Archives of Current Medical Research
Arch Curr Med Res 2026; 7(1): 102-119

Received: 07 October 2025
Revised: 23 November 2025
Accepted: 01 December 2025
DOI: 10.47482/acmr.1798670

ORIGINAL ARTICLE

Injuries Among Children and Adolescents Caused by Traffic Accidents: Prognostic Indicators and Clinical Outcomes

Mustafa Oguz Cumaoglu[1] **Abdussamed Vural**[1] **Hakan Guner**[2]
Recep Kemal Soylu[3] **Sabri Sekme**[1] **Turkan Yildiz**[1]

1 Nigde Omer Halisdemir University Faculty of Medicine, Department of Emergency Medicine, Niğde, Türkiye
2 General Directorate of Emergency Health Services, Ministry of Health, Ankara, Türkiye
3 Kayseri State Hospital, Department of Emergency Medicine, Kayseri, Türkiye

Abstract

Background: Traffic accidents are a major cause of morbidity and mortality in children and adolescents. Comprehensive data combining demographic, clinical, and laboratory findings in Türkiye are limited. This study aimed to evaluate epidemiology, injury distributions, laboratory results, and prognostic factors associated with clinical outcomes and mortality.

Methods: This retrospective single-center cohort included 586 patients (0–17 years) who presented to the emergency department in 2024 after traffic accidents (ICD-10 V00–V89). Demographic characteristics, mechanisms, injury sites, laboratory parameters, treatments, and outcomes were analyzed. Binary logistic regression identified factors independently associated with mortality after age adjustment.

Results: The cohort comprised 392 males (66.9%) and 194 females (33.1%) with a median age of 12 years (IQR 8–15). In-vehicle accidents (54.6%) and pedestrian injuries (24.6%) were most common. Male sex and adolescent age were associated with greater injury severity and adverse outcomes. Among laboratory parameters, only INR was significantly higher in non-survivors (median 1.18 vs 1.06; $p < 0.001$) and was also elevated among hospitalized and surgically treated patients. Mortality occurred in 13 patients (2.2%). Head trauma was the strongest independent predictor of death (adjusted OR 24.7; 95% CI 6.6–93.0; $p<0.001$), while thoracic, abdominal/pelvic, and lower-extremity injuries also increased risk.

Conclusion: Head trauma is the key determinant of mortality in pediatric traffic accidents, with male gender and adolescence conferring additional risk. Incorporating simple clinical and laboratory indicators—particularly INR—into early evaluation may enhance triage, optimize resource use, and improve outcomes. These findings highlight the importance of early identification of high-risk injury patterns in optimizing pediatric emergency management.

Keywords: Accidents, adolescent, child, risk factors, traffic.

Corresponding Author:
Mustafa Oğuz Cumaoğlu, MD, Nigde Omer Halisdemir University Faculty of Medicine, Department of Emergency Medicine
Nigde Omer Halisdemir University Rectorate, Central Campus, 51240, Niğde/Türkiye
E-mail: mdmoc38@gmail.com

INTRODUCTION

Traffic accidents are among the leading causes of death in individuals aged 5–29 years worldwide, and children and adolescents represent one of the most vulnerable groups in this regard (1). Developmental characteristics during childhood, such as limited risk perception and insufficient motor coordination, make this population particularly susceptible to traffic-related injuries (2).

Recent epidemiological studies have emphasized that pediatric traffic accidents (PTA) constitute a major public health problem, contributing to the global burden of mortality and morbidity in both developed and developing countries (3,4). For example, a nationwide analysis conducted in China reported that traffic-related injuries are among the leading causes of death in the 0–14 age group (5). Data from European countries indicate that approximately one-third of major pediatric traumas are caused by traffic accidents (6). In the United States, police records between 2016 and 2020 documented 206,429 pedestrian injuries and 148,828 bicycle accidents among individuals aged 0–19 years, demonstrating that traffic-related injuries in children present with varying patterns across different regions (7).

When the mechanisms of injury are examined, pedestrian, bicycle, and motorcycle accidents, as well as in-vehicle crashes, emerge as the predominant causes (8). Pedestrian injuries pose the greatest risk, particularly in countries with inadequate road infrastructure (9). Bicycle- and motorcycle-related accidents are commonly associated with head and extremity injuries, whereas thoracic and abdominal traumas are more frequently reported in in-vehicle crashes (10,11). In addition, the growing use of electric scooters and e-bikes has recently emerged as a new risk factor contributing to pediatric traffic injuries (12).

International studies have investigated the determinants of mortality and morbidity associated with pediatric traffic trauma and have demonstrated that factors such as age, sex, injury region, and trauma severity scores influence both short- and long-term outcomes (13,14). Large-scale cohort studies have reported that adolescents tend to sustain more severe injuries and have a greater need for surgical intervention compared to younger children (15).

According to data from the Turkish Statistical Institute for 2023, children aged 0–17 years accounted for 10.1% of all traffic-related deaths in the country (16). Despite this mortality rate, the literature on pediatric traffic trauma in Türkiye remains limited. Recent single-center studies have reported that the most common causes of trauma among pediatric emergency admissions were in-vehicle accidents and pedestrian impacts (17,18). Additionally, previous research from Türkiye has evaluated commonly used trauma scoring tools—such as the Glasgow Coma Score, Pediatric Trauma Score, and Injury Severity Score—emphasizing the prognostic relevance of structured assessment frameworks in this population (18). However, existing studies have predominantly focused on trauma scores or mortality outcomes, and there is a lack of comprehensive analyses that simultaneously evaluate laboratory parameters and clinical outcomes (19).

This gap in the literature highlights the need for multifaceted evaluations that address the demographic, clinical, and laboratory characteristics of pediatric and adolescent traffic trauma in Türkiye. Therefore, this study aimed to analyze the demographic features, etiologies, injury patterns, laboratory findings, and clinical outcomes of children and adolescents aged 0–17 years who presented to the emergency department (ED) due to traffic accidents throughout 2024, thereby contributing to filling an important gap in the current literature.

MATERIALS AND METHODS

Study Design and Setting

This retrospective, observational, single-center study was conducted in the ED of Nigde Omer Halisdemir University Training and Research Hospital. All pediatric and adolescent patients (0–17 years) who presented between January 1, 2024, and December 31, 2024, and were coded under ICD-10 classifications related to traffic accidents (V00–V89) were included. The study was approved by the Non-Interventional Ethics Committee of the Faculty of Medicine, Nigde Omer Halisdemir University (Approval No: 2025/37; Date: March 25, 2025). The hospital is a tertiary care center with a high patient volume and serves as a referral facility for pediatric trauma care in the region. Data were retrieved retrospectively from the institutional electronic medical record system (SISOFT®).

Exclusion Criteria

Patients aged ≥18 years, those admitted for non–traffic-related trauma, and cases with incomplete clinical or laboratory data were excluded.

Data Collection

Demographic variables included sex and age; age was additionally categorized into three groups (0–5, 6–11, and 12–17 years). The time of admission was recorded by day of the week and month of the year.

Trauma etiology was classified as pedestrian, bicycle, motorcycle, or motor vehicle occupant. The presence of injury was coded as absent or present, and specific injury sites were recorded separately (head, thoracic, abdominal/pelvic, upper extremity, lower extremity).

Diagnostic imaging was categorized as none, X-ray only, Computed Tomography (CT) only, or combined X-ray and CT. Treatment in the ED was classified as medical management/observation or surgical interventions (including suturing, wound care, and splinting). Suturing/ wound care and splint application were also recorded separately.

Clinical outcomes included discharge, hospitalization, surgery during hospitalization, and mortality. Laboratory parameters [leukocyte (WBC) ($\times 10^9$/L), hemoglobin (Hb) (g/dL), platelet count (PLT) ($\times 10^9$/L), urea (mg/dL), creatinine (mg/dL), Alanine aminotransferase (ALT) (IU/L), Aspartate aminotransferase (AST) (IU/L), International Normalized Ratio (INR)] were extracted as continuous variables and analyzed accordingly.

Outcome Measures

The primary outcome measure was the evaluation of clinical outcomes, including type of emergency treatment, imaging utilization, hospitalization, surgical interventions during hospitalization, and mortality.

The secondary outcome measures comprised the associations of demographic characteristics (age, sex, time of admission), trauma etiology, injury sites, and laboratory parameters WBC, Hb, PLT, urea, creatinine, ALT, AST, INR with clinical outcomes. These analyses aimed to identify prognostic indicators and variations in clinical course according to patient- and trauma-related factors. In addition, binary logistic regression analysis was performed to identify factors associated with mortality based on age and injury sites.

Statistical Analysis

All analyses were conducted using IBM SPSS Statistics for Windows, Version 27.0 (IBM Corp., Armonk, NY, USA). A two-sided p-value <0.05 was considered statistically significant.

Categorical variables were presented as counts and percentages. Normality was assessed with both visual (histogram, stem-and-leaf, scatter, and box plots) and analytical methods (Kolmogorov–Smirnov test, skewness, kurtosis). Since all continuous variables violated normality, they were summarized as median with interquartile range (IQR, 25th–75th percentiles).

Associations between categorical variables were analyzed using the Chi-square or Fisher's exact test. Comparisons of continuous variables between two groups were performed with the Mann–Whitney U test, while comparisons across three or more groups were conducted using the Kruskal–Wallis test. Spearman's correlation analysis was employed to assess associations between age and laboratory parameters.

Binary logistic regression analysis was performed to evaluate the association between mortality and clinical or injury-related variables. Mortality was defined as the dependent variable (0 = Survivor, 1 = Non-survivor). Because of the small number of deaths (n = 13, 2.2%), the number of variables included in the multivariable model was restricted to minimize the risk of overfitting. Following the events per variable (EPV) principle, separate two-variable logistic regression models were constructed, each including age (as a continuous covariate) and one injury site variable (head, thoracic, abdominal/ pelvic, or lower extremity trauma). Sex and upper extremity trauma were not included in the model because they were not statistically significant in the univariable analysis. This parsimonious modeling strategy allowed adjustment for age while maintaining model stability and interpretability despite the limited number of outcome events. Although age was found to be statistically significant at varying levels across all multivariable models, it was deliberately kept as a constant covariate rather than being highlighted in each model. The primary objective of the logistic regression analysis was to determine the independent effects of different injury sites on mortality among pediatric traffic accident cases. Therefore, age was included in all models as an adjustment variable to control for its potential confounding effect, while the emphasis was placed on the comparative impact of specific trauma regions on fatal outcomes.

RESULTS

Demographic and Descriptive Characteristics

Table 1 presents the demographic and clinical characteristics of the study cohort and their distribution by sex. A flow diagram summarizing the identification, exclusion, and inclusion process of the study population is shown in Figure 1. Of the 15,694 trauma visits recorded among patients aged 0–17 years during the study period, non-traffic injuries and cases with incomplete clinical or laboratory data were excluded, and the remaining cases constituted the final study cohort. A total of 586 children aged 0–17 years were included, comprising 392 males (66.9%) and 194 females (33.1%). The median age was 13 years (IQR 8–16) in males and 10 years (IQR 7–14) in females. Of all cases, 14.5% were aged 0–5 years, 35.0% were 6–11 years, and 50.5% were 12–17 years. The most common day of presentation was Friday (16.7%), and the most frequent month was June (13.8%).

With respect to trauma etiology, 54.6% of cases were in-vehicle accidents, 24.6% pedestrian, 14.2% motorcycle, and 6.7% bicycle accidents. On physical examination, no injury was detected in 64.2% of patients, whereas 35.8% had at least one injury. The most frequently affected regions were the head (13.1%), lower extremities (14.2%), and upper extremities (10.9%).

Regarding imaging, 25.6% of patients underwent X-ray only, 23.9% CT only, and 38.6% both X-ray and CT; 11.9% had no imaging performed. In the ED, 58.9% of patients received medical treatment, and 41.1% underwent interventional procedures (wound care/suturing 31.2%; splinting 12.6%). Overall, 86 patients (14.7%) required hospitalization, and 67 (11.4%) underwent surgery. The mortality rate was 2.2% (n=13), including three deaths that occurred in the ED (Table 1).

Comparisons by Sex

Among adolescents (12–17 years), 76.4% were male ($p<0.001$). In-vehicle accidents were more frequent among females (65%) compared with males (50%) ($p<0.001$). Of all patients with injuries, 77.1% were male ($p<0.001$). Head trauma occurred in 16% of males and 7% of females; overall, 81.8% of patients with head trauma were male ($p=0.003$). Upper extremity trauma was observed in 13% of males and 6% of females, with 81% of such cases occurring in males ($p=0.01$).

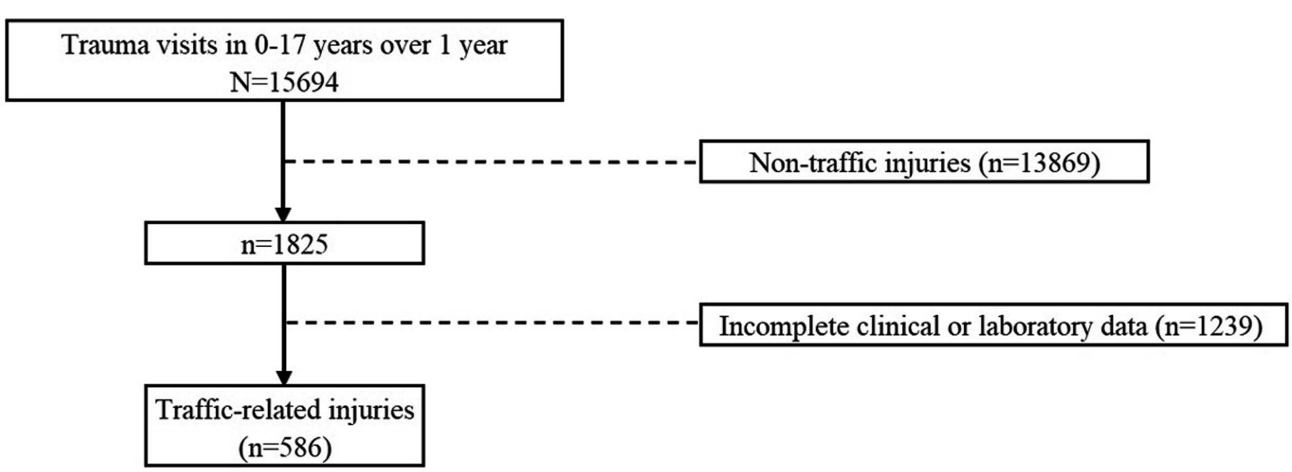

Figure 1: Flow diagram of study population and case selection process

In the ED, 61.7% of patients receiving medical treatment and 74.3% of those undergoing interventional/surgical treatment were male (p=0.002). Wound care and suturing were performed in 31.2% of cases and were significantly more common in males compared with females (p=0.002) (Table 1).

Comparisons by Age Group

Across all age groups, in-vehicle accidents were the leading trauma mechanism. Among injured patients, 60% belonged to the adolescent group (p<0.001). Upper extremity injuries (73%, p<0.001) and lower extremity injuries (59%, p=0.009) were predominantly observed in adolescents. Dual imaging was most frequently used in the 6–11 and 12–17 age groups. In contrast, 27% of children aged 0–5 years underwent no imaging (p<0.001).

Treatment patterns varied by age: medical management predominated in the 0–5 (75%) and 6–11 (64%) groups, whereas medical and surgical treatments were equally distributed in the 12–17 group (p<0.001). Wound care/suturing (58%), splinting (69%), and mortality (85%) were predominantly seen in adolescents (p=0.016, 0.003, 0.04) (Table 2).

Comparisons by Trauma Etiology

Among patients without injuries, 62.5% were due to in-vehicle accidents. In those with injuries, the etiologies were in-vehicle (40.5%), pedestrian (28.6%), motorcycle (25.2%), and bicycle accidents (5.7%) (p<0.001). Upper extremity injuries were most commonly associated with in-vehicle accidents (48.4%), while lower extremity injuries were more frequent in pedestrian accidents (41%) (p<0.001).

Of the patients who did not undergo imaging, 67.1% were involved in in-vehicle accidents, compared with only 2.9% of motorcycle accidents. Dual imaging was performed in 65% of motorcycle accidents, whereas this rate was approximately 35% in in-vehicle and pedestrian accidents (p<0.001). Interventional/surgical procedures in the ED were most often performed for in-vehicle accidents (42.7%, p<0.001). Bicycle accidents had the lowest hospitalization rate (7%, p<0.001), whereas mortality was highest among motorcycle accidents (46.2%, p=0.01) (Table 3).

Comparisons by Injury Status

81.6% of patients with no physical injuries underwent X-ray and/or CT imaging (p<0.001). X-ray and/or CT was used for 98.3% of those who underwent surgical intervention in the ED, and for 80.9% of those who received medical treatment (p<0.001). Nearly all hospitalized patients (96.5%) belonged to the injured group; 93% underwent emergency surgical intervention, and 74.4% required surgery. Notably, three patients who underwent surgery were discharged from the ED rather than admitted for inpatient care, as they declined hospitalization and opted to continue follow-up in another city. (p<0.001) (Table 4).

98.6% of those with head trauma and 86.4% of those without underwent imaging. Furthermore, 72.7% of head trauma cases received wound care/suturing, 46.8% required hospitalization, and 32.5% underwent surgical operation; the mortality rate in this group was 13% (p<0.001). Thoracic injuries were observed in 11.2% of those with surgical intervention, 18.6% of hospitalized patients, 14.9% of operated patients, and 30.8% of deaths. Abdominal/pelvic injuries were found in 8.3%, 15.1%, 14.9%, and 23.1% of these respective groups (all p<0.001). Among patients with upper extremity trauma, 92.2% underwent surgical intervention in the ED (p<0.001); 54.7% received splinting and 60.9% wound care/suturing (p<0.001). Upper extremity injuries were present in 17.4% of hospitalized patients (p=0.036) and 20.9% of those who underwent surgery (p=0.005). Lower extremity trauma was observed in 30.3% of those with surgical intervention, 60.8% with splinting, 23% with wound care/suturing, 47.7% of hospitalized patients, 55.2% of operated patients, and 38.5% of deaths (all p<0.001) (Table 5).

Analysis of Quantitative Data

As shown in Table 6, the comparative analysis of routine laboratory parameters across demographic, mechanistic, and clinical subgroups revealed several statistically significant differences. Only significant results identified through the Mann–Whitney U and Kruskal–Wallis tests are presented in the table. All variables are expressed as median values with interquartile ranges (25th–75th percentiles). Analyses without letter annotations indicated highly significant differences with p values <0.001.

Table 1. A) Demographic and Clinical Characteristics of Pediatric Patients by Sex				
Variable	**Total (n=586, %100)**	**Male (n=392, %66.9)**	**Female (n=194, %33.1)**	***p*-value**
Age, years, median (IQR)	12 (7.75-16)	13 (8–16)	10 (7–14)	**<0.001**
Age groups, n (%)				
0–5 years	85 (14.5)	48 (56.5)	37 (43.5)	**<0.001**
6–11 years	205 (35.0)	118 (57.6)	87 (42.4)	
12–17 years	296 (50.5)	226 (76.4)	70 (23.6)	
Mechanism of injury, n (%)				
In-vehicle	320 (54.6)	194 (60.6)	126 (39.4)	**<0.001**
Pedestrian	144 (24.6)	97 (67.4)	47 (32.6)	
Motorcycle	83 (14.2)	67 (80.7)	16 (19.3)	
Bicycle	39 (6.7)	34 (87.2)	5 (12.8)	
Any injury detected, n (%)				
None	376 (64.2)	230 (61.2)	146 (38.8)	**<0.001**
Present	210 (35.8)	162 (77.1)	48 (22.9)	
Trauma detected, n (%)				
Head				
None	509 (86.9)	329 (64.6)	180 (35.4)	**0.003**
Present	77 (13.1)	63 (81.8)	14 (18.2)	
Thorax				
None	558 (95.2)	371 (66.5)	187 (33.5)	**0.35**
Present	28 (4.8)	21 (75)	7 (25)	
Abdominal/Pelvic				
None	560 (95.6)	376 (67.1)	184 (32.9)	**0.553**
Present	26 (4.4)	16 (61.5)	10 (38.5)	
Upper extremity				
None	522 (89.1)	340 (65.1)	182 (34.9)	**0.01**
Present	64 (10.9)	52 (81.3)	12 (18.7)	

Table 1. B) Demographic and Clinical Characteristics of Pediatric Patients by Sex

Lower extremity				
None	503 (85.8)	331 (65.8)	172 (34.2)	**0.168**
Present	83 (14.2)	61 (73.5)	22 (26.5)	
Imaging modality, n (%)				
X-ray only	150 (25.6)	98 (65.3)	52 (34.7)	**0.952**
CT only	140 (23.9)	93 (66.4)	47 (33.6)	
X-ray + CT	226 (38.6)	154 (68.1)	72 (31.9)	
None	70 (11.9)	47 (67.1)	23 (32.9)	
Treatment in ED, n (%)				
Medical	345 (58.9)	213 (61.7)	132 (38.3)	**0.002**
Interventional	241 (41.1)	179 (74.3)	62 (25.7)	
Wound care/suturing, n (%)				
None	403 (68.8)	253 (62.8)	150 (37.2)	**0.002**
Present	183 (31.2)	139 (76)	44 (24)	
Splinting, n (%)				
None	512 (87.4)	336 (65.6)	176 (34.4)	**0.086**
Present	74 (12.6)	56 (75.7)	18 (24.3)	
Hospitalization, n (%)				
Discharge	500 (85.3)	333 (66.6)	167 (33.4)	**0.715**
Present	86 (14.7)	59 (68.6)	27 (31.4)	
Surgery, n (%)				
None	519 (88.6)	345 (66.5)	174 (33.5)	**0.547**
Present	67 (11.4)	47 (70.1)	20 (29.9)	
Mortality, n (%)				
Survival	573 (97.8)	381 (66.5)	192 (33.5)	**0.170**
Non-survival	13 (2.2)	11 (84.6)	2 (15.4)	

&Age is presented as median (interquartile range, 25–75th percentile); categorical variables are expressed as number (percentage). Comparisons of age between sexes were performed using the Mann–Whitney U test, while categorical variables were compared using the Chi-square test or Fisher's exact test, as appropriate. A p-value <0.05 was considered statistically significant.
&& CT: Computed Tomography, ED: Emergency Department.

Table 2. Clinical and Trauma Characteristics According to Age Group

Variable	0–5 years (n=85)	6–11 years (n=205)	12–17 years (n=296)	*p*-value
Mechanism of injury, n (%)				
In-vehicle	60 (18.8)	109 (34)	151 (47.2)	**<0.001**
Pedestrian	20 (13.9)	76 (52.8)	48 (33.3)	
Motorcycle	4 (4.8)	10 (12)	69 (83.2)	
Bicycle	1 (2.6)	10 (25.6)	28 (71.8)	
Any injury detected, n (%)				
None	66 (17.6)	140 (37.2)	170 (45.2)	**<0.001**
Present	19 (9)	65 (31)	126 (60)	
Trauma detected, n (%)				
Upper extremity				
None	80 (15.3)	193 (37)	249 (47.7)	**<0.001**
Present	5 (7.8)	12 (18.8)	47 (73.4)	
Lower extremity				
None	82 (16.3)	174 (34.6)	247 (49.1)	**0.009**
Present	3 (3.6)	31 (37.3)	49 (59)	
Imaging modality, n (%)				
X-ray only	17 (11.3)	61 (40.7)	72 (48)	**<0.001**
CT only	23 (16.4)	49 (35)	68 (48.6)	
X-ray + CT	22 (9.7)	75 (33.2)	129 (57.1)	
None	23 (32.8)	20 (28.6)	27 (38.6)	
Treatment in ED, n (%)				
Medical	64 (18.6)	132 (38.3)	149 (43.2)	**<0.001**
Interventional	21 (8.7)	73 (30.3)	147 (61)	
Wound care/suturing, n (%)				
None	68 (16.9)	145 (36)	190 (47.1)	**0.016**
Present	17 (9.3)	60 (32.8)	106 (57.9)	
Splinting, n (%)				
None	78 (15.2)	189 (36.9)	245 (47.9)	**0.003**
Present	7 (9.5)	16 (21.6)	51 (68.9)	
Mortality, n (%)				
Survival	84 (14.7)	204 (35.6)	285 (49.7)	**0.04**
Non-survival	1 (7.7)	1 (7.7)	11 (84.6)	

[&] Categorical variables are expressed as number (percentage). Categorical variables were compared using the Chi-square test or Fisher's exact test, as appropriate. A p-value <0.05 was considered statistically significant.
[&&] CT: Computed Tomography; ED: Emergency Department.

Table 3. Clinical Characteristics and Outcomes According to Trauma Etiology

Variable	In-vehicle (n=320)	Pedestrian (n=144)	Motorcycle (n=83)	Bicycle (n=39)	*p*-value
Any injury detected, n (%)					
None	235 (62.5)	84 (22.3)	30 (8)	27 (7.2)	**<0.001**
Present	85 (40.5)	60 (28.6)	53 (25.2)	12 (5.7)	
Trauma detected, n (%)					
Upper extremity					
None	289 (55.4)	133 (25.5)	63 (12.1)	37 (7.1)	**<0.001**
Present	31 (48.4)	11 (17.2)	20 (31.3)	2 (3.1)	
Lower extremity					
None	303 (60.2)	110 (21.9)	56 (11.1)	34 (6.8)	**<0.001**
Present	17 (20.5)	34 (41)	27 (32.5)	5 (6)	
Imaging modality, n (%)					
X-ray only	61 (40.7)	57 (38)	21 (14)	11 (7.3)	**<0.001**
CT only	102 (72.9)	24 (17.1)	6 (4.3)	8 (5.7)	
X-ray + CT	110 (48.7)	52 (23)	54 (23.9)	10 (4.4)	
None	47 (67.1)	11 (15.7)	2 (2.9)	10 (14.3)	
Treatment in ED, n (%)					
Medical	217 (62.9)	86 (24.9)	19 (5.5)	23 (6.7)	**<0.001**
Interventional	103 (42.7)	58 (24.1)	64 (26.6)	16 (6.6)	
Hospitalization, n (%)					
Discharge	289 (57.8)	124 (24.8)	54 (10.8)	33 (6.6)	**<0.001**
Present	31 (36)	20 (23.3)	29 (33.7)	6 (7)	
Mortality, n (%)					
Survival	317 (55.3)	141 (24.6)	77 (13.4)	38 (6.6)	**0.01**
Non-survival	3 (23.1)	3 (23.1)	6 (46.2)	1 (7.7)	

[&] Categorical variables are expressed as number (percentage). Categorical variables were compared using the Chi-square test or Fisher's exact test, as appropriate. A p-value <0.05 was considered statistically significant.
[&&] CT: Computed Tomography; ED: Emergency Department.

Table 4. Comparison of Injury Status, Emergency Treatments, and Surgical Procedures in Relation to Imaging Modalities and Hospitalization

Variable	Injury (+) (n=210)	Injury (–) (n=376)	*p*-value	Medical (n=345)	Interventional (n=241)	*p*-value	Surgery (+) (n=67)	Surgery (-) (n=519)	*p*-value
Imaging modality, n (%)									
X-ray only	53 (35.3)	97 (64.7)	**<0.001**	98 (65.3)	52 (34.7)	**<0.001**	8 (5.3)	142 (94.7)	**<0.001**
CT only	35 (25)	105 (75)		87 (62.1)	53 (37.9)		8 (5.7)	132 (94.3)	
X-ray + CT	121 (53.5)	105 (46.5)		94 (41.6)	132 (58.4)		51 (22.6)	175 (77.4)	
None	1 (1.4)	69 (98.6)		66 (94.3)	4 (5.7)		0 (0)	70 (100)	
Hospitalization, n (%)									
Discharge	127 (25.4)	373 (74.6)	**<0.001**	339 (67.8)	161 (32.2)	**<0.001**	3 (0.6)	497 (99.4)	**<0.001**
Present	83 (96.5)	3 (3.5)		6 (7)	80 (93)		64 (74.4)	22 (25.6)	

& Categorical variables are expressed as number (percentage). Categorical variables were compared using the Chi-square test or Fisher's exact test, as appropriate. A p-value <0.05 was considered statistically significant.
&& CT: Computed Tomography.

Sex: The median PLT count was lower in males (p=0.007), while females had significantly lower median Hb, urea, and creatinine levels (all p<0.001).

Age groups: Adolescents had higher median Hb levels but lower median PLT counts compared with other age groups (p<0.001). Median Hb was also higher in the 6–11 group than in the 0–5 group (p=0.047). Median creatinine was higher in adolescents than in other groups and higher in the 6–11 group than in the 0–5 group (p<0.001). Conversely, the 0–5 group had higher median AST levels than older groups, and AST levels in the 6–11 group were higher than in adolescents (p<0.001).

Etiology: Compared with in-vehicle accidents, pedestrian injuries were associated with lower median Hb and creatinine levels but higher PLT counts (p=0.025, <0.001, 0.021). Compared with motorcycle crashes, pedestrian accidents had lower Hb and creatinine but higher PLT (all p<0.001). Compared with bicycle accidents, pedestrian crashes showed higher PLT (p=0.004) and lower creatinine (p<0.001). In-vehicle accidents had higher PLT levels than motorcycle accidents (p=0.016), but lower Hb, WBC, and creatinine (p=0.008, <0.001, <0.001).

Injury status: Injured children had significantly higher median WBC, ALT, and AST values than non-injured children (p<0.001, 0.017, 0.011). Median WBC was higher in head and thoracic trauma cases (p<0.001), while AST was elevated in thoracic injuries (p=0.003). Abdominal/pelvic trauma was associated with lower Hb (p=0.028) and higher WBC, ALT, and AST (p=0.003, <0.001, <0.001). Upper extremity trauma correlated with higher Hb and creatinine (p=0.002), whereas lower extremity trauma was linked to elevated WBC levels (p<0.001).

Treatment and clinical outcomes: Patients requiring surgical intervention had lower median PLT (p=0.021) but higher WBC levels (p<0.001). Hospitalized patients had lower Hb (p=0.002) and higher WBC, INR, ALT, and AST (all p<0.001). Operated patients had lower Hb (p=0.004) and higher WBC, INR, and AST levels (p<0.001, 0.018, <0.001). Mortality analysis revealed that non-survivors had significantly higher INR levels compared with survivors (p<0.001).

Correlation Between Age and Laboratory Parameters

Spearman correlation analysis revealed significant associations between age and laboratory parameters. Age showed a moderate negative correlation with PLT (r=

Table 5. Clinical Management and Outcomes by Trauma Location

Variable	Head Trauma		Thorax Trauma		Abdominal/Pelvic Trauma		Upper extremity		Lower extremity		*p* values
	(+) (n=77)	(-) (n=509)	(+) (n=28)	(-) (n=558)	(+) (n=26)	(-) (n=560)	(+) (n=64)	(-) (n=522)	(+) (n=83)	(-) (n=503)	
Imaging modality, n (%)											
X-ray only	5 (3.3)	145 (96.7)	2 (1.3)	148 (98.7)	3 (2)	147 (98)	18 (12)	132 (88)	31 (20.7)	119 (79.3)	<0.001 (all groups)
CT only	28 (20)	112 (80)	5 (3.6)	135 (96.4)	6 (4.3)	134 (95.7)	1 (0.7)	139 (99.3)	1 (0.7)	139 (99.3)	
X-ray + CT	43 (19)	183 (81)	21 (9.3)	205 (90.7)	17 (7.5)	209 (92.5)	45 (19.9)	181 (80.1)	51 (22.6)	175 (77.4)	
None	1 (1.4)	69 (98.6)	0 (0)	70 (100)	0 (0)	70 (100)	0 (0)	70 (100)	0 (0)	70 (100)	
Treatment in ED, n (%)											
Medical	8 (2.3)	337 (97.7)	1 (0.3)	344 (99.7)	6 (1.7)	339 (98.3)	5 (1.4)	340 (98.6)	10 (2.9)	335 (97.1)	<0.001 (all groups)
Interventi-onal	69 (28.6)	172 (71.4)	27 (11.2)	214 (88.8)	20 (8.3)	221 (91.7)	59 (24.5)	182 (75.5)	73 (30.3)	168 (69.7)	
Wound care/suturing, n (%)											
None	21 (5.2)	382 (94.8)	10 (2.5)	393 (97.5)	****	****	25 (6.2)	378 (93.8)	41 (10.2)	362 (89.8)	<0.001 (all groups)
Present	56 (30.6)	127 (69.4)	18 (9.8)	165 (90.2)	****	****	39 (21.3)	144 (78.7)	42 (23)	141 (77)	
Splinting, n (%)											
None	****	****	****	****	****	****	29 (5.7)	483 (94.3)	38(7.4)	474 (92.6)	<0.001 (all groups)
Present	****	****	****	****	****	****	35 (47.3)	39 (52.7)	45 (60.8)	29 (39.2)	
Hospitalization, n (%)											
Discharge	41 (8.2)	459 (91.8)	12 (2.4)	488 (97.6)	13 (2.6)	487 (97.4)	49 (9.8)	451 (90.2)	42 (8.4)	458 (91.6)	<0.001
Present	36 (41.9)	50 (58.1)	16 (18.6)	70 (81.4)	13 (15.1)	73 (84.9)	15 (17.4)	71 (82.6)	41 (47.7)	45 (52.3)	0.036[#]
Surgery, n (%)											
None	52 (10)	467 (90)	18 (3.5)	501 (96.5)	16 (3.1)	503 (96.9)	50 (9.6)	469 (90.4)	46 (8.9)	473 (91.1)	<0.001
Present	25 (37.3)	42 (62.7)	10 (14.9)	57 (85.1)	10 (14.9)	57 (85.1)	14 (20.9)	53 (79.1)	37 (55.2)	30 (44.8)	0.005[##]
Mortality, n (%)											
Survival	67 (11.7)	506 (88.3)	24 (4.2)	549 (95.8)	23 (4)	550 (96)	****	****	78 (13.6)	495 (86.4)	<0.001 (all groups)
Non-sur-vival	10 (76.9)	3 (23.1)	4 (30.8)	9 (69.2)	3 (23.1)	10 (76.9)	****	****	5 (38.5)	8 (61.5)	

[&] Categorical variables are expressed as number (percentage). Categorical variables were compared using the Chi-square test or Fisher's exact test, as appropriate. A p-value <0.05 was considered statistically significant. [&&] CT: Computed Tomography, ED: Emergency Department.
****: Datas are not found statistically significant (p > 0.05), [#]: Hospitalization vs. Upper extremity traumas, [##]: Surgery vs. Upper extremity traumas.

Table 6. Comparison of Routine Laboratory Parameters by Demographics, Mechanism, Injury Site, and Clinical Course

Variable	WBC (×10⁹/L)	Hb (g/dL)	PLT (×10⁹/L)	Urea (mg/dL)	Creatinine (mg/dL)	ALT (IU/L)	AST (IU/L)	INR	*p* values
Sex									
Male	–	13.8 (12.6-15.15)	293 (239-352.5)[a]	26 (22-30)	0.62 (0.47-0.78)	–	–	–	<0.001,0.007[a]
Female	–	12.6 (12-13.3)	312 (277-358)[a]	24 (19-28)	0.50 (0.41-0.62)	–	–	–	
Age groups									
0–5 years	–	12.2 (11.8-12.8)[b]	331 (276.25-424.25)	–	0.35 (0.31-0.41)	–	41.5 (32.75-77)	–	<0.001,0.047[b]
6–11 years	–	12.8 (12.2-13.35)[b]	329 (295-391.5)	–	0.48 (0.41-0.54)	–	30 (25-37.75)	–	
12–17 years	–	14.3 (13.05-15.4)	278 (228.5-309.5)	–	0.73 (0.61-0.81)	–	24 (21-32)	–	
Mechanism of injury									
In-vehicle	10 (8.1-12.4)	13.3 (12.2-14.7)[c, g]	298 (256-355)[d, f]	–	0.58 (0.45-0.74)	–	–	–	<0.001, 0.025[c] 0.021[d], 0.004[e] 0.016[f], 0.008[g]
Pedestrian	10.2 (8.85-13.35)	13 (12.2-13.5)[c]	317 (285-380)[d, e]	–	0.46 (0.41-0.54)	–	–	–	
Motorcycle	12.25 (9.25-15.32)	14.15 (12.77-15.2)[g]	262.5 (217.75-336)[f]	–	0.71 (0.60-0.82)	–	–	–	
Bicycle	10.25 (9.1-11.27)	13.6 (12.12-14.25)	265 (232.25-324.5)[e]	–	0.65 (0.58-0.79)	–	–	–	
Any injury detected									
None	9.8 (8.1-11.8)	–	–	–	–	16 (12-23)[h]	26.5 (22-35)[ı]	–	<0.001, 0.017[h] 0.011[ı]
Present	11.26 (8.82-14.97)	–	–	–	–	17 (13-28)[h]	30 (23-42)[ı]	–	
Head trauma									
None	10.1 (8.17-12.5)	–	–	–	–	–	–	–	<0.001
Present	11.95 (9.72-15.42)	–	–	–	–	–	–	–	
Thorax trauma									
None	10.2 (8.2-12.6)	–	–	–	–	–	28 (22-37)[i]	–	<0.001, 0.003[i]
Present	12.7 (11.54-16.2)	–	–	–	–	–	45 (28.25-70.75)[i]	–	
Abdominal/Pelvic trauma									
None	10.2 (8.2-12.6)[k]	13.3 (12.3-14.55)[j]	–	–	–	16 (12-23.5)	28 (22-36)	–	<0.001, 0.028[j] 0.003[k]
Present	12.9 (9.7-17.8)[k]	12.8 (11.7-14)[j]	–	–	–	47 (19-114)	69 (31-186)	–	
Upper extremity trauma									
None	–	13.1 (12.2-14.37)[l]	–	–	0.57 (0.44-0.72)[l]	–	–	–	0.002[l]
Present	–	14.2 (13-15.27)[l]	–	–	0.69 (0.54-0.80)[l]	–	–	–	
Lower extremity trauma									
None	10.2 (8.2-12.35)	–	–	–	–	–	–	–	<0.001
Present	12.3 (9.4-15.5)	–	–	–	–	–	–	–	
Treatment in ED									
Medical	9.45 (8-11.81)	–	306.5 (265-365.25)[m]	–	–	–	–	–	<0.001, 0.021[m]
Interventi-onal	11.15 (8.8-14.62)	–	289 (244.75-347.50)[m]	–	–	–	–	–	
Hospitalization									
Discharge	9.98 (8.2-12)	13.4 (12.5-14.6)[n]	–	–	–	16 (12-24)	27 (22-36)	1.05 (1.02-1.11)	<0.001, 0.002[n]
Present	12.55 (10-16.5)	12.6 (11.87-14.12)[n]	–	–	–	17.5 (14-34.25)	32.5 (26-52.75)	1.10 (1.03-1.18)	
Surgery									
None	10.05 (8.2-12.07)	13.4 (12.4-14.6)[o]	–	–	–	–	27 (22-36)	1.06 (1.02-1.12)[ö]	<0.001, 0.004[o] 0.018[ö]
Present	12.75 (9.97-16.5)	12.45 (11.92-14)[o]	–	–	–	–	32.5 (26-71.5)	1.09 (1.03-1.17)[ö]	
Mortality									
Survival	–	–	–	–	–	–	–	1.06 (1.02-1.12)	<0.001
Non-survival	–	–	–	–	–	–	–	1.18 (1.11-1.25)	

[&] Statistical analyses were performed using the Mann–Whitney U and Kruskal–Wallis tests. Only statistically significant results are presented in the table. All values are expressed as median (interquartile range, 25th–75th percentile). For analyses without letter annotations, all p values were <0.001.

[&&] WBC: Leukocyte; Hb: Hemoglobin; PLT: Platelets; ALT: Alanine aminotransferase; AST: Aspartate aminotransferase; INR: International Normalized Ratio, CT: Computed tomography, ED: Emergency Department

–0.411, p<0.001) and AST (r= –0.394, p<0.001), a positive correlation with Hb (r=0.584, p<0.001), a weak positive correlation with urea (r=0.133, p=0.016), and a very strong positive correlation with creatinine (r=0.827, p<0.001).

Logistic Regression Analysis

Binary logistic regression analysis was performed to identify factors associated with mortality (Table 7). Age and each injury site were evaluated separately. In the univariable analysis, age, head trauma, thoracic trauma, abdominal/pelvic trauma, and lower extremity trauma were significantly associated with mortality (all $p < 0.05$). Sex and upper extremity trauma were not included in the model, as they were not statistically significant.

The presence of head trauma emerged as the strongest predictor of mortality in both the univariable (OR = 25.174; 95% CI: 6.758–93.779; $p < 0.001$) and age-adjusted multivariable analyses (OR = 24.698; 95% CI: 6.56–92.98; $p < 0.001$). Similarly, thoracic trauma (OR = 8.198; 95% CI: 2.302–29.194; $p < 0.001$), abdominal/pelvic trauma (OR = 5.784; 95% CI: 1.465–22.839; $p = 0.012$), and lower extremity trauma (OR = 3.553; 95% CI: 1.124–11.237; $p = 0.031$) remained independently associated with mortality after adjustment for age.

Age showed a weak yet statistically significant association with mortality in the univariable analysis (OR = 1.204; 95% CI: 1.021–1.420; $p = 0.027$). However, due to the small number of deaths, age was kept constant across multivariable models, as the primary aim was to evaluate the independent effects of different injury sites on mortality.

DISCUSSION

This study provides a comprehensive evaluation by examining demographic, clinical, and laboratory data of pediatric and adolescent patients who presented to the ED due to traffic accidents. Our findings indicate that trauma etiology and injury regions are significantly associated with clinical outcomes in the pediatric population and that emergency laboratory parameters may play a complementary role in risk stratification. In particular, INR levels were found to be associated with mortality, whereas WBC and transaminase levels were related to injury severity and surgical requirements. In addition, our logistic regression analysis revealed that head trauma was the strongest independent predictor of pediatric mortality. These findings support that the combined assessment of high-risk trauma regions and laboratory indicators in the early period may be useful in clinical decision-making processes.

Previous European data show that the majority of major pediatric traumas result from traffic accidents and that male children are predominant in these cases. Castelão et al. (20) reported that 75% of injured children were

Table 7. Predictors of Mortality in Pediatric Traffic Accidents: Logistic Regression Analysis

	Univariable			Multivariable		
Variable	**OR**	**95% CI**	***p*-value**	**OR**	**95% CI**	**p-value**
Age (continue variable)	1.204	1.021-1.420	0.027	–	–	–
Head trauma (+/-)	25.174	6.758-93.779	<0.001	24.698	6.56-92.98	<0.001
Thorax trauma (+/-)	10.167	2.922-35.368	<0.001	8.198	2.302-29.194	<0.001
Abdominal/pelvic trauma (+/-)	7.174	1.849-27.838	0.004	5.784	1.465-22.839	0.012
Lower extremity trauma (+/-)	3.966	1.265-12.434	0.018	3.553	1.124-11.237	0.031

Binary logistic regression analysis showing univariable and multivariable predictors of mortality. Variables with $p < 0.05$ in univariable analysis were entered into multivariable models adjusted for age. Head trauma, thorax trauma, abdominal/pelvic trauma, and lower extremity trauma remained independently associated with mortality. OR: Odds ratio; CI: Confidence interval.

involved in traffic accidents and that males were more frequently represented in head and extremity traumas. Similarly, Bener et al. (21) stated that male children were not only more frequently exposed to accidents but also experienced more severe injuries. In our cohort, males constituted approximately two-thirds of the cases, and this proportion further increased in the adolescent age group. Moreover, head trauma, upper extremity injuries, and the need for medical or surgical interventions in the ED were significantly higher in males. These findings suggest that male gender may represent a disadvantaged group in pediatric traffic trauma in terms of both frequency and severity. According to World Health Organization data, the mortality rate due to traffic accidents in male children is approximately twice as high as in females, and this difference has been attributed to greater exposure, risk-taking tendencies, and sociocultural factors (22). Spending more time outdoors, starting to use motorcycles and bicycles at an earlier age, and undertaking tasks such as delivery or carrying work at younger ages in some societies are among the environmental factors that increase the level of risk.

Many studies have shown that the adolescent group carries a higher risk in PTA. Lee et al. (23) reported that in the 13–18 age group, both the rate and severity of accidents were higher, and the need for surgical intervention was significantly increased compared to younger children. Price et al. (24) also demonstrated that mortality among adolescents was significantly higher than that of younger children. In our cohort, the adolescent group had markedly higher rates of injury, surgical intervention, and mortality compared to other age groups. This finding may be explained by behavioral factors such as greater independence, risk-taking tendencies, peer influence, and active use of vehicles or motorcycles. Moreover, adolescents' tendency to engage in social activities and to be outdoors during nighttime hours may be another environmental factor that increases the risk of accidents. On the other hand, conservative management predominated in the younger age group (0–5 years). The literature reports that physicians tend to avoid radiation exposure and limit invasive procedures in young children (25). In our study, 27% of patients in the 0–5 age group did not undergo any imaging, and 75% were managed with medical treatment only. This finding suggests that clinicians adopt a more cautious and protective approach in younger children. Additionally, due to the challenges in obtaining anamnesis and limitations in physical examination in this group, it is natural for clinicians to act more selectively.

The most common etiologies of PTA vary depending on geographical and infrastructural conditions; however, in-vehicle accidents, motorcycle crashes, and pedestrian injuries are among the most frequently reported causes. A study conducted in Singapore reported that motor vehicle passengers accounted for 60.4% of cases, pedestrians for 28.5%, and bicycle users for 9.9% (26). This finding indicates that in-vehicle traumas occur at a high rate in pediatric accidents. It has also been reported that in low- and middle-income countries, motorcycle accidents stand out in terms of both frequency and mortality (27). Similarly, a study conducted in Brazil showed that motorcycle accidents were the most common and most severe trauma etiology, especially in the adolescent group (28). In our findings, the higher mortality rate in motorcycle accidents once again supports the contribution of this etiology to the risk of severe trauma. The literature emphasizes that in-vehicle accidents are generally considered "partially protective," but high-energy collisions increase the risk of serious injury (29). In our study, in-vehicle accidents were the most common etiology and were also associated with the highest rate of surgical interventions. Approximately 65% of patients without any injury had been involved in in-vehicle accidents, supporting the paradox described in the literature as "protective but risky in high-energy collisions." This finding suggests that safety systems alone are not sufficient for child passengers and that additional safety measures—such as speed control, child-specific seating systems, and enhanced vehicle safety standards—may reduce the risk. Furthermore, lower extremity injuries are among the most common injury sites in pediatric pedestrian accidents (30), and this finding was also confirmed in our cohort.

Injury regions play a critical role in determining prognosis in PTA. Previous studies have emphasized that head trauma is the injury type most strongly associated with mortality in childhood (31). Giovannini et al. (8) reported that among child passengers in motor vehicle accidents, head and trunk injuries were the most frequent. In our study, patients with head trauma had higher rates of imaging, hospitalization, and surgical intervention, and the mortality rate reached 13%. Moreover, our logistic regression analysis determined that head trauma remained the strongest independent predictor of mortality even after adjustment for age (OR ≈ 25). This finding supports that head trauma is not only a frequent injury but also plays a central role in determining the risk of death.

Thoracic and abdominal injuries are also prognostically important in PTA (32). In our study, children with thoracic and abdominal/pelvic trauma had significantly higher rates of surgical intervention and hospitalization. Our logistic regression results also showed that thoracic and abdominal/pelvic traumas were independently associated with mortality. This finding supports that these injuries require early diagnosis and aggressive management.

Although extremity injuries are not generally directly associated with mortality, they may contribute to the overall trauma burden. Prieto et al. (33) reported that open fractures and vascular injuries were common in extremity traumas and that a significant proportion required surgical intervention. Qiu et al. (34) reported from Chinese data that upper extremity fractures were the predominant type in pediatric trauma and that surgical or immobilization treatments were frequently applied. Similarly, in our study, the majority of patients with upper extremity trauma underwent interventional procedures, whereas lower extremity trauma significantly increased both surgical operation and hospitalization rates. Moreover, lower extremity trauma was observed in 38% of fatal cases and was independently associated with mortality in logistic regression analysis. This finding suggests that although extremity injuries are not fatal by themselves, they may have prognostic importance in multi-injury scenarios.

Imaging in pediatric trauma is an important topic of discussion in terms of balancing diagnostic accuracy and radiation exposure. Ohana et al. (35) stated that CT was frequently used unnecessarily in pediatric emergency cases. Bako et al. (36) reported that in 93.6% of children with mild head trauma, no lesion was found on CT scans, and this situation was interpreted as "overuse of CT". These findings suggest that CT indications in trauma management should be carefully reviewed and that alternative non-radiation imaging methods (ultrasonography, MRI) should be considered in appropriate cases. Furthermore, defensive medical practices may also play a role in these high usage rates (37). Cheng et al. (38) reported that physicians' risk perception and malpractice concerns were decisive factors in CT decision-making. In our cohort, the high rate of CT use even in cases with mild trauma severity parallels these findings. On the other hand, lower imaging rates in the younger age group reflect clinicians' tendency to limit radiation exposure in these patients. These two different approaches demonstrate that imaging strategies in pediatric trauma should vary according to age and clinical context.

Laboratory parameters provide valuable information in predicting injury severity and clinical outcomes (39,40). In our study, strong associations were observed between laboratory findings and clinical outcomes. Higher INR levels in fatal cases suggest that the presence of coagulopathy may be associated with poor prognosis (41). Higher WBC values in injured, surgically treated, and hospitalized patients support that leukocytosis reflects the trauma burden (42). Similarly, the relationship of AST and ALT levels with injury, hospitalization, and surgical requirements indicates that transaminases may provide diagnostic assistance, particularly in abdominal and thoracic trauma (43). The higher AST levels observed in the younger age group show that laboratory values may be affected by age-related physiological differences (44). Lower Hb levels in patients with abdominal trauma and those requiring surgical intervention may be an early indicator of occult bleeding and the need for transfusion (45). Lower PLT levels in adolescents and in surgically treated patients may be associated with trauma severity (46). In addition, positive correlations between age and Hb and creatinine and negative correlations between age and AST and PLT demonstrate the marked effect of biological development on laboratory parameters (44). Our findings indicate that although laboratory parameters alone are not diagnostic, they provide strong complementary indicators in clinical decision-making in pediatric traffic trauma.

Our study demonstrated that head trauma was the strongest independent predictor of mortality in PTA, while thoracic, abdominal/pelvic, and lower extremity injuries also made significant contributions to mortality risk. The combined evaluation of these high-risk trauma regions and routine laboratory findings can enhance the accuracy of early clinical assessments. Taken together, these findings underscore the importance of integrating anatomical and biochemical parameters into pediatric trauma management to improve risk stratification and guide timely interventions in emergency settings.

This study has several limitations. First, its retrospective and single-center design may limit the generalizability of the findings. Second, the relatively small number of mortality cases (n = 13; 2.2%) constrained the inclusion of multiple covariates in multivariable logistic regression models, which may have led to residual confounding. Third, data were obtained from electronic medical records, and several important variables were unavailable. Validated trauma severity scoring systems (e.g., Injury Severity Score and Pediatric Trauma Score) were not recorded in the dataset, which may limit comparability with studies using standardized scoring methods. In addition, data on behavioral or preventive factors—such as seat-belt or helmet use, road and environmental conditions, and driver-related variables—were lacking and could have influenced injury mechanisms or outcomes. Follow-up or repeat laboratory testing for hospitalized patients was also not available, precluding evaluation of dynamic biochemical changes and their potential prognostic implications. Finally, because long-term or post-discharge follow-up data were not available, delayed morbidity and mortality could not be assessed.

Despite these limitations, the study provides valuable insights into the prognostic factors of pediatric traffic trauma and offers a framework for future multicenter research.

Head trauma remains the leading independent determinant of mortality in PTA. In addition, male gender and adolescent age were identified as important risk factors associated with increased injury severity and adverse outcomes. Among laboratory markers, elevated INR showed consistent prognostic value across mortality, hospitalization, and surgical subgroups. Incorporating simple laboratory and clinical indicators into trauma evaluation may strengthen early risk assessment and support rapid decision-making in ED. Further multicenter and prospective studies are warranted to validate these results and refine evidence-based pediatric trauma care strategies. From a broader perspective, these findings highlight the public health importance of pediatric traffic injury prevention and the need for policies promoting road safety education, enforcement of seat-belt and helmet use, and community-based injury prevention programs. Implementing such risk-based approaches in pediatric emergency algorithms may contribute to more efficient resource allocation and improved patient outcomes.

REFERENCES

1. World Health Organization. Global status report on road safety 2018. Geneva: WHO; 2018. Available from: https://www.who.int/publications/i/item/9789241565684 Accessed October 1,2025
2. Cloutier MS, Beaulieu E, Fridman L, Macpherson AK, Hagel BE, Howard AW, et al. Preventing child and youth pedestrian motor vehicle collisions: critical issues and future directions. Inj Prev. 2021;27(1):77-84.
3. Popa Ș, Ciongradi CI, Sârbu I, Bîcă O, Popa IP, Bulgaru-Iliescu D. Traffic Accidents in Children and Adolescents: A Complex Orthopedic and Medico-Legal Approach. Children (Basel). 2023;10(9):1446.
4. Popa Ș, Sârbu I, Ciongradi CI, Popa IP, Bulgaru-Iliescu D. Current Epidemiological Trends of Pediatric Traffic Accidents at a Romanian Clinical Hospital. Children (Basel). 2023;10(9):1525.
5. Yin Z, Wu J, Luo J, Pak AWP, Choi BCK, Liang X. Burden and trend analysis of injury mortality in China among children aged 0–14 years from 2004 to 2011. BMJ Open. 2015;5(7):e007307.
6. Fylli C, Schipper IB, Krijnen P. Pediatric Trauma in The Netherlands: Incidence, Mechanism of Injury and In-Hospital Mortality. World J Surg. 2023;47(5):1116-1128.
7. Swedler DI, Ali B, Hoffman R, Leonardo J, Romano E, Miller TR. Injury and fatality risks for child pedestrians and cyclists on public roads. Inj Epidemiol. 2024;11(1):15.
8. Giovannini E, Santelli S, Pelletti G, Bonasoni MP, Cornacchia A, Pelotti S, et al. Pediatric motor vehicle crashes injuries: A systematic review for forensic evaluation. Int J Legal Med. 2024;138(4):1329-1341.
9. Qi M, Hu X, Li X, Wang X, Shi X. Analysis of road traffic injuries and casualties in China: a ten-year nationwide longitudinal study. PeerJ. 2022;10:e14046.
10. Popa Ș, Sârbu I, Bulgaru-Iliescu D, Surd AO, Candussi I, Popa IP, et al. Injuries to the lower limbs and associated injuries in children and adolescents resulting from road traffic incidents. J Family Med Prim Care. 2024;13(11):4994-5001.
11. Mullen S, Tolson A, Bouamra O, Watson B, Lyttle MD, Roland D, et al. Comparison of injury patterns and interventions between adolescent, adult and paediatric trauma cases: a cross-sectional review of TARN data. BMJ Open. 2023;13(5):e064101.
12. Moati S, Tavor O, Capua T, Sukhotnik I, Glatstein M, Rimon A, et al. The incidence and severity of pediatric injuries sustained by electric bikes and powered scooters. Pediatr Emerg Care. 2025;41(2):77-85.
13. Sadoway A, Kinden R, Erdogan M, Kureshi N, Johnsonet M, Green RS, et al. Epidemiology and factors associated with mortality among pediatric major trauma patients: a 17-year retrospective analysis. Injury. 2024;55(6):111484.
14. Larsson G, Larsson S, Strand V, Magnusson C, Hagiwara MA. Pediatric trauma patients in Swedish ambulance services: a retrospective observational study. Scand J Trauma Resusc Emerg Med. 2024;32(1):51.
15. Nakao S, Katayama Y, Kitamura T, Hirose T, Tachino J, Ishida K, et al. Trends and characteristics of severe road traffic injuries in children: a nationwide cohort study in Japan. Eur J Trauma Emerg Surg. 2024;50(6):2631-2640.
16. Türkiye İstatistik Kurumu (TÜİK). Karayolu Trafik Kaza İstatistikleri, 2023. Yayın No: 53479. Available from: https://data.tuik.gov.tr/Bulten/Index?p=Karayolu-Trafik-Kaza-Istatistikleri-2023-53479) Accessed October 1, 2025
17. Pervane SŞ, Halil H. Evaluation of children applying to emergency service after motor vehicle trauma. Injury. 2024;55(12):111925.
18. Özensoy HS, Gürü S. A retrospective study to compare the Glasgow Coma Score, Pediatric Trauma Score, and Injury Severity Score and outcomes in 118 pediatric trauma patients at a single emergency center in Turkey. Med Sci Monit. 2024;30:e943501.
19. Yavuz CI, Hamzaoğlu O. Road traffic-related injury among the 0-17 age group in Turkey. Ulus Travma Acil Cerrahi Derg. 2011;17(4):318-322.
20. Castelão M, Lopes G, Vieira M. Epidemiology of major paediatric trauma in a European Country - trends of a decade. BMC Pediatr. 2023;23(1):194.
21. Bener A, Dafeeah EE, Verjee M, Yousafzai MT, Al-Khatib H, Nema N, et al. Gender and age differences in risk taking behaviour in road traffic crashes. Adv Transport Stud. 2013;31:53–62
22. World Health Organization https://www.who.int/news-room/fact-sheets/detail/road-traffic-injuries
23. Lee JJ, Kim BW, Kong SY, Park G, Chai H, Kim YM, et al. Age-specific characteristics of road traffic injuries among children and adolescents in South Korea. Traffic Inj Prev. 2023;24(6):482-7.
24. Price MS, Raaber N, Gundtoft PH, Trier F. Pediatric trauma over a decade: demographics, mechanisms of injury, and mortality at a major Danish trauma center-a retrospective cohort study. Scand J Trauma Resusc Emerg Med. 2025;33(1):39.
25. You JS, Lee HJ, Chung YE, Lee HS, Kim MJ, Chung SP, et al. Diagnostic radiation exposure of injury patients in the emergency department: a cross-sectional large scaled study. PLoS One. 2013;8(12):e84870.
26. Chong SL, Tyebally A, Chew SY, Lim YC, Feng XY, Chin ST, et al. Road traffic injuries among children and adolescents in Singapore—who is at greatest risk? Accid Anal Prev. 2017;100:59-64.
27. Adeloye D, Thompson JY, Akanbi MA, Azuh D, Samuel V, Omoregbe N, et al. The burden of road traffic crashes, injuries and deaths in Africa: a systematic review and meta-analysis. Bull World Health Organ. 2016;94(7):510-521A.
28. Cavalcanti AL, Ferreira FHC, Olinda RA, Padilha WWN, Cavalcanti AFC. Motorcycle-related cranio-maxillofacial injuries among Brazilian children and adolescents. Biomedical and Pharmacology Journal. 2017;10(4):1603-09.
29. Macy ML, Lee JY, Kendi S, Zonfrillo MR, Hill A. Ease of Use ratings and real-world child restraint system errors from Safe Kids Illinois seat checks, 2015-2019. Traffic Inj Prev. 2023;24(7):625-631.
30. Kendi S, Johnston BD. Epidemiology and Prevention of Child Pedestrian Injury. Pediatrics. 2023;152(1):e2023062508.
31. Aoki M, Abe T, Saitoh D, Oshima K. Epidemiology, Patterns of treatment, and Mortality of Pediatric Trauma Patients in Japan. Sci Rep. 2019;9(1):917.
32. Akpinar G. Characteristics of pediatric injuries due to road traffic accidents and their effects on mortality. Journal of Surgery and Medicine, 2021;5(1): 12-6.

33. Prieto JM, Van Gent JM, Calvo RY, Checchi KD, Wessels LE, Sise CB, et al. Evaluating surgical outcomes in pediatric extremity vascular trauma. J Pediatr Surg. 2020;55(2):319-23

34. Qiu X, Deng H, Zhao Z, Zeng S, Zeng Y, Wang X, et al. Upper limb pediatric fractures in 22 tertiary children's hospitals, China: a multicenter epidemiological investigation and economic factor analysis of 32,832 hospitalized children. J Orthop Surg Res. 2022;17(1):300.

35. Ohana O, Soffer S, Zimlichman E, Klang E. Overuse of CT and MRI in paediatric emergency departments. Br J Radiol. 2018;91(1085):20170434.

36. Bako D, Özer U, Beydoğan E. Computed Tomography Overuse in Pediatric Minor Head Trauma: Insights from a Single-Center Experience. CT-Überbeanspruchung bei leichten Kopfverletzungen im Kindesalter: Erkenntnisse aus einer Einrichtung. Klin Padiatr. 2024;236(1):11-5.

37. Chen J, Majercik S, Bledsoe J, Connor K, Morris B, Gardner S, et al. The prevalence and impact of defensive medicine in the radiographic workup of the trauma patient: a pilot study. Am J Surg. 2015;210(3):462-67.

38. Cheng CY, Pan HY, Li CJ, Chen YC, Chen CC, Huang YS, et al. Physicians' Risk Tolerance and Head Computed Tomography Use for Pediatric Patients With Minor Head Injury. Pediatr Emerg Care. 2021;37(3):e129-e135.

39. Weber B, Lackner I, Braun CK, Kalbitz M, Huber-Lang M, Pressmar J, et al. Laboratory Markers in the Management of Pediatric Polytrauma: Current Role and Areas of Future Research. Front Pediatr. 2021;9:622753.

40. Nasr Isfahani M, Nasri Nasrabadi E, Rabiei Z, Fatemi NA, Heydari F. Enhancing clinical risk assessment in pediatric blunt abdominal trauma: A novel scoring system using ultrasound and laboratory data. BMC Emerg Med. 2025;25(1):34.

41. Hochart A, Momal R, Garrigue-Huet D, Drumez E, Susen S, Bijok B. Prothrombin Time ratio can predict mortality in severe pediatric trauma: Study in a French trauma center level 1. Am J Emerg Med. 2020;38(10):2041-44.

42. Kuas C, Acar N, Ozakin E, Karakilic E, Arda MS, Bastug BT, et al. The diagnostic value of laboratory tests in detecting solid organ injuries in pediatric patients with blunt abdominal trauma. Am J Emerg Med. 2022;57:133-37.

43. Bruhn PJ, Østerballe L, Hillingsø J, Svendsen LB, Helgstrand F. Posttraumatic levels of liver enzymes can reduce the need for CT in children: a retrospective cohort study. Scand J Trauma Resusc Emerg Med. 2016;24(1):104.

44. Chuang GT, Tsai IJ, Tsau YK. Serum Creatinine Reference Limits in Pediatric Population-A Single Center Electronic Health Record-Based Database in Taiwan. Front Pediatr. 2021;9:793446.

45. Yumoto T, Obara T, Hongo T, Iida A, Tsukahara K, Katsura M, et al. Age-specific assessment of initial hemoglobin levels and shock index for predicting life-saving interventions in pediatric blunt liver and spleen injuries. Sci Rep. 2025;15(1):8502.

46. Pang Y, Zhang YH, Yue C, Wang L. Reduced Platelets Associated with All-Cause Mortality in the Pediatric Intensive Care Unit. Clin Appl Thromb Hemost. 2024;30:10760296241271390.

Abbreviations List

PTA: Pediatric Traffic Accidents; CT: Computed Tomography; ED: Emergency Department; WBC: Leukocyte; Hb: Hemoglobin; PLT: Platelet; ALT: Alanine aminotransferase; AST: Aspartate aminotransferase; INR: International Normalized Ratio.

Ethics Approval and Consent to Participate

The study was approved by the Non-Interventional Ethics Committee of the Faculty of Medicine, Nigde Omer Halisdemir University (Approval No: 2025/37; Date: March 25, 2025) and conducted in accordance with the principles of the Declaration of Helsinki. According to institutional regulations, informed consent was not required for retrospective studies. Permission for data access and use was obtained from the ethics committee. All patient data were anonymized prior to analysis and processed according to General Data Protection Regulation (GDPR) -compliant data protection protocols.

Consent for Publication

This study is based on content analysis of the document. It does not contain any personal data.

Availability of Data and Materials

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Competing Interests

There are no conflicts of interest. The author have no financial or proprietary interest in the materials presented herein.

Funding

This study has received no funding, granting or sponsorship.

Authors' Contributions

Conceptualization and methodology: MOC, AV. Data curation and project administration: MOC, SS, TY. Investigation and data analysis: MOC, HG, RKS. Software: AV, HG, RKS. Supervision: MOC, AV. Manuscript writing—original draft: MOC, AV, HG, RKS, SS, and TY. Manuscript editing and manuscript review: MOC, AV.

Acknowledgements

None.