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Pattern of Injuries in Pedestrians Died in Road Traffic Occurrence – An Autopsy-Based Study.

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Abstract

Background: Pedestrians are among the most vulnerable road users in road traffic occurrences. The pattern and distribution of injuries can provide important forensic information regarding the mechanism of impact, relative position of the pedestrian and vehicle, type of offending vehicle, and cause of death. This study was undertaken to evaluate injury patterns in fatal pedestrian road traffic occurrences and assess their usefulness in reconstructing the events. ***Methods:*** A cross-sectional descriptive study was conducted on 100 medico-legal autopsies of pedestrians who died in road traffic occurrences at Government T.D. Medical College, Vandanam, Alappuzha, from January 2018 to August 2019. Relevant information regarding age, sex, time and circumstances of the accident, direction of impact, type of vehicle and place of death was collected from police records, clinical records and accompanying persons. External and internal injuries were documented during autopsy using a structured proforma. Data were entered into Microsoft Excel and analysed using SPSS. The association between bumper fracture and type of offending vehicle was assessed using the chi-square test. ***Results:*** Of the 100 victims, 78% were males and 22% females, with a male-to-female ratio of 3.54:1. The mean age was 60.59 ± 15.92 years, with the 61–80-year age group comprising 56%. Most accidents occurred between 12:00 pm and 6:00 pm (30%) and on national highways (64%). Forty-seven percent of pedestrians were hit while stationary and 22% while crossing the road. Head injury was the commonest cause of death (77%), with head injury alone accounting for 41 deaths. ***Conclusion:*** The study demonstrates that injury patterns in fatal pedestrian road traffic occurrences provide valuable forensic clues for reconstructing the accident. Head injury was the predominant cause of death, while bumper fracture showed a significant association with the offending vehicle type. Detailed autopsy examination, including documentation of patterned injuries, is therefore important in forensic reconstruction.

Keywords: Pedestrian; Road Traffic Occurrence; Autopsy; Injury Pattern; Bumper Fracture; Head Injury; FORENSIC Medicine.

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INTRODUCTION

Road traffic accidents (RTAs) are a major public health concern worldwide and represent an important cause of preventable mortality and disability. According to the World Health Organization, approximately 1.35 million people die every year as a result of road traffic accidents. More than half of road traffic deaths occur among vulnerable road users, including pedestrians, cyclists, and motorcyclists. Road traffic injuries are also recognized as the leading cause of death among individuals aged 5–29 years.[1]

The burden of road traffic injuries is particularly significant in developing countries such as India. India has witnessed a rapid increase in motorization and vehicular traffic over the past few decades, contributing substantially to road traffic-related morbidity and mortality. India accounts for approximately 10% of road traffic accidents worldwide.[2] The death rate due to road traffic accidents increased from 16.8 per 100,000 population in 2009 to 18.9 per 100,000 population in 2013.

According to National Crime Records Bureau data from 2011, a total of 441,023 road traffic accidents were reported in India, resulting in 136,834 deaths. Accidental deaths also showed a substantial increase of 44.2% in 2011 compared with 2001. The magnitude of the problem was further highlighted by the observation that approximately one person died every five minutes on Indian roads, with projections suggesting an increase to one death every three minutes by 2020.

Kerala has also experienced a considerable burden of road traffic accidents. According to statistics released by the Kerala Police, there were 39,420 road traffic accidents with 44,108 injuries and 4,287 deaths in 2016. In 2017, 38,470 accidents, 42,671 injuries, and 4,131 deaths were reported. The number increased again in 2018, with 40,181 accidents, 45,458 injuries, and 4,303 deaths.[3] These figures demonstrate the continuing and substantial burden of road traffic accidents in the state.

Among road users, pedestrians are particularly vulnerable because they have no protective structure to absorb the energy generated during a collision. The injuries sustained by pedestrians can provide valuable information regarding the mechanism of impact, type of vehicle involved, relative position of the victim, and circumstances of the accident. A systematic evaluation of injury patterns during medico-legal autopsy can therefore assist in reconstructing the events surrounding fatal pedestrian road traffic accidents and determining the cause of death.

AIMS AND OBJECTIVES

The aim of the study is to evaluate the pattern of injuries sustained by pedestrians who died in road traffic occurrences and to assess the usefulness of these injury patterns in reconstructing the circumstances and mechanism of the event. The study also aims to compare the pattern of injuries sustained by pedestrians according to the type of offending vehicle involved and to determine the cause of death in these fatal pedestrian road traffic occurrences.

MATERIALS AND METHODS

Study Design

A cross-sectional descriptive study was conducted on medico-legal autopsies performed at the mortuary of Government T.D. Medical College, Vandanam, Alappuzha, over a period of 18 months from January 2018 to August 2019. The study population comprised pedestrians who died in road traffic occurrences and were brought for medico-legal autopsy at the institution. The cases were predominantly from road traffic accidents occurring in Alappuzha district, as well as parts of Ernakulam and Kollam districts.

Inclusion and Exclusion Criteria

All deaths of pedestrians involved in road traffic occurrences and subjected to medico-legal autopsy at Government T.D. Medical College Hospital, Vandanam, Alappuzha, were included in the study. Cases were excluded when the history of death due to a road traffic occurrence or the mode of travel of the person involved was unclear, as well as cases in which the identity of the deceased was unknown.

Sample Size Calculation

All medico legal autopsy cases brought to forensic medicine department involving pedestrians died in road traffic occurrence in the specific study period as this is a novel study in Kerala population. Annual autopsy rate at Govt. T.D.M.C Alappuzha is around 1000, total road traffic accidents measures about 250 in which there is around 100 cases in which pedestrians are involved.

So the sample size for this study is determined as 100.

Data Collection Procedure

Data were collected using a pre-structured proforma from multiple sources. Epidemiological and circumstantial details, including age, sex, direction of travel, type of vehicle involved, time and place of accident, period of survival following the accident, and time of death, were obtained from the KPF 102 form, inquest report, clinical records, and information provided by the investigating police officer.

Additional relevant information was obtained by interviewing the police personnel accompanying the deceased and, where available, relatives, friends, neighbours, or other accompanying persons. During the medico-legal autopsy, external injuries were examined and documented directly from the body, followed by dissection and systematic recording of internal injuries and other relevant findings in the proforma.

The information obtained from police records and accompanying persons was subsequently correlated with the autopsy findings.

Statistical Analysis

The data collected during the study were entered into Microsoft Excel and subsequently analysed using Statistical Package for the Social Sciences (SPSS) software with the assistance of a statistical expert. Descriptive statistics were used to summarize the study variables, and the results were presented in the form of frequencies, percentages, tables, and appropriate graphical representations.

RESULTS

Table 1. Sociodemographic and Circumstantial Profile of the Study Subjects (N=100)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	78	78
	Female	22	22
Age (years)	≤20	3	3
	21–40	9	9
	41–60	28	28
	61–80	56	56
	>80	4	4
Time of accident	00:00–06:00	15	15
	06:00–12:00	27	27
	12:00–18:00	30	30
	18:00–24:00	25	25
	Data not available	3	3

Table 1 observes the sociodemographic and temporal distribution of the study subjects. Males constituted the majority of victims (78%), while females accounted for 22%. The most commonly affected age group was 61–80 years (56%), with a mean age of 60.59 ± 15.92 years. The maximum number of accidents occurred between 12:00 and 18:00 hours (30%), followed by 06:00–12:00 hours (27%).

Table 2. Circumstances and Characteristics of Road Traffic Occurrences (N=100)

Variable	Category	Frequency (n)	Percentage (%)
Place of death	Accident site	20	20
	On the way to hospital	2	2
	On reaching hospital	10	10
	While on treatment	67	67
	Due to complications of injury	1	1
Direction of impact	Walking along the direction	8	8
	Walking opposite to direction	4	4
	Stationary	47	47
	Walking sidewise	14	14
	Crossing road	22	22
	Data not available	5	5
Type of road	National highway	64	64
	Other roads	32	32
	Data not available	4	4

Table 2 illustrates the circumstances surrounding the road traffic occurrences. Most victims died while on treatment (67%), whereas 32% died before receiving treatment. Regarding the direction of impact, 47% of pedestrians were stationary at the time of impact, followed by those crossing the road (22%). National highways accounted for the majority of accident sites (64%).

Table 3. Distribution According to Type of Offending Vehicle and Evidence of Hit-and-Run (N=100)

Variable	Category	Frequency (n)	Percentage (%)
Type of offending vehicle	Light motor vehicle (LMV)	29	29
	Heavy motor vehicle (HMV)	15	15
	Two wheelers	40	40
	No data available	14	14
	Unidentified vehicle	1	1
	More than one vehicle	1	1
Evidence of hit-and-run/vehicle contact	Foreign body (paint, glass, oil, grease, soot)	5	5
	Tyre tread marks	1	1
	Imprint injury	3	3
	No evidence	89	89
	Burns from exhaust	1	1
	History present in KPF 102	1	1

Table 3 illustrates the distribution of pedestrians according to the type of offending vehicle and evidence suggestive of hit-and-run or vehicle contact. Two-wheelers were the most frequently involved vehicles (40%), followed by LMVs (29%) and HMVs (15%). Evidence suggestive of hit-and-run was documented in a small proportion of cases, with foreign body material being the most frequent finding (5%).

Table 4. Distribution of Injuries According to Body Region and Bumper Fracture (N=100)

Variable	Category	Frequency (n)	Percentage (%)
Region of Injury	Head	93	93
	Neck	14	14
	Chest	67	67
	Abdomen	43	43
	Pelvis	20	20
	Upper limb	82	82
	Lower limb	79	79
	Multiple injuries	4	4
Bumper Fracture	Present	55	55
	Absent	45	45

Table 4 observes the distribution of injuries according to body region and the presence of bumper fracture. Head injuries were the most frequent (93%), followed by upper-limb injuries (82%) and lower-limb injuries (79%). Chest and abdominal injuries were present in 67% and 43% of cases, respectively. Bumper fracture was documented in 55% of victims.

Table 5. Distribution of Mechanical Injuries Sustained by Pedestrians (N=100)

Type of Mechanical Injury	Frequency (n)	Percentage (%)
Abrasions other than graze	93	93
Imprint abrasion	3	3
Graze abrasion	37	37
Contusion	92	92
Laceration	81	81
Fracture	96	96
Penetrating injury	5	5
Amputation	0	0
Hemisection	2	2
Transection	1	1

Table 5 illustrates the pattern of mechanical injuries sustained by the pedestrians. Fractures were the most common injury, occurring in 96% of victims, followed by abrasions (93%), contusions (92%) and lacerations (81%). Penetrating injuries were observed in 5% of cases, while hemisection and transection were noted in 2% and 1% of cases, respectively. No cases of amputation were recorded.

Table 6. Distribution of Head Injuries Among Pedestrians (N=100)

Type of Head Injury	Frequency (n)	Percentage (%)
Scalp injury	93	93
Skull fracture	73	73
Subarachnoid haemorrhage (SAH)	78	78
Brain oedema associated with head injury	70	70
Subdural haemorrhage (SDH)	67	67
Brain contusion	54	54
Brain laceration	29	29
Extradural haemorrhage (EDH)	7	7
No gross evidence of head injury	6	6
Transection of brain stem	4	4

Table 6 illustrates the distribution of different types of head injuries. Scalp injury was the most common finding (93%), followed by subarachnoid haemorrhage (78%) and skull fracture (73%). Brain oedema and subdural haemorrhage were

observed in 70% and 67% of cases, respectively. Extradural haemorrhage was present in 7% of victims, while brain-stem transection was observed in 4%.

Table 7. Comparison of Offending Vehicle with Bumper Fracture and Distribution of Injuries as Cause of Death

A. Type of Offending Vehicle and Bumper Fracture			
Type of Offending Vehicle	**Bumper Fracture Present n (%)**	**Bumper Fracture Absent n (%)**	**Total**
LMV	18 (62.1%)	11 (37.9%)	29
HMV	14 (93.3%)	1 (6.7%)	15
Two wheelers	15 (37.5%)	25 (62.5%)	40
No data available	6 (42.9%)	8 (57.1%)	14
Unidentified vehicle	1 (100.0%)	0 (0.0%)	1
More than one vehicle	1 (100.0%)	0 (0.0%)	1
Total	**55 (55.0%)**	**45 (45.0%)**	**100**
Pearson Chi-square = 16.91; df = 5; p = 0.005			
B. Injury as Cause of Death			
Injury as Cause of Death	**Only Cause (n)**	**Combined with other Causes (n)**	
Head	41	36	
Neck	1	3	
Chest	1	33	
Abdomen	0	21	
Upper limb	0	3	
Lower limb	3	8	
Pelvis	0	9	
Spine	0	4	
Other causes	1	0	
Multiple injuries	9	5	

Table 7 compares the type of offending vehicle with the occurrence of bumper fracture and also summarizes the injuries responsible for death. Bumper fracture was most frequent among victims struck by HMVs (93.3%), followed by LMVs (62.1%) and two-wheelers (37.5%), with a statistically significant association (p=0.005). Head injury was the predominant cause of death, accounting for 41 deaths as the sole cause and 36 deaths when combined with other injuries.

DISCUSSION

The present study was conducted at Government T.D. Medical College, Alappuzha, during the period from January 2018 to August 2019. During the study period, 100 cases of fatal road traffic occurrences involving pedestrians brought for medico-legal autopsy were studied. Details regarding the history of the accident, identity of the victim, time and place of occurrence, and place of death were collected from KPF 102, eyewitness accounts, and hospital treatment records.

In the present study, 78% of the victims were males and 22% were females, with a male-to-female ratio of 3.54:1. Thus, males considerably outnumbered females. A previous study titled Road Safety in India: Status Report of 2016 reported that the majority of road traffic accident victims were males (70.3%). Another retrospective study reported 82.5% male and 17.8% female fatalities, with an overall male-to-female ratio of 4.72:1. Similar findings were also reported in a study conducted in the USA[4] by the National Transportation Safety Board in 2018. The predominance of males may be attributed to greater exposure to road traffic and higher frequency of outdoor activities and road use among men.

Regarding the time of occurrence, the present study showed that the maximum number of accidents occurred between 12:00 PM and 6:00 PM (30%), followed by 6:00 AM to 12:00 PM (27%). The least number of accidents occurred between 12:00 AM and 6:00 AM (15%). Another study reported that the majority of pedestrian injuries (41.8%) occurred during peak traffic hours in the evening. The higher frequency of accidents during daytime and evening hours may be related to increased vehicular and pedestrian movement and greater traffic density during these periods.

With regard to the place and time of death, 20% of the victims died at the accident site, 2% died while being transported to the hospital, and 10% died after reaching the hospital. The majority of victims (67%) died while undergoing treatment, whereas 1% died after discharge from the hospital due to complications of the injuries. In comparison, a retrospective study conducted by Sachin Chourasia[5] reported spot death in 9.89% of cases, while the survival period was 2–6 days in 18.6% of fatalities. The higher proportion of deaths occurring during hospital treatment in the present study may reflect the severity of injuries sustained by pedestrians and the complications that develop following major trauma.

In the present study, 64% of the accidents occurred on national highways, whereas 32% occurred on other roads. The higher incidence of fatal pedestrian accidents on highways may be related to the higher speed of vehicles on well-maintained highway roads. According to official statistics[6] from Road Safety in India, the increasing number of vehicles on roads and the absence of coordinated, evidence-based policies to control road traffic injuries have contributed to the increasing number of fatalities. These data also showed that the number of fatalities had continued to increase by approximately 7% per year over the preceding decade, except during the last few years. The good condition of highway roads, while facilitating faster movement of vehicles, may therefore contribute to increased severity of pedestrian injuries in the event of a collision.

A study conducted by Dr. V. Chandra Sekhar,[7,8] along with data from the National Crime Records Bureau during 2016, showed that 44% of victims sustained trauma on highways. This was explained by the extensive highway network, heavy traffic load, and absence of side lanes along several stretches of highways in Visakhapatnam. The present study was conducted in Alappuzha, which also has a lengthy highway, NH66, extending from Aroor to Kayamkulam, making the findings comparable with those reported from Visakhapatnam. In the present study, 64 cases occurred on highways and 32 cases occurred on secondary roads. The relatively higher occurrence on highways may be related to heavy traffic and higher vehicle speeds, while secondary roads may also contribute to accidents because of their numerous intersections with highways and diversion of traffic through these roads for quicker travel.

Regarding the direction of impact, the present study showed that 47% of the victims were hit by the offending vehicle while stationary, followed by 22% who were hit while crossing the road. Impact from the back was observed in 8% and impact from the front in 4% of cases. These findings are comparable with the study conducted by Dongo Remi Kouabenan,[9] which analysed 55 reports of pedestrian accidents in the Ivory Coast. The study found that a typical pedestrian accident involved a collision between a pedestrian who suddenly entered the road, often while running, and a moving vehicle whose driver was unable to brake in time, possibly because the pedestrian emerged suddenly from behind an object. Rural accidents differed from urban accidents in that they often occurred on downhill roads while the pedestrian was talking to someone or engaged in another activity.

Similar findings were reported by Sachin Dass,[10] who emphasized that walking is an important mode of transportation and that all individuals are pedestrians at some point while using roads. Large numbers of people, including children, elderly persons, persons with disabilities and pregnant women, use roads regularly. As pedestrians constitute one of the largest groups of road traffic fatalities in India, efforts to improve pedestrian safety and make roads more pedestrian-friendly are essential.

The type of offending vehicle showed an important relationship with the occurrence of bumper fracture. In the present study, among 29 cases involving light motor vehicles, 18 victims sustained bumper fractures. Among 40 cases in which two-wheelers were the offending vehicles, 15 victims sustained bumper fractures. In cases involving heavy motor vehicles, 90% of victims sustained bumper fractures. Similar findings were reported by B.S. Roudsari et al.[11] who suggested that the type of vehicle strongly influences the severity and risk of injury and death among pedestrians. Similar findings were also reported by Wong et al.15 in 1980, who noted that lower-extremity fractures were influenced by the interaction between gravitational force and the velocity of the vehicle at the time of the accident.

In the present study, 55% of victims sustained bumper fractures. Another study by Ravi Raj K. et al.[12] reported fractures of the extremities among pedestrian victims, with fractures of the tibia and femur observed in six cases each, hip joint dislocation in six cases, fracture of the arm bone in six cases, and fracture of the forearm bone in one case. A study conducted in Fiji[13] also reported that fractures of the head and face were closely followed by fractures of the lower extremities. These findings highlight the importance of lower-extremity injuries and bumper fractures in pedestrian-vehicle collisions.

In the present study, a comparison was made between the type of offending vehicle and the presence of bumper fracture using the chi-square test. A statistically significant association was observed, with a p-value of 0.005. This indicates that the type of offending vehicle has a significant influence on the occurrence of bumper fractures and may provide useful information for reconstruction of the accident.

Among the offending vehicles in the present study, two-wheelers constituted the largest proportion (40%), followed by light motor vehicles (29%) and heavy motor vehicles (15%). In one case, the victim was hit by one vehicle and subsequently thrown into the pathway of another vehicle.

The present study showed that head injury was the most common injury, occurring in 93% of victims. Injuries to the upper limbs were observed in 82% and injuries to the lower limbs in 79% of victims. Chest injuries were present in 67%,

abdominal injuries in 43%, pelvic injuries in 20%, and neck injuries in 14% of victims. Injuries involving all regions of the body were observed in four cases. These findings were broadly consistent with studies conducted in India and other parts of the world.

A retrospective study by James et al.14 conducted in Fiji reported that head injuries were the most frequent injuries (65.7%), followed by multiple injuries (55.6%), thoracic injuries (54.9%), abdominal injuries (30.3%), vertebral injuries (20.5%), and vessel injuries (11.7%). Similarly, a study by Dr. D. Rao and Dr. S. Mukerjee[14] showed that the head and face were the most frequently affected regions, accounting for 34.64%, while the abdomen was the least affected region, accounting for 03.5%. The predominance of head injuries in the present study and previous studies emphasizes the vulnerability of pedestrians to severe cranial trauma during vehicle-pedestrian collisions.

In the present study, 11 victims showed evidence of hit-and-run, including the presence of foreign material and tyre tread marks. Three victims had imprint abrasions, while 37 victims had graze abrasions. Bumper fracture was present in 55 victims, and its comparison with the type of offending vehicle showed a statistically significant association with a p-value of 0.005.

CONCLUSION

Pedestrian road traffic deaths in this study were predominantly seen among males, with most accidents occurring during peak traffic hours and on highways. Most victims were struck while stationary or crossing the road, with two-wheelers being the commonest offending vehicles. Head injuries were the major cause of death, while abrasions and fractures were the most frequent injuries. A significant association was observed between bumper fracture and the type of offending vehicle. The findings emphasize the importance of improved road safety measures, pedestrian awareness, and effective traffic control to reduce pedestrian fatalities.

REFERENCES

1. World health organisation, news room/fact sheets/detail; road traffic injuries, 7 Dec 2018.
2. World health organisation; India /health topics/road safety and injury prevention. Bloom berg philanthropies global road safety programme-India.
3. KERALA POLICE. Road accidents in Kerala 2001 -2018 (internet), Available from: http://kerala police.gov.in/ crime statistics. Last updated 21/8/19.
4. National Transportation Safety Board. Pedestrian Safety. Special Investigation Report NTSB/SIR-18/03. Washington, DC 2018.
5. Chourasia S, Radhakrishna KV, et al. Road traffic accidents attending casualty in a tertiary care hospital: a 03 year study from South Western India. International Journal of Research in Medical Sciences 20197(10):3744-750.
6. Mohan D, Tiwari G, Bhalla k. Transportation Research & Injury Prevention Programme Indian Institute of Technology Delhi. Road Safety in India: Status Report 2016.
7. Sekhar VC, Bandaru S, Ramakrishna P, et al. Autopsy study pattern of pedestrian injuries in road traffic accidents. Sch J App Med 2017;5(12):5201-9.
8. National crime record bureau. Accidental deaths & suicides in India, Chapter- 1A, Traffic accidents. 2015;117-26.
9. Kouabenan DR, Guyot JM. Study of the causes of pedestrian accidents by severity. Journal of Psychology in Africa 2004;14(2):35-42.
10. Dass S, Singhal D, Aggarwal P. Study of Pedestrian Flow or behaviour on Indian Roads. IOSR Journal of Mechanical and Civil Engineering 2015.
11. Roudsari BS, Mock CN, et al; Injury Prevention 2004;10:154-8.
12. Ravi Raj KG, Shobhana SS. An Autopsy Study on Pattern of Fatal Injuries Sustained by Pedestrians. Journal of Evidence based Medicine and Healthcare 2015;2(12):1911-5.
13. Kalougivaki JJVP, Gounder RPS. Retrospective autopsy-based study of fatal road traffic accidents in Fiji. J Forensic Res 2014;5:6.
14. Rao D, Mukerjee S. A study of pattern of injuries in road traffic collisions. Journal of Punjab Academy of Forensic Medicine & Toxicology 10 (2010).