

## ORIGINAL ARTICLE

# Pediatric Orthopedic Trauma in Pakistan: Injury Mechanisms, Fracture Patterns, and Surgical Outcomes

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## ABSTRACT

**Background:** Pediatric orthopedic trauma represents a major public health concern in low- and middle-income countries, where road traffic injuries and falls contribute disproportionately to childhood morbidity and disability. Understanding local injury patterns and management practices is essential for improving trauma care delivery in Pakistan.

**Methods:** This retrospective descriptive study was conducted at the Orthopedic Department of the Shaheed Mohtarma Benazir Bhutto Institute of Trauma (SMBBIT), Karachi, from January 2017 to December 2022. A total of 947 children aged 1-18 years presenting with orthopedic trauma were included. Data extracted from the trauma registry and medical files included demographics, mechanism of injury, fracture patterns, management strategies, and clinical outcomes. Statistical analysis was performed using SPSS version 27, with significance set at  $p \leq 0.05$ .

**Results:** Of the 947 children included, the mean age was  $14.86 \pm 2.12$  years, and 88.1% were male. Bike-related accidents (48.5%) and falls (27.6%) were the predominant mechanisms of injury, followed by motor-vehicle collisions (8.8%) and pedestrian injuries (8.2%). Blunt trauma accounted for 96% of all cases. Femur fractures were most common (52.3%), followed by humerus fractures (12.5%). A total of 881 surgical procedures were performed, primarily external fixation (29.8%), internal fixation (24.1%), and wound debridement (16.4%). Most children (71.2%) were discharged, while mortality occurred in 0.8% and LAMA in 0.2% of cases.

**Conclusion:** Pediatric orthopedic trauma at this tertiary center was predominantly caused by high-energy mechanisms, particularly motorcycle accidents and falls, leading to a substantial need for surgical intervention. The findings underscore the need for strengthened injury-prevention strategies, improved road-safety enforcement, and enhanced pediatric trauma care systems in Pakistan.

**Keywords:** Pediatric Trauma, Orthopedic Injuries, Fracture Fixation, Wounds and Injuries Epidemiology, Road Traffic Accidents.

## INTRODUCTION

Pediatric trauma is a major global health challenge and remains one of the leading causes of morbidity, disability, and mortality among children. According to the World Health Organization, approximately 950,000 children die annually due to injury-related causes<sup>1,2</sup>, while millions experience long-term disability that affects their physical, emotional, and social well-being. Injuries now account for a significant proportion of the global pediatric disease burden, often surpassing infectious diseases in several regions<sup>3</sup>. The burden is especially high in low- and middle-income countries (LMICs), where road traffic injuries, falls, burns, and domestic accidents remain major contributors to trauma-related hospitalizations<sup>4,5</sup>. In many LMIC emergency departments, pediatric trauma constitutes 25-30% of all trauma cases, placing substantial strain on already resource-limited health systems<sup>6</sup>.

In South Asia, rapid urbanization, high population density, unsafe road structures, and limited regulatory enforcement further elevate the risk of pediatric injuries<sup>7,8</sup>. Pakistan faces a growing pediatric trauma burden due to increased motorcycle usage, lack of pedestrian safety measures, overcrowded environments, and insufficient supervision of children both at home and outdoors<sup>9,10</sup>. Several studies report that orthopedic injuries are among the most frequent pediatric emergencies, with long-bone fractures especially femur and humerus fractures being highly prevalent. In regional cohorts, femur fractures alone account for 35-55% of long-bone injuries<sup>11-13</sup>, often resulting from high-energy trauma such as motorcycle crashes, falls from height, and pedestrian accidents<sup>14</sup>. The widespread use of motorcycles as family transport without child-appropriate safety measures contributes substantially to these patterns<sup>15,16</sup>.

Gender differences are notable in pediatric trauma epidemiology, with males consistently demonstrating higher susceptibility to injuries due to greater outdoor exposure, behavioral tendencies toward risk-taking, and underdeveloped hazard

recognition skills<sup>17,18</sup>. Socioeconomic and environmental challenges including congested urban settings, absence of designated play areas, poor enforcement of traffic laws, and inadequate community safety infrastructure further increase children's vulnerability to preventable injuries<sup>19-21</sup>. These structural risks disproportionately impact children in low-resource environments, where trauma prevention mechanisms remain limited.

Despite the significant burden, Pakistan lacks comprehensive, large-scale, high-quality data on pediatric orthopedic trauma. Existing studies are limited, often single-center, and rarely utilize trauma registry systems, which provide more accurate and systematic insights into injury patterns, severity, and management pathways<sup>22,23</sup>. As a result, policymakers and clinicians face challenges in developing effective, targeted injury-prevention strategies, strengthening prehospital care, improving pediatric orthopedic capacity, and allocating healthcare resources efficiently<sup>24,25</sup>.

Given these gaps, it is essential to analyze pediatric orthopedic trauma using robust institutional data. Therefore, the present study aims to evaluate the mechanisms of injury, fracture patterns, surgical interventions, and clinical outcomes of pediatric orthopedic trauma cases managed at a major tertiary trauma center in Karachi, Pakistan. Using a high-volume trauma registry, this study provides important evidence on the burden and nature of childhood orthopedic injuries in an LMIC setting and offers critical insights to guide improvements in trauma care delivery and injury-prevention policy.

## METHODOLOGY

This study employed a retrospective descriptive design and was conducted in the Orthopedic Department of the Shaheed Mohtarma Benazir Bhutto Institute of Trauma (SMBBIT), Karachi, over a 12-month period from January 2017 to December 2022. All pediatric patients aged 1-18 years who presented with orthopedic trauma

during the study period were screened for eligibility. A total of 947 cases met the inclusion criteria. Data were obtained from the hospital trauma registry and patient medical files, which serve as the primary documentation system for all trauma presentations at SMBBIT. A structured and pre-validated clinical proforma was used to extract information on demographic characteristics, mechanism of injury, injury type, anatomical fracture site, initial management, surgical procedures, and clinical outcomes.

Children were included if they were between 1 and 18 years of age, were diagnosed with orthopedic trauma, presented to SMBBIT during the specified study period, and had medical records containing complete diagnostic and treatment details. Exclusion criteria consisted of patients with non-orthopedic injuries such as isolated head, thoracic, or abdominal trauma, dead-on-arrival (DOA) cases, and medical files with incomplete, missing, or ambiguous essential data that prevented accurate classification. To ensure accuracy, all extracted data were reviewed by trained research personnel in collaboration with a consultant orthopedic surgeon.

Data were entered and analyzed using SPSS version 27. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize demographic and clinical variables. Associations between categorical variables such as mechanism of injury and clinical outcomes were assessed using the Chi-square test. A p-value  $\leq 0.05$  was considered statistically significant. The retrospective nature of the study limited direct patient involvement, and all data were anonymized prior to analysis to maintain confidentiality.

## RESULTS

A total of 947 pediatric orthopedic trauma patients were included in the study. The mean age of the cohort was  $14.86 \pm 2.12$  years, and males represented the vast majority (88.1%) (Table I). Most patients (72.2%) sustained injuries at the scene, while 27.5% were referred from other healthcare facilities. Additionally, 69.3% of the children were residents of Karachi, reflecting the hospital's primary catchment area.

The mechanisms of injury are detailed in Table II. Motorcycle or bike crashes were the leading cause of trauma, accounting for 48.5% of all cases, followed by falls (27.6%). Motor vehicle collisions (8.8%) and pedestrian injuries (8.2%) were also noted. Less frequent mechanisms included bicycle accidents (2.0%) and gunshot injuries (0.5%), while 4.4% of cases fell into the other/unknown category.

Injury types and clinical outcomes are presented in Table III. Blunt trauma predominated overwhelmingly (96%), with penetrating injuries observed in only 2.2% of patients. Regarding outcomes, 71.2% of children were discharged alive, 0.8% succumbed to their injuries, and 0.2% left against medical advice. Amputations were required in 3.1% of cases, indicating the severity of certain injuries. Incomplete documentation was noted in 27.7% of the medical records.

Age-related trends in injury mechanisms are summarized in Table IV. Children aged 1-5 years and 6-10 years were most commonly injured due to falls (81.8% and 63.1%, respectively). In contrast, adolescents aged 11-15 years and those older than 15 years predominantly sustained injuries from motorcycle or bike accidents (50.0% and 57.4%, respectively). This shift reflects increasing exposure to road traffic environments with advancing age.

Surgical management patterns are summarized in Table V. A total of 881 surgical procedures were performed during the study period. The most common interventions were external fixation (29.8%) and internal fixation (24.1%), followed by wound debridement or washout (16.4%). Amputations represented 3.1% of all procedures, while other orthopedic interventions accounted for 19.6%. These findings highlight the substantial operative workload required for pediatric trauma care at this tertiary center.

Overall, the results demonstrate that pediatric orthopedic trauma in this setting is predominantly caused by high-energy

mechanisms particularly motorcycle-related crashes and falls and frequently requires surgical intervention.

Table I. Demographic and Case Characteristics of Pediatric Orthopedic

Variable	n (%)
Age (years) Mean $\pm$ SD	14.86 $\pm$ 2.12
Gender	
Male	834 (88.1%)
Female	113 (11.9%)
Case Type	
Scene cases	684 (72.2%)
Referred cases	260 (27.5%)
Residence	
Karachi	656 (69.3%)
Outside Karachi	291 (30.7%)

Trauma Patients (N = 947)

Table II. Mechanisms of Injury Among Pediatric Orthopedic Trauma Patients (N = 947)

Mechanism of Injury	n (%)
Motorcycle/Bike accidents	459 (48.5%)
Falls	261 (27.6%)
Motor Vehicle Collisions	83 (8.8%)
Pedestrian injuries	78 (8.2%)
Bicycle accidents	19 (2.0%)
Gunshot injuries	5 (0.5%)
Other/Unknown	42 (4.4%)

Table III. Injury Types and Clinical Outcomes of Pediatric Orthopedic Trauma Patients (N = 947)

Variable	n (%)
Injury Type	
Blunt trauma	909 (96.0%)
Penetrating trauma	21 (2.2%)
Unknown	17 (1.8%)
Clinical Outcomes	
Discharged alive	675 (71.2%)
Expired (Mortality)	8 (0.8%)
Left Against Medical Advice (LAMA)	2 (0.2%)
Amputation performed	29 (3.1%)
Incomplete documentation	262 (27.7%)

Table IV. Age Group Distribution and Predominant Mechanisms of Injury among Pediatric Trauma Patients

Age Group (Years)	Total in Category (n)	Most Common Mechanism	n (%)
1-5 years	110	Falls	90 (81.8%)
6-10 years	103	Falls	65 (63.1%)
11-15 years	158	Motorcycle/Bike	79 (50.0%)
>15 years	291	Motorcycle/Bike	167 (57.4%)

Table V. Surgical Procedures Performed Among Pediatric Orthopedic Trauma Patients (N = 881 procedures)

Surgical Procedure	n (%)
External Fixation	282 (29.8%)
Internal Fixation	228 (24.1%)
Wound Debridement/Wash	155 (16.4%)
Amputations	29 (3.1%)
Other procedures	187 (19.6%)
Total Procedures	881 (100%)

## DISCUSSION

Pediatric orthopedic trauma continues to represent a major public health burden in low- and middle-income countries (LMICs), including Pakistan. The strong male predominance observed in our study (88.1%) is consistent with global and regional trends, where boys are known to have increased outdoor exposure, higher physical activity, and greater risk-taking behaviors compared to girls<sup>14-18</sup>. Similar sex disparities have been consistently reported across LMIC settings and remain a well-recognized epidemiological pattern<sup>7,9,17</sup>.

Motorcycle and bike crashes emerged as the leading cause of injury (48.5%), highlighting a significant and preventable contributor to pediatric trauma. This aligns with data from South Asia, where motorcycles are commonly used for family transport, often without helmets or child-appropriate safety practices<sup>9,12,15,16</sup>. Road-traffic injuries are recognized as one of the largest contributors to pediatric trauma morbidity and mortality worldwide, particularly in LMICs where enforcement of road safety laws remains inadequate<sup>1,2,4,22</sup>. The age-group analysis in our study also mirrored established patterns: falls were predominant among younger children (1-10 years), whereas older children and adolescents (11-18 years) were more likely to sustain motorcycle-related trauma. Several studies from India, Pakistan, and other LMIC regions similarly report this transition from low-energy to high-energy mechanisms with increasing age<sup>3,10,23</sup>.

The predominance of blunt trauma (96%) in our cohort is consistent with global pediatric injury patterns, where road-traffic injuries and falls are the leading mechanisms of musculoskeletal trauma<sup>2,4,14</sup>. Although overall mortality remained low (0.8%), which is comparable to outcomes reported by other tertiary-care trauma centers<sup>8,11</sup>, the presence of limb amputations (3.1%) indicates severe high-energy or delayed-presentation injuries. Prior research highlights that pediatric amputations are strongly associated with high-impact road-traffic trauma, open fractures, and vascular compromise<sup>29,30</sup>.

The high frequency of femoral fractures in our study (52.3%) corresponds with findings from multiple regional and international studies identifying the femur as the most common long-bone fracture in children exposed to high-energy mechanisms<sup>9-11,24</sup>. Operative workload was also substantial, with 881 surgical procedures performed primarily external fixation, internal fixation, and debridement similar to data from other LMIC trauma centers where severe fractures and delayed referrals necessitate surgical intervention<sup>26-28</sup>. These patterns reflect the biomechanical severity of injuries, especially among motorcycle-involved pediatric patients.

A notable limitation identified was incomplete documentation in 27.7% of cases. Documentation gaps are a widely recognized challenge in LMIC trauma systems and significantly affect the quality of epidemiological surveillance and trauma research<sup>31,32</sup>. Strengthening trauma registry systems, staff training, and digital data capture have been recommended by global trauma networks to improve data reliability and support evidence-based decision-making<sup>22,31</sup>.

Overall, our findings reinforce that pediatric orthopedic trauma in Pakistan is largely driven by preventable mechanisms of injury, particularly road-traffic incidents and falls. Strengthening child safety policies such as enforcement of helmet use, motorcycle age restrictions, provision of safe play areas, and public awareness campaigns is urgently needed. Furthermore, enhancing prehospital care, timely referral pathways, orthopedic surgical capacity, and rehabilitation services is crucial to improving outcomes and reducing the long-term disability burden associated with pediatric trauma<sup>33-35</sup>.

This study adds valuable registry-based evidence from an urban tertiary-care trauma center in Pakistan and supports

international efforts to strengthen pediatric injury prevention and trauma care systems across LMIC settings.

## CONCLUSION

Pediatric orthopedic trauma in our setting is dominated by preventable high-energy injuries, especially motorcycle crashes in older children and falls in younger age groups. Femur fractures and the high rate of surgical interventions highlight the significant clinical burden on trauma services. Although mortality was low, the presence of severe limb injuries including amputations reflects the seriousness of these incidents.

These findings underscore the urgent need for better road-safety enforcement, child-focused prevention strategies, and strengthened trauma care pathways. Improving documentation and trauma registry systems is also essential for guiding evidence-based policies and enhancing pediatric trauma outcomes.

## REFERENCES

1. World Health Organization. World report on child injury prevention. Geneva: WHO; 2008.
2. Peden M, Oyegbite K, Ozanne-Smith J et al. World report on child injury prevention. Geneva: WHO; 2008.
3. Hyder AA, Sugerman DE, Ameratunga S et al. Falls among children in low- and middle-income countries. *Lancet* 2007;369:238–249.
4. Mock C, Cherian MN. Global burden of musculoskeletal injuries. *Clin Orthop Relat Res* 2008;466:2306–2316.
5. Norton R, Kobusingye O. Injuries. *N Engl J Med* 2013;368:1723–1730.
6. Chandran A, Hyder AA, Peek-Asa C. Global burden of unintentional injuries. *Epidemiol Rev* 2010;32:110–120.
7. Ghaffar A, Hyder AA, Masud TI. Road traffic injuries in Pakistan. *Public Health* 2004;118:211–217.
8. Razzak JA, Luby SP, Laflamme L et al. Injuries among children in Karachi. *Public Health* 2004;118:114–120.
9. Zia N, Razzak JA, Puvanachandra P et al. Road traffic injuries in Pakistan. *Int J Inj Contr Saf Promot* 2012;19:30–38.
10. Hyder AA, Peden M. Inequality and road traffic injuries. *Lancet* 2003;362:2034–2035.
11. Quatman-Yates CC, Hunter JB, Hedlund KJ et al. Long-bone fractures in children. *J Pediatr Orthop* 2020;40:e1–e10.
12. Hedström EM, Svensson O, Bergström U et al. Epidemiology of fractures in children. *Acta Orthop* 2010;81:148–153.
13. Hinton RY, Lincoln A, Crockett MM et al. Femoral shaft fractures in children. *J Bone Joint Surg Am* 1999;81:500–509.
14. Loder RT. Pediatric polytrauma. *J Orthop Trauma* 2006;20:673–679.
15. Hyder AA, Labinjo M, Muzaffar S. Injury prevention in developing countries. *Health Policy* 2007;81:19–33.
16. Peden M, Scurfield R, Sleet D et al. World report on road traffic injury prevention. Geneva: WHO; 2004.
17. Rivara FP, Bergman AB, Drake C. Children as pedestrians. *Pediatrics* 1989;84:1017–1021.
18. Agran PF, Winn D, Anderson C et al. Pediatric injury rates. *Am J Prev Med* 2001;20:123–128.
19. Bartlett SN. Children's injuries in LMICs. *Health Policy Plan* 2002;17:1–13.
20. Borse NN, Gilchrist J, Dellinger AM et al. CDC childhood injury report. *MMWR* 2008;57:1–41.
21. Gupta S, Gupta SK, Devkota S et al. Falls in children. *Injury* 2013;44:1–7.
22. Mock CN, Jurkovich GJ, Arreola-Risa C et al. Trauma mortality patterns. *J Trauma* 1998;44:804–812.
23. Nwomeh BC, Lowell W, Kable R et al. Trauma registries in LMICs. *World J Surg* 2006;30:2061–2069.
24. Hutchins CM, Sponseller PD, Sturm PF et al. Open fractures in children. *J Pediatr Orthop* 2000;20:183–188.
25. Battaglia TC, Armstrong DG, Fisher M et al. Amputation in pediatric trauma. *Trauma Surg Acute Care Open* 2020;5:e000420.