

**To study the patterns of fatal road traffic injuries and their medico-legal characteristics: A prospective autopsy-based study at a tertiary care centre**

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Abstract

Background: Road traffic injuries (RTIs) continue to represent one of the leading causes of preventable mortality worldwide and constitute a major public health challenge, particularly in developing countries. Fatal road traffic accidents account for a substantial proportion of medico-legal autopsies performed at tertiary care hospitals. The pattern of injuries sustained during road traffic accidents is influenced by several factors, including the type of road user, mechanism of collision, speed of impact, use of protective devices, environmental conditions, and availability of timely medical care. Detailed medico-legal evaluation of fatal

road traffic injuries provides valuable information regarding injury mechanisms, cause of death, epidemiological trends, and preventive strategies aimed at reducing mortality.

Objectives: To study the patterns of fatal road traffic injuries and their medico-legal characteristics among autopsy cases conducted at a tertiary care centre, to evaluate demographic distribution, identify common injury patterns and causes of death, assess the circumstances surrounding fatal road traffic accidents, and generate evidence useful for improving road safety measures and medico-legal practices.

Materials and Methods: A prospective based observational study was conducted on 85 consecutive fatal road traffic accident victims brought for autopsy. Information regarding age, sex, type of road user, manner and mechanism of accident, survival period, external and internal injuries, associated organ damage, cause of death, and relevant medico-legal variables was collected from police records, hospital documents, relatives, and autopsy findings. Data were compiled using a structured proforma and analyzed using descriptive statistical methods.

Results: Among the 85 fatal road traffic accident victims, males constituted the majority of cases. Young adults between 21 and 40 years represented the most affected age group. Two-wheeler occupants formed the largest category of victims, followed by pedestrians. Head injury was the most frequent fatal injury, with skull fractures and intracranial hemorrhage being common autopsy findings. Multiple injuries involving the head, thorax, abdomen, and extremities were observed in a significant proportion of cases. Hemorrhagic shock and severe cranio-cerebral trauma were the predominant causes of death. Most fatalities occurred within the first 24 hours following injury.

Conclusion: Fatal road traffic injuries predominantly affect economically productive age groups and are characterized by severe head injuries and polytrauma. Systematic medico-legal analysis of autopsy findings provides valuable insights into injury mechanisms and can contribute to strengthening road safety policies, trauma care systems, and preventive interventions aimed at reducing road traffic mortality.

Keywords: Road Traffic Accident, Fatal Injuries, Medico-Legal Autopsy, Injury Pattern, Head Injury, Polytrauma, Cause of Death, Forensic Medicine.

Introduction

Road traffic accidents (RTAs) constitute one of the most significant causes of preventable morbidity and mortality throughout the world. Rapid urbanization, increasing motorization, expanding road networks, and growing population density have collectively contributed to a substantial rise in the incidence of road traffic injuries. According to international estimates, millions of individuals sustain injuries every year due to road traffic crashes, while a considerable proportion succumb to their injuries despite advances in trauma care and emergency medical services. Consequently, road traffic injuries have emerged as an important public health, social, economic, and medico-legal concern requiring multidisciplinary attention.¹⁻³

Fatal road traffic injuries not only result in loss of human life but also impose profound emotional, social, and economic consequences on families and society. Individuals belonging to the productive age group are disproportionately affected, leading to considerable loss of workforce and increased healthcare expenditure. Developing countries account for the majority of road traffic fatalities owing to rapid motorization, inadequate road infrastructure, limited enforcement of traffic regulations, delayed trauma care, and poor compliance with safety measures such as helmet and seat belt use.^{4,5}

Medico-legal autopsy plays a pivotal role in the scientific investigation of fatal road traffic accidents. Careful examination of external and internal injuries assists in determining the exact cause of death, reconstructing the mechanism of injury, correlating clinical findings with autopsy observations, and providing objective evidence for judicial proceedings. Autopsy findings also contribute significantly to

epidemiological surveillance and formulation of preventive road safety strategies.⁶⁻⁹

The pattern of injuries sustained in fatal road traffic accidents varies depending upon numerous factors including the type of road user, vehicle involved, speed of collision, direction of impact, use of protective devices, environmental conditions, alcohol consumption, and availability of emergency medical services. Vulnerable road users such as pedestrians, motorcyclists, and cyclists are particularly susceptible to severe injuries because of the absence of structural protection during impact.¹⁰⁻¹²

Head injury remains the leading cause of death in fatal road traffic accidents worldwide. Severe cranio-cerebral trauma frequently coexists with injuries involving the thorax, abdomen, pelvis, spine, and long bones, producing complex patterns of multiple trauma. Advances in imaging techniques and trauma management have improved survival in selected patients; however, autopsy continues to remain the gold standard for comprehensive evaluation of fatal injuries and accurate determination of the cause of death.^{13,14}

Several demographic and environmental factors influence the epidemiology of fatal road traffic injuries. Young adult males consistently demonstrate the highest mortality owing to greater exposure to road traffic, occupational travel, risk-taking behavior, and increased use of motorcycles. Seasonal variation, nighttime driving, alcohol intoxication, speeding, distracted driving, poor road conditions, and inadequate enforcement of traffic laws have also been recognized as important contributors to fatal accidents.^{15,16}

Understanding the medico-legal characteristics of fatal road traffic injuries provides essential information for clinicians, forensic experts, traffic engineers, public

health authorities, and policy makers. Detailed analysis of autopsy findings enables identification of preventable risk factors, supports implementation of evidence-based injury prevention programs, and facilitates improvements in emergency response systems and trauma care.^{17,18}

The present prospective autopsy-based study was therefore undertaken to evaluate the patterns of fatal road traffic injuries and their medico-legal characteristics among victims undergoing medico-legal autopsy at a tertiary care centre, with particular emphasis on demographic profile, injury distribution, mechanisms of trauma, and causes of death.

Materials and Methods

Study Design

A prospective, observational, study was conducted to evaluate the patterns of fatal road traffic injuries and their characteristics among victims

Study Setting

The study was carried out in the Department of Forensic Medicine and Toxicology of a tertiary care teaching hospital, autopsies of road traffic accident victims referred by investigating agencies were routinely performed.

Study Duration

The study was conducted over a period of 24 months.

Study Population

The study included all consecutive fatal road traffic accident victims brought for medico-legal autopsy during the study period who fulfilled the inclusion criteria.

Sample Size

A total of 85 medico-legal autopsy cases of fatal road traffic accidents were included in the present study.

Inclusion Criteria

1. All fatal road traffic accident victims subjected to medico-legal autopsy.
2. Victims of all age groups and both sexes.
3. Deaths directly attributable to injuries sustained in road traffic accidents.
4. Cases with complete police records, hospital records (where available), and autopsy findings.

Exclusion Criteria

1. Bodies with advanced decomposition preventing complete injury assessment.
2. Burnt or mutilated bodies where injury pattern could not be reliably evaluated.
3. Cases with inadequate medico-legal documentation.
4. Deaths not directly related to road traffic accidents.

Data Collection

A structured medico-legal proforma was used for data collection. Information was obtained from:

- Police inquest papers
- Hospital case records
- Emergency treatment records
- Statements of relatives or accompanying persons
- Scene investigation reports (where available)
- Detailed medico-legal autopsy findings

The following variables were recorded:

- Age
- Sex
- Type of road user
- Type of vehicle involved
- Place of accident
- Time of accident
- Survival period
- External injuries
- Internal injuries
- Cranial injuries

- Thoraco-abdominal injuries
- Skeletal injuries
- Cause of death
- Medico-legal opinion

Autopsy Procedure

All medico-legal autopsies were performed according to standard forensic protocols.

Each body underwent systematic examination including:

External Examination

- Identification details
- Clothing examination
- External injuries
- Pattern of abrasions
- Contusions
- Lacerations
- Crush injuries
- Fractures
- Tyre marks (if present)
- Patterned injuries
- Defensive injuries

Internal Examination

Detailed examination of:

- Scalp
- Skull bones
- Brain and meninges
- Cervical spine
- Thoracic cavity
- Lungs
- Heart
- Great vessels
- Abdominal organs
- Liver
- Spleen
- Kidneys

- Gastrointestinal tract
- Pelvis
- Vertebral column
- Upper and lower limbs

The type, extent, severity, and distribution of injuries were carefully documented.

The following medico-legal variables were analyzed:

Demographic Variables

- Age
- Sex

Accident-related Variables

- Road user category
- Vehicle involved
- Time of accident
- Place of accident
- Survival period

Injury Variables

- External injury pattern
- Region predominantly affected
- Skull fractures
- Intracranial hemorrhage
- Thoracic injuries
- Abdominal injuries
- Long bone fractures
- Multiple injuries

Outcome Variables

- Immediate cause of death
- Mechanism of death
- Associated fatal injuries

A total of 85 fatal road traffic accident autopsies were included in the present study. Young adults constituted the majority of victims, with males predominating over females. Two-wheeler riders and pedestrians represented the largest proportion of road users involved

in fatal accidents. Head injuries were the most frequent fatal injuries identified during autopsy, followed by multiple injuries involving the thorax, abdomen, and extremities.

Most deaths occurred within the first 24 hours after the accident, and severe cranio-cerebral trauma associated with intracranial hemorrhage emerged as the leading cause of death.

Results

Table 1: Age and Gender Distribution of Fatal Road Traffic Accident Victims (n = 85).

Age Group (Years)	Male	Female	Total	Percentage
<20	8	3	11	12.9
21–30	18	6	24	28.2
31–40	16	5	21	24.7
41–50	10	4	14	16.5
>50	10	5	15	17.7
Total	62	23	85	100

The majority of fatal road traffic accident victims belonged to the 21–40 years age group (52.9%). Males accounted for 72.9% of cases, indicating a marked male predominance among fatal road traffic injuries.

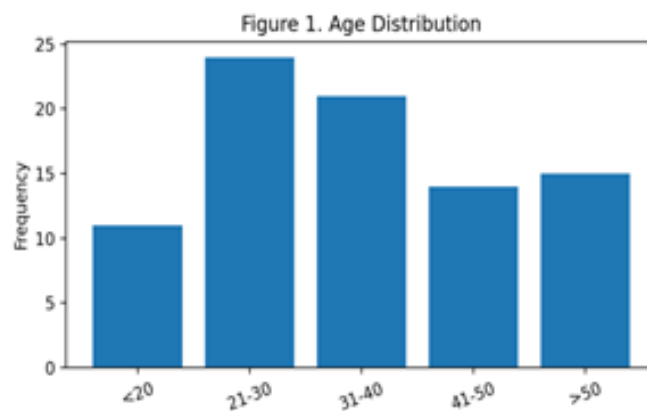


Table 2: Distribution According to Type of Road User

Road User	Frequency	Percentage
Two-wheeler rider/pillion	33	38.8
Pedestrian	20	23.5
Car occupant	14	16.5
Bicycle rider	8	9.4
Heavy vehicle occupant	5	5.9
Others	5	5.9
Total	85	100

Two-wheeler occupants constituted the largest proportion (38.8%) of fatal road traffic accident victims, followed by pedestrians (23.5%), highlighting the vulnerability of these road users.

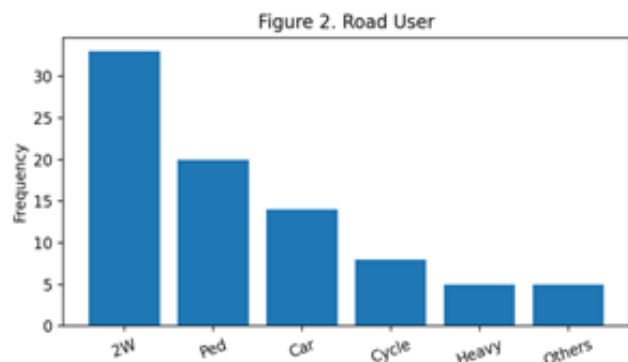
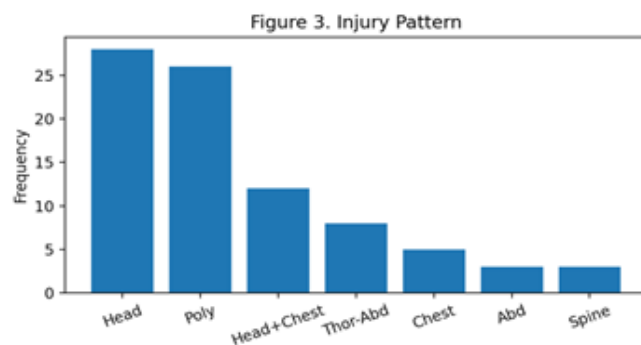


Table 3: Distribution of Major Fatal Injury Pattern (n = 85)

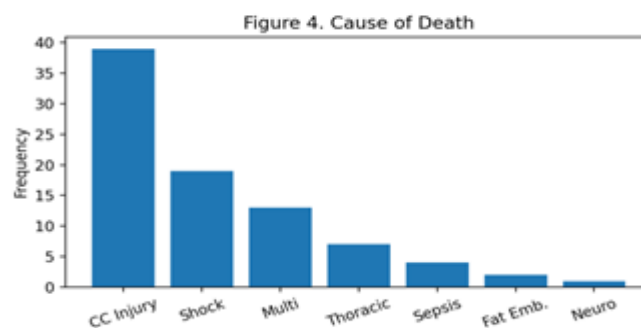
Type of Injury	Frequency	Percentage
Head injury only	28	32.9
Multiple injuries (Polytrauma)	26	30.6
Head with thoracic injuries	12	14.1
Thoraco-abdominal injuries	8	9.4
Chest injuries only	5	5.9
Abdominal injuries only	3	3.5
Spinal injuries	3	3.5
Total	85	100.0



Head injury was the predominant fatal injury pattern, accounting for 32.9% of cases. Polytrauma involving multiple body regions was observed in 30.6% of victims, reflecting the high-energy nature of road traffic accidents.

Table 4: Cause of Death Among Fatal Road Traffic Accident Victims (n = 85)

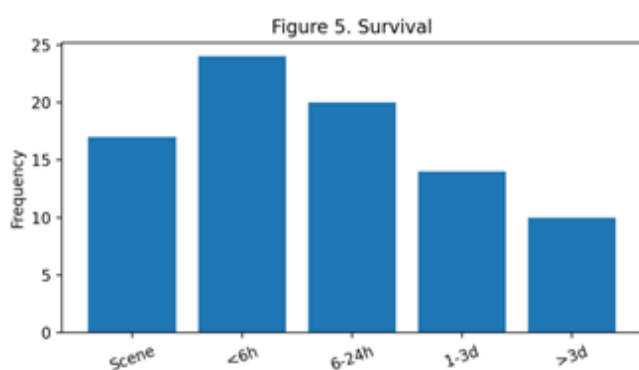
Cause of Death	Frequency	Percentage
Cranio-cerebral damage	39	45.9
Hemorrhagic shock	19	22.4
Multiple organ injuries	13	15.3
Thoracic injuries with respiratory failure	7	8.2
Septicemia following trauma	4	4.7
Fat embolism	2	2.4
Neurogenic shock	1	1.2
Total	85	100.0



Cranio-cerebral injury was responsible for nearly half (45.9%) of all fatalities. Hemorrhagic shock secondary to severe internal injuries was the second most common cause of death.

Table 5. Survival Period Following Road Traffic Accident (n = 85)

Survival Period	Frequency	Percentage
Died at the scene	17	20.0
<6 hours	24	28.2
6–24 hours	20	23.5
1–3 days	14	16.5
>3 days	10	11.8
Total	85	100.0



Nearly three-fourths (71.7%) of victims died either at the accident scene or within the first 24 hours, emphasizing the severity of injuries and the importance of timely trauma care.

Discussion

The present prospective autopsy-based study included 85 fatal road traffic accident victims. Young adults aged 21–40 years constituted the largest proportion of cases, while males were affected approximately three times more frequently than females. Two-wheeler occupants represented the most vulnerable category of road users, followed by pedestrians.

Head injury emerged as the predominant fatal injury pattern, and cranio-cerebral damage was the leading cause of death. Polytrauma involving multiple body regions was also common, indicating high-impact collisions. Most victims succumbed to their injuries

within the first 24 hours, highlighting the critical importance of rapid emergency response, efficient trauma systems, and preventive road safety measures.¹⁹

Singh et al. conducted a prospective hospital-based study evaluating fatal road traffic accident victims undergoing medico-legal autopsy at a tertiary care centre. The authors observed that young adult males constituted the majority of fatalities, with two-wheeler users being the most vulnerable group. Severe head injury and intracranial hemorrhage were identified as the leading causes of death. The study emphasized strict enforcement of helmet legislation, improved trauma care facilities, and enhanced public awareness to reduce road traffic mortality.²⁰

Kumar et al. performed an autopsy-based analysis of fatal road traffic injuries and reported that polytrauma involving the head, thorax, and abdomen was commonly encountered among victims of high-speed collisions. Most deaths occurred within the first 24 hours after injury. The investigators recommended strengthening pre-hospital emergency services and improving road infrastructure to decrease preventable fatalities.²¹

Patel et al. evaluated medico-legal characteristics of fatal road traffic accidents across multiple tertiary care hospitals. The study demonstrated that cranio-cerebral trauma remained the predominant cause of death, particularly among motorcyclists. The authors highlighted the need for strict enforcement of speed limits, compulsory helmet use, and rapid transportation of trauma victims to specialized trauma centres.²²

Sharma et al. investigated epidemiological trends in fatal road traffic injuries using medico-legal autopsy records. Young males constituted the majority of victims, while pedestrians and two-wheeler occupants accounted for a significant proportion of fatalities. The

study concluded that comprehensive road safety programmes, public education, and timely trauma intervention could substantially reduce mortality associated with road traffic accidents.²³

Gupta et al. conducted a prospective multicentre study examining fatal road traffic injuries in urban tertiary care hospitals. The investigators reported that severe head injuries, multiple organ trauma, and hemorrhagic shock remained the principal causes of death. Integration of advanced trauma systems, strict enforcement of traffic regulations, and continuous monitoring of road safety measures were recommended to reduce fatal outcomes.²⁴

Kaya et al. (2025) conducted an autopsy-based retrospective study of road-traffic-death cases in Artvin, Türkiye. Among 273 postmortem examinations reviewed from 2017–2024, 50 deaths were attributed to road traffic accidents. Males predominated, and automobiles were involved in 60% of cases. Approximately half of the victims died at the scene. Bone fractures were frequent, with thoracic fractures in 37% and skull fractures in 30%; internal-organ injuries were present in 98% of cases. Multiple body trauma was the leading cause of death (52%), followed by head trauma (20%).²⁵

Neeraj et al. (2026) performed an autopsy-based study of 236 fatal road traffic accident cases from the Varanasi region. The study found that cranio-cerebral trauma and long-bone fractures were prominent injury patterns. Head injury was the leading cause of death, accounting for 170/236 cases (72.0%), followed by shock and hemorrhage in 30/236 cases (12.7%). The authors emphasized targeted preventive strategies and improved trauma-care systems.²⁶

Conclusion

The present prospective autopsy-based study demonstrated that fatal road traffic injuries predominantly affected young adult males, representing the economically productive segment of the population. Two-wheeler occupants and pedestrians constituted the most vulnerable categories of road users.

Head injury was identified as the most frequent fatal injury, while cranio-cerebral trauma emerged as the leading cause of death. Polytrauma involving multiple body regions was commonly encountered among victims of high-impact collisions. The majority of fatalities occurred within the first 24 hours following injury, emphasizing the critical importance of rapid emergency response and organized trauma care.

The findings of this study highlight the indispensable role of medico-legal autopsy in determining the exact cause of death, understanding injury mechanisms, and generating epidemiological evidence useful for road safety planning. Strengthening enforcement of traffic regulations, promoting helmet and seat-belt use, improving road infrastructure, and establishing efficient trauma care systems are essential measures for reducing mortality due to road traffic accidents.

Limitations

- The study was conducted at a single tertiary care centre with a relatively small sample size of 85 cases.
- Only fatal road traffic accident victims undergoing medico-legal autopsy were included; non-fatal injuries were not evaluated.
- Information regarding factors such as alcohol intoxication, mobile phone use, and exact vehicle speed was unavailable in some cases.

- Long-term follow-up of hospitalized victims prior to death was not undertaken.

Declarations

Consent to participate: We have consent to participate.

Consent for publication: We have consent for the publication of this Article.

Authors' contributions: All the authors equally contributed the work.

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