRANSPORT VEHICLES. So, in our study we categorised vehicles as LMV (light motor vehicle), HMV (heavy motor vehicle) and 2- Wheeler (motorcycles with or without gear).

2.3 Primary Impact of Injury:

Traffic accidents occur all over the world. One of the main reasons for this is increase in population and simultaneously in the number of vehicles. In 2019 almost three million new car registrations were recorded in the country. Traffic Accident- It can be taken as event resulting in injury or death of a person, where at least one moving vehicle is involved. Injury- In general term refers to harm caused by any accident, hits, weapons and more. Injury can be divided in two main categories. 1: Impact injury 2: Penetrating injury

Impact injuries are typically caused when a part of person's body hit by the part of vehicle. Penetrating injuries are like cuts and scrapes. Injury patterns vary depending on the age, gender and socioeconomic statis of the individual. Children, older adults and those of lower socioeconomic status are most affected. The burden of injury on the individual their family and society are frequently devastating.

3. Result:

Figure 1 shows that age group 55-64 is the most affected group (n=12/63, 27%) followed by senior citizens(table 1) who are 65 or above (n=12/63, 19%). Age group 10-19 least affected contributing 1.6%. study also shows that males are more affected in crashes then females (table 2)males are 69.8%affected. Same result is observed in other studies also [25] (fontaine and gourlet 1997).The study also reveals that the major contributor to pedestrian collision is the LMV(n=36/63, 57.1%) users(table3) although the proportion of the 2-wheeler is also high as compare to HMV (n=8/63, 12.7%). Personal car is the most involved type of vehicle in LMV. In winter season most of the pedestrian RTA (road traffic accident) happened 49.2% and 25.4% (table 4) from September to November. Friday (table 5) accounts for the highest number of pedestrian accidents followed by Monday and least on Saturday (table 6). 36.5% of accidents occur in the evening (6 pm to 11:59 pm). During crossing of the road highest pedestrians' crashes occur and least while roadside (table7). 9 cases out of 63 pedestrian RTA results in death of the pedestrian while in 85.7% pedestrian injured. District Hamirpur shows 29.2% of pedestrian crashes as compare to District Kangra. LMV and then HMV accounts for most of the death in the districts . In our study death rate is not as high as seen in metropolitan cities as speed of the vehicle is less in Himachal due to the structure of road which are not as good as there in cities and the population density in the cities are more.

In the cases we studied we find that lower extremities were the most often injured body part. The primary impact depends upon the shape size height of the bumper it also depends upon position and height of the victim. In case of motorcycles the primary impact of injury area is tibia fibula that is on lower leg. Primary impact of lmv is most commonly involved knees and lower leg. But when height of the bumper increased like in the case of pickup van and SUV's the primary impact was seen on femur. But the fatal injuries in our study seen only in heavy motor vehicle (truck, bus and crane). In Pickup van (lmv) the primary impact was on pelvis along with femur (visible deformity of pelvic bone and compound fracture of femur). In case of HMV the primary impact involved chest and abdomen mostly which cause the fractures of rib cage and contusions and lacerations in internal organs like liver heart lungs kidney intestine and spleen.

Figure 1: Age wise distribution of pedestrian RTA cases (n=63)

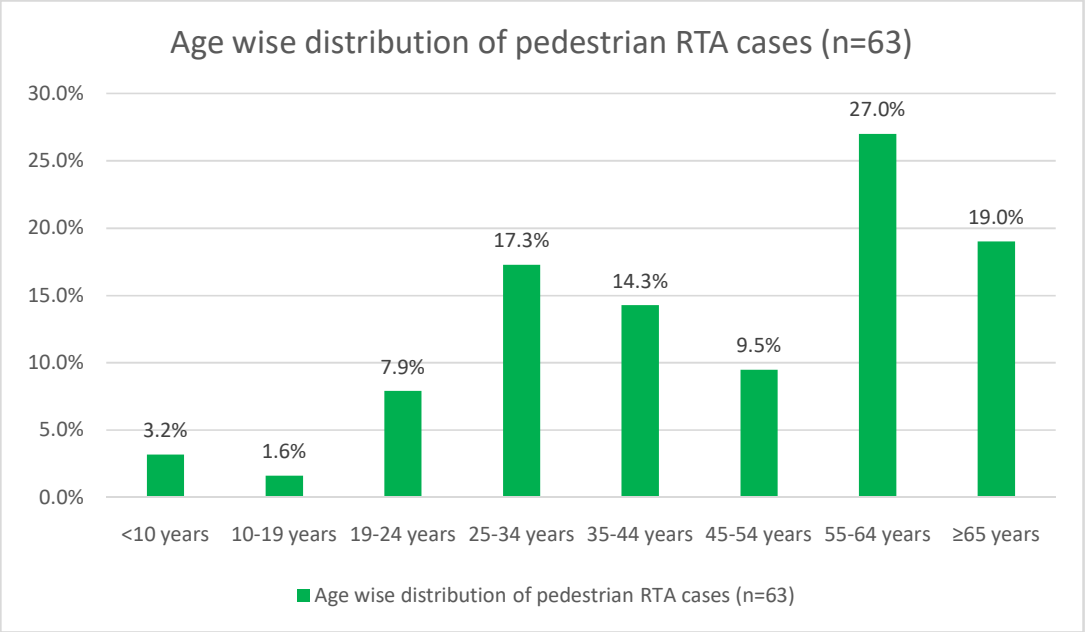

Table 1: Age wise distribution of pedestrian RTA cases (n=63)

Age group (in years)	Frequency	Percentage
<10 years	2	3.2
10-19 years	1	1.6
19-24 years	5	7.9
25-34 years	11	17.5
35-44 years	9	14.3
45-54 years	6	9.5
55-64 years	17	27.0
≥65 years	12	19.0
Total	63	100

Table 2: Gender wise distribution of pedestrian RTA cases (n=63)

Gender	Frequency	Percentage
Male	44	69.8
Female	19	30.2
Total	63	100

Table 3: Type of vehicle involved in pedestrian RTAcases (n=63)

Type of Vehicle	Hamirpur district (n=33)		Kangra district (n=30)		Total (n=63)	
	No.	%	No.	%	No.	%
Two Wheeler	10	30.3	9	30.0	19	30.1
LMV	17	51.5	19	63.3	36	57.1
HMV	6	18.2	2	6.7	8	12.7

Table 4: Seasonal distribution of pedestrian RTAcases (n=63)

Season	Hamirpur district (n=33)		Kangra district (n=30)		Total (n=63)	
	No.	%	No.	%	No.	%
Summer (June to Aug)	8	24.2	7	26.7	15	23.8
Autumn (Sep to Nov)	7	21.2	9	30.0	16	25.4
Winter (Dec to Feb)	18	54.5	13	43.3	31	49.2
Spring (Mar to May)	0	0.0	1	3.3	1	1.6

Table 5: Day wise distribution of pedestrian RTAcases (n=63)

Day	Hamirpur district (n=33)		Kangra district (n=30)		Total (n=63)	
	No.	%	No.	%	No.	%
Monday	4	12.1	7	23.3	11	17.5
Tuesday	5	15.2	4	13.3	9	14.3
Wednesday	9	27.3	1	3.3	10	15.9
Thursday	3	9.1	3	10.0	6	9.5
Friday	8	24.2	5	16.7	13	20.6
Saturday	1	3.0	3	10.0	4	6.3
Sunday	3	9.1	7	23.3	10	15.9

Table 6: Timing of pedestrian RTAduring accident (n=63)

Timing of accident	Hamirpur district (n=33)		Kangra district (n=30)		Total (n=63)	
	No.	%	No.	%	No.	%
Midnight (12:00 AM to 6:00 AM)	1	3.1	3	10.0	4	6.3
Morning (6:01 AM to 11:59 AM)	9	27.3	4	13.3	13	20.6
Afternoon (12:00 PM to 6:00 PM)	13	39.4	9	30.0	22	34.9
Evening (6:01 PM to 11:59 PM)	10	30.3	13	43.3	23	36.5

Table 7: Position of road traffic accident cases during accident (n=63)

Position	Hamirpur district (n=33)		Kangra district (n=30)		Total (n=63)	
	No.	%	No.	%	No.	%
Crossing	12	36.4	10	33.3	22	34.9
Roadside	5	15.2	0	0.0	5	7.9
Standing	9	27.3	12	40.0	21	33.3
Walking	7	21.2	8	26.7	15	23.8

4. Conclusion:

Male accounts higher number of accidents as compare to female is observed in our study which is similar to other studies in past [26]. Here we have seen that winter season results in most of the accidents it may be due to the poor visibility and fog at that time. So better visibility techniques should be there to improve the visibility. In most of the studies done in Developed nation, on weekend most of the causalities seen but in our study Friday and Monday are the days having maximum crashes as compare to Saturday and Sunday. Most of the accident occurs at the time of crossing. District Hamirpur shows greater number of pedestrian accidents as compare to Kangra but the total number of accidents are more in Kangra that is 361 and 113 in Hamirpur in 2020. It may be due to the high density of population of Hamirpur.

Collision from front of the vehicle occurs when centre of gravity is above the bumper in case of adult pedestrian and in case of paediatric pedestrian below the bumper that is highly categorized by the height of the victim and speed of vehicle. In adult front bumpers strike the lower leg region legs are noted to be accelerated in the direction of vehicle. Whereas the upper body strikes with the upper edge, causing rotations and secondary impact of injury. In the present study the factors that possibly contribute to RTA of pedestrian like stress of driver , alcohol and drug consumption are not consider due to missing.

4.2 Forensic benefit of impact of injury:

If the bumper fractures are on different level on both legs, then it indicates that the victim was either running or walking. In children, bumper fracture is seen in femur. Femoral head may be driven through the acetabulum. The vehicle can be identified from the height of the bumper fracture from the ground and matching the same with the offending vehicle's height of bumper from the ground. When brakes are applied, the height of the bumper dips down, thus the height of the bumper fracture is less than the height of the bumper. On studying the primary impact, the type of vehicle, height of vehicle can be identifying the impression of tyres can be studied from the body and help in investigating the case.

5. Measures to reduce accidents in Hilly areas:

Road accidents are considered common in India rather than reacting towards it. This problem is persistent from long time, lack of infrastructure over crowded roads and tracks other causes like crossing red lights, over speed, drunk and driving etc. are the main causes here. But issues like poor pedestrian walking space steep curves narrow roads and poor infrastructures are main cause of problem in hilly area of the state. So, for better results with improvement of infrastructure improvement in Law and Forces is also needed. Use of emerging technologies and more trauma care centres to be open near highways for the safety and provision of first aid to the victims. Roads are not broader in Himachal Pradesh in most of the areas narrow single road are there thus pedestrian and the vehicle are sharing very inconvenient path resulting in accidents. Anti-sleep technology is needed for the vehicle which can help driver on long drives although Artificial Intelligence are now in cooperated in many luxury vehicles but it should be there in other vehicles also. With use of artificial intelligence and GPS, notifications regarding sharp curves, steeps and speed limit will help in states like Himachal Pradesh. Other safety precautions like avoid use of cell phones while driving, pay attentions to signals and don't block pedestrian walking area by sand stone more attentive towards senior citizens.Categorization of road on basis of its geometry can be an effective way of controlling accidents. There can be n number of precautions and solutions to avoid accident but what is important is willingness to bring it real. Government and traffic in charges can never fulfil.

There can be many more solutions to avoid accidents. But what is the matter is willingness to bring it in real. It can never be the task of government alone we citizens should obey and follow the safety rules.

Acknowledgment:

The authors are thankful to Traffic police headquarters, health department and Medical College of Hamirpur and officials for providing the data used in this study. Authors would also like to give special acknowledgement & thanks to the Forensic Department of Hamirpur for providing the details of injury.

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