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Original Research

Injury Epidemiology in Emergency Departments in Tbilisi, Republic of Georgia: A Multicenter Study

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Introduction: Injuries are a major cause of mortality, disability, and economic loss worldwide, disproportionately affecting low- and middle-income countries. In the Republic of Georgia, limited emergency department–level data constrain evidence-based injury prevention and trauma care planning. This study aimed to describe the epidemiological profile of injuries presenting to hospital emergency departments.

Methods: A retrospective observational study was conducted using data extracted from hospital electronic medical records and organized into a predefined injury registry dataset from selected tertiary, multi-profile hospitals in Tbilisi, Republic of Georgia. All patients presenting with acute physical injuries or acute poisoning/toxic exposure were included. Descriptive statistics, chi-square tests, and multivariable binary logistic regression were applied. Statistical significance was set at $P < 0.05$.

Results: A total of 12,563 patients were analyzed; 67.0% were male, the mean age was 24.5 years (SD 15.3), and the median age was 21 years (IQR 16–29). Individuals aged 17–65 years accounted for 51% of cases. Falls were the leading injury mechanism (47%), followed by road traffic injuries (16%). Contusions (18%) and fractures (16.3%) were the most common injury types, with upper extremities (28%) and head injuries (24%) most frequently affected. Most injuries occurred at home (40%). Nearly 80% of patients were discharged within 24 hours, while 20.1% required hospitalization or intensive care. Road traffic injuries were independently associated with higher odds of hospital-level care. Overall, emergency department mortality was 0.6%.

Conclusions: Injury-related emergency department presentations in tertiary hospitals in Tbilisi, Republic of Georgia, primarily affected young and working-age populations, placing substantial demands on emergency care. Targeted prevention, improved road and home safety, strengthened emergency medical services, and a national injury surveillance system are urgently needed.

Keywords: Injury epidemiology; Emergency department; Trauma; Road traffic injuries; Injury severity; Georgia

Injuries are among the leading causes of mortality and disability worldwide. According to estimates from the 2021 *Global Burden of Disease* study, injuries were responsible for approximately 4.34 million deaths, accounting for about 8% of all deaths globally.[1] Traumatic injuries also contribute substantially to the burden of disability, representing nearly 10% of total morbidity.[2]

More than 90% of injury-related deaths occur in low- and middle-income countries, placing a disproportionate burden on developing nations where health system resources are often limited.[3]

The World Health Organization estimates that injuries impose a substantial economic burden on both affected individuals

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Table 1. Demographics of patients by age group

	<17	17-65	>65	Total
Sex				
Male	3312 (68)	4567 (71)	583 (46)	8462 (67)
Female	1532 (32)	1896 (29)	673 (54)	4101 (33)
Total	4844 (39)	6463 (51)	1256 (10)	12563 (100)
Injury occurred in:				
Urban	3659 (76)	5083 (79)	1023 (81)	9765 (77.7)
Rural	997 (21)	1255 (19)	198 (16)	2450 (19.5)
Unknown	188 (4)	125 (2)	35 (3)	348 (2.8)
Mode of Arrival				
Ambulance	3500 (72)	3345 (52)	995 (79)	7840 (62)
Private/public transport	1344 (28)	3118 (48)	261 (21)	4723 (38)
Place of occurrence				
Home	2578 (53)	1678 (26)	832 (66)	5088 (40)
Transport area: public highway, street, or road	594 (12)	1397 (22)	176 (14)	2167 (17)
School, educational area	378 (8)	0	0	378 (3)
Sports area	319 (7)	164 (3)	0	483 (4)
Industrial/Construction area	0	281 (4)	43 (3)	324 (3)
Recreational area	176 (4)	112 (2)	16 (1)	304 (2)
Commercial area	92 (2)	87 (1)	0	179 (1)
Other	84 (2)	90 (1)	35 (3)	209 (2)
Unspecified	623 (13)	2654 (41)	154 (12)	3431 (27)
Total	4844 (39)	6463 (51)	1256 (10)	12563

Note: Values of 0 indicate that no cases were recorded in that category; they do not represent missing data.

and their families, as well as on national economies as a whole. This burden includes not only direct medical costs, but also indirect costs related to lost productivity and broader economic losses.

The financial burden of injuries is unevenly distributed across countries and regions. For example, road traffic injuries account for approximately 2% of gross domestic product (GDP) in high-income countries, whereas in low- and middle-income countries this figure reaches nearly 6%, reflecting significant socioeconomic inequalities in health outcomes.[4]

In Georgia, injury-related mortality accounted for 4.3% of all deaths in 2020, indicating injuries represent a major public health and healthcare challenge for the country.[5] Beyond premature mortality, injuries are a leading cause of disability and loss of work capacity, thereby imposing a considerable social and economic burden on individuals, families, and society as a whole. Understanding the epidemiology of injuries is essential for effective injury prevention, identification of risk factors, reduction of disability, prevention of mortality, and the development of appropriate treatment strategies and health policies.

In Georgia, as in many other low- and middle-income countries, evidence-based data on injuries remain limited. This is primarily due to the absence of a comprehensive and integrated injury surveillance and registration system. Existing official statistics mainly rely on injury-related mortality and hospitalization data, which fail to capture the true magnitude and structure of traumatic injuries. In particular, the epidemiology of injury-related visits to hospital emergency departments remains insufficiently studied, despite the fact that a substantial proportion of injury cases are managed at this level of care.

The aim of this study is to characterize the epidemiological profile of injuries in Georgia at the emergency department level. The findings are expected to support evidence-based

policymaking, strengthen injury prevention strategies, improve the emergency medical care system, and promote more efficient allocation of healthcare resources.

Methods

Study Design

This study is a retrospective observational analysis aimed at examining the epidemiological characteristics, injury severity, and emergency department outcomes of trauma patients at the emergency department (ED) level. The study covers a one-year period, from January 1 to December 31, 2025.

Study Setting

This study was conducted in the emergency departments of 10 tertiary multidisciplinary hospitals located in Tbilisi, Republic of Georgia. To preserve institutional confidentiality, hospitals were coded as Hospital 1 through Hospital 10. The contribution of each hospital to the total study population is presented in Supplementary Table 1 (available online).

The included hospitals comprised both public and private tertiary-level medical institutions that provide 24-hour emergency services and function as major referral centers for trauma care. These hospitals were selected based on official health system statistics indicating they consistently report the highest annual volumes of trauma-related emergency department visits and hospitalizations in the country. Together, they serve a large urban catchment population and receive referrals not only from Tbilisi but also from surrounding regions, particularly for moderate to severe injuries requiring specialized care.

All facilities included were equipped with advanced diagnostic capabilities, including imaging and laboratory services, as well as surgical departments and, where applicable, intensive care units. These resources allowed the hospitals to manage a wide spectrum of traumatic injuries. As such, the selected hospitals represent the core of Georgia's urban emergency and trauma care infrastructure.

Data Sources

Data were retrospectively extracted from hospital electronic medical records and organized into a predefined injury registry dataset for analysis. The dataset should be interpreted as an electronic medical record (EMR)-based injury registry dataset rather than as a prospectively maintained, nationally governed trauma registry comparable to internationally established systems such as the National Trauma Data Bank or American College of Surgeons Trauma Quality Improvement Program.

The registry dataset included standardized fields for demographic characteristics, injury mechanism, injury type, anatomical site, injury severity, mode of arrival, time from injury occurrence to emergency department arrival, disposition, and treatment outcome. Data were extracted from routinely recorded clinical and administrative documentation at participating hospitals. Basic data consistency checks were performed to identify duplicate visits, repeat visits for the same injury, implausible values, and incomplete records for key variables.

No publicly available national registry protocol or formal external validation system was available for this dataset. Inter-rater reliability was not formally assessed. Therefore, the findings should be interpreted in light of the limitations inherent to retrospective EMR-based data extraction, including possible variation in documentation practices across hospitals and incomplete recording of selected variables.

Inclusion criteria comprised all cases of acute physical injury for which patients presented to the emergency department for diagnostic evaluation, investigation, or treatment and that corresponded to injury categories defined in the registry dataset. Acute poisoning and toxic exposure were also included because these conditions are captured within the same registry framework for injury, poisoning, and external causes.

Exclusion criteria included adverse effects and complications related to medical, surgical, or other healthcare interventions; psychological harm and psychological consequences of trauma; emergency department visits not related to traumatic injuries; and repeat visits to the emergency department for the same injury.

Potential Sources of Bias

Several potential sources of bias were considered. Selection bias may have occurred because the study was restricted to selected tertiary multidisciplinary hospitals in Tbilisi, which may overrepresent urban injury patterns and patients with moderate to severe injuries referred for specialized care. Information bias may have resulted from retrospective EMR-based data extraction and variation in routine documentation practices across participating hospitals. Transfer or referral bias may also have occurred because the included hospitals function as major trauma referral centers and receive patients from surrounding regions, potentially increasing the proportion of more severe cases. To reduce classification error, data were organized using predefined registry fields, ICD-10–aligned mechanism and diagnosis categories, and basic consistency checks for duplicate records, implausible values, and incomplete key variables. These potential biases are further addressed in the Limitations section.

Study Population

The study population included both patients who were admitted to hospital wards from the emergency department for further observation and treatment and patients who were discharged home after completion of diagnostic procedures and treatment and received outpatient care. The study population was stratified into three age groups: <17 years,

17–65 years, and >65 years. These categories were defined *a priori* to reflect clinically and epidemiologically meaningful life-course groups: children and adolescents, working-age adults, and older adults. Age-stratified injury reporting is recommended in injury surveillance frameworks because injury mechanisms, exposure patterns, physiological vulnerability, care needs, and outcomes differ substantially across the life course. The 17–65-year group was used to represent the working-age and economically productive population, which is particularly relevant for assessing the public health and socioeconomic burden of injuries. The threshold of >65 years was used to define older adults, consistent with common practice in trauma and geriatric injury research, although some trauma systems apply lower age thresholds depending on local triage criteria.[6-8]

Variables and Data Structure

Collected data included patients' demographic characteristics (age, sex), injury-related characteristics (date of injury, location of occurrence, intent, activity at the time of injury,

Table 2. Distribution of injury characteristics by age group

	<17	17-65	>65	Total
Mechanism of injury				
Fall	2502 (52)	2496 (39)	845 (67)	5843 (47)
Road traffic injuries	587 (12)	1243 (19)	119 (9)	1949 (16)
Exposure to mechanical forces	693 (14)	867 (13)	123 (10)	1683 (13)
Other external causes	695 (14)	931 (14)	65 (5)	1691 (13)
Unknown	25 (1)	123 (2)	11 (1)	159 (1)
Type of traumatic injury				
Contusion, bruise	1054 (22)	974 (15)	286 (23)	2314 (18)
Sprain and strain	603 (12)	1231 (19)	145 (12)	1979 (15.8)
Open wound and abrasion	1026 (21)	784 (12)	123 (10)	1933 (15)
Fracture	552 (11)	1123 (17)	376 (30)	2051 (16.3)
Concussion/brain injury	592 (12)	765 (12)	162 (13)	1519 (12)
Dislocation and subluxation	403 (8)	32 (0)	25 (2)	460 (4)
Multiple injuries	34 (1)	52 (1)	0 (0)	86 (1)
Injury to muscle and tendon, blood vessels and nerves	17 (0)	27 (0)	13 (1)	57 (0)
Other	51 (1)	89 (1)	6 (0)	146 (1)
Unknown	15 (0)	8 (0)	9 (1)	32 (0)
Clinical condition				
Acute poisoning/toxic exposure	497 (10)	1378 (21)	111 (9)	1986 (15.8)
Part of the body injured				
Head/skull	1761 (36)	1015 (16)	261 (21)	3037 (24)
Face	517 (11)	402 (6)	45 (4)	964 (8)
Neck	5 (0)	32 (0)	0	37 (0)
Thoracic/lumbar spine	37 (1)	187 (3)	87 (7)	311 (2)
Chest wall	123 (3)	563 (9)	76 (6)	762 (6)
Abdominal wall	35 (1)	27 (0)	24 (2)	86 (1)
Upper extremity	1553 (32)	1692 (26)	316 (25)	3561 (28)
Lower extremity	640 (13)	1587 (25)	269 (21)	2496 (20)
Internal organs	13 (0)	32 (0)	4 (0)	49 (0)
Multiple body parts	32 (1)	76 (1)	16 (1)	124 (1)
Other	128 (3)	850 (13)	154 (12)	1132 (9)
Unknown	0	0	4 (0)	4 (0)
Total	4844	6463	1256	12563

Note: Acute poisoning/toxic exposure is presented as a distinct clinical condition rather than as a mechanism of injury or anatomical injury type.

mechanism of injury, type of injury, anatomical site of injury, and injury severity), mode of arrival at the hospital, and time elapsed from injury to hospital arrival.

The available time-related variable was the interval from injury occurrence to emergency department arrival. Emergency department waiting time, triage-to-physician time, and the interval from hospital arrival to initiation of treatment were not consistently recorded across all participating hospitals and therefore were not included in the analysis.

Injury Classification and Conceptual Framework

To ensure conceptual clarity and internal consistency, injuries in this study were classified using a structured framework that clearly distinguishes between the mechanism of injury, type of injury, clinical condition, and injury severity. Mechanism of injury refers to the external event or physical force that directly caused the injury. In the present study, mechanisms of injury were categorized as road traffic crashes, falls, exposure to mechanical forces (e.g., being struck by or against objects), and other external causes. Other external causes represented mechanisms that could not be reliably reclassified into the main clinically coherent categories based on the available retrospective EMR documentation; therefore, they were retained as a separate category. Mechanism categories were defined in accordance with the external cause framework of the World Health Organization's International Classification of Diseases (ICD-10).[9]

The type of injury describes the anatomical or pathological nature of the injury sustained as a result of the external mechanism. Injury types were classified into mutually exclusive categories, including contusion/bruise, fracture, open wound, dislocation, burn, and other specified traumatic injuries. These categories correspond to ICD-10 Chapter XIX (injury, poisoning and certain other consequences of external causes) and reflect the primary injury diagnosis recorded at the emergency department.

Clinical conditions, such as acute poisoning or toxic exposure, were treated as a distinct analytical category rather than as a mechanism or injury type. In this study, poisoning was defined as a clinical condition resulting from the ingestion, inhalation, or exposure to toxic substances, including medication overdose and chemical intoxication, and was classified in line with ICD-10 codes T36–T65.

Injury severity was assessed using a locally applied six-level ordinal clinical severity classification used in participating hospitals for emergency department documentation and disposition planning. This classification is not equivalent to internationally standardized anatomical trauma scoring systems such as the Injury Severity Score (ISS), Abbreviated Injury Scale (AIS), or Revised Trauma Score (RTS), and no underlying continuous severity score was available in the dataset. Operational definitions of the local clinical injury severity classification are provided in Supplementary Table 2 (available online).

The six categories were defined according to treatment need, physiological support, and disposition as follows: mild injuries required no active treatment; moderate injuries required ambulatory treatment only; serious injuries required hospitalization without intensive care; severe injuries required intensive care unit monitoring and/or treatment; critical injuries required intubation, mechanical ventilation, vasopressor support, or comparable advanced life-support interventions; and maximal injuries were incompatible with life.

Because this was a locally applied ordinal clinical classification rather than a validated international severity score, it was used descriptively and to define clinically meaningful binary outcomes for regression analysis. Mild and moderate injuries, which did not require inpatient care, were used as the reference category. The absence of a validated continuous severity score limits direct comparability with studies using ISS, AIS, or RTS and is acknowledged as a study limitation.

Statistical Analysis

Statistical analyses were conducted using IBM SPSS Statistics version 23.0 (IBM Corp., Armonk, NY, USA), which was the licensed statistical software available in the authors' institutional environment at the time of analysis. All statistical procedures reported in this study, including descriptive statistics, normality testing, chi-square tests, Fisher's exact test with Monte Carlo correction where appropriate, multivariable binary logistic regression, interaction testing, collinearity diagnostics, ROC-based assessment of model discrimination, and the Hosmer–Lemeshow goodness-of-fit test, are supported by this software version.

Descriptive statistics were used to summarize patient demographics, injury characteristics, mechanisms, injury types, severity categories, and clinical outcomes. Categorical variables are presented as frequencies and percentages. Continuous variables are reported as means with standard deviations (SD) and, where distributions were skewed, as medians with interquartile ranges (IQR).

Normality of continuous variables was assessed using visual inspection of histograms and Q–Q plots, together with the Shapiro–Wilk test. Variables with non-normal distributions were summarized using medians and interquartile ranges (IQRs), while normally distributed variables were summarized using means and standard deviations.

Bivariate analyses were performed to examine associations between age group, sex, injury mechanism, injury type, and injury severity. Differences between categorical variables were

Table 3. Distribution of patients by injury severity

Severity of injury	n	%
Mild (no treatment required)	260	2.1
Moderate (requires outpatient treatment only)	9778	77.8
Serious (requires hospitalization without intensive care unit)	2278	18.1
Severe (requires observation and/or treatment in intensive care unit)	134	1.1
Critical (requires intubation, mechanical ventilation, or use of vasopressors)	96	0.8
Maximal (incompatible with life)	17	0.1

assessed using the chi-square test of independence. Where expected cell counts were less than 5, Fisher's exact test or Monte Carlo correction was used as appropriate. Because multiple bivariate comparisons were performed, no formal adjustment for multiple comparisons was applied. These bivariate analyses were interpreted as exploratory and hypothesis-generating rather than confirmatory, while the multivariable logistic regression model was used as the primary adjusted analysis. Statistical significance was set at $P < 0.05$.

Injury severity was analyzed as an ordinal categorical variable in descriptive analyses. Because no validated continuous severity score was available and the six-level severity variable was highly imbalanced, ordinary least-squares linear regression was not used. For regression analysis, severity was dichotomized into a clinically meaningful outcome: injury requiring hospital-level care versus injury not requiring hospital-level care. Hospital-level care was defined as serious, severe, critical, or maximal injury, corresponding to admission to an inpatient ward or ICU-level care. Mild and moderate injuries were classified as not requiring hospital-level care.

Multivariable binary logistic regression was used to examine factors associated with hospital-level care. The main independent variable was the injury mechanism/condition category, classified as falls, road traffic injuries, exposure to mechanical forces, other external causes, and acute poisoning/toxic exposure, with falls used as the reference category.

For regression analysis, a mutually exclusive mechanism/condition variable was constructed hierarchically. Cases recorded as acute poisoning/toxic exposure were first assigned to the acute poisoning/toxic exposure category. All remaining acute physical injury cases were then classified according to their recorded external mechanism as falls, road traffic injuries, exposure to mechanical forces, or other external causes. Thus, each patient contributed to only one mechanism/condition category in the regression model. Cases with unknown mechanism/condition status or missing covariate data were excluded from the complete-case regression analysis.

The model was adjusted for age group, sex, urban/rural injury occurrence, mode of arrival, and time from injury occurrence to emergency department arrival. Adjusted odds ratios (aORs) with 95% confidence intervals (CIs) and *P* values were reported. To assess whether the association between injury mechanism and hospital-level care differed by age group, formal interaction terms between age group and injury mechanism were tested in the multivariable logistic regression model. If statistically significant interaction was observed, age-stratified models were planned. If interaction terms were not statistically significant, the pooled adjusted model was retained, with age group included as an adjustment variable.

Missing or unspecified categories were retained in descriptive analyses to transparently present data completeness. Data completeness was high for most variables; however, missing or unspecified values were present for selected registry fields, primarily reflecting incomplete routine documentation. Because missingness occurred mainly in routinely recorded categorical registry fields rather than patient-reported variables, no imputation was performed. Regression analyses were restricted to complete cases for variables included in the model (N = 11,985). The study was reported in accordance with the STrengthening the Reporting of OBservational studies in Epidemiology (STROBE) guidelines.

Ethical Considerations

Patients' personal data were anonymized and encrypted in electronic medical records, precluding individual identification. Prior to study initiation, ethical approval was obtained from the Research Ethics Committee (CU No. 2025-012).

Results

During the one-year study period, a total of 12,563 patients presented to the emergency departments of the participating hospitals with a primary diagnosis of trauma. Of these, 67% were male (n = 8,462). Patients' ages ranged from 0 to 83 years, with a mean age of 24.5 years (SD = 15.3) and a median age of 21 years (IQR 16–29 years). The largest proportion of trauma patients belonged to the 17–65-year age group (n = 6,463; 51%) (Table 1).

The majority of patients were urban residents (n = 9,765; 77.7%). The most common mode of arrival at the emergency department was ambulance transport (n = 7,840; 62%). The

most frequent location of injury occurrence was the home environment (40%; n = 5,088), followed by transportation-related settings, including roads, streets, and highways (17%; n = 2,167), and sports and recreational areas (4%; n = 483) (Table 1). The leading causes of injury-related and acute poisoning/toxic exposure emergency department visits were falls (47%; n = 5,843), road traffic injuries (16%; n = 1,949), exposure to mechanical forces (13%; n = 1,683), and other external causes (13%; n = 1,691). Acute poisoning/toxic exposure was recorded separately as a distinct clinical condition in 1,986 cases (15.8%). Among injury types, contusions/bruises were most frequently recorded (18%; n = 2,314), followed by fractures (16.3%; n = 2,051). The most commonly affected anatomical site was the upper extremity (28%; n = 3,561), followed by the head (24%; n = 3,037) and the lower extremity (20%; n = 2,496) (Table 2).

Data completeness was high for most key variables. Unknown values were recorded for injury occurrence location in 348 cases (2.8%), injury mechanism in 159 cases (1.3%), injury type in 32 cases (0.3%), and anatomical site in 4 cases (<0.1%). The highest proportion of incomplete information was observed for place of occurrence, where 3,431 cases (27.3%) were recorded as unspecified. Because place of occurrence was a descriptive contextual variable and had a high unspecified proportion, it was not included in the multivariable regression model. Regression analyses were restricted to complete cases for variables entered into the model; 11,985 of 12,563 records were included in the final model, while 578 records were excluded because of missing covariate data.

Acute poisoning/toxic exposure was recorded as a distinct clinical condition in 1,986 cases (15.8%). In accordance with the study's conceptual framework, poisoning was not treated as a traumatic injury mechanism or anatomical injury type, but as an injury-related clinical condition captured within the registry. However, the registry did not consistently capture the specific toxic agent involved or the intentionality of exposure across all participating hospitals. Therefore, poisoning cases could not be further stratified by substance type or by accidental versus intentional exposure.

Following emergency department management, 79.9% of patients (n = 10,038) were discharged home. Among these, the majority (77.8%; n = 9,778) were classified as having moderate injuries requiring outpatient treatment only and were discharged within 24 hours after completion of ambulatory care. Mild injuries not requiring treatment were identified in 2.1% of cases (n = 260) (Table 3).

A total of 20.1% of patients (n = 2,525) required hospital admission to inpatient wards or the intensive care unit (ICU). Of

Table 4. Multivariable logistic regression for hospital-level care

Variable	Adjusted OR	95% CI	*P* value
Injury Mechanism/Condition Category (Ref: Falls)			
Road Traffic Injury	1.56	1.32–1.84	<0.001
Mechanical Forces	1.21	1.02–1.43	0.028
Other External Causes	1.05	0.89–1.24	0.542
Acute poisoning/toxic exposure	0.88	0.74–1.05	0.165
Age Group (Ref: 17–65 years)			
< 17 years	0.78	0.68–0.89	<0.001
> 65 years	1.45	1.22–1.72	<0.001
Sex (Ref: Female)			
Male	1.12	0.98–1.28	0.091
Mode of Arrival (Ref: Private/Public)			
Ambulance	1.62	1.42–1.85	<0.001
Urban vs. Rural (Ref: Urban)			
Rural	1.28	1.08–1.52	0.004
Time to Emergency Department Arrival (Ref: <1 hour)			
1–2 hours	1.15	0.98–1.35	0.086
2–4 hours	1.28	1.05–1.56	0.015
> 4 hours	1.42	1.18–1.71	<0.001

Note: Outcome: hospital-level care, defined as serious, severe, critical, or maximal injury according to the registry severity classification. Mild and moderate injuries were used as the reference outcome category. Regression analyses were performed using complete cases for variables included in the model; 11,985 of 12,563 records were included in the final model, while 578 records were excluded because of missing covariate data. Adjusted OR = adjusted odds ratio; CI = confidence interval.

these, 18.1% (n = 2,278) were admitted to hospital wards due to serious injuries, while 2% (n = 247) were transferred to the ICU. Among ICU patients, 1.1% (n = 134) were classified as severe, requiring ICU monitoring and/or treatment; 0.8% (n = 96) were classified as critical, requiring intubation, mechanical ventilation, or vasopressor support; and 0.1% (n = 17) sustained maximal injuries incompatible with life. The highest hospitalization rate was observed among patients aged >65 years (36%), whereas the lowest rate was found among patients aged <17 years (17%).

For regression analysis, hospital-level care was defined as serious, severe, critical, or maximal injury. A total of 2,525 patients (20.1%) met this outcome definition, while 10,038 patients (79.9%) had mild or moderate injuries and did not require hospital-level care.

To assess the stability of the regression model and the distribution of outcome events across mechanism categories, the number of hospital-level care events was examined for each injury mechanism category. Outcome events were present across all main mechanism groups, and the total number of events was sufficient for the number of parameters included in the multivariable model. The distribution of hospital-level care events by injury mechanism is presented in Supplementary Table 3 (available online).

In multivariable binary logistic regression, road traffic injuries, exposure to mechanical forces, older age, ambulance transport, and rural injury occurrence were independently associated with higher odds of hospital-level care (Table 4). In multivariable binary logistic regression, road traffic injuries were independently associated with higher odds of hospital-level care compared with falls (aOR = 1.56; 95% CI: 1.32–1.84; $P < 0.001$). Exposure to mechanical forces was also associated with increased odds of hospital-level care (aOR = 1.21; 95% CI: 1.02–1.43; $P = 0.028$). Other external causes and acute poisoning/toxic exposure were not significantly associated with hospital-level care compared with falls.

Age was independently associated with hospital-level care. Compared with patients aged 17–65 years, children and adolescents aged <17 years had lower odds of hospital-level care (aOR = 0.78; 95% CI: 0.68–0.89; $P < 0.001$), whereas patients aged >65 years had higher odds (aOR = 1.45; 95% CI: 1.22–1.72; $P < 0.001$). Male sex was not independently associated with hospital-level care after adjustment (aOR = 1.12; 95% CI: 0.98–1.28; $P = 0.091$).

Ambulance transport was associated with higher odds of hospital-level care compared with private or public transport (aOR = 1.62; 95% CI: 1.42–1.85; $P < 0.001$). Injuries occurring in rural areas were also associated with increased odds of hospital-level care compared with urban injuries (aOR = 1.28; 95% CI: 1.08–1.52; $P = 0.004$).

Multivariable binary logistic regression was performed to identify factors associated with hospital-level care. The model was adjusted for age group, sex, urban/rural setting, mode of arrival, and time from injury occurrence to emergency department arrival. Formal interaction terms between age group and injury mechanism were tested to assess potential effect modification in the association with hospital-level care. No statistically significant interaction was observed (P for interaction = 0.245); therefore, the pooled multivariable logistic regression model was retained, with age group included as an adjustment variable. No evidence of multicollinearity was observed among candidate predictors, as all variance inflation factor values were below 2.0. The model demonstrated acceptable discrimination (C-statistic = 0.72) and adequate calibration according to the Hosmer–Lemeshow goodness-of-fit test ($P = 0.308$). Table 5 presents the distribution of fatal and non-fatal injuries by age group and sex. During the study period, 81 deaths were recorded, corresponding to a mortality rate of 0.6%. The highest number of deaths occurred among patients aged 17–65 years (n = 57).

Table 5. Emergency department treatment outcomes by age and sex

Age groups	Treatment outcomes	Female	%	Male	%	Total
	Non-fatal	1528	32	3304	68	4832
<17	Fatal	4	33	8	67	12
	Total	1532	32	3312	68	4844
	Non-fatal	1881	29	4525	71	6406
17-65	Fatal	15	26	42	74	57
	Total	1896	29	4567	71	6463
	Non-fatal	669	54	575	46	1244
>65	Fatal	4	33	8	67	12
	Total	673	54	583	46	1256
	Total	4101	33	8462	67	12563

Nearly half of patients (48.2%; n = 6,054) arrived at the emergency department within one hour of injury; 25.7% (n = 3,228) arrived within 1–2 hours; 11.0% (n = 1,387) within 2–4 hours; and 15.1% (n = 1,894) more than four hours after injury. Because cross-tabulated estimates by injury location and mode of transport could not be reliably reconciled across all registry fields, subgroup-specific percentages for urban/rural injury location and ambulance transport were not reported. The overall distribution of time from injury to emergency department arrival is presented in Table 6.

Discussion

The study demonstrated a significant association between sex and the occurrence of trauma, with injuries being substantially more frequent among males than females. This finding is consistent with epidemiological studies conducted in other countries, particularly in low- and middle-income countries (LMICs), as well as with previous research carried out in Georgia.[10-12] This pattern may reflect differences in exposure to injury-related environments and mechanisms, including motor vehicle transport and physically demanding work, which have been reported in trauma epidemiology studies examining injury mechanisms by demographic characteristics.[13]

Female patients appeared to have a higher hospitalization rate in the observed data; however, the registry did not allow a detailed assessment of whether this pattern was related to injury mechanism, interpersonal violence, comorbidities, age distribution, injury severity at presentation, or differences in care-seeking behavior. Previous research suggests sex-based differences in trauma outcomes may reflect a complex interaction of biological, clinical, and social factors. Therefore, the observed difference should be interpreted cautiously. Future studies should examine sex-specific injury mechanisms, interpersonal violence-related injuries, comorbidities, treatment pathways, complication rates, and clinical outcomes in greater detail.

Age emerged as a key determinant in the epidemiology of trauma. In our study, more than half of trauma cases occurred among individuals aged 17–65 years (n = 6,463; 51%), with a mean patient age of 24.5 years. These findings are consistent with international evidence indicating the burden of injuries is concentrated among young and working-age populations.[14] According to the Global Burden of Disease studies, injuries are among the leading causes of mortality and disability in the 15–49-year age group, which corresponds to the most economically productive segment of the population.[15] Similarly, multicenter studies conducted in South and Southeast Asia have shown the majority of trauma-related hospitalizations occur among individuals aged 20–40 years, largely associated with active participation in road traffic, physically demanding occupations, and suboptimal workplace safety standards.

Comparable trends have been documented across LMICs, where the high incidence of injuries is closely linked to road traffic exposure, manual labor, and insufficient occupational safety regulations.[16,17] Epidemiological studies from South and Southeast Asia further indicate that trauma-related hospitalizations disproportionately affect individuals aged 20–40 years, particularly in the context of road traffic injuries.[18] A similar pattern has also been reported in Europe and North America, where, despite lower overall injury incidence, the economic and social burden of trauma remains concentrated among the working-age population.[19]

Thus, the high prevalence of injuries in the 17–65-year age group represents not merely a local phenomenon but a global epidemiological pattern. In LMICs, including Georgia, this trend is particularly concerning because injuries disproportionately affect the most productive segment of society and may be associated with important health-system and socioeconomic consequences. However, the present study did not directly measure medical costs, productivity losses, or long-term work-capacity outcomes.

Accordingly, the findings of this study are aligned with international evidence and underscore the need for targeted preventive policies focused on working-age populations, road safety, occupational safety, and safer injury-related environments. In the multivariable logistic regression model, road traffic injuries were independently associated with higher odds of hospital-level care compared with falls. This finding suggests that road traffic injuries represent a clinically important mechanism associated not only with frequency, but also with a greater need for hospital-based treatment. However, the need for hospital-level care is unlikely to be determined by injury mechanism alone. It may also reflect the combined influence of patient age, injury context, delayed presentation, mode of transport, prehospital care, and other factors not fully captured in the registry, such as the use of protective equipment.

The most common cause of injury identified in this study was falls (47%; n = 5,843), encompassing both falls from height and slip-related injuries. This pattern closely resembles findings from other LMICs, where falls account for 35%–50% of injury-related emergency visits, particularly among children and older adults.[20] For example, studies from India and Nepal report falls as the primary injury mechanism in

Table 6. Time from injury to Emergency Department (ED) arrival

Time from injury to ED arrival	n	%
<1 hour	6054	48.2
1–2 hours	3228	25.7
2–4 hours	1387	11.0
>4 hours	1894	15.1

40%–55% of emergency department presentations.[21] Age-specific analysis showed the majority of fall-related injuries occurred among older adults (n = 845; 67%) and children (n = 2,502; 52%). Raising awareness within these age groups about the seriousness of fall-related injuries should be considered a key preventive strategy.

Road traffic injuries ranked second among the leading causes of trauma in this study (16%; n = 1,949). In contrast, in many high-income countries, road traffic injuries constitute a smaller proportion of overall injury visits (typically 10–15%) but remain the dominant cause of severe and fatal trauma.[22] The relatively high proportion of road traffic injuries observed in our study aligns with regional patterns in Eastern Europe and Caucasus, where road safety indicators remain below European Union averages.[23]

Regarding injury type, contusions/bruises were the most frequently recorded injuries (18%; n = 2,314), followed by fractures (16.3%; n = 2,051). These findings are consistent with international epidemiological studies reporting that contusions, soft tissue injuries, and fractures are among the most common diagnoses in trauma-related emergency department visits.[24]

The anatomical distribution of injuries in this study, predominantly affecting the upper extremities (n = 3,561; 28%), head (n = 3,037; 24%), and lower extremities (n = 2,496; 20%), is also consistent with international trauma epidemiology.[25] Comparable distributions have been reported in multicenter studies from Europe and Asia, where extremity injuries account for approximately 45%–55% of all trauma cases, followed by head injuries ranging from 20% to 30%.[26,27] Head injuries are of particular concern due to their association with long-term disability and mortality, especially in road traffic crashes and falls among older adults. The similarity of injury patterns suggests that, despite contextual differences, the biomechanical consequences of common injury mechanisms are broadly comparable across regions.

Regarding the location of injury occurrence, our finding that the home was the most frequent injury setting (n = 5,088; 40%), followed by road and transport environments (n = 2,167; 17%), closely mirrors results from other LMICs. Studies from South Asia and Eastern Europe report that 35%–45% of injuries occur in residential settings, particularly among children and older adults, while road-related injuries account for 15%–30% of cases.[28] In high-income countries, although the home remains a common injury location, a higher proportion of injuries occur in recreational and occupational settings, reflecting differences in lifestyle and safety regulation.[29] These comparisons highlight the importance of home-based injury prevention strategies in Georgia, alongside continued investments in road safety.

Time from injury occurrence to emergency department arrival is an important indicator of prehospital access and emergency care system performance. In the present study, nearly half of patients (n = 6,054; 48.2%) reached the emergency department within one hour of injury. This one-hour interval is historically associated with the "golden hour" concept, which emphasizes the importance of rapid assessment and early definitive care after trauma.[30] However, contemporary trauma literature questions whether a universal 60-minute threshold applies equally to all trauma patients, as the relationship between time and outcome depends on injury type, physiological instability, hemorrhage, prehospital care, and trauma system organization.[31,32] Therefore, in this study, arrival within one hour should be interpreted as a pragmatic indicator of timely access to hospital-based emergency care rather than as evidence of a strict survival threshold. It should also not be interpreted as a measure of emergency department waiting time, triage response, or time to treatment initiation after arrival. Because the registry did not consistently capture arrival-to-triage, triage-to-physician, or arrival-to-treatment intervals, the present study cannot assess delays occurring within the emergency department after patient arrival. Because subgroup-specific time-to-arrival estimates by urban/rural injury location could not be reliably reconciled across registry fields, this study does not draw conclusions about urban–rural differences in time to emergency department arrival.[33]

The study found ambulance transport was the most common mode of arrival to the emergency department. However, because cross-tabulated time-to-arrival estimates by transport mode could not be reliably reconciled across all registry fields, the present analysis does not draw firm conclusions about differences in arrival time by ambulance versus private or public transport. Future studies should examine transport mode, prehospital response time, and time to definitive care using prospectively standardized emergency care data.

In the multivariable model, injuries occurring in rural areas were associated with higher odds of hospital-level care compared with urban injuries. This finding indicates a difference in the likelihood of hospital-level care, but it should not be interpreted as evidence of delayed presentation, because reliable subgroup-specific time-to-arrival estimates by urban/rural injury location were not available. Future studies should examine rural injury severity, transport distance, emergency medical service response time, and time to definitive care using prospectively standardized and geographically detailed data.

Our findings further indicate 79.9% of patients (n = 10,038) were discharged home within 24 hours following emergency department treatment. The high volume of patients with mild to moderate injuries may delay timely care for those with severe trauma. Managing non-urgent cases in outpatient or alternative healthcare settings could help reduce emergency department overcrowding.

The overall emergency department mortality rate was 0.6% (n = 81). Because mortality was reported only by age group and sex, and mechanism-specific mortality data were not available in the present analysis, no conclusions can be drawn regarding the leading mechanisms of fatal injury. Mortality rates among polytrauma patients reported in the literature are substantially higher, ranging from 5.5% to 41.5%. Polytrauma is defined as a "syndrome of combined injuries" that triggers a systemic inflammatory response and may result in significant organ dysfunction or failure. Because the dataset included only emergency department presentations, deaths occurring before hospital arrival were not captured. Therefore, the observed emergency department mortality rate should not be interpreted as a population-level injury fatality rate. Beyond its clinical and epidemiological findings, this study also has implications for injury prevention and trauma system planning in Georgia.

Although this study did not measure direct medical costs, indirect costs, productivity losses, or rehabilitation expenditures, the findings have potential relevance for health-system planning. More than half of emergency department injury presentations occurred among individuals aged 17–65 years, and 20.1% required hospital admission or ICU-level care. These patterns suggest that injuries may impose important clinical and resource demands;[34,35] however, no conclusions can be drawn about the actual monetary burden of injuries in Georgia from the present data. Future studies should link injury surveillance data with hospital cost, rehabilitation, employment, and long-term outcome data to estimate the economic burden more directly.

From a policy perspective, the findings support targeted injury prevention based on the observed epidemiological pattern. Given that falls were the leading cause of injury, particularly among children and older adults, home-based injury prevention should remain an important prevention priority. Relevant measures may include environmental modifications, community education, and fall-risk assessment for older adults. These priorities are consistent with evidence supporting fall-prevention interventions in community-dwelling older adults.[36,37]

Road traffic injuries, although less frequent than falls, were associated with higher odds of hospital-level care, underscoring the importance of strengthening road safety policies, including enforcement of speed limits, seatbelt and helmet laws, and alcohol-impaired driving regulations. Because this study did not assess costs or cost-effectiveness, no conclusions can be drawn about the economic returns of road safety interventions in Georgia. Future studies should directly evaluate the impact of road safety interventions on healthcare use, costs, productivity, and long-term outcomes.

Finally, the findings related to time from injury occurrence to emergency department arrival and mode of transport highlight the importance of strengthening prehospital emergency care documentation and capacity. However, because subgroup-specific time-to-arrival estimates by urban/rural injury location could not be reliably reconciled across registry fields, this study does not draw conclusions about urban–rural differences in delayed presentation. Future studies should examine rural injury severity, transport distance, emergency medical service response time, and time to definitive care using prospectively standardized and geographically detailed data.[38]

In summary, while this study primarily quantified the epidemiological and clinical dimensions of injury-related emergency department presentations, the findings have potential relevance for health-system planning. The concentration of injuries among working-age individuals, the need for hospitalization or ICU-level care in one in five cases, and the prominence of preventable injury mechanisms support injury prevention and trauma system strengthening as important policy priorities for Georgia. Because direct medical costs, productivity losses, rehabilitation expenditures, and cost-effectiveness were not measured, economic implications should be interpreted cautiously and evaluated directly in future research.

Limitations

This study has several limitations. First, the findings may not be fully generalizable to rural regions, smaller hospitals, or primary-level facilities, where injury patterns, access to emergency services, and care-seeking behavior may differ substantially. In these settings, access barriers, transport pathways, and care-seeking behavior may differ, while minor injuries may be underreported because of limited access to emergency departments. In contrast, urban tertiary emergency departments may overrepresent injuries related to road traffic and domestic or urban environments. Consequently, reliance on data from urban tertiary hospitals may have led to an underrepresentation of rural- and occupation-related injuries and an overrepresentation of injury patterns typical of urban settings.

Second, the study relied on retrospective EMR-based data extraction rather than a prospectively maintained and externally validated trauma registry. Therefore, data quality depended on the completeness and consistency of routine hospital documentation. Inter-rater reliability of data abstraction was not formally assessed, and no national registry governance structure comparable to established international trauma registry systems was available. These factors may have introduced information bias and between-hospital variation in variable completeness and classification.

Third, the injury severity measure was a locally applied six-level ordinal clinical classification based primarily on treatment need, physiological support, and disposition. It was not equivalent to validated anatomical trauma scoring systems such as ISS or AIS, and no underlying continuous severity score was available. Inter-rater reliability of severity

assignment was not formally assessed. Therefore, severity estimates may be affected by between-hospital variation in clinical classification and should not be directly compared with studies using standardized trauma scores.

Fourth, missing or unspecified data were present for several registry variables. The highest proportion of incomplete information was observed for place of occurrence, where 3,431 cases were recorded as unspecified. Unknown values were also present for injury occurrence location, injury mechanism, injury type, and anatomical site, although at lower proportions. These missing or unspecified categories were retained in the descriptive tables to transparently present data completeness. No imputation was performed because missingness was primarily related to incomplete routine documentation rather than patient non-response. This may have introduced information bias and limited the interpretation of some subgroup comparisons. The high proportion of unspecified place-of-occurrence data may have led to underestimation or misclassification of specific injury settings, particularly home, occupational, recreational, or transport-related environments. Therefore, comparisons by place of occurrence should be interpreted cautiously.

Fifth, the registry did not consistently capture emergency department waiting time, triage-to-physician time, or the interval from hospital arrival to initiation of treatment across all participating hospitals. Therefore, the present analysis was limited to the interval between injury occurrence and emergency department arrival. This restricts the ability to assess the full emergency care pathway and to evaluate in-hospital response times after patient arrival.

Sixth, although injuries have important economic implications, direct medical cost data were not consistently available across all participating hospitals. Therefore, the study did not estimate patient-level direct costs, indirect costs, productivity losses, or long-term rehabilitation expenditures.

Seventh, several important external-cause and intent categories, including self-inflicted injuries, drowning, assault, and interpersonal violence, were not consistently captured as separate standardized variables across all participating hospitals. As a result, the study could not provide reliable separate estimates for these categories or examine interpersonal violence-related injuries by sex and severity. This limits the ability to fully describe the burden of intentional and unintentional injuries, including gender-specific patterns of violence-related injury and hospitalization.

Finally, although acute poisoning/toxic exposure accounted for a substantial proportion of emergency department presentations, the registry did not consistently capture the type of toxic agent or the intentionality of exposure. Therefore, the study could not distinguish accidental poisoning from intentional poisoning or identify the most common substances involved. Future research should expand data collection to regional and rural healthcare facilities, as well as prehospital and mortality registries, to enable a more comprehensive and nationally representative assessment of injury epidemiology and outcomes in Georgia.

Conclusions

This multicenter retrospective study shows injury-related emergency department presentations in tertiary hospitals in Tbilisi, Republic of Georgia, primarily affected males and working-age adults. Although most cases were mild or moderate, one in five patients required hospitalization or intensive care, indicating a substantial burden on emergency and inpatient services. These findings support targeted injury prevention strategies, particularly fall prevention in residential settings, strengthened road safety enforcement, improved prehospital emergency services in non-urban areas, and the development of standardized national injury surveillance. The study also highlights important gaps in current injury surveillance, including incomplete data on interpersonal violence, self-inflicted injuries, drowning, poisoning details, and in-hospital emergency care process indicators. Future injury surveillance in Georgia should incorporate standardized indicators for external cause, intent, severity, poisoning characteristics, and emergency care time intervals to support comprehensive injury prevention and trauma system planning.

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