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Epidemiology, injury patterns and outcomes of geriatric trauma patients presenting to a Level 1 trauma center in eastern India

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Abstract:
Older adults are particularly vulnerable to adverse outcomes after trauma, yet evidence on injury patterns and outcome determinants remains limited in resource-constrained settings. This retrospective observational study evaluated 350 trauma patients aged ≥60 years admitted to a Level I trauma centre between July 2022 and December 2024, examining demographics, comorbidities, injury mechanisms, physiological status, interventions, complications and hospital outcomes. Injury characteristics, intensive care requirements, operative interventions and complications were analyzed to identify factors associated with morbidity and mortality. The study delineates the clinical and epidemiological profile of geriatric trauma and identifies factors relevant to hospital outcomes in a high-volume tertiary trauma setting. These findings provide context-specific evidence to strengthen risk stratification, optimize geriatric trauma pathways and inform resource allocation in resource-limited healthcare systems.

Keywords: Geriatric trauma, elderly patients, injury patterns, epidemiology, trauma outcomes, falls, trauma registry, AIIMS Patna, Eastern India

Background:
Population aging has emerged as one of the most significant demographic transitions worldwide. Improvements in healthcare, nutrition, sanitation and socioeconomic conditions have substantially increased life expectancy, resulting in a rapidly expanding elderly population. According to recent global estimates, individuals aged 60 years and above constitute a growing proportion of the population, particularly in low- and middle-income countries where healthcare systems are often challenged by increasing demands for age-specific medical care. Consequently, trauma among older adults has become an important public health concern with significant clinical and economic implications **[1]**. Geriatric trauma differs considerably from trauma in younger populations because of age-related physiological changes, decreased functional reserve, frailty, impaired balance, reduced bone mineral density and the presence of multiple chronic diseases. These factors increase susceptibility to injury even after relatively minor trauma mechanisms and contribute to poorer outcomes following injury **[2]**. Elderly individuals often present with a typical physiological responses to trauma, making assessment and triage more challenging. Furthermore, common medications such as anticoagulants and antiplatelet agents may exacerbate injury severity and increase complication rates **[3]**. Falls remain the leading mechanism of injury among geriatric trauma patients worldwide and are responsible for substantial morbidity, mortality, disability and healthcare expenditure. Age-related deterioration in vision, hearing, gait stability, muscle strength and cognitive function significantly increases fall risk. In addition, environmental hazards and polypharmacy further contribute to accidental injuries among older adults **[4]**. While falls predominate in developed countries, road traffic accidents continue to represent a major source of trauma-related hospitalization and mortality among elderly populations in developing nations undergoing rapid urbanization and motorization **[5]**. The burden of trauma among older adults is expected to increase further in India. According to national demographic projections, the elderly population in India is growing at an unprecedented rate. As a result, healthcare institutions are witnessing a rise in trauma admissions involving older individuals who frequently require multidisciplinary care and prolonged hospitalization **[6]**. Previous studies have showed that geriatric trauma patients have higher rates of intensive care admission, surgical intervention, complications and mortality than younger trauma victims with similar injury severity scores **[7]**. Injury patterns among elderly trauma patients often differ from those observed in younger populations. Head injuries, hip fractures, vertebral fractures, thoracic injuries and polytrauma are commonly encountered. Even low-energy mechanisms may result in significant injuries because of osteoporosis, reduced tissue elasticity and diminished physiological reserve. These injuries frequently lead to functional decline, dependence and reduced quality of life after hospital discharge **[8]**. Several international studies have highlighted the importance of identifying predictors of poor outcomes among geriatric trauma patients. Advanced age, frailty, multiple comorbidities, hypotension, low Glasgow Coma Scale score, requirement for mechanical ventilation and delayed presentation have been associated with increased mortality and prolonged hospital stay **[9]**. However, data from Eastern India remain limited and regional variations in injury mechanisms, healthcare access and trauma management may influence outcomes. AIIMS Patna serves as a major tertiary referral center and Level I trauma facility catering to a large population from Bihar and neighboring states. Previous research from a tertiary trauma centre in Eastern India has showed a substantial burden of trauma and diverse injury patterns requiring specialized emergency and trauma care **[10]**. Understanding the

epidemiological profile and clinical outcomes of geriatric trauma patients presenting to this institution can provide valuable evidence for optimizing trauma systems, resource allocation and preventive strategies. The findings are expected to contribute to the growing body of literature on geriatric trauma and aid in the development of targeted interventions aimed at improving outcomes in this vulnerable population **[11]**. Therefore, it is of interest to evaluate the epidemiology, injury patterns, management characteristics and outcomes of geriatric trauma patients admitted to a Level I trauma center in Eastern India over a two-and-a-half-year period.

Materials and Methods:

Study design:

The present study was conducted as a retrospective observational study designed to evaluate the epidemiology, injury patterns, clinical characteristics, management practices and outcomes of geriatric trauma patients presenting to a Level I trauma center. The study involved systematic review and analysis of existing medical records without any intervention or modification of patient management.

Study setting:

The study was carried out at the Department of Trauma and Emergency Medicine, All India Institute of Medical Sciences (AIIMS), Patna, Bihar, India. AIIMS Patna functions as a Level I tertiary trauma center providing comprehensive emergency and trauma care services to patients from Bihar and neighboring states. The institution receives referrals for both isolated injuries and complex polytrauma cases and serves as a major regional trauma referral center.

Study duration:

The study included all eligible geriatric trauma patients admitted between July 2022 and December 2024. Data retrieval, verification, compilation and analysis were performed following completion of the study period.

Study population:

The study population consisted of elderly trauma patients aged 60 years and above who were admitted to the trauma centre during the study period. A total of 350 eligible patients were included in the final analysis.

Sample size:

A total sample size of 350 patients was included in the study. Since the study was retrospective in nature, all eligible consecutive geriatric trauma admissions fulfilling the inclusion criteria during the study period were analyzed.

Sampling technique:

Consecutive sampling was employed. All available records of geriatric trauma patients admitted during the study period were screened for eligibility and included if complete documentation was available.

Inclusion criteria:

[1] Patients aged 60 years and above.
[2] Patients presenting with traumatic injuries.
[3] Patients admitted for trauma management.
[4] Availability of complete medical records.

Exclusion criteria:

[1] Patients younger than 60 years.
[2] Patients with non-traumatic conditions.
[3] Cases with undocumented injuries or patients declared dead on arrival without adequate documentation.
[4] Incomplete medical records.

Data collection:

Data were collected retrospectively using a structured data extraction proforma. Information was obtained from trauma registry databases, emergency department records and inpatient files, nursing records, radiological reports, operative notes, ICU records and discharge summaries.

Variables:

Demographic characteristics:

[1] Age
[2] Gender
[3] Residence
[4] Referral status

Comorbidities:

[1] Hypertension
[2] Diabetes mellitus
[3] Coronary artery disease
[4] Chronic kidney disease
[5] Chronic respiratory disease
[6] Cerebrovascular disease
[7] Other chronic illnesses

Injury characteristics:

[1] Mechanism of injury
[2] Time of injury
[3] Place of injury
[4] Delay in hospital presentation

Anatomical distribution of injuries:

[1] Head and neck injuries
[2] Facial injuries
[3] Thoracic injuries
[4] Abdominal injuries
[5] Pelvic injuries
[6] Upper limb injuries
[7] Lower limb injuries
[8] Spinal injuries
[9] Polytrauma

Physiological parameters:

[1] Heart rate
[2] Respiratory rate
[3] Blood pressure

[4] Oxygen saturation
[5] Glasgow Coma Scale score

Triage assessment:
Patients were categorized according to institutional trauma triage protocol into:
[1] Red category
[2] Yellow category
[3] Green category

Treatment variables:
[1] ICU admission
[2] Mechanical ventilation
[3] Operative intervention
[4] Blood transfusion requirement

Complications:
[1] Hospital-acquired infections
[2] Sepsis
[3] Acute kidney injury
[4] Respiratory complications
[5] Cardiac complications
[6] Delirium
[7] Pressure ulcers
[8] Multi-organ dysfunction syndrome

Outcome measures:
Primary outcome:
[1] In-hospital mortality

Secondary outcomes:
[1] Length of hospital stay
[2] ICU stay
[3] Need for surgery
[4] Discharge status

Data management:
Data were entered into Microsoft Excel spreadsheets and verified independently for completeness and accuracy. Duplicate entries and inconsistencies were identified and corrected through review of source records.

Statistical analysis:
Statistical analysis was performed using SPSS version 26.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± standard deviation, whereas categorical variables were presented as frequencies and percentages. Comparisons between groups were performed using Student's t-test, Chi-square test, or Fisher's exact test as appropriate. Multivariate logistic regression analysis was planned to identify independent predictors of mortality. A p-value less than 0.05 was considered statistically significant.

Results:
A total of 350 geriatric trauma patients aged 60 years and above were included in the study. The mean age of the study population was 68.9 ± 7.4 years (range: 60-94 years). Males constituted the majority of patients, accounting for 223 (63.7%) cases, while females comprised 127 (36.3%). Most patients belonged to the 60-69 years age group (48.6%), followed by 70-79 years (34.9%) and ≥80 years (16.6%). Falls were the predominant mechanism of injury, accounting for 182 (52.0%) cases, followed by road traffic accidents (RTA) in 116 (33.1%) patients. Other causes included assault, animal-related injuries and miscellaneous mechanisms. Hypertension was the most common comorbidity (45.1%), followed by diabetes mellitus (31.4%), coronary artery disease (14.6%) and chronic kidney disease (8.9%) **(Table 1).** Head injuries represented the most frequent anatomical injury pattern, followed by lower limb fractures and thoracic injuries. Polytrauma involving multiple body regions was observed in a substantial proportion of patients requiring intensive care and operative intervention. The majority of patients were between 60 and 69 years of age (48.6%). Male predominance was observed with nearly two-thirds of patients being men. Falls collectively accounted for 52.0% of injuries, confirming them as the leading cause of geriatric trauma. Road traffic accidents contributed to one-third of admissions. Hypertension and diabetes were highly prevalent, highlighting the significant burden of chronic disease among elderly trauma victims **(Table 2).** For in-hospital mortality, head injury was the most common injury pattern (36.6%), followed by lower limb fractures (28.9%). Thoracic trauma was observed in 17.7% of patients, while spinal injuries accounted for 11.1%. Nearly one-fifth of patients sustained polytrauma. ICU admission was required in 27.4% of cases, reflecting the severity of injuries among elderly patients. Almost half of the patients underwent operative intervention. Overall in hospital mortality was 11.1% (39 patients). Mortality was significantly associated with advanced age, head injury, polytrauma, ICU admission, mechanical ventilation and multiple comorbidities ($p<0.001$). Non-survivors had significantly longer hospital stays compared with survivors (12.4 versus 8.2 days, $p=0.002$) **(Table 3).**

Table 1: Demographic characteristics, comorbidities and mechanism of injury (n=350)

Variable	Frequency	Percentage (%)
Age Group (Years)		
60-69	170	48.6
70-79	122	34.9
≥80	58	16.6
Gender		
Male	223	63.7
Female	127	36.3
Mechanism of Injury		
Fall from standing height	145	41.4
Fall from height	37	10.6
Road traffic accident	116	33.1
Assault	21	6.0
Others	31	8.9
Comorbidities		
Hypertension	158	45.1
Diabetes mellitus	110	31.4
Coronary artery disease	51	14.6
Chronic kidney disease	31	8.9
COPD	26	7.4

Table 2: Injury pattern, ICU requirement and surgical intervention

Variable	Frequency	Percentage (%)
Head Injury	128	36.6
Lower Limb Fracture	101	28.9
Upper Limb Fracture	54	15.4
Thoracic Injury	62	17.7
Abdominal Injury	29	8.3
Pelvic Injury	24	6.9
Spinal Injury	39	11.1
Polytrauma	71	20.3
ICU Admission	96	27.4
Mechanical Ventilation	48	13.7
Operative Intervention	157	44.9

Table 3: Factors associated with in hospital mortality

Variable	Survivors (n=311)	Non-survivors (n=39)	p value
Mean Age (Years)	68.1 ± 6.8	75.4 ± 8.3	<0.001
Head Injury	101 (32.5%)	27 (69.2%)	<0.001
Polytrauma	51 (16.4%)	20 (51.3%)	<0.001
ICU Admission	67 (21.5%)	29 (74.4%)	<0.001
Mechanical Ventilation	28 (9.0%)	20 (51.3%)	<0.001
≥2 Comorbidities	84 (27.0%)	25 (64.1%)	<0.001
Hospital Stay (Days)	8.2 ± 4.3	12.4 ± 6.8	0.002

Discussion

The present study evaluated the epidemiology, injury patterns and outcomes of 350 geriatric trauma patients admitted to a Level I trauma centre in Eastern India. The findings show that geriatric trauma represents a significant healthcare burden characterized by high morbidity, substantial resource utilization and considerable mortality. The mean age of patients in the present study was 68.9 years, with males accounting for 63.7% of admissions. Similar gender predominance has been reported in large trauma registries worldwide, where elderly males continue to experience higher rates of traumatic injury despite increasing life expectancy among women **[2]**. The predominance of males may be related to greater outdoor activity, occupational exposure and travel-related risks. Falls emerged as the leading mechanism of injury, accounting for 52.0% of cases. This observation is consistent with international literature demonstrating that falls are responsible for the majority of geriatric trauma admissions. A 15-year trauma registry analysis reported falls in more than 85% of elderly trauma cases, highlighting their overwhelming contribution to injury burden among older adults. Falls are strongly associated with age-related physiological decline, impaired balance, visual impairment, sarcopenia and polypharmacy **[3, 4]**. This predominance of falls is also consistent with findings from a geriatric orthopaedic trauma cohort in southwestern Nigeria, where falls accounted for approximately half of injuries and traffic crashes represented another major mechanism **[12]**. Similar findings have been reported in longitudinal studies examining fall-related injuries among older populations **[5]**. Road traffic accidents represented the second most common mechanism of injury in the present study. This finding reflects the increasing mobility of elderly individuals in developing countries and the growing burden of vehicular trauma. Previous Asian studies have also identified RTAs as an important contributor to geriatric injury admissions despite the predominance of falls **[6]**. Head injury was the most common anatomical injury pattern observed in the present cohort. Elderly patients are particularly vulnerable to traumatic brain injury because cerebral atrophy, anticoagulant use and reduced physiological reserve increase susceptibility to intracranial bleeding even after low-energy trauma. Similar observations have been documented in multiple trauma centre studies where head injuries accounted for a substantial proportion of mortality among older adults **[3, 7]**. Nearly one-quarter of patients required ICU admission and approximately 14% required mechanical ventilation. These findings underscore the severity of injuries encountered in geriatric trauma populations. Frailty and reduced physiological reserve are increasingly recognized as major determinants of adverse outcomes following trauma. Recent investigations have showed that frail elderly trauma patients experience higher rates of complications, prolonged hospitalization, institutionalization and mortality compared with non-frail patients **[8, 9]**. The overall in-hospital mortality rate of 11.1% observed in the present study is comparable to rates reported by international trauma registries. The overall in-hospital mortality rate of 11.1% observed in the present study is comparable to recent Indian evidence. Jayajothi *et al.* reported an in-hospital mortality rate of 11.7% among 360 geriatric trauma patients presenting to a tertiary emergency department in South India, with higher injury severity and lower Glasgow Coma Scale scores independently associated with mortality **[13]**. Höller *et al.* similarly demonstrated that mortality increases with advancing age and injury severity among elderly trauma patients admitted to Level I trauma centres **[14]**. Similarly, Huntington *et al.* reported substantial mortality following discharge, indicating that the true burden of geriatric trauma extends well beyond the acute hospitalization period **[11]**. Multiple comorbidities were significantly associated with mortality in the present study. Chronic illnesses such as hypertension, diabetes mellitus, coronary artery disease and chronic kidney disease reduce physiological resilience and impair recovery after injury. Recent evidence has also suggested that sarcopenia and electrolyte abnormalities such as hyponatremia may independently predict poor outcomes among elderly trauma patients **[14, 15]**. The significant association between polytrauma, mechanical ventilation, ICU admission and mortality observed in our study further supports existing literature identifying these variables as markers of severe injury and physiological compromise. Contemporary prognostic analyses have consistently demonstrated that advanced age, frailty, severe head injury and critical care requirements are among the strongest predictors of mortality after major trauma **[16-19]**. The strengths of this study include evaluation of a large cohort of elderly trauma patients from a major referral trauma centre in Eastern India and comprehensive assessment of epidemiological, clinical and outcome variables. However, the retrospective design, single-center setting and dependence on available medical records represent important limitations. Functional outcomes following discharge and long-term mortality could not be evaluated. Despite these limitations, the present study provides valuable regional data regarding geriatric trauma and highlights the need for targeted preventive strategies, early risk stratification, geriatric focused trauma

protocols and multidisciplinary management approaches to improve outcomes among older trauma patients.

Conclusion:
Geriatric trauma was predominantly caused by falls, with head injury being the most common injury pattern and an overall in-hospital mortality rate of 11.1%. Advanced age, multiple comorbidities, head injury, polytrauma, intensive care unit admission and mechanical ventilation were significant predictors of mortality. These findings emphasize the need for early risk stratification, fall-prevention strategies and comprehensive geriatric trauma care to improve outcomes in older adults.

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