

# Pattern of injuries in Two-Wheeler riders involved in Road Traffic Occurrence –an Autopsy Study

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**How to cite this article:** Amjith E Kutty, Sreelekshmi J, Cyriac Job. Pattern of injuries in Two-Wheeler riders involved in Road Traffic Occurrence –an Autopsy Study. Medico Legal Update / Volume 24 No 1, January-March 2024.

## Abstract

**Background:** Road traffic injuries are India's sixth leading cause of death, affecting youth and middle-aged individuals. Rapid motorized traffic growth, particularly two-wheelers (72% of vehicles), has increased accidents. Inadequate and non-uniform helmet regulations worsen the situation. Road injuries strain healthcare, demanding hospitalization, and rehabilitation. Kerala experiences significant two-wheeler accidents, often fatal due to head injuries. Studying injury patterns and causes among riders in fatal accidents is vital.

**Methods:** A cross-sectional study was conducted at Govt TD Medical College, Vandanam, Kerala, following approval from the Institutional Ethics Committee. The study included all deaths of two-wheeler riders involved in road traffic accidents with clear vehicle information, excluding decomposed or unidentified bodies. A total of 101 cases were analyzed, recording external and internal injuries directly onto the Proforma during autopsy. Data were summarized using frequencies and proportions, while the chi-square test assessed relationships between categorical variables.

**Conclusion:** The study found that most accidents occurred between 6-9 pm, involving mainly male (91.1%) two-wheeler riders (80.8%). Few wore helmets (5%). Head injuries (97%) were common, often caused by ejection from vehicles (87%). Non-helmet use and ejection related significantly to head injuries, a leading cause of two-wheeler accident fatalities.

**Keywords:** Two-wheeler injuries, pattern of injuries, helmet safety, contre coup injuries

## Introduction

India has experienced rapid growth of motorized traffic in the last few decades, which resulted in an increase in road traffic accidents. Motor vehicle traffic in India is different from that of other developed countries. Two-wheeler accidents form a major component of all road traffic accidents in Kerala<sup>1</sup>. According to Spitz and Fishers the motor cyclist is unprotected for all practical purposes.<sup>2</sup> Most of the

deaths in two-wheeler accidents are due to head injuries. Helmets can reduce the risk of serious head injury, but do not protect the wearer from all types of possible head injuries. Crash helmet reduces the friction of the head against the ground and make the decelerations less drastic by allowing the protected head to skid across the ground. Helmet reduces the risk of head injuries by 30% and fatalities by 40%. However, in India helmet regularization is not uniform and it is poorly implemented. In India, two wheelers

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**Submission date:** October 8, 2023

**Revision date:** Oct 17, 2023

**Published date:** Feb 14, 2024

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constitute 72% of the total vehicles registered<sup>1</sup>. Two wheelers include motor cycles, scooters, mopeds, and pedal cycles. Accidents to two wheelers are commonly caused by turning in front of a vehicle from one side to the other. The vehicle is hit and the person is thrown violently into the ground or some other object. Road traffic injuries also place a huge burden on the health sector in terms of hospitalization, acute care, and rehabilitation.<sup>3</sup> According to national statistics of road traffic accidents in India, half of those dying on the world's roads are 'vulnerable road users' that include Pedestrians, cyclists, and motorcyclists. Sincetwo-wheeler accidents accounts for 78.67% of road traffic accidents in Kerala and 33.1% of the total number of deaths in 2014 due to road traffic accidents, it is important to understand injury patterns, causes of death, and head/neck injuries among two-wheeler riders in fatal road accidents.

### Methodology

A cross-sectional study, based on autopsy findings of deaths involving two-wheeler riders, was conducted at Government TD Medical College Hospital, Vandanam, Kerala from January 2014 to May 2015. Most of the autopsied cases originated from accidents that occurred in Alappuzha district, with some cases from parts of Ernakulam and Kollam districts. Cases where information about the nature of the vehicle involved was unclear, as well as cases involving unknown identities and decomposed bodies, were excluded from the study. The total sample size comprised of 101 cases. The study was initiated after getting approvals from institutional research and ethics committees.

A Proforma was prepared for data collection. The epidemiological features related to victim like age,

sex, type of vehicle involved, time of accident, place of death of victim, nature of treatment given, period of survival of victim after accident and other relevant data were collected from KPF 102 provided by police, clinical case records, details from concerned investigating officers, relatives, friends, and others accompanying the body. Details of the injuries were recorded into the Proforma during autopsy examination. These data were entered into Microsoft excel and statistical analysis was done using SPSS software version 15.

### Results

During the study period, 101 two-wheeler accident deaths were autopsied at Government T D medical college Alappuzha. The most affected age group was 20-29 years 32.3% (n=32), followed by 40-49 years 21.0% (n=21) and 50-59 years 18.0% (n=18). Males constituted 91.1% (n= 92) of cases, while females were 8.9% (n=9). The age range of victims was 15 to 73 years.

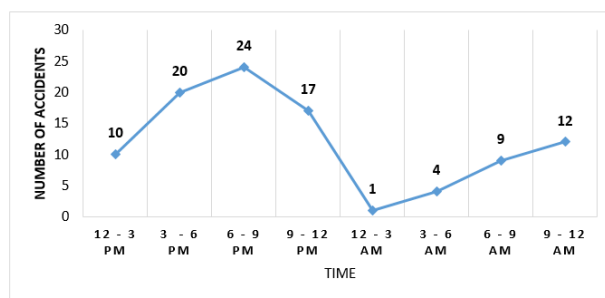


Fig 1: Distribution according to time of accident

Most two-wheeler accidents occurred between 6 pm to 9 pm 23.8% (n=24), with 40% of deaths occurring within 2 hours and none surviving beyond one-month post-accident. (Fig 1)

Table 1: Distribution of factors related to the two-wheeler accidents.

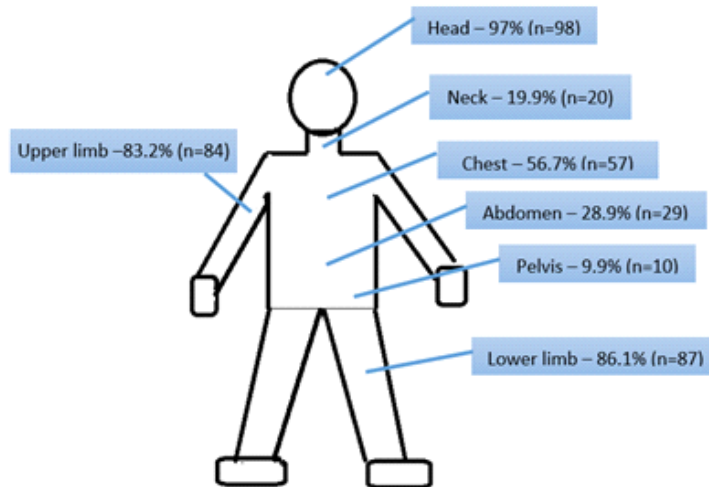
Sl.No	Factors	Categories	Frequency	Percentage
1	Type of road	National highway	64	63.4
		Other roads	35	34.7
		Data not available	2	2
2	Type of two-wheeler	Motor cycle	62	60.4
		Scooter	18	17.8
		Moped	0	0
		Bicycle	21	20.8
3	Type of rider	Rider	81	80.8
		Pillion rider	20	19.2

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4	Wearing helmet	yes	5	5
		no	88	87.1
		Data not available	8	7.9
5	Direction of impact	Along the direction	19	18.9
		Opposite to direction	50	49.5
		To stationary object	14	13.9
		skidding	2	2
		Data not available	12	11.9
		Not applicable	4	4
6	Type of Offending vehicle	Two-wheeler	17	16.8
		Three-wheeler	7	7
		Light Motor Vehicle	30	29.7
		Heavy vehicle	24	23.8
		Stationary object	13	12.9
		Not applicable	10	9.9
7	Ejected out	yes	88	87.1
		no	10	9.9
		Data not available	3	3

Majority of two-wheeler accidents occurred on national highways 63.4% (n=64) and other roads 34.7% (n=35). Among the victims, 60.4% (n=62) were motorcycle riders, 20.8% (n=21) were bicyclists, and 17.8% (n=18) were scooter riders. Most victims 80.8% (n=81) were riders, not pillion passengers 19.2%

(n=20). Despite helmet mandates in Kerala, 87.1% (n=88) of victims were not wearing helmets. Collisions primarily involved vehicles from opposite directions 49.5% (n=50). Two-wheelers mostly collided with light motor vehicles 29.7% (n=30). Ejection from the two-wheeler occurred in 87.1% (n=88) of cases. (Table 1)



**Fig 2 : Showing the injuries in the body of the victims**

Head injuries were prevalent in 97% (n=98) of victims, followed by lower limb 86.1% (n=87) and upper limb injuries 83.2% (n=84). while injuries to the chest and abdomen were present in 56.7% (n=57)

and 28.9% (n=29) of cases, respectively. Combined injuries to the head, chest, upper limb, and lower limb were noted in 17.8% (n=18) of cases, and head, upper limb, and lower limb injuries in 16.8% (n=17).

Common injuries included abrasions 99% (n=100), contusions 94% (n=95), lacerations 81.1% (n=82), and fractures 88% (n=89), while penetrating injuries were rare 2% (n=2), and amputations were not observed. (Fig 2)

**Table 2: Pattern of injuries in the head and neck region**

Sl.no	Variables	Pattern of injuries in head and neck region		
		Categories	Frequency (n)	Percentage (%)
1	Region of head	Scalp	92	91.1
		Skull	80	79.2
		Face	47	46.5
		Neck	12	11.9
		Extra Dural Hemorrhage	16	15.84
		Sub Dural Hemorrhage	69	68.3
		Sub-Arachnoid Hemorrhage	74	73.3
		Intracranial bleed	8	7.9
		Brain contusion	46	45.5
		Brain Laceration	23	22.8
	No head injury	3	3	
2	Coup and contrecoup injuries of brain	Coup injury	86	85.1
		Contrecoup	65	64.1
		Both	58	57.4
		No injury	8	7.9
3	Region of skull fractures	Vault	68	67.3
		Base	58	57.4
		Face	17	16.8
		No fracture	19	18.8
		Others	1	1
4	Neck injuries	Fracture cervical spine	12	11.9
		Spinal cord injury	4	4
		Hyoid bone fracture	1	1
		Deep Soft tissue injury	1	1
		No injury	87	86.1

In this study, scalp injuries were the most prevalent 91.1% (n=92), followed by skull fractures 79.2% (n=80), subarachnoid hemorrhage 73.3% (n=74), and subdural hemorrhage 68.3% (n=69). Only 3% (n=3) of participants exhibited no head injuries. Brain injuries were significant, with 85.1% (n=86) experiencing coup injuries and 64.4% (n=65) contrecoup injuries, while 57.4% (n=58) demonstrated both. Skull fractures were primarily vault fractures 67.3% (n=68) and base fractures 57.4% (n=58). Combined base and vault fractures occurred in 31.6% (n=32) of cases, with face, base, and vault fractures combined affecting 13.9% (n=14) of participants. Cervical spine fractures were

found in 11.9% (n=12) of cases, with all neck spinal cord injuries linked to cervical fractures 4% (n=4). Hyoid bone fracture was rare 1% (n=1), while 86.1% (n=87) had no neck injuries. (Table 2)

Chest injuries primarily comprised of soft tissue injuries to the chest wall, occurring in most cases, followed by rib fractures in 29.7%. Lung and heart injuries were observed in 14.9% and 4% of cases, respectively. Clavicle and sternum fractures were present in 4% and 5.9% of cases. Chest injuries were absent in 38.6% of cases. Soft tissue chest wall injuries were associated with rib fractures in 9.9% of cases. Abdominal injuries included soft tissue injuries in

20% and liver injuries in 13.9% of cases, with the majority (72.3%) having no abdominal injuries. Pelvic bone fractures were observed in 6% of cases, while urinary bladder injuries occurred in 2%, all of which were associated with pelvic bone fractures.

In the upper limb, soft tissue injuries were the most common (84.2%), with a few cases of humerus and radius fractures (3 cases) and isolated instances of elbow dislocation and wrist fracture dislocation (1 case); shoulder dislocation was not observed. In the lower limb, soft tissue injuries were predominant (90.1%), with rare femur fractures (2 cases), more common tibia fractures (18 cases), and 6.9% of cases involving fibula fractures. Knee dislocation was observed in 2 cases, and 8.9% of cases had no lower limb injuries.

Head injuries were the primary cause of death, leading to the demise of 62 individuals. Head injuries combined with other injuries were implicated in 90.1% (n=101) of cases resulting in death. Chest and abdominal injuries, when standalone, caused death in two cases each, but when combined with other injuries, contributed to death in 16.8% (n=17) and 12.9% (n=13) of cases, respectively. Lower limb injuries alone were not fatal, but in combination with other injuries, led to death in 11.9% (n=12) of cases. Upper limb injuries alone were non-fatal, except when coupled with head injuries, resulting in one death. Spine injuries combined with head, chest, and pelvic injuries contributed to death in 5% (n=5) of cases, while pelvic injuries combined with other injuries led to 4% (n= 4) of fatalities. In 2% (n=2) of cases, death was attributed to late complications arising from the injuries.

## Discussion

This study on two-wheeler accident victims (n=101) found that most fatalities occurred in the third decade of life, with 31.7% (n=32) aged between 20-29 years. Age groups 40-50 and 50-60 years accounted for 20.8% (n=21) and 17.8% (n=18) respectively. Studies from other parts of India also showed that majority of the victims were of the age group 20 to 40 years (56.5%)<sup>4</sup>. The male to female ratio was 10: 1, aligning with similar studies in India and Jamaica, which also reported male predominance due to a higher number of male two-wheeler passengers (5,6).

These findings underscore the vulnerability of young adults and males to two-wheeler accidents.

Most two-wheeler accidents took place between 6:00 pm and 9:00 pm (23.8%), with the fewest occurring between 12:00 midnight and 3:00 am (1%). Overall, 60% of accidents happened between 3:00 pm and 12:00 pm. Comparable studies indicate that two-wheeler accidents tend to peak during local rush hours<sup>7</sup>. The study revealed that a significant majority of deaths occurred shortly after the accident, with over 42% of victims succumbing within 2 hours, and 11.9% of victims dying at the accident scene, findings consistent with previous research.<sup>8,9</sup>

The study revealed that 63.4% of accidents occurred on national highways, possibly due to their well-maintained conditions favoring higher speeds. Among deceased two-wheeler riders, 60.4% were on motorcycles, followed by bicycle riders (20.8%). This trend may be attributed to the prevalence of motorcycles in Kerala, their compact design, speed, and power compared to other two-wheelers, consistent with previous studies.<sup>10,11</sup> Most victims were riders (80.8%), with pillion riders accounting for 19.2%. This aligns with similar findings from another study conducted in a South Indian state<sup>12</sup>.

Out of 101 individuals in the study, only 5 wore helmets during accidents, while 88 did not, and data for 8 cases were unavailable. This highlights a widespread reluctance among two-wheeler riders to wear helmets, despite mandatory regulations in Kerala, underscoring the need for improved driver education on the benefits of protective gear. Most of the two wheelers collided with light motor vehicles (29.7%), followed by heavy vehicles (23.8%), and in 17 cases with other two wheelers. However, studies in different locations have reported varying proportions of offending vehicles <sup>10</sup>. Notably, in 87% of cases, occupants were ejected from two-wheelers during accidents due to the absence of mechanisms like seat belts. Sudden braking led to occupants continuing their motion due to momentum, emphasizing the need for safety measures in two-wheelers.

In this study, head injuries predominated (97%), with substantial rates of lower limb (86.1%) and upper limb injuries (83.2%). Chest and abdomen injuries were also notable at 56.7% and 28.9%,

respectively. Combined injuries to the head, chest, upper limb, and lower limb occurred in 17.8% of cases, and head, upper limb, and lower limb injuries in 16.8%. These findings align with previous Indian studies<sup>4</sup> where head injuries were prevalent in two-wheeler accidents. However, studies from outside India reported that majority of the injuries were on the extremities, suggesting a regional variation possibly linked to Indian riders' reluctance to wear helmets.

Abrasions were the most prevalent injury type (99%), followed by contusions (94%), consistent with existing literature. Lacerations and fractures were present in 81% and 88% of cases, respectively. Head injuries predominantly involved scalp injuries (91.1%) and skull fractures (79.2%). Subarachnoid hemorrhage (73.3%), subdural hemorrhage (68.3%), and epidural hematoma (15.8%) were common findings. Brain contusion and laceration affected 45.5% and 22.8% of victims, respectively, with only 3% free from head injuries. Skull fractures involved vault fractures (67.3%) and base fractures (57.4%), notably hinge fractures in the middle cranial fossa. Combined base and vault fractures occurred in 31.7% of cases. Coup injuries were observed in 85.1% of victims, contrecoup injuries in 64.4%, and both in 57.4%. Even though wearing of helmet can protect the head from injuries, it cannot protect the head from all type of injuries, especially contrecoup injuries which are seen in 64.4 % of cases.

Cervical spine fracture was present in 11.9% of victims. All case of spinal cord injuries of neck were associated with cervical spine fracture (4%). The most common chest injury was soft tissue damage (84.2%), followed by rib fractures (29.7%), resulting in death in only 2 cases. Abdominal wall soft tissue injuries occurred in 20% of victims, with 13.9% experiencing liver injuries, leading to death in 2 cases. Pelvic bone fractures were observed in 6% of cases, along with urinary bladder injuries in 2%, exclusively associated with pelvic fractures.

Upper limb injuries mainly consisted of soft tissue injuries (84.2%), with rare cases of humerus and radius fractures (3 each), along with elbow dislocation and wrist fracture-dislocation (1 each). Shoulder dislocations were absent, and upper limb injuries were fatal in only 1% of cases. Lower limb

injuries primarily involved soft tissues (90.1%), with 2 femur fractures and 18 tibia fractures. Lower limb injuries contributed to 12 fatalities.

Head injuries were identified as the leading cause of death in two-wheeler accidents, responsible for 62 fatalities. Notably, 90.1% of deaths resulted from head injuries combined with other injuries. A study in Calicut supported these findings, showing head injuries as the primary cause of death among drivers (70.2%) and pillion riders (66.6%) (10). Chest and abdominal injuries independently led to two fatalities each, while combined chest injuries contributed to 16.8% of deaths and abdominal injuries to 12.9%. Although lower limb injuries were non-lethal alone, they contributed to 11.9% of fatalities when combined with other injuries. Upper limb injuries were fatal only when accompanied by head injuries, resulting in one fatality. Spinal injuries or pelvic injuries combined with other injuries or late complications from injuries led to death only in a small proportion of cases. These findings emphasize the critical role of head injuries in two-wheeler accident fatalities and the impact of combined injuries on outcomes.

Statistical analyses using chi-square tests revealed significant associations in three comparisons: between individuals ejected from two-wheelers and those with head injuries ( $p=0.004$ ), between head injury as a cause of death and not wearing a helmet ( $p=0.043$ ), and between head injury and non-helmet use at the time of the accident ( $p<0.001$ ).

## Conclusion

The study highlights several critical findings regarding two-wheeler accidents. It reveals a striking gender disparity, with males comprising most victims. Most accidents occur during the afternoon and evening hours, and victims are predominantly in their third decade of life. Highways are the primary accident location, with motorcycles being the most common vehicle involved. Alarming, helmet usage is extremely low, and head injuries are the leading cause of death in these accidents, both in isolation and when combined with other injuries. Ejection from vehicles is a significant risk factor for head injuries. These findings underscore the urgent need for mandatory helmet laws for both riders and pillion riders, with strict enforcement, to mitigate the high

incidence of head injuries and fatalities. Furthermore, exploring preventive measures like seat belts to reduce ejection from two-wheelers should be a priority in improving road safety for this vulnerable demographic.

**Acknowledgement:** We would like to extend our sincere gratitude to (Late) Dr. P Rema, former Professor and Head, Department of Forensic Medicine, Govt. Medical College, Alappuzha, for her contribution and guidance in this study.

**Conflict of interest:** Nil

**Source of funding:** Self

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