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Variation in Pattern of Injuries with Type of Vehicle in Road Traffic Accident -An Autopsy Based Study in Western Odisha

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ABSTRACT

Background: Road traffic injuries and fatalities remain a major global public health and development challenge, with India reporting higher road accident mortality than many other developing countries. The present study aimed to analyze the pattern of injuries among road traffic accident victims with respect to the type of vehicle involved, demographic profile, duration of survival, and causes of death in Western Odisha, and to suggest appropriate preventive measures.

Methods: The study was carried out retrospectively in the Department of Forensic Medicine and Toxicology, BBMCH, Balangir on cases of death due to RTA, brought for autopsy from 1st June 2022 to 31st May 2024. The data was compiled, tabulated and analysed by descriptive statistics using statistical methods.

Results: Fatal road traffic accidents accounted for 231 (22.98%) of 1005 autopsies. Most victims were males (88.31%) aged 21–30 years (32.47%). Accidents occurred predominantly in semi-urban areas (83.98%), during evening/night hours (50.21%), and in winter (40.26%). Most victims (74.89%) died at the scene. Two-wheeler riders (55.42%) and pedestrians (29%) were the most affected, while two-wheelers (31.60%) and heavy vehicles (24.24%) were the commonest offending vehicles. Abrasions (97.40%) and bruises (95.67%) were the most frequent injuries, with the head and face being the most commonly involved body region (90.48%). Head injury was the leading cause of death (83.11%), with sub-scalp hematoma, subdural hemorrhage, and skull fractures being common findings. Helmet non-use was observed in 98.99% of two-wheeler victims, while alcohol consumption was documented in 6.06% of cases.

Conclusion: Stringent enforcement of existing traffic rules, improving trauma care and emergency healthcare can decrease overall mortality.

Key-words: Skull fracture, Subarachnoid haemorrhage, Haemorrhagic shock, Alcohol, Road traffic deaths

INTRODUCTION

Road traffic deaths and injuries remain a major global health and development challenge. As per UNECE, Eurostat, statistically agreed definitions for road transport accidents is '' Any accident involving at least one road vehicle in motion on a public road or private road to which the public has right of access, resulting in at least one injured or killed person.[1] There were an estimated 1.19 million road traffic deaths in 2021; this corresponds to a rate of 15 road traffic deaths per 100 000 population. As of 2019, road traffic injury remains the leading cause of death for children and young people aged 5–29 years and are the 12th leading cause of death when all ages are considered. The risk of death is three times higher in low-income countries than high-income countries despite these countries having less than 1% of all motor vehicles. [2] Road traffic deaths impact people during their most productive years. According to the recent WHO South-East Asia Region (SEAR), the estimated road traffic deaths for the year 2021 is 216 618. The estimated road traffic deaths in

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India have increased by 2% during the period 2010–2021.[3] National Crime Records Bureau data 2024 shows more than 1.8 lakh deaths from road accidents. In global comparison, road accidents in India fatalities remain higher than those in many developing nations, despite fewer vehicles per capita. These statistics shows how we need to focus on road safety and raising standards of emergency trauma care facility.

Road safety status is the reflection of traffic culture and it is extremely poor in India. Tremendous increase in the number of fast-moving vehicles, inexperienced drivers, influence of alcohol, ignorance or violation of traffic rules, and poor designing and condition of roads has collectively led to increase in deaths due to traffic accidents at an alarming rate.[4] When Road accidents result in fatalities, forensic investigations, especially autopsies, provide critical insights into the cause of death and assist in determining any legal responsibilities. In many cases, judicial authorities mandate forensic examinations to clarify whether death resulted directly from the accident or was influenced by other factors such as pre-existing medical conditions or substance intoxication. Alcohol is the leading contributor, found in nearly 25% of cases involving fatal road accidents. [5] Its role in impairing cognitive and motor functions is well-documented, significantly increasing the likelihood of crashes and exacerbating the severity of injuries sustained. The correlation between BAC levels and fatal outcomes is well-documented, particularly in high-speed collisions and single-vehicle crashes.[6]

Preventive measures such as the use of seat belts and helmets have proven highly effective in reducing road accident fatalities. Research indicates that wearing a seat belt lowers the risk of death by 40% to 65% for front-seat occupants and by 25% to 75% for rear-seat passengers. Similarly, wearing a helmet reduces the risk of fatal head injuries by 40% and the risk of serious head injuries by 70%. [7]

In some nations, such as Sweden and Finland, forensic autopsies are legally mandated for all road accident fatalities to determine the precise cause of death and assess potential contributing factors, including alcohol or drug impairment. [6,8] Forensic medicine plays a crucial role in investigating fatalities resulting from road accidents, particularly in assessing physical injuries and toxicological findings to determine their correlation with accident dynamics. The expertise of forensic pathologists is essential not only in establishing the cause of death but also in reconstructing the events leading to the fatal outcome and identifying the potential influence of alcohol or psychoactive substances. [9] As no similar study has been conducted in this region of Odisha, the present study was undertaken to assess the pattern of injuries among road traffic accident victims with respect to the type of vehicle involved, demographic profile, duration of survival, and causes of death in Western Odisha. The findings are expected to provide baseline regional data and assist healthcare authorities and policymakers in implementing appropriate preventive strategies to reduce road traffic fatalities and associated morbidity.

MATERIALS AND METHODS

Study Design and Setting- This hospital-based cross-sectional observational study was conducted in the Department of Forensic Medicine and Toxicology, BBMCH, Balangir, Odisha, India. The study included all medico-legal autopsy cases of fatal road traffic accidents conducted during the study period. Relevant information was collected from police records, inquest reports, hospital records, and postmortem examination findings.

Study Population- A total of 231 fatal road traffic accident cases were included in the study from 1005 medico-legal autopsies performed during the study period. Cases with complete medico-legal records and detailed autopsy findings were included for analysis.

Inclusion Criteria

- ✓ All medico-legal autopsy cases of fatal road traffic accidents.
- ✓ Complete history and relevant police, hospital, and postmortem records available.
- ✓ Victims of all age groups and both sexes.

Exclusion Criteria

- ✓ Decomposed or mutilated bodies with inadequate findings.
- ✓ Cases with incomplete medico-legal or autopsy records.
- ✓ Deaths due to causes other than road traffic accidents.

Data Collection- Information regarding age, sex, place and time of accident, type of road user, offending vehicle, duration of survival, external and internal injury

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patterns, body regions involved, cause of death, toxicological findings, and use of protective devices such as helmets was collected using a predesigned proforma. Detailed autopsy examinations were performed following standard forensic protocols.

Outcome Measures- The primary outcome was the pattern of injuries and causes of death among fatal road traffic accident victims. Secondary outcomes included demographic characteristics, type of vehicle involved, body regions affected, survival duration, and factors contributing to mortality.

Statistical Analysis- Data were entered into Microsoft Excel and analyzed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). Categorical variables were expressed as frequencies and percentages. Continuous variables were summarized as mean ± standard deviation (SD), wherever applicable. Results were presented using tables and figures. A p value <0.05 was considered statistically significant.

Ethical Considerations- The study was approved by the Institutional Ethics Committee of BBMCH, Balangir, Odisha, India. As the study was based on medico-legal autopsy records, confidentiality of all personal information was strictly maintained throughout the study.

RESULTS

Out of 1005 medicolegal autopsies conducted during the study period (1 June 2022 to 31 May 2024), fatal road traffic accidents accounted for 231 cases (22.98%). Males constituted the majority of victims (88.31%), with a male-to-female ratio of 7.6:1. The age of the victims ranged from 2 to 82 years, with the highest proportion belonging to the 21–30 years age group (32.47%), followed by 31–40 years (19.48%). Most accidents occurred in semi-urban areas (83.98%), predominantly during the evening and night hours (6:00 PM–12:00 midnight; 50.21%), and were most frequent in the winter season (40.26%). Regarding survival, 74.89% of victims died at the accident site before reaching the hospital, while 18.62% succumbed within the first 24 hours after injury (Table 1).

Table 1: Demographic Profile, Time of Accident, and Survival Pattern among Fatal Road Traffic Accident Victims (n = 231)

Characteristics	Category	n (%)
Age group (years)	0–10	2 (0.87)
	11–20	23 (9.96)
	21–30	75 (32.47)
	31–40	45 (19.48)
	41–50	38 (16.45)
	51–60	21 (9.09)
	61–70	13 (5.63)
	71–80	12 (5.19)
	>80	2 (0.87)
Time of accident	6:00 AM–12:00 Noon	29 (12.55)
	12:00 Noon–6:00 PM	55 (23.81)
	6:00 PM–12:00 Midnight	116 (50.21)
	12:00 Midnight–6:00 AM	31 (13.42)
Survival period	Died on the spot	173 (74.89)
	Within 1 day	43 (18.62)
	2–7 days	11 (4.76)
	>7 days	4 (1.73)

Table 2 illustrates the pattern of collision and the type of road users involved in fatal road traffic accidents. Two-wheeler riders constituted the largest group of victims, followed by pedestrians and bicyclists.

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Table 2: Nature of Collison

Type of vehicle collision	Category	Victim	Percentage	Number	Percentage
Heavy vehicle - pedestrian	Pedestrian	67	29.00	8	3.46
4-Wheeler - pedestrian				20	8.66
Two-wheeler -pedestrian				39	16.88
Heavy vehicle -Bicycle rider	Bicycle	32	13.85	8	3.46
4-Wheeler - Bicycle				7	3.03
2-wheeler -Bicycle				17	7.36
Heavy vehicle – 4-wheeler	4- wheeler	4	1.73	3	1.30
4-wheeler-4 wheeler				1	0.43
heavy vehicle -Two-wheeler	Two-Wheeler	126	54.55	37	16.02
4-wheeler - 2-wheeler				23	9.96
Two-wheeler -2-wheeler				17	7.36
Two-wheeler – hitting tree/pole				12	5.19
Self-fall from two-wheeler				32	13.85
Unknown vehicle-2-wheeler				5	2.16
Tractor	Tractor	2	0.87	2	0.87
Total		231	100	231	100

Table 3 summarizes the distribution of external and skeletal injuries across different body regions. Abrasions and bruises were the most frequent injuries, with the head, face, and upper limbs being the most commonly affected regions.

Table 3: Distribution of injuries across body parts involved in accidents

	Abrasion		Bruise		Laceration		Crush Injury		Fracture	
	Number	%	Number	%	Number	%	Number	%	Number	%
Head	5	2.16	-	-	64	27.7	14	6.06	74	32.03
Face	118	51.08	106	45.89	26	11.26	4	1.73	8	3.46
Neck	21	9.09	12	5.19	5	2.16	0	0	2	0.87
Chest and abdomen	92	39.8	71	30.34	8	3.46	3	1.29	52	22.5
Back	131	56.7	79	34.2	5	2.16	3	1.29	2	0.87
Upper limb	221	95.6	214	92.6	54	23.3	8	3.46	24	10.39
Lower limb	188	81.38	146	63.2	61	26.4	2	0.87	41	17.7
Genitals	0	0	2	0.87	4	0.87	2	0.87	0	0
Total	225	97.4	217	95.67	94	40.69	20	8.66	93	40.26

Table 4 presents the causes of death among fatal road traffic accident victims. Head injury was the leading cause of death, followed by hemorrhagic shock resulting from thoracic and abdominal injuries.

Table 4: Cause of death and body systems involved

Causes of death			Cases	Percentage
Head injury			192	83.11
Hemorrhagic shock	Chest	12	36	15.58
	Abdomen	19		
Others			3	1.29

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Table 5 compares the frequency of injuries among different categories of road users. Head injuries predominated across all victim groups, while injury patterns varied according to the mode of transport and type of road user.

Table 5: Comparison of injury frequency with type of vehicle occupant

	Pedestrian		Bike rider		Pillion rider		4-wheeler		Bicyclist		Tractor		Total	
	No	%	No	%	No	%	No	%	No	%	No	%	No	%
Head injury	63	94.02	80	86.96	33	97.06	2	50	30	93.75	1	50	209	90.48
Fatal head injury	57	85.07	76	82.61	31	91.18	1	25	27	84.36	0	0	192	83.12
Chest injury	49	73.13	55	59.78	20	58.82	3	75	21	65.62	2	100	150	64.93
Abdomen injury	15	22.39	22	23.91	4	11.76	2	50	6	18.75	1	50	50	21.64
Upper limb injury	65	97.01	78	84.78	32	94.12	3	75	25	78.12	1	50	204	88.31
Lower limb injury	60	89.55	83	90.22	18	52.94	4	100	23	71.86	1	50	189	81.82
Total victim	67		92		34		4		32		2		231	-

Table 6 shows the distribution of various intracranial and skull injuries observed among victims with head trauma. Sub-scalpal hematoma was the most common finding, followed by subdural hemorrhage and skull fractures.

Table 6: Pattern of head injuries

Pattern of head injury	Number	Percentage
Sub-Scalpal hematoma	186	80.50
Skull Fracture	82	35.50
Extra dural hemorrhage	28	12.12
Sub dural hemorrhage	94	40.69
Sub arachnoid hemorrhage	84	36.36
Intra cerebral hemorrhage	21	9.09

DISCUSSION

The present study analysed 231 road traffic accidental deaths out of total 1005 autopsies done during study period in the mortuary of BBMCH, Balangir. We found the predominance of males (88.31%) and highest victims in the 21–30-year age group (32.47%) which is similar to studies by Nahyan MS and Amin [9], Salam *et al*. [10], González-Sánchez *et al*. [11], Thippeswamy *et al*. [12], Kanchan *et al*. [13] in a cross-sectional study in Manipal, India observed that most of the victims of RTA were in the third decade of life i.e. 21-30 years of age. Chettri and Ahmed [14] also observed that age groups 21-40 years were the most vulnerable with the highest percentage of 58.4% in 2018 and 50.6% in 2019. Kumar and Srinivasan [15] in Karimnagar observed that the peak age group of 21-30 years (52.5%) followed by 31-40 years (26.2%). This could be due to the fact that there are more male population who commute for work or other outdoor activities are operating vehicles and a lesser percentage of woman vehicle users. Young and middle age groups largely consisted of the working populace who travel using their own vehicles, use public transport or walk.

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We found 83.98% accidents occurred in semi- urban areas which are in concurrence to study by Sharma *et al*. [16] where 83.67% cases were from urban and 16.32% from rural areas. Our analysis revealed that maximum incidences (50.21%) occurred during evening and night hours between 6pm to 12 midnight followed by afternoon i.e .12:01 p.m-6 p.m (23.81%, n=55). This is in contrast to results found by Salam *et al*. [10] who got highest incidence during 12:01 PM-6 PM (44.6%), followed by 6:01PM 12AM (32.1%); Singh [17] where they found high number between 12PM-9PM and Sharma *et al*. [16] who got maximum cases in the day time (11 a.m.–5 p.m.) This may be due to poor lighting conditions of roads in this semiurban area. We detected maximum (40.26%) incidents in winter followed by rainy (32.90%). As this western part of Odisha is one of the hottest regions in India, winter season becomes a preferred time for increased outdoor activities thus raising the traffic volume during this period.

Following the road traffic accidents, our study revealed most of the victims (74.89%) died on the spot before reaching the hospital, while 18.62% died within 1day after the accident; these findings are similar to the studies by Thippeswamy *et al*. [12] and Menon *et al*. [18], But studies by Manoranjan *et al*. [19] shows different findings where most victims (76.6%) died within the first 24 hours, with only 34.6% brought dead. This may be the fact that most of the severe head injury patients are referred to higher centre in absence of ICU and neurosurgery Dept.

We found two-wheeler riders (motorcyclists) are the largest victims (55.42%) followed by pedestrian (29%), which is similar to study by Manoranjan *et al*. [19] where Two-wheeler rider alone constituted nearly 40%, and Salam *et al*. [10] where two-wheelers are 62.2% followed by pedestrians (16.8%). This is because young males riding 2 wheelers like bikes have a tendency of speeding and overtaking vehicles from the wrong side of the lanes or they may be under the influence of alcohol or triple riding or driving without proper training. The lack of efficient public transport between rural areas to state or national highways leads to high traffic, and also requires commuters to either walk or use their personal vehicles to reach their destinations. Our study reveals accident by self-fall from vehicle in 19.91% and was mostly from two-wheeler. This finding is similar to study by Salam *et al*. [10]. They also in 22 out of 201 cases were females and 179 were males. The higher number of self-accident cases in males may be due to the use of alcohol and or speeding with aggressive driving behaviour, etc. [10] But with respect to offending vehicle our finding (mostly 2 wheelers) is in contrast to results by Salam S where offending vehicle is a 4-wheeler (38.1%) followed by 2-wheeler (36.4%).As in this semi urban region two-wheeler are the preferred means of transport.

Among injuries, commonest injury was abrasion (97.4%) followed by bruise (95.67%). This is consistent with previous autopsy findings in Sharma *et al*. [20] and Sengupta *et al*. [21] found abrasions (23.4%) and lacerations (21.4%) were the most common external injuries.

The head & face were most affected body parts (90.48%, n=209) followed by upper limbs (88.31%). This pattern aligns with global and Indian literatures like Nahyan *et al*. [9] and Kumar *et al*. (71.7%) [22] where they also found head injuries as the leading cause of death. In a study by Salam *et al*. [10] head and face was involved in 42.2% followed by the lower limb (30.6%), Chhetri and Ahmed [14] in their study observed that head trauma was the most (73.3%) affected region which is in conjunction with the present study. Sengupta *et al*. [21] found skull and maxillofacial region (25.0% of all fractures) was the most commonly affected site which is similar tours where Skull fractures were seen in 35.5% cases. But studies by Hassan and Emara A [23] where the highest number of injuries are sustained in the lower limb (37.26%) closely followed by head injury (23.84%).

Head injuries were the predominant cause of death (83.11%) followed by haemorrhagic shock (15.58%). This is consistent with the results documented by other researchers. [12,18,22] where head injury was the most common cause of death. A high occurrence of head injury was due to the fact that almost all the two-wheeler users were not using helmets and, in the pedestrians, it can be explained due to high speed of the offending vehicle and also being run over in many instances. Thoracic and abdominal injuries contributed significantly to hemorrhagic deaths, particularly in cases involving unbelted vehicle occupants or pedestrians struck by heavy vehicles.

Our study revealed alcohol intake in only 6.06% cases which is very less as compared to study by Sharma *et al*.[16] where 25.20% cases were affected by excessive intake of alcohol. Alcohol remains the most frequently

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detected substance in fatal road accidents, followed by cannabis and benzodiazepines. A Chinese study by Zhao *et al*. [24] explained that under the influence of alcohol, drivers exhibited the characteristics of being imbalance, impulsive, sensation seeking, adventurous, and moving faster. At the same time, the ability of judgment, recognition, reaction, and operation were impaired. Therefore, drink driving will produce a high probability to serious accidents. In a study by AL-Abdallat *et al*. [25] conducted in the Amman district, Jordan, toxicological analysis revealed the presence of alcohol and psychotropic drugs in 36.5% of cases involving fatal road accidents. Benzodiazepines and barbiturates were the most commonly detected substances.

LIMITATION

The toxicological analysis findings in suspected drunk drivers and all victims could not be incorporated.

CONCLUSIONS

Fatal road traffic accidents accounted for a considerable proportion of medicolegal autopsies in Western Odisha, predominantly affecting young adult males, particularly two-wheeler users. Most accidents occurred in semi-urban areas during evening and night hours, with a large proportion of victims dying at the scene. Head injury was the leading cause of death, and lack of helmet use was observed in almost all two-wheeler fatalities. The findings highlight the urgent need for strict enforcement of traffic regulations, compulsory helmet use, prevention of drunken driving, improved road infrastructure, and rapid prehospital trauma care. Public awareness programmes targeting high-risk groups, especially young riders, along with strengthening emergency medical services and trauma centres, may substantially reduce preventable road traffic deaths and associated morbidity in this region.

CONTRIBUTION OF AUTHORS

Research concept- Abarnita Sethi, Chandan Samantaray
Research design- Abarnita Sethi, Chandan Samantaray
Supervision- Abarnita Sethi
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