International Journal of Medicine
pISSN 1468-3814 | eISSN 2667-7008
https://theinternationalmedicine.com/

Original Research Article *DOI: 10.61336/im/26-06-22*

Assessment of Risk Factors, Mode of Accidents, and Pattern of Injuries in Road Traffic Accident Patients Presenting to the Emergency Department of a Tertiary Care Centre

Umesh Bishnoi[1], Dharmendra Manderwal[2], Akhileshwar Reddy[3], Amol Gite[4]

[1]*Resident, Department of Community Medicine, National Institute of Medical Sciences & Research (NIMS&R), NIMS University Rajasthan, Jaipur, Rajasthan, India*

[2]*Professor and Head, Department of Community Medicine, NIMS&R, NIMS University Rajasthan, Jaipur, Rajasthan, India*

[3]*Senior Resident Department of Community Medicine, Dr. B.S. Tomar Institute of Medical Sciences & Research, Jagatpura, Jaipur*

[4]*Assistant Professor & Statistician ,Department of Community Medicine, NIMS&R, NIMS University Rajasthan, Jaipur, Rajasthan, India*

Correspondence:
Dr. Umesh Bishnoi,
Department of Community Medicine, NIMS&R, NH-8, Jaipur, Rajasthan 303121, India.
Email:
umeshbishnoi22@gmail.com

Received: 21-04-2026
Revised: 07-05-2026
Accepted: 19-05-2026
Published: 05-06-2026

Abstract

Background: Road traffic accidents (RTAs) represent a major global public health burden, causing approximately 1.35 million deaths annually. India reported 155,622 RTA fatalities in 2021, with emergency departments (EDs) of tertiary care centres serving as the primary interface for acute trauma management. Despite this, context-specific epidemiological data from North India remain limited. ***Objectives:*** To assess the sociodemographic profile, risk factors, mode of accidents, and injury patterns among RTA patients presenting to the ED of a tertiary care hospital in Jaipur, Rajasthan. ***Methods:*** A hospital-based cross-sectional study was conducted at the ED of NIMS&R, Jaipur, from June 2024 to December 2025. A total of 384 RTA patients were enrolled using purposive sampling. Data were collected via a pre-tested semi-structured questionnaire and analysed using SPSS version 24. ***Results:*** Males constituted 70% of victims; the most affected age group was 21–30 years (23%). Nearly half (48%) of accidents involved defective road infrastructure; fatigue (42%), drowsiness (43%), and driver vision problems (53%) were the leading human factors. Alcohol and smoking each accounted for 20% of antecedent risk factors. Traffic junctions accounted for 73% of accident-prone sites. Head-on collisions were most common (26%). Head injuries were the predominant injury type (26%), followed by internal organ injuries (20%). ***Conclusion:*** RTAs disproportionately affect young adult males in this setting. Human behavioural factors, infrastructural deficiencies, and low safety equipment use are the dominant modifiable risk factors. Targeted traffic enforcement, road safety education, infrastructure improvement at junctions, and strengthened pre-hospital care are urgently required.

Keywords: Road traffic accidents; risk factors; injury patterns; emergency department; tertiary care; Rajasthan

INTRODUCTION

Road traffic accidents (RTAs) constitute one of the most pressing global public health crises of the twenty-first century. Defined as incidents occurring on a public road involving at least one moving vehicle and resulting in death or injury, RTAs cause approximately 1.35 million fatalities annually and injure an estimated 20–50 million people worldwide. [1,2] They rank as the eighth leading cause of death globally and the single leading cause of mortality among individuals aged 5–29 years. Low- and middle-income countries (LMICs) bear over 90% of this mortality burden despite accounting for only about half of the world's vehicles. [1]

The economic consequences are equally severe, with global estimates placing road traffic injury losses at 2–3% of national GDP, rising to 5% in some LMICs. [3] Beyond direct healthcare costs, RTAs generate lasting disability and psychosocial morbidity, diminishing productive years and placing significant strain on families and health systems alike.

India bears a disproportionately high share of this burden. The Ministry of Road Transport and Highways reported 155,622 fatalities and 371,884 injuries in 2021 alone, equivalent to a death rate of 11.4 per 100,000 population. [4] Studies from tertiary trauma centres in New Delhi have documented that 84% of RTA victims are male, with a mean age of 32.7 years, and that motorised two-wheelers are involved in more than half of all incidents. [5] Despite this scale, comprehensive epidemiological data capturing risk factor profiles, accident modes, and injury patterns from North Indian tertiary care settings remain scarce.

Emergency departments (EDs) of tertiary hospitals serve as the critical first point of care for the majority of RTA victims and are therefore optimal sites for prospective epidemiological surveillance. A recent multicentre Indian study found that only 3% of road trauma victims received any form of prehospital care, underlining the importance of strengthening both emergency response systems and injury surveillance frameworks. [6]

The present study was undertaken to address this evidence gap by systematically assessing the sociodemographic characteristics, behavioural and environmental risk factors, mode of accidents, and pattern of injuries among RTA patients presenting to the ED of a tertiary care centre located on National Highway NH-8, Jaipur, Rajasthan.

MATERIALS AND METHODS

Study design and setting

A hospital-based observational cross-sectional study was conducted at the Emergency Department of the National Institute of Medical Sciences & Research (NIMS&R), a tertiary care hospital situated on National Highway NH-8, Jaipur, Rajasthan, India, from June 2024 to December 2025.

Participants

All RTA victims presenting to and admitted in the ED of NIMS&R during the study period were eligible. Patients reporting with road traffic injuries who provided written informed consent (or whose relatives consented for incapacitated patients) were included. Patients with minor injuries not requiring hospital admission, and those sustaining injuries on a road without involvement of a moving vehicle (e.g., falls on the roadway), were excluded.

Sample size and sampling

Sample size was calculated using Cochran's formula: $n = Z^2P(1-P)/d^2$, where $Z = 1.96$ (95% confidence), $P = 0.50$ (maximum variance), and $d = 0.05$ (margin of error), yielding $n = 384$. Purposive sampling was employed until the required sample was reached.

Data collection instrument

A pre-designed, pre-tested semi-structured questionnaire was administered. The instrument captured: socio-demographic variables (age, sex, education, occupation, residence, marital status, religion); driver-related variables (licence status, safety equipment use, driving duration, fatigue, drowsiness, vision status, disability); antecedent factors (alcohol, tobacco, drug use, comorbidities); personal negligence (over-speeding, rash driving, mobile phone use); environmental and temporal variables (road type, season, weather, time of accident); and injury data (body part involved, type and severity of injury). The questionnaire was piloted on 50 patients in October 2024 and revised accordingly.

Statistical analysis

Data were entered and analysed using SPSS version 24. Descriptive statistics (frequency and percentage distributions) were computed for all categorical variables. Ethical approval was obtained from the Institutional Ethics Committee of NIMS&R prior to data collection, and written informed consent was obtained from all participants.

RESULTS

Sociodemographic profile

A total of 384 RTA patients were enrolled during the study period. Males constituted 70% (n = 268) and females 30% (n = 116) of the study population. The most affected age group was 21–30 years (23%, n = 89), followed by those aged >60 years (19%, n = 73) and 31–40 years (18%, n = 71) (Table 1). Married individuals accounted for 54% and unmarried for 46%. Secondary (19%) and senior secondary (19%) education levels predominated, though 12% were illiterate. Residence was nearly equally distributed between rural (51%) and urban (49%) areas.

Table 1. Age distribution of road traffic accident patients (n = 384).

Age Group (Years)	Number	Percentage (%)
18–20	16	4
21–30	89	23
31–40	71	18
41–50	69	18
51–60	66	17
>60	73	19
Total	**384**	**100**

Driving licence status and behavioural risk factors

Only 52% (n = 201) of patients possessed a valid driving licence; 22% (n = 86) had none, and 25% were not applicable (passengers/pedestrians). Driver vision problems were the most prevalent individual risk factor (53%). Fatigue was reported in 42% and drowsiness while driving in 43% of patients. Seatbelt use was documented in only 47% and helmet use in 45% of applicable cases, while 40% in each category reported non-use (Table 2). Physical disability was present in 26% of victims, and 52% had a prior RTA history.

Table 2. Behavioural risk factors among study participants.

Risk Factor	Present n (%)	Absent n (%)	N/A n (%)
Fatigue while driving	161 (42%)	195 (51%)	28 (7%)
Sleepiness while driving	164 (43%)	210 (55%)	10 (3%)
Driver vision problems	202 (53%)	154 (40%)	28 (7%)
Seatbelt used	182 (47%)	153 (40%)	49 (13%)
Helmet used	173 (45%)	153 (40%)	58 (15%)

Antecedent and infrastructural factors

Alcohol consumption and smoking each accounted for approximately 20% of antecedent factors; drug use was present in 15%, and a medical condition in 18%. Only 9% had no identifiable antecedent risk factor. Defective road conditions were reported in 48% of cases and defective signboards in 46%. Despite 61% of respondents reporting traffic rule compliance, 39% admitted non-compliance. Among personal negligence factors, rash driving (23%) was most common, followed by mobile phone use (19%), talking to passengers (17%), and over-speeding (17%).

Environmental and temporal distribution

Traffic junctions were the predominant accident-prone sites: T-junctions (26%), four-way junctions (25%), and Y-type junctions (22%) collectively accounted for 73% of accidents. Accidents were distributed broadly across road types — city roads (29%), national highways (28%), state highways (22%), and local roads (21%). Clear weather accounted for 36% of accidents and foggy conditions for 31%. Temporal distribution was relatively uniform across morning (25%), afternoon (27%), evening (24%), and night (24%). Summer had the highest seasonal frequency (35%), followed by the rainy season (34%) and winter (31%).

Table 3. Distribution by accident-prone site.

Accident-Prone Site	Number	Percentage (%)
T-Junction (Tiraha)	99	26
Four-Way Junction (Chouraha)	96	25
Y-Type Junction	84	22
Other	84	22
Local Road	6	2
National Highway	6	2
City Road	5	1
State Highway	4	1
Total	**384**	**100**

Mode of accidents

Victims themselves were drivers in 51% of cases; 49% were passengers or pedestrians. Four-wheeled vehicles (cars, jeeps, vans, SUVs) were the most common mode of transport at the time of accident (32%), followed by motorcycles (16%) and three-wheelers (16%); pedestrians accounted for 15% (Table 4). Among documented collision types, head-on collisions were most frequent (26%), followed by sideway collisions (23%) and rear-end collisions (21%); collision type was unknown in 28% of cases (Table 5).

Table 4. Mode of transport of RTA victims.

Mode of Transport	Number	Percentage (%)
Car/Jeep/Van/SUV/Pick-up	122	32
Motorcycle	62	16
Three-Wheeler	60	16
Pedestrian	59	15
Cycle	46	12
Heavy Vehicle	35	9
To	**384**	**100**

Table 5. Type of collision among RTA patients.

Type of Collision	Number	Percentage (%)
Unknown	108	28
Head-on	100	26
Sideway	87	23
From behind	82	21
With fixed object	5	1
With animal	2	1
Total	**384**	**100**

Pattern of injuries

The head/neck/face/thorax complex and upper limbs were equally the most affected body regions (30% each), followed by lower limbs (19%), pelvis (11%), and back/abdomen (9%) (Table 6). Head injuries were the most prevalent injury type (26%), followed by internal organ/blood vessel injuries (20%), fractures (14%), crushing injuries (14%), traumatic amputations (12%), and open injuries (11%) (Table 7).

Table 6. Distribution of injured body regions (n = 384).

Body Region	Number	Percentage (%)
Head/Neck/Face/Thorax	117	30
Upper Limb	115	30
Lower Limb	74	19
Pelvis	42	11
Back and Abdomen	36	9
Total	**384**	**100**

Table 7. Type of injuries sustained by RTA patients.

Injury Type	Number	Percentage (%)
Head Injury	101	26
Internal Organ/Blood Vessel Injury	78	20
Fracture	54	14
Crushing Injury	52	14
Traumatic Amputation	47	12
Open Injury	44	11
Lower Back Injury	4	1
Muscle/Tendon Injury	4	1
Total	**384**	**100**

DISCUSSION

This hospital-based cross-sectional study of 384 RTA patients presenting to the ED of a tertiary care centre in Jaipur, Rajasthan, provides a comprehensive characterisation of the sociodemographic profile, risk factor burden, accident modes, and injury patterns in a high-volume North Indian emergency setting.

Sociodemographic profile

The predominance of young adult males (21–30 years, 23%; males 70%) is consistent with global and national literature. Misra et al. reported 84% male victims with a mean age of 32.7 years at a New Delhi trauma centre. [5] This pattern reflects greater male exposure to traffic, higher engagement in risk-taking driving behaviour, and elevated mobility among economically active young adults. The nearly equal urban–rural split (49% vs. 51%) underscores that RTAs are not solely an urban phenomenon; rural victims additionally face delayed prehospital care and limited trauma infrastructure. [7]

Behavioural and human risk factors

Fatigue (42%) and drowsiness (43%) emerged as highly prevalent human factors. Experimental and observational studies confirm that driver fatigue substantially impairs reaction time and judgment, with drowsy driving associated with distinct accident patterns characterised by late-night occurrence and single-vehicle crashes. [8] The high prevalence of driver vision problems (53%) is a notable and underreported finding; periodic vision assessment during licence renewal is not mandated in India, representing a clear policy gap.

Alcohol consumption was documented in 20% of patients — consistent with Sundet et al.'s international pooled estimate of 21.8% alcohol-related road deaths, [9] and Borges et al.'s finding of 18.9% acute alcohol positivity among ED-presenting RTA patients in a LMIC context. [10] Seatbelt use was reported in only 47% and helmet use in 45% of applicable cases. Mathew et al. similarly found that fewer than 51% of Indian motorcycle riders wore helmets. [6] Baru et al. demonstrated that riding without a helmet was independently associated with a 4.7-fold increase in severe injury risk (AOR 4.7). [11] Muslim et al. estimated that rigorous adherence to safety devices and better vehicle design could have prevented 59% of ASEAN road fatalities. [12] The 22% unlicensed driving rate and 39% traffic rule non-compliance observed here further highlight the enforcement deficit in the region.

Environmental and infrastructural factors

Traffic junctions — T-junctions, four-way crossings, and Y-junctions — collectively accounted for 73% of accident-prone sites. This convergence of vehicles from multiple directions, combined with inadequate signage (46% defective) and poor road surfaces (48% defective), creates a disproportionately high crash risk at intersection nodes. Elvik demonstrated that geometric design and surface quality improvements at junctions generate significant reductions in both collision frequency and severity. [13] The nearly uniform temporal distribution across all quarters of the day differs from some studies reporting nocturnal peaks, possibly reflecting the continuous high-traffic nature of the NH-8 corridor.

Mode of accidents and injury patterns

Head-on collisions were the most common documented mechanism (26%), followed by sideway (23%) and rear-end (21%) collisions. Four-wheeled vehicles constituted 32% of the transport modes involved, while motorcycles and three-wheelers each accounted for 16%. Although motorised two-wheelers are the dominant vehicle class in many Indian urban studies, [5] the higher proportion of four-wheeled vehicle involvement here may reflect the high-speed national highway context of the study site.

Head/neck/face/thorax injuries and upper limb injuries were equally prevalent (30% each), with head injuries constituting the leading injury type (26%). This aligns with Seid et al., who reported head injuries in 50.4% of victims, [14] and with the global literature consistently identifying the head and extremities as the most vulnerable body regions in road traffic trauma. The high proportion of internal organ injuries (20%) and traumatic amputations (12%) underscores the severity of impacts on NH-8 and the critical need for rapid, well-equipped trauma response. Woyessa et al. found that 66.1% of RTA casualties sustained multiple injuries, [15] and the combination of head injury with internal organ damage documented in this cohort represents a particularly high-acuity injury profile.

Strengths and limitations

Strengths of this study include an adequate sample size (n = 384), systematic capture of both behavioural and environmental risk factors, inclusion of rural and urban populations, and prospective data collection at the point of care. Limitations include the single-centre design, which restricts generalisability; purposive sampling, which may introduce selection bias; and self-reporting of antecedent factors (alcohol, fatigue), which is susceptible to recall and social desirability bias. Validated injury severity scoring (ISS, KTS) was not applied, limiting outcome-level analysis. Absence of a comparison group precludes causal inference, and long-term disability outcomes were not captured.

CONCLUSION

RTAs impose a substantial and preventable burden at this tertiary care ED, disproportionately affecting young adult males across both rural and urban populations. Driver fatigue, drowsiness, uncorrected vision impairment, substance use, low safety equipment adoption, and deficient road infrastructure at traffic junctions are the dominant modifiable risk factors. Head injuries and internal organ injuries constitute the most critical injury burden, reflecting high-severity collision dynamics. A multifaceted response is required: strict enforcement of helmet and seatbelt laws, mandatory periodic vision testing during licence renewal, engineering interventions at high-risk junctions, targeted anti-alcohol driving campaigns, and expansion of structured prehospital trauma care. Future multicentre prospective studies incorporating standardised injury severity scoring, objective blood alcohol measurement, and GIS-based accident mapping will be essential to generate actionable, location-specific road safety intelligence.

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