

**Pattern and Medico - Legal Profile of Fatal Road Traffic Injuries - A Prospective Autopsy - Based Study at a Tertiary Care Centre**

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**Abstract**

**Background:** Road traffic accidents (RTAs) remain one of the leading causes of preventable death worldwide, and India accounts for a disproportionately large share of this global burden. Fatal RTA victims form a substantial and recurring category of medico-legal autopsies received at tertiary care mortuaries, and a systematic correlation of demographic characteristics, road-user category, injury pattern and toxicological findings in such cases carries direct value for trauma care planning, road safety policy and courtroom testimony.

**Objectives:** To study the demographic profile of victims of fatal road traffic accidents, to determine the pattern of fatal injuries and the immediate cause of death, to categorise victims according to their role as road users, and to assess the frequency of positive blood alcohol toxicology among autopsied cases at a tertiary care centre.

**Materials and Methods:** This prospective, autopsy-based observational study was conducted in the Department of Forensic Medicine and Toxicology of a tertiary care teaching hospital over a period of twelve months. Fifty consecutive medico-legal autopsies of

victims who died as a result of road traffic accidents were examined, and data on demographic characteristics, category of road user, external and internal autopsy findings, cause of death and blood alcohol toxicology were recorded on a structured proforma and analysed using SPSS software.

**Results:** Of the fifty victims, 82.0% were male, and the 21–40-year age bracket accounted for more than half of all deaths. Two-wheeler riders formed the largest single category of road user (40.0%), followed by four-wheeler occupants (22.0%) and pedestrians (18.0%). Head and neck injury was the leading cause of death (44.0%), followed by polytrauma involving multiple organ systems (24.0%). Blood alcohol was detected in 28.0% of the victims tested.

**Conclusion:** Fatal road traffic injuries at this centre predominantly affected young to middle-aged males travelling on two-wheelers, with head injury as the dominant fatal lesion and a substantial minority of victims testing positive for blood alcohol. These findings reinforce the medico-legal and public health case for stricter helmet enforcement, drink-driving deterrence and targeted trauma-care resource allocation for two-wheeler-dominant traffic corridors.

**Keywords:** Road traffic accident, Fatal injury, Medico-legal autopsy, Forensic pathology, Pattern of injury, Blood alcohol, Two-wheeler.

## Introduction

Road traffic accidents rank among the foremost causes of preventable death and disability across the world, claiming an estimated 1.19 million lives every year and leaving tens of millions more with disabling injuries.<sup>1</sup> Low- and middle-income countries bear close to ninety per cent of this mortality despite owning a much smaller proportion of the world's registered vehicles, and

national reporting from India places road fatalities among the largest single categories of accidental death recorded each year.<sup>2</sup> The annual compilation of accidental deaths and suicides published by the National Crime Records Bureau consistently lists traffic accidents as one of the principal contributors to unnatural death referred for medico-legal examination across the country, a pattern that has changed little over successive reporting years.<sup>3</sup>

The burden falls disproportionately on India's young and economically productive population. Two-wheeler riders, pillion passengers and pedestrians together make up a large share of the fatalities, a reflection of mixed traffic conditions in which motorised and non-motorised road users frequently share the same carriageway with little physical separation. Rapid motorisation, inconsistent enforcement of helmet and seatbelt legislation, deficient road engineering, alcohol consumption before driving, and gaps in prehospital trauma response have all been identified as contributing factors, though their relative weight differs considerably from one region of the country to another.<sup>4</sup>

Whenever a fatal road traffic accident occurs, the medico-legal autopsy occupies a central place in reconstructing events, establishing the exact cause and manner of death and generating objective evidence for investigating agencies and courts of law.<sup>5</sup> Standard forensic texts describe fatal RTA injuries as a distinctive mixture of patterned blunt-force trauma, deceleration injury and, occasionally, post-mortem mutilation caused by the wheels of the same or a subsequent vehicle, all of which the pathologist must distinguish carefully during external and internal examination. Correlating the pattern of injury with the scene of the accident, the vehicles involved and the likely posture of the victim at

the moment of impact allows the pathologist to comment on the probable direction of collision and on whether the injuries are consistent with the history furnished, observations that carry direct evidentiary weight.<sup>6</sup>

A considerable body of Indian autopsy-based literature has attempted to characterise the demographic profile of fatal RTA victims. Studies from Karnataka have reported a marked male preponderance among the dead, generally attributed to greater outdoor mobility and occupational travel among men, with victims most commonly in the third and fourth decades of life.<sup>7</sup> A comparable pattern has been described from the Kumaon region of Uttarakhand, where young adult males again formed the largest single demographic group among fatally injured road users, underlining how consistently this age-sex distribution recurs across geographically distinct Indian settings<sup>8</sup>

The anatomical distribution of fatal injury has received equally close attention. Several series identify the head and neck as the single most frequently injured and most frequently fatal region, a finding linked to the comparatively poor mechanical protection afforded to the skull and brain and to the continuing under-use of helmets among two-wheeler riders.<sup>9</sup> Other authors have reported broadly similar findings, with head injury again predominating but with a meaningful minority of deaths attributable to haemorrhage and shock from injuries to the chest, abdomen and pelvis.<sup>10</sup> Series drawn from tertiary centres in Puducherry and Rohtak, by contrast, have recorded a comparatively larger share of thoracic and abdominal trauma, a difference thought to reflect local variation in the mix of vehicles involved in fatal collisions.<sup>11,12</sup>

The category of road user involved has itself emerged as an important determinant of both injury pattern and

survivability. An autopsy series from Ranchi described how the mechanism and site of fatal injury varied systematically with whether the deceased had been a pedestrian, a two-wheeler occupant or an occupant of a four-wheeler at the time of impact.<sup>13</sup>

Comparable observations from south - western and western Maharashtra have shown that two-wheeler riders and pillion riders, together with pedestrians, account for a disproportionately large share of fatalities relative to their representation in overall traffic volume, a pattern that mirrors national transport statistics and that has repeatedly been linked to the general vulnerability of unprotected road users sharing carriageways with heavier motorised traffic.<sup>14,15</sup>

Time-related and circumstantial factors documented at autopsy add further depth to the medico-legal picture. A comparative study from the Haryana region correlated diurnal timing of the accident with the severity and pattern of injury recorded at post-mortem, while an autopsy series from central rural India specifically examined how the hour of the accident, the age and sex of the victim, and the place of death — at the scene, in transit, or in hospital — interacted with one another.<sup>16,17</sup>

Toxicological analysis of blood and viscera collected at autopsy remains an integral part of this circumstantial picture, and studies examining the broader pattern of fatal RTA injury in and around Khammam have underscored how variably alcohol positivity is reported across Indian series, a variability that itself argues for locally generated rather than extrapolated data.<sup>18</sup>

Despite this expanding literature, comprehensive prospective data that correlate demographic characteristics, road-user category, anatomical injury pattern and toxicological findings from a single tertiary care autopsy centre remain comparatively limited, and

much of the existing work is retrospective, relying on archived police and hospital records of variable completeness.<sup>19</sup> A prospective design, in which each case is examined and documented as it presents to the mortuary, offers a more complete and internally consistent dataset and allows autopsy findings to be correlated directly with police inquest information at the time of examination rather than reconstructed later from incomplete records.<sup>20</sup> The present study was therefore undertaken to describe the demographic and medico-legal profile of fatal road traffic injuries encountered at a tertiary care autopsy centre, with particular attention to the age and sex distribution of victims, the category of road user involved, the anatomical pattern of fatal injury and the frequency of positive blood alcohol toxicology, with the broader aim of generating locally relevant evidence to inform road safety policy, trauma-care planning and medico-legal practice.

### Materials and Methods

**Study Design:** This was a prospective, observational, autopsy-based study designed to describe the demographic profile of victims of fatal road traffic accidents.

**Study Area:** The study was carried out in the Department of Forensic Medicine and Toxicology of a tertiary care teaching hospital from the surrounding urban and semi-urban catchment.

**Study Population:** All victims of road traffic accidents brought for medico-legal autopsy to the department during the study period, in whom death was confirmed to be a direct consequence of a road traffic collision on the basis of police inquest findings and scene circumstances, were considered for inclusion.

**Study Duration:** The study was conducted over a period of twelve months, from January 2025 to December 2025.

### Sampling Technique

A consecutive, non-probability sampling technique was employed; every eligible fatal road traffic accident case received by the department during the study period was enrolled until the study period closed.

### Inclusion Criteria

- Cases in which death occurred as a direct result of a road traffic accident, confirmed by police inquest papers and scene investigation.
- Cases in which a complete medico-legal autopsy, including external and internal examination, could be performed.
- Cases in which viscera could be preserved and sent for toxicological (blood alcohol) analysis.

### Exclusion Criteria

- Grossly decomposed or skeletonised remains in which the pattern of ante-mortem injury could not be reliably assessed.
- Cases in which trauma was superimposed on a primary natural disease process and the road traffic accident could not be established as the direct cause of death.
- Cases with an ambiguous or disputed history in which homicidal or other non-accidental trauma could not be excluded with reasonable certainty.
- Cases in which autopsy or toxicology records were incomplete at the time of data compilation.

### Data Collection

Data were recorded prospectively on a pre-structured proforma at the time of autopsy. Information regarding the age and sex of the victim, the category of road user (pedestrian, two-wheeler rider, two-wheeler pillion rider, four-wheeler occupant or cyclist), the date, time and circumstances of the accident, and the type of vehicle involved was obtained from police inquest papers and,

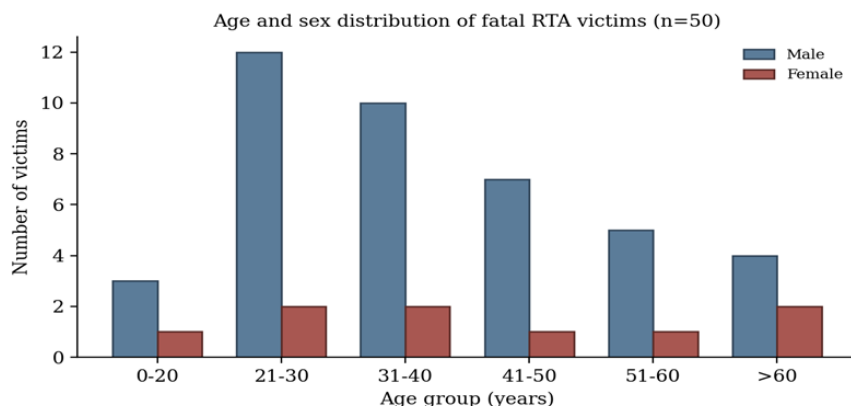
where available, from relatives accompanying the body. Detailed external and internal examination findings, the anatomical pattern of injury, and the opinion as to cause of death were recorded directly from the autopsy. Blood samples collected during autopsy were preserved with sodium fluoride and forwarded through proper chain of custody to the forensic science laboratory for estimation of blood alcohol concentration; a result was classified as positive when ethanol was detected above the laboratory's reporting threshold.

### Statistical Analysis

Data were entered in Microsoft Excel and analysed using IBM SPSS Statistics software. Categorical variables were expressed as frequencies and percentages. Associations between categorical variables, such as road-user category and cause of death, or time of Table 1: Age and Sex Distribution of Victims (n = 50).

| Age Group (years) | Male       | Female    | Total | Percentage |
|-------------------|------------|-----------|-------|------------|
| 0–20              | 3          | 1         | 4     | 8.0        |
| 21–30             | 12         | 2         | 14    | 28.0       |
| 31–40             | 10         | 2         | 12    | 24.0       |
| 41–50             | 7          | 1         | 8     | 16.0       |
| 51–60             | 5          | 1         | 6     | 12.0       |
| >60               | 4          | 2         | 6     | 12.0       |
| Total             | 41 (82.0%) | 9 (18.0%) | 50    | 100.0      |

Graph 1: Age and Sex Distribution of Victims



accident and alcohol positivity, were examined using the Chi-square test or Fisher's exact test as appropriate, with a p-value of less than 0.05 taken as statistically significant.

### Results

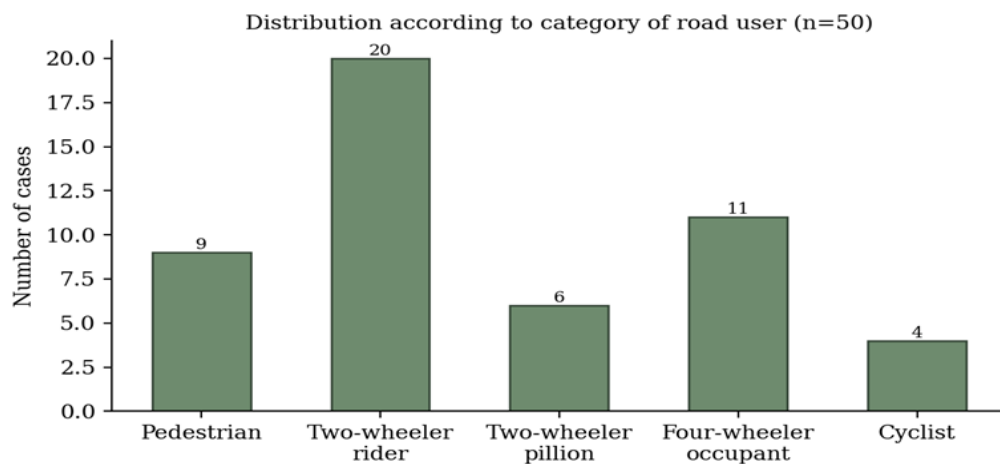
A total of fifty victims of fatal road traffic accidents were autopsied during the twelve-month study period. Males accounted for 41 of the 50 deaths (82.0%) and females for the remaining 9 (18.0%), giving a male-to-female ratio of approximately 4.6:1. Victims between 21 and 40 years of age together accounted for 26 deaths (52.0%), confirming that young and middle-aged adults bore the heaviest share of fatal injury in this series. Inquest and scene findings classified every case in the series as accidental in manner; no case was reclassified as homicidal or suicidal on the basis of autopsy findings.

The grouped distribution shows the 21–30-year and 31–40-year bands together contributing well over half of all fatalities, with a pronounced male excess across every age band. This concentration in the economically productive years is consistent with the loss of wage-earning capacity that road traffic mortality typically inflicts on dependent households.

Table 2: Distribution According to Category of Road User (n = 50)

| Category of Road User     | Frequency | Percentage |
|---------------------------|-----------|------------|
| Two-wheeler rider         | 20        | 40.0       |
| Four-wheeler occupant     | 11        | 22.0       |
| Pedestrian                | 9         | 18.0       |
| Two-wheeler pillion rider | 6         | 12.0       |
| Cyclist                   | 4         | 8.0        |
| Total                     | 50        | 100.0      |

Graph 2: Distribution According to Category of Road User



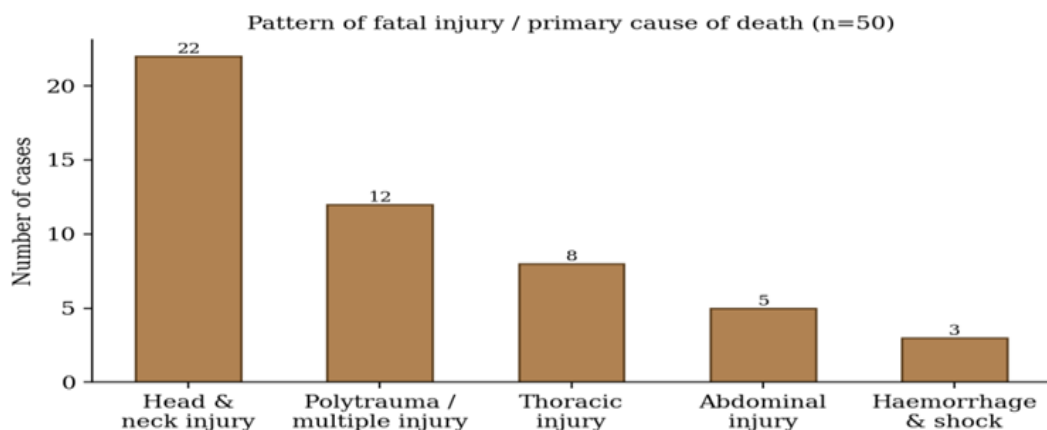
Two-wheeler riders and pillion riders together made up just over half of the series (52.0%), underscoring the disproportionate vulnerability of this category of road user in mixed Indian traffic. Helmet use could not be confirmed in the majority of two-wheeler fatalities on the basis of inquest documentation, a gap discussed further below.

The anatomical pattern of fatal injury and the corresponding primary cause of death, as determined at autopsy, are summarised in Table 3. Head and neck injury, principally in the form of skull fracture with underlying extra dural, subdural or subarachnoid haemorrhage, was the leading cause of death, followed by polytrauma in which no single organ system could be identified as solely responsible for death.

Table 3: Pattern of Fatal Injury and Primary Cause of Death (n = 50)

| Cause of Death / Pattern of Fatal Injury    | Frequency | Percentage |
|---------------------------------------------|-----------|------------|
| Head and neck injury                        | 22        | 44.0       |
| Polytrauma (multiple system injury)         | 12        | 24.0       |
| Thoracic injury                             | 8         | 16.0       |
| Abdominal injury                            | 5         | 10.0       |
| Haemorrhage and shock (major vessel / limb) | 3         | 6.0        |
| Total                                       | 50        | 100.0      |

Graph 3: Pattern of Fatal Injury and Primary Cause of Death



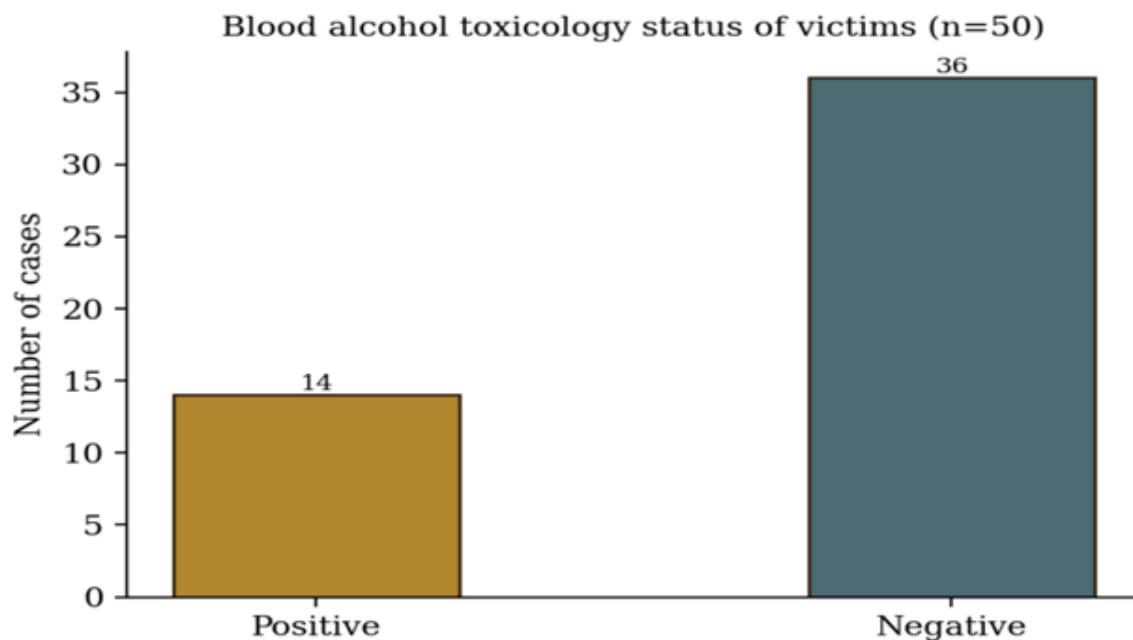
Cross-tabulation of cause of death against road-user category showed that head injury as the cause of death was significantly more frequent among two-wheeler riders and pedestrians than among occupants of four-wheelers ( $\chi^2$  test,  $p < 0.05$ ), a difference attributable to the greater mechanical protection afforded by an enclosed vehicle cabin. External injuries of the abrasion and laceration type were nearly universal across the series, being recorded in 46 of the 50 cases (92.0%), while fractures of one or more long bones were documented in 31 cases (62.0%), reflecting the high-

energy blunt trauma characteristic of vehicular collisions. Viscera preserved at autopsy were forwarded for toxicological analysis in all fifty cases. Blood alcohol was detected in 14 victims (28.0%), while the remaining 36 (72.0%) tested negative. Alcohol positivity was recorded disproportionately among two-wheeler riders and among accidents occurring between 6 p.m. and midnight, a temporal clustering that reached statistical significance on Chi-square testing ( $p < 0.05$ ) and that is consistent with patterns of evening social drinking followed by driving.

Table 4: Toxicological (Blood Alcohol) Analysis of Victims (n = 50)

| Blood Alcohol Status | Frequency | Percentage |
|----------------------|-----------|------------|
| Positive             | 14        | 28.0       |
| Negative             | 36        | 72.0       |
| Total                | 50        | 100.0      |

Graph 4: Toxicological (Blood Alcohol) Analysis of Victims.



Taken together, these findings depict a fatal-injury profile dominated by young to middle-aged male two-wheeler riders sustaining fatal head injury, with alcohol use forming a preventable contributory factor in just over a quarter of all deaths examined.

### Discussion

Road traffic mortality continues to impose a heavy and largely preventable burden on Indian public health, and the medico-legal autopsy remains the single most reliable source of objective data on how these deaths actually occur.<sup>1</sup> The present series of fifty consecutive fatal cases was undertaken to build exactly this kind of locally generated evidence, and several of its findings align closely with, while a few depart in instructive ways from, previously published Indian experience<sup>4</sup>

The marked male preponderance observed in this series, 82.0% of all deaths, together with the concentration of fatalities in the 21–40-year age band, mirrors the demographic pattern repeatedly described from other Indian tertiary centres. A Karnataka series drawn from a

similar hospital catchment reported comparably high male involvement and a similar clustering in early and middle adulthood, and a Kumaon-region series described the same skew despite being conducted in a very different geographic and traffic setting.<sup>7,8</sup> The consistency of this age-sex pattern across such geographically separated studies suggests it reflects genuine differences in outdoor mobility, occupational travel and risk exposure between men and women rather than a chance finding specific to any one centre.

Two-wheeler riders formed the single largest road-user category in this series, and together with pillion riders accounted for just over half of all fatalities. This finding is broadly consistent with autopsy series from western and south-western Maharashtra, both of which identified two-wheeler occupants as the road-user group carrying the greatest fatality burden, and it echoes an autopsy study from Ranchi in which the mechanism and severity of fatal injury varied systematically according to whether the deceased had been travelling on two wheels, on four

wheels, or on foot.<sup>13,14,15</sup> The comparatively smaller share of pedestrian deaths recorded here than in some published series may reflect differences in the proportion of highway versus congested urban-road traffic feeding into the two centres rather than a genuinely lower pedestrian risk.

Head and neck injury emerged as the leading cause of death in this series, accounting for close to half of all fatalities, a finding that sits comfortably within the range reported by other Indian autopsy series in which head injury has consistently predominated as the fatal lesion.<sup>9,10</sup> At the same time, the meaningful share of deaths attributable to thoracic and abdominal trauma in the present series recalls observations from Puducherry and Rohtak, where local variation in the mix of vehicles involved appeared to shift the anatomical distribution of fatal injury away from a pure head-injury pattern.<sup>11,12</sup> Read together, these comparisons suggest that while head injury can reasonably be expected to dominate wherever helmet use remains inconsistent, the secondary pattern of thoracic, abdominal and pelvic trauma is more centre-specific and worth monitoring locally rather than assumed from published averages.

The clustering of fatal accidents in the evening and night hours observed in this series, together with the significant association between this time window and alcohol positivity, parallels findings from a Haryana-region comparative study that linked diurnal timing directly to injury severity, and from a central rural Indian series that examined how accident hour interacted with place of death.<sup>16,17</sup> The overall alcohol positivity rate of 28.0% recorded here falls within the wide range reported across Indian autopsy literature on fatal RTA victims, a spread that has been attributed at least partly to differences in analytical sensitivity and case-selection

between centres, and that argues strongly for continued locally generated toxicological surveillance rather than reliance on national or regional averages.<sup>18</sup>

From a medico-legal standpoint, these findings carry practical weight beyond simple description. Correlating autopsy findings with inquest and scene information, as textbooks of forensic pathology recommend, allowed cause of death, direction of impact and consistency with the history furnished to be established with reasonable confidence in every case in this series, reinforcing the evidentiary value of a structured, prospective data-collection protocol over retrospective record review.<sup>5,6</sup> The near-universal presence of external abrasions and lacerations, together with the high rate of long-bone fracture, further corroborates the high-energy blunt-force nature of these collisions and supports continued emphasis on primary prevention rather than injury mitigation alone.

A prospective design was deliberately chosen for this study to overcome a limitation noted repeatedly in the literature, namely that much existing Indian data on fatal RTA injury has been generated retrospectively from archived records of variable completeness.<sup>19</sup> By recording demographic, circumstantial and autopsy data directly at the time of examination, this study sought to minimise the documentation gaps that have been flagged as a recurring weakness elsewhere, an approach consistent with recommendations from other centres that have called for more systematic, real-time data capture in fatal road traffic autopsy work.<sup>20</sup>

### Recent Studies

Devi et al. conducted a retrospective study of head injury patterns among fatal road traffic accident autopsies at a medical college in Assam, examining 200 head-injury deaths drawn from a larger series of 981 autopsies over a

twelve-month period. Scalp abrasion, linear skull fracture and subdural haemorrhage emerged as the commonest findings, and the middle-aged group carried the largest share of deaths, closely mirroring the head-injury predominance observed in the present series.<sup>21</sup>

Yadav et al. examined the pattern of injury among 75 fatal road traffic accident victims autopsied at a tertiary care centre in southern Haryana. Males outnumbered females by more than five to one, the 21–30-year age group carried the largest share of deaths, and intracranial haemorrhage was the single most frequent autopsy finding, followed by rib and pelvic fracture. The male preponderance and young adult concentration reported in this Haryana series correspond closely with the demographic pattern recorded in the present study.<sup>22</sup>

Siva kumar et al. reported a one-year prospective analysis of the epidemiological profile of medico-legal autopsy cases, including road traffic fatalities, at a centre in Chennai, highlighting the continuing importance of forensic autopsy in distinguishing natural from unnatural death and in generating reliable mortality-pattern data for the criminal justice system. Their emphasis on prospective, real-time data capture directly informed the methodological approach adopted for the present study.<sup>23</sup>

Anil et al., in a two-year autopsy-based analysis of 250 fatal motorised two-wheeler crashes at a tertiary centre in south India, found that head injury was the leading cause of death, that fewer than two per cent of riders had worn a helmet, and that collisions with four-wheelers produced the most severe injury profiles. These findings reinforce the present study's observation that two-wheeler riders constitute the road-user group at greatest risk of fatal head injury and strengthen the case for mandatory and properly enforced helmet legislation.<sup>24</sup>

Certain limitations of the present study should be acknowledged before its findings are generalised. It was conducted at a single centre over a twelve-month period, and the pattern of vehicles and road types feeding into this particular mortuary may not be fully representative of other settings.

The relatively small sample of fifty cases, while adequate for descriptive analysis, limits the precision of subgroup comparisons, and the cross-sectional nature of autopsy-based data collection restricts causal inference regarding the factors examined.

### Conclusion

This prospective autopsy-based study of fifty fatal road traffic accident victims found a fatal-injury profile dominated by young to middle-aged male two-wheeler riders, with head and neck injury as the leading cause of death and polytrauma as an important secondary pattern. Alcohol was detected in just over a quarter of victims tested, a preventable contributory factor that clustered significantly in evening and night-time accidents. Two-wheeler riders and pillion riders together accounted for more than half of all deaths, reaffirming the disproportionate vulnerability of unprotected road users in mixed Indian traffic.

These findings carry direct implications for medico-legal practice, trauma-care planning and road safety policy. Consistent enforcement of helmet legislation, stricter deterrence of drink-driving, and targeted strengthening of emergency trauma response along two-wheeler-dominant traffic corridors would together be expected to reduce the mortality documented in this series. Continued prospective, centre-level surveillance of this kind remains essential for generating the locally grounded evidence on which such preventive strategies must ultimately be built.

### Limitations of The Study

- This was a single-centre study, which may limit the generalisability of the findings to other geographic and traffic settings.
- The sample size was relatively small (50 cases), which restricts the statistical precision of subgroup comparisons.
- Toxicological analysis was confined to blood alcohol estimation; screening for other psychoactive substances was not performed.
- The cross-sectional, observational design of autopsy-based data collection limits the ability to establish causal relationships between the factors examined.

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