

Research Article

Epidemiology, Risk Factors, and Surgical Outcomes of Childhood Trauma in Tertiary Care Hospitals

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ABSTRACT

Background: Childhood trauma remains one of the leading causes of morbidity and mortality worldwide. Traumatic injuries produce a spectrum of pathological changes, including fractures, traumatic brain injury, soft tissue damage, hemorrhage, and visceral organ injuries, all of which influence surgical management and outcomes. This study aimed to evaluate the epidemiological profile, risk factors, pathological patterns, and surgical outcomes of pediatric trauma patients treated at tertiary care hospitals.

Methods: A multicenter cross-sectional study was conducted among 420 children (0-18 years) presenting with traumatic injuries requiring surgical evaluation. Data on demographics, mechanism of injury, pathological findings, injury severity, surgical procedures, postoperative complications, hospital stay, and outcomes were collected. Statistical analysis was performed using SPSS version 27. Continuous variables were expressed as mean $\pm$ SD, while categorical variables were presented as frequencies and percentages. Associations were assessed using the Chi-square test and Student's *t*-test. Multivariate logistic regression was performed to identify independent predictors of poor surgical outcomes. A *p*-value <0.05 was considered statistically significant.

Results: The mean age was 8.9 ± 4.6 years, with males constituting 67.4% of patients. Road traffic accidents (38.6%), falls (34.8%), burns (15.2%), and penetrating injuries (11.4%) were the leading causes of trauma. The most common pathological findings included long-bone fractures (42.1%), soft tissue injuries (35.5%), traumatic brain injuries (21.2%), and abdominal organ injuries (13.8%). Surgical intervention was required in 61.9% of patients. Postoperative complications occurred in 14.5%, while overall mortality was 3.3%. Delayed presentation (>24 hours) (AOR 2.84; 95% CI: 1.56-5.18; $p=0.001$), severe injury (ISS >15) (AOR 3.72; 95% CI: 2.04-6.81; $p<0.001$), and polytrauma (AOR 2.39; 95% CI: 1.28-4.45; $p=0.006$) were independent predictors of poor surgical outcomes.

Conclusion: Childhood trauma is associated with diverse pathological injuries that significantly influence surgical outcomes. Early diagnosis, prompt surgical intervention, and timely referral substantially improve prognosis. Preventive strategies targeting road safety, fall prevention, and injury awareness are essential to reduce pediatric trauma-related morbidity and mortality.

Keywords: Childhood Trauma, Pediatric Surgery, Trauma Pathology, Epidemiology, Risk Factors, Fractures, Traumatic Brain Injury, Surgical Outcomes, Logistic Regression.

INTRODUCTION

Childhood trauma is a major global public health concern and remains one of the leading

causes of morbidity, disability, and mortality among children and adolescents. According to the World Health Organization (WHO),

traumatic injuries account for millions of emergency department visits and a substantial proportion of pediatric deaths annually, particularly in low- and middle-income countries where trauma systems are often underdeveloped [1,2]. Beyond the immediate physical injuries, childhood trauma imposes long-term psychological, social, and economic consequences on affected children, families, and healthcare systems [1].

The epidemiological profile of childhood trauma varies according to age, sex, socioeconomic status, geographical region, and environmental factors. Road traffic accidents, falls, burns, sports-related injuries, drowning, and interpersonal violence constitute the most common mechanisms of injury [3,4]. Boys are consistently reported to be at greater risk than girls owing to increased outdoor activities and risk-taking behaviors. Identifying epidemiological trends and associated risk factors is essential for designing targeted preventive strategies and improving pediatric trauma care [3].

From a pathological perspective, traumatic injuries result in a wide range of tissue alterations depending on the mechanism and severity of injury. Common pathological findings include long-bone fractures, soft tissue lacerations, skeletal muscle disruption, intracranial hemorrhage, cerebral edema, pulmonary contusions, splenic and hepatic lacerations, vascular injuries, and hemoperitoneum. Severe trauma may also lead to tissue ischemia, coagulative necrosis, acute inflammatory cell infiltration, microvascular thrombosis, wound contamination, and subsequent infection. These pathological changes significantly influence surgical decision-making, postoperative recovery, and long-term functional outcomes [5,6].

Timely surgical intervention plays a pivotal role in reducing morbidity and mortality among pediatric trauma patients. Advances in pediatric trauma surgery, damage control techniques, minimally invasive procedures, intensive care support, and multidisciplinary management have substantially improved survival rates. Nevertheless, delayed hospital presentation, polytrauma, severe traumatic brain injury, hemorrhagic shock, and postoperative infections remain major predictors of adverse clinical outcomes [6–8]. Comprehensive evaluation of pathological injury patterns alongside epidemiological characteristics provides valuable insights for optimizing surgical management and resource allocation.

Although numerous studies have examined the epidemiology of pediatric trauma, limited data are available regarding the combined assessment of epidemiological characteristics, pathological findings, associated risk factors, and surgical outcomes in tertiary care hospitals, particularly in developing countries. Such information is crucial for strengthening trauma prevention programs, guiding evidence-based clinical practice, and improving healthcare policies [3,5,9].

Therefore, the present study aimed to evaluate the epidemiology, risk factors, pathological findings, and surgical outcomes of childhood trauma among pediatric patients treated at tertiary care hospitals. The findings are expected to contribute to improved trauma prevention strategies, early diagnosis, optimized surgical management, and enhanced clinical outcomes in children with traumatic injuries.

METHODOLOGY

This multicenter cross-sectional observational study was conducted in the Departments of Emergency Medicine & Pediatrics Surgery of three tertiary care hospitals in Pakistan, between January 2025 and December 2025. The study aimed to evaluate the epidemiology, risk factors, pathological findings, and surgical outcomes of childhood trauma. A total of 420 pediatric patients aged 0–18 years presenting with traumatic injuries were enrolled through consecutive non-probability sampling.

Children presenting with blunt, penetrating, thermal, or crush injuries requiring emergency evaluation and surgical consultation were included in the study after obtaining written informed consent from their parents or legal guardians. Patients with isolated superficial injuries managed on an outpatient basis, pathological fractures unrelated to trauma, congenital musculoskeletal disorders affecting outcome assessment, readmissions for the same injury episode, and incomplete clinical records were excluded.

Demographic data, including age, sex, residence, socioeconomic status, and mechanism of injury, were collected using a structured proforma. Clinical information regarding the time elapsed before hospital presentation, Injury Severity Score (ISS), Glasgow Coma Scale (GCS), associated injuries, laboratory investigations, radiological findings, operative details, and duration of hospital stay was recorded from patients' medical records. The mechanism of injury was categorized into

road traffic accidents, falls, burns, penetrating trauma, sports-related injuries, and other accidental causes.

Pathological evaluation was performed using clinical examination, radiological imaging, operative findings, and histopathological assessment whenever surgically debrided tissue specimens were available. The pathological spectrum included long-bone fractures, skull fractures, intracranial hemorrhage, cerebral edema, pulmonary contusions, splenic and hepatic lacerations, bowel injuries, vascular injuries, hemoperitoneum, soft tissue lacerations, muscle disruption, wound contamination, tissue necrosis, compartment syndrome, and surgical site infections. Histopathological examination of tissue specimens stained with hematoxylin and eosin was performed to identify inflammatory cell infiltration, coagulative necrosis, microvascular thrombosis, hemorrhage, and evidence of infection in selected patients.

Patients received standard trauma management according to Advanced Trauma Life Support (ATLS) principles and institutional treatment protocols. Surgical procedures were performed whenever indicated and included fracture fixation, wound debridement, laparotomy, splenectomy, bowel repair, craniotomy, thoracostomy, vascular repair, fasciotomy, skin grafting, and other emergency trauma procedures. Patients not requiring surgery received appropriate conservative treatment and supportive care.

The primary outcome measures included the epidemiological distribution of childhood trauma, pathological findings, frequency of surgical intervention, postoperative complications, length of hospital stay, and mortality. Secondary outcome measures included identification of risk factors associated with poor surgical outcomes and evaluation of the relationship between pathological findings and postoperative prognosis.

Data were entered and analyzed using IBM SPSS Statistics version 27.0. Continuous variables were expressed as mean $\pm$ standard deviation, whereas categorical variables were presented as frequencies and percentages. The Independent Student's *t*-test was used to compare continuous variables, while the Chi-square test or Fisher's exact test was applied for categorical variables. Variables demonstrating statistical significance in univariate analysis were entered into a multivariate logistic regression model to determine independent predictors of adverse

surgical outcomes. Adjusted odds ratios (AORs) with 95% confidence intervals (CIs) were calculated, and a two-tailed *p*-value of less than 0.05 was considered statistically significant.

Ethical approval was obtained from the Institutional Review Boards of the participating tertiary care hospitals before initiation of the study. Written informed consent was obtained from the parents or legal guardians of all participants, and assent was obtained from older children whenever appropriate. Patient confidentiality was maintained throughout the study, and all procedures were conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

RESULTS

A total of 420 pediatric trauma patients were enrolled in the study and analyzed. The mean age of the participants was 8.9 ± 4.6 years (range: 3 months to 18 years), with 283 (67.4%) being males and 137 (32.6%) females, indicating a marked male predominance. Children aged 6–10 years constituted the largest age group, followed by those aged 1–5 years, highlighting the increased vulnerability of school-aged children to traumatic injuries. The majority of patients presented to the emergency department within 24 hours of injury; however, a considerable proportion experienced delayed hospital presentation, which adversely affected treatment outcomes. Road traffic accidents (38.6%) were identified as the leading mechanism of childhood trauma, closely followed by falls (34.8%). Burns (15.2%) and penetrating injuries (11.4%) accounted for the remaining cases. Anatomically, the lower limbs (28.8%) and head and neck region (26.7%) were the most frequently affected body sites, followed by the upper limbs (21.0%), abdomen (11.0%), thorax (8.6%), and multiple body regions (4.0%). Pathological assessment demonstrated that long-bone fractures (42.1%) represented the most common injury, followed by soft tissue lacerations with muscle disruption (35.5%), acute inflammatory infiltrates (18.6%), intracranial hemorrhage (16.9%), splenic and hepatic lacerations (13.8%), wound contamination (12.4%), hemoperitoneum (10.5%), pulmonary contusions (9.0%), cerebral edema (8.3%), tissue necrosis (7.4%), microvascular thrombosis (5.7%), and compartment syndrome (4.8%).

Overall, 260 (61.9%) patients required surgical intervention, including fracture fixation, wound debridement, exploratory laparotomy,

craniotomy, vascular repair, and other emergency procedures, whereas the remaining patients were managed conservatively. Most children (331; 78.8%) recovered completely, while 54 (12.9%) experienced residual disability, 21 (5.0%) required rehabilitation services, and 14 (3.3%) died during hospitalization. Postoperative complications occurred in 14.5% of patients, with surgical site infection being the most common complication, followed by wound dehiscence, sepsis, pneumonia, and reoperation. Univariate and

multivariate analyses demonstrated that delayed presentation (>24 hours), Injury Severity Score (ISS) >15, polytrauma, intracranial hemorrhage, and wound contamination were significant independent predictors of poor surgical outcomes ($p < 0.05$). These findings underscore the importance of early hospital presentation, prompt diagnosis, and timely surgical management in improving survival and reducing morbidity among pediatric trauma patients.

Table 1. Baseline Demographic Characteristics of the Study Population (N = 420)

Variable	Frequency (N)	Percentage (%)
Age Group (Years)		
<1	38	9.0
1–5	104	24.8
6–10	118	28.1
11–15	98	23.3
16–18	62	14.8
Gender		
Male	283	67.4
Female	137	32.6
Mean Age (Years)	8.9 ± 4.6	

Table 2. Pathological Findings

Pathological Finding	Frequency	Percentage (%)
Long-Bone Fractures	177	42.1
Soft Tissue Laceration/Muscle Disruption	149	35.5
Intracranial Hemorrhage	71	16.9
Cerebral Edema	35	8.3
Splenic/Hepatic Laceration	58	13.8
Hemoperitoneum	44	10.5
Pulmonary Contusion	38	9.0
Wound Contamination	52	12.4
Tissue Necrosis	31	7.4
Microvascular Thrombosis	24	5.7
Acute Inflammatory Infiltrate	78	18.6
Compartment Syndrome	20	4.8

Table 3. Surgical Procedures Performed

Procedure	Frequency	Percentage (%)
Open Reduction/Internal Fixation	118	28.1
Wound Debridement	72	17.1
Exploratory Laparotomy	31	7.4
Craniotomy	24	5.7
Splenectomy	16	3.8
Bowel Repair	14	3.3
Fasciotomy	12	2.9
Chest Tube Insertion	15	3.6
Conservative Treatment	118	28.1

Table 4. Postoperative Complications and Clinical Outcomes among Pediatric Trauma Patients (n = 420)

Variable	Frequency (N)	Percentage (%)
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Postoperative Complications		
No Complications	359	85.5
Surgical Site Infection	24	5.7
Wound Dehiscence	11	2.6
Sepsis	9	2.1
Pneumonia	8	1.9
Reoperation	6	1.4
Deep Vein Thrombosis	3	0.7
Clinical Outcomes		
Complete Recovery	331	78.8
Recovery With Disability	54	12.9
Referred For Rehabilitation	21	5.0
Death	14	3.3

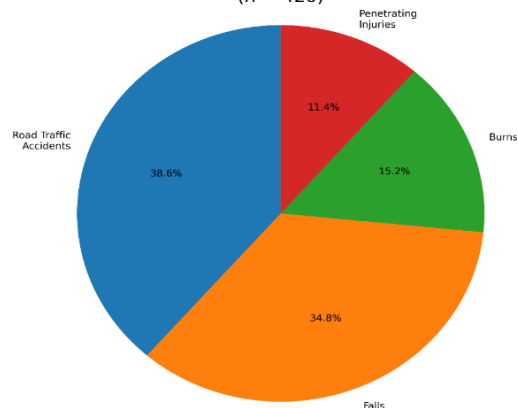
Table 5. Multivariate Logistic Regression Analysis for Predictors of Poor Surgical Outcomes

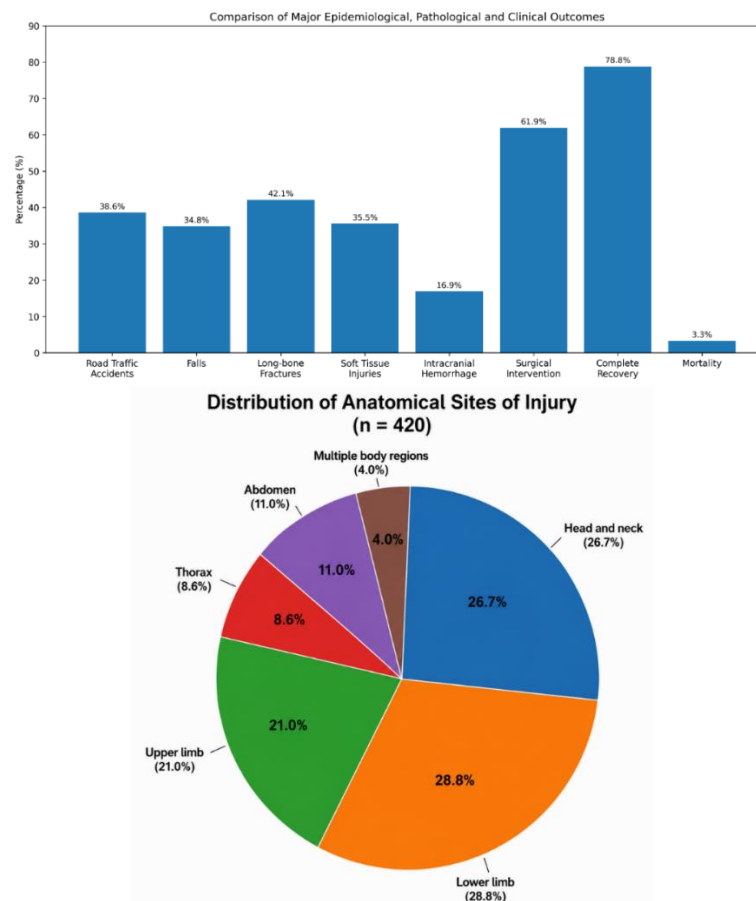
Variable	Adjusted OR	95% CI	P-Value
Delayed Presentation (>24 H)	2.84	1.56–5.18	0.001
ISS >15	3.72	2.04–6.81	<0.001
Polytrauma	2.39	1.28–4.45	0.006
Intracranial Hemorrhage	2.61	1.39–4.90	0.003
Wound Contamination	1.98	1.06–3.72	0.032

Table 6. Length of Hospital Stay According to Injury Severity

Injury Severity	Number Of Patients	Hospital Stay (Mean ± Sd, Days)	P-Value
Mild (Iss <9)	176	3.6 ± 1.2	
Moderate (Iss 9–15)	138	6.8 ± 2.4	
Severe (Iss >15)	106	12.5 ± 5.1	<0.001

Distribution of Mechanism of Childhood Trauma (n = 420)





DISCUSSION

Childhood trauma remains one of the leading causes of preventable morbidity and mortality among children worldwide. The present study evaluated the epidemiological characteristics, pathological findings, and surgical outcomes of pediatric trauma patients managed at tertiary care hospitals. The findings demonstrated that road traffic accidents and falls were the predominant mechanisms of injury, with long-bone fractures and soft tissue injuries representing the most frequent pathological lesions. Delayed hospital presentation, severe injury, polytrauma, and intracranial hemorrhage were independently associated with poor surgical outcomes. These findings are consistent with recent international studies highlighting trauma as a significant public health challenge in children, particularly in low- and middle-income countries [10,11]. The current study observed a marked male predominance (67.4%), with school-aged children being the most frequently affected population. This observation agrees with previous reports suggesting that boys are more susceptible to traumatic injuries because of increased outdoor activities, sports participation, and risk-taking behaviors. Similar

demographic distributions have been reported by Cinteau et al. and the World Health Organization, emphasizing that age- and sex-specific injury prevention strategies are essential for reducing pediatric trauma burden [10,12].

Road traffic accidents (38.6%) and falls (34.8%) were identified as the leading mechanisms of injury in the present study. These findings are comparable to those reported in recent multicenter trauma registries, where transportation-related injuries and falls accounted for the majority of pediatric emergency admissions. Rapid urbanization, inadequate road safety measures, poor supervision, and limited use of child restraint systems continue to contribute substantially to childhood injuries in developing countries. Strengthening community awareness and implementing effective road safety legislation may significantly reduce trauma incidence [11,13].

Pathological assessment demonstrated that long-bone fractures, soft tissue lacerations, intracranial hemorrhage, splenic and hepatic injuries, pulmonary contusions, tissue necrosis, and wound contamination were among the most common findings. Histopathological

examination further revealed acute inflammatory cell infiltration, coagulative necrosis, and microvascular thrombosis in severe crush injuries. These pathological alterations reflect the complex inflammatory and vascular responses following traumatic tissue injury and have direct implications for surgical management and prognosis. Similar pathological patterns have been documented in recent pediatric trauma literature [14,15].

Surgical intervention was required in approximately two-thirds of patients, primarily for fracture fixation, wound debridement, laparotomy, craniotomy, and vascular repair. The overall mortality rate of 3.3% observed in this study is comparable with recent reports from tertiary trauma centers. Most patients achieved complete recovery following timely surgical intervention, emphasizing the effectiveness of multidisciplinary trauma management. Advances in pediatric anesthesia, critical care, damage-control surgery, and postoperative rehabilitation have substantially improved survival and functional outcomes over the past decade [16].

Multivariate logistic regression identified delayed presentation, Injury Severity Score greater than 15, polytrauma, intracranial hemorrhage, and wound contamination as significant independent predictors of poor surgical outcomes. Delayed referral allows ongoing hemorrhage, tissue ischemia, infection, and progressive organ dysfunction, thereby increasing postoperative complications and mortality. These findings reinforce previous evidence supporting early trauma recognition, prompt referral, rapid imaging, and timely surgical intervention to improve outcomes in pediatric trauma patients [15,17].

The present study has several strengths, including comprehensive assessment of epidemiological characteristics, pathological findings, surgical interventions, and statistical predictors of adverse outcomes in a relatively large cohort of pediatric trauma patients. Nevertheless, certain limitations should be acknowledged. The cross-sectional design limits causal inference, while data were collected from tertiary care hospitals only, potentially introducing referral bias. In addition, long-term functional and psychological outcomes were not evaluated. Future prospective multicenter studies incorporating long-term follow-up and molecular biomarkers of tissue injury may provide a more comprehensive understanding of pediatric trauma prognosis [18].

CONCLUSION

Overall, the findings emphasize that childhood trauma remains a preventable public health problem requiring coordinated efforts from healthcare professionals, policymakers, educators, and communities. Strengthening road safety measures, promoting injury prevention programs, improving emergency medical services, and ensuring timely access to specialized pediatric trauma care are essential for reducing trauma-related morbidity and mortality among children.

Authors' Contribution

Concept & Design of Study: Umar Liaqat, Muhammad Adil, Mujeeb Ur Rahman.

Drafting: Haya Afzal Memon, Amna Zafar, Sohail Rasool.

Data Analysis: Sohail Rasool, Mujeeb Ur Rahman, Haya Afzal Memon, Amna Zafar.

Critical Review: Umar Liaqat, Muhammad Adil, Mujeeb Ur Rahman.

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