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Head Injury in Children: A 3-Year Review from a Tertiary Care Hospital in South Punjab, Pakistan

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ABSTRACT

Background and Goals: Traumatic brain injury is still a major global health issue, especially for children in middle-income and low-income countries. The purpose of this retrospective study is to assess the prevalence, clinical features, and results of pediatric head injuries at a tertiary care facility in South Punjab, Pakistan, over a three-year period.

Methodology: Between January 2019 and December 2021, 384 children ages 0–14 who presented with confirmed head trauma had their data obtained. To ensure accuracy and consistency, data was collected methodically from case files and electronic medical records using a pre-made data collection form. Demographic information, clinical presentation, treatment methods, and results were among the variables. SPSS v.26.0 was used to analyze the data.

Findings: The study found that the prevalence was slightly higher in females (54.7%), with a nearly equal gender distribution. Sports injuries, assaults, and being struck by objects were among the most frequent causes of injury. Mild, moderate, and severe cases were equally distributed across severity levels according to the Glasgow Coma Scale. Radiological evaluations often revealed extradural hemorrhage, brain edema, and subarachnoid hemorrhage. Complications like aspiration pneumonia, CNS infections, and wound infections were common, and a sizable percentage of patients (45.3%) needed surgical intervention. Poor outcomes occurred in 55.2% of the cases overall, highlighting the urgent need for enhanced trauma care infrastructure and preventative measures.

Conclusion: The study concludes that in order to lessen the prevalence of pediatric TBI in underprivileged areas like South Punjab, targeted public health policies, early diagnosis procedures, and rehabilitation services are desperately needed.

INTRODUCTION:

Traumatic brain injury (TBI) affects a lot of people around the world, including those from every age group and background, but children are hit the hardest (Asif et al., 2021; Islam et al., 2020). Group surveys show that a large number of children, around 10 million each year, develop TBI which greatly increases morbidity and mortality for this age group, making TBI a major international health concern (Marchese et al., 2022). As well as the immediate physical injury caused by TBI in children, the condition can often lead to lasting effects on their brain, behavior, and emotions which may greatly affect their growth and everyday life (Ogunmayowa et al., 2024). Limited facilities for pediatric trauma, lacking road safety, and social background in South Punjab all make TBI more frequent among children in that area (Rao et al., 2023). Without standard terms for TBI in children, it is harder to give proper treatments which might cause treatment delays and less favorable outcomes (Chiabi et al., 2023).

Keating et al. (2022) have found that traumatic injury registries at hospitals help identify weaknesses and contribute to more innovative quality improvement programs. The range of TBI incidence in Europe is 47.3/10 million to 849/10 million, while mortality from TBI is 3.3/10 million to 28.1/10 million (Huang et al., 2022). It is necessary to do additional research on TBI in the Middle East and North Africa to guide the development of helpful prevention and intervention plans (Al-Hajj et al., 2021). Care for TBI causes high medical expenses and a reduction in how productive people can be (Yokobori et al., 2020). Each year, thousands of people face serious injury and death because of road traffic accidents, which total over 1.2 million fatalities and 50 million injured people (Khan et al., 2020). Like other nations in the Eastern Mediterranean, Pakistan plays a significant part in the deaths caused by these accidents (Khan et al., 2020). WHO estimates that about 5.8 million people die from traumatic injuries globally each year, and more than 90% of these deaths happen in low- and middle-income nations (Umo et al., 2022). TBI is responsible for many deaths and disabilities around the globe, and patients may face challenging rehabilitation and risk developing long-term physical, thinking, emotional and behavioural issues (Ghroubi et al., 2021). Road safety challenges are made worse by road regulations, political instability and violence towards women and men within the home (Adamson et al., 2020).

There are many injury mechanisms involved in TBI, and both the initial and later damage contribute to brain changes. Primary injuries usually happen right away and include skull fractures, contusions, lacerations and diffuse axonal injury, which can break neural pathways and initiate a range of cellular changes (Koliatsos & Rao, 2020). The other type, called secondary injuries, is caused by problems inside the body that grow over time and include processes such as excitotoxicity, oxidative stress, inflammation, and swelling in the brain. Because these second injuries make the main ones worse, they can cause additional nerve disruption and cell loss (as explained by Rauchman et al., 2023). External shocks are what cause brain injuries, resulting in molecular and structural changes, abnormal activity in nerves, neuroinflammation and a loss of nerves (Rauchman et al., 2023). Inflammation, oxidative stress, problems controlling calcium and apoptosis arise from harmful changes happening at a cellular and molecular level. A damaged blood supply, ischemia and a breached blood-brain barrier all play a role in destroying brain tissue (Rauchman et al., 2023). Right after a TBI, neuroinflammation helps trigger secondary brain injury, which can seriously damage neurons and lead to lasting brain dysfunction.

According to Dehhaghi and colleagues, TBI is divided into mild, moderate and severe depending on test scores and behavioural changes after an injury (Dehhaghi et al., 2023). TBI can significantly change how well a person moves, their ability to look after themselves and their thinking, feeling and ability to interact with others (Armstrong & Murtaugh, 2020). Since most TBIs are mild and the symptoms do not last long, people often do not report their condition to seek treatment (McBride et al., 2023). Long-term neurological diseases associated with moderate to severe traumatic brain injury (TBI) include post-traumatic epilepsy, chronic traumatic encephalopathy, Parkinson's disease and Alzheimer's disease (Corrigan et al., 2023). The early diagnosis of TBI is essential for guiding treatment and demands an understanding of the most recent diagnostic approaches (Yue & Deng, 2023). The standard approach to scanning the brain for TBI is with

computed tomography and magnetic resonance imaging (Rauchman et al., 2022).

While these are helpful in identifying structural lesions, their sensitivity in detecting diffuse axonal injury and non-structural lesions is limited. The psychological trauma associated with events resulting in traumatic brain injury is an important and frequently overlooked factor that may impede brain recovery and worsen mental health following TBI (Weis et al., 2021). Early psychological intervention has been shown to improve outcomes and accelerate recovery.

Many individuals with TBI experience persistent cognitive loss, behavioral difficulties, headaches, and visual abnormalities that compromise their capacity to work, socialize, and fully participate in daily activities (Rauchman et al., 2023). Although most patients with TBI, particularly mild TBI, recover from their symptoms within a few weeks, a small but meaningful subset experience symptoms that persist for months or years after injury and significantly impact the quality of life for the individual and their family (Haarbauer-Krupa et al., 2021). The usual rehabilitation pathway for TBI patients is not suitable for some due to serious behavioral disturbances and impaired self-awareness, leading them to be either discharged prematurely to their homes or admitted to a nursing home or psychiatric institution (Timmer et al., 2020). Behavioral disturbances in TBI patients also affect the lives of their caregivers and significant others.

Mental health disorders, including depression, anxiety, and post-traumatic stress disorder, are common after TBI and can exacerbate cognitive and functional deficits (Chan et al., 2022). Sleep disruption is a common and persistent consequence of mild traumatic brain injury (mTBI), with up to 90% of individuals reporting issues such as insomnia, frequent wakefulness, and poor sleep quality (Raikes et al., 2021). Brain injuries constitute a major public health issue and a significant source of disability and death in the United States and worldwide (Conti et al., 2024).

In South Punjab, Pakistan, data on pediatric TBI is limited, preventing the establishment of prevention, early detection and management strategies based on evidence. This retrospective study aimed to analyze carefully all the cases of pediatric head injury admitted to a leading tertiary hospital serving South Punjab for a period of three years. Study examined the TBI occurrence among children visiting the hospital, listing their demographics, reasons for the injury, levels of injury, how the injuries were managed and the expected results.

Methodology:

At Nishtar Medical University Hospital, a tertiary health center in South Punjab, Pakistan, a descriptive retrospective study investigated incidents of pediatric head injuries from January 2019 to December 2021. The hospital which includes pediatric and neurosurgical services, is a key center for a lot of children, so it is suitable for analyzing head injuries in children.

The inclusion criteria comprised children aged 0–14 years presenting with confirmed head injuries and complete medical records. Patients with non-traumatic head injuries, incomplete records, intentional injuries (such as assault), or declared dead upon arrival were excluded to focus on unintentional head injuries. The sample size was calculated using a standard formula for proportions, assuming a population proportion of 50%, a 5% margin of error, and a 95% confidence level, resulting in a required sample size of 384 cases.

Data were collected systematically from electronic medical records and case files using a pre-designed data collection form to ensure consistency and accuracy. Variables included demographic data (age, gender, location), clinical presentation (mechanism of injury, symptoms, Glasgow Coma Scale [GCS] score), imaging results (CT scans), treatment interventions (conservative vs. surgical), and outcomes (recovery and long-term sequelae). Data was analyzed using SPSS v.26.0. Descriptive statistics (frequencies, percentages, means, and standard deviations) summarized the data.

Ethical Considerations: The study protocol was reviewed and approved by the Institutional Ethical Review Board of the hospital. Given the retrospective nature of the study, informed consent was waived; however, patient confidentiality was strictly maintained by anonymizing all personal identifiers. The study was

conducted in accordance with the principles outlined in the Declaration of Helsinki.

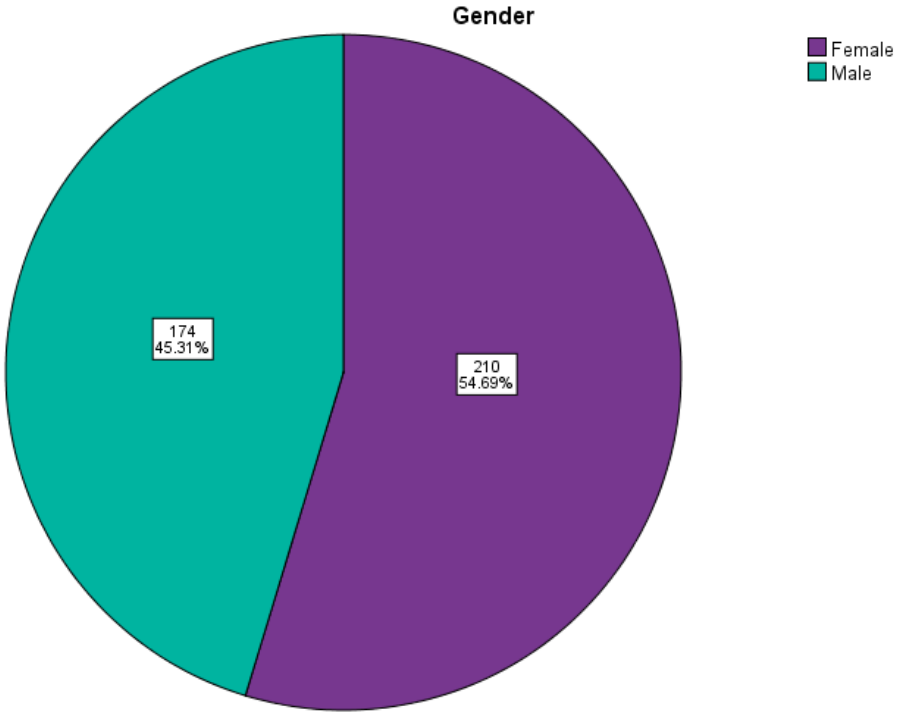
Results

A total of 384 pediatric patients with head injuries were included in the study. The demographic characteristics and injury modes are summarized in Table 1. Females constituted 54.7% (n=210) of the cohort, with males representing 45.3% (n=174). The age distribution was fairly balanced across the pediatric age groups: 35.7% (n=137) were aged 0–5 years, 33.3% (n=128) were 6–10 years, and 31.0% (n=119) were 11–14 years. Regarding the mechanism of injury, the most frequent causes included being hit by an object (18.5%, n=71), sports injuries (15.6%, n=60), and assault (15.1%, n=58), followed by firearm injuries, falls, other injuries, and road traffic accidents.

Table 1: Demographics and Injury Characteristics

Variable	Category	Frequency	Percent
Gender	Female	210	54.7
	Male	174	45.3
Age Group	0-5 years	137	35.7
	6-10 years	128	33.3
	11-14 years	119	31.0
Mode of Injury	Assault	58	15.1
	Fall	48	12.5
	Firearm Injury	52	13.5
	Hit by Object	71	18.5
	Road Traffic Accident (RTA)	42	10.9
	Sports Injury	60	15.6
	Other	53	13.8

Table 2 provides a detailed overview of clinical presentation, imaging findings, associated injuries, and midline shift. Glasgow Coma Scale (GCS) scores were nearly evenly distributed with 34.6% (n=133) severe, 34.4% (n=132) mild, and 31.0% (n=119) moderate cases. Pupil status varied, with 36.7% (n=141) exhibiting fixed dilated pupils and 28.4% (n=109) showing anisocoria. Common CT findings included subarachnoid hemorrhage (14.8%, n=57), brain edema (14.1%, n=54), and extradural hemorrhage (13.0%, n=50). Associated injuries were frequent and varied; isolated head injuries comprised 17.2% (n=66), while fractures of the face and chest trauma were also common. Midline shift greater than 3 mm was observed in 37.0% (n=142) of patients, indicating substantial intracranial mass effect.


Gender
Female
Male
174
45.31%
210
54.69%

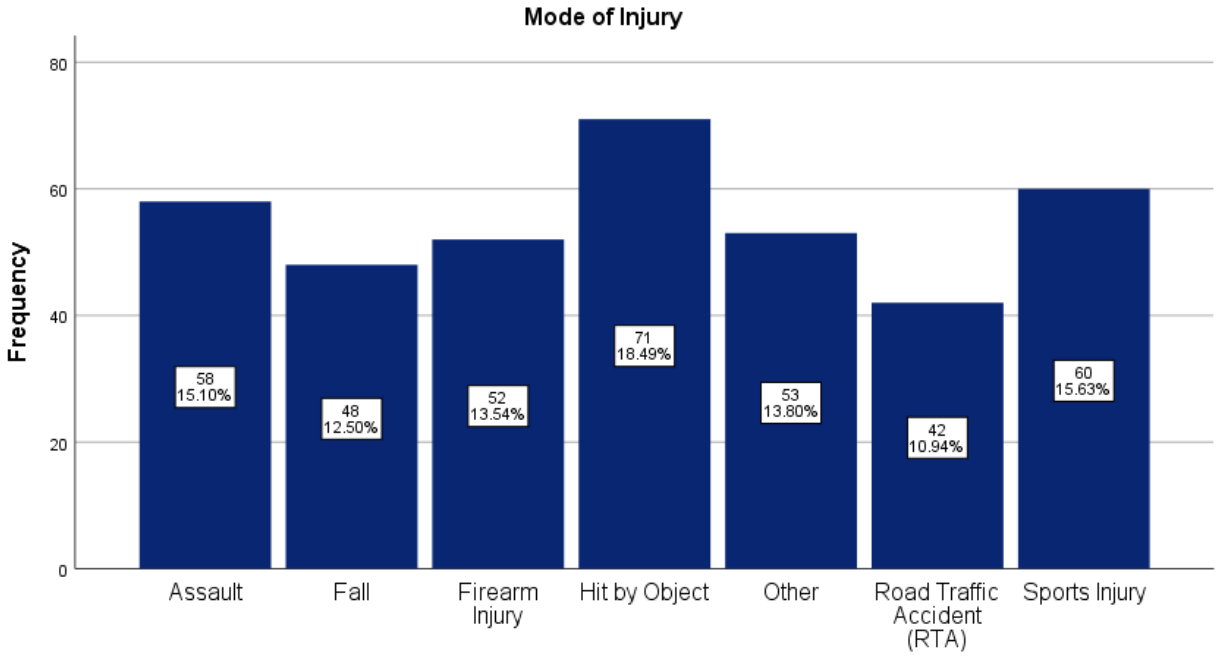
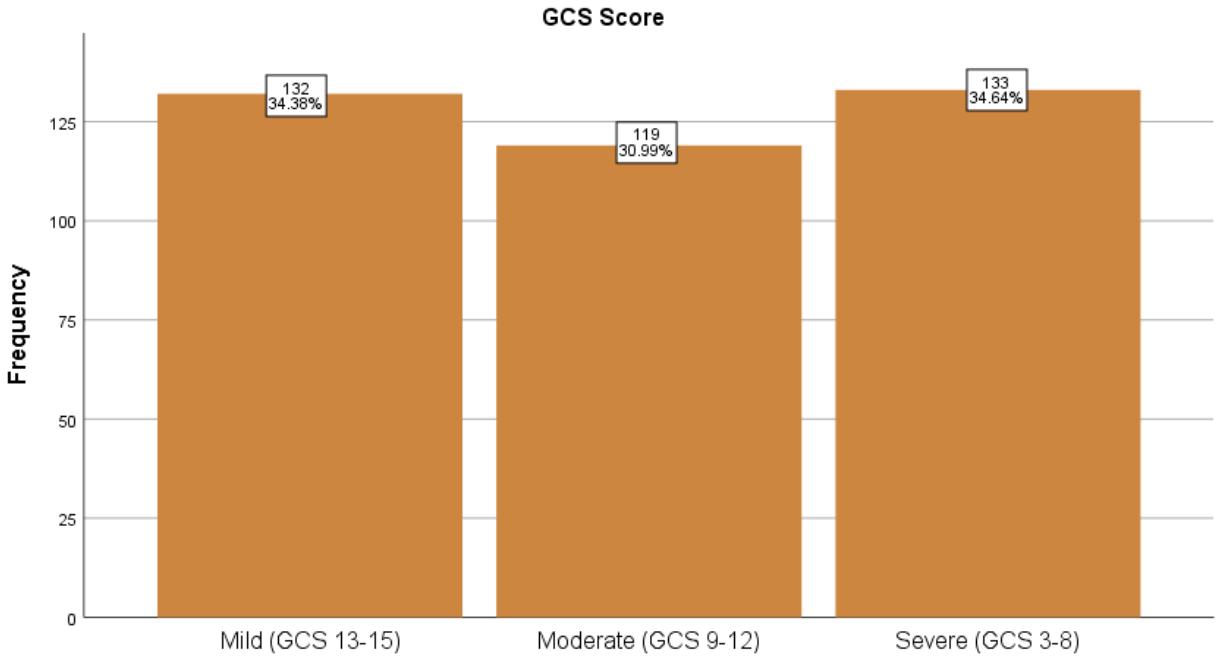

Mode of Injury
Frequency
80
60
40
20
0
58
15.10%
48
12.50%
52
13.54%
71
18.49%
53
13.80%
42
10.94%
60
15.63%
Assault
Fall
Firearm Injury
Hit by Object
Other
Road Traffic Accident (RTA)
Sports Injury

Table 2: Clinical Presentation, Imaging Findings, Associated Injuries, and Midline Shift

Variable	Category	Frequency	Percent
GCS Score	Mild (13-15)	132	34.4
	Moderate (9-12)	119	31.0
	Severe (3-8)	133	34.6
Pupil Status	Anisocoria (unequal pupils)	109	28.4
	Fixed Dilated Pupils	141	36.7
	Normal	134	34.9
CT Findings	Brain Edema	54	14.1
	Contusion or Hematoma	44	11.5
	Extradural Hemorrhage (EDH)	50	13.0
	Pneumocephalus/Aerocele	38	9.9
	Skull Fracture	49	12.8
	Subarachnoid Hemorrhage	57	14.8
	Subdural Hemorrhage (SDH)	45	11.7
	Normal	47	12.2
Associated Injuries	Abdominal Trauma	49	12.8
	Chest Trauma	56	14.6
	Fractures of the Face	59	15.4
	Isolated Head Injury	66	17.2
	Limb Fractures	54	14.1
	Multiple Injuries	55	14.3
	Spinal Trauma	45	11.7
Midline Shift (MLS)	MLS < 3 mm	103	26.8

MLS > 3 mm	142	37.0
No MLS	139	36.2



Treatment modalities and surgical complications are detailed in Table 3. More than half of the patients (54.7%, n=210) received conservative management, while 45.3% (n=174) underwent surgical intervention. Surgical complications were frequent, including aspiration/pneumonia (22.4%, n=86), wound infection (21.1%, n=81), and central nervous system infections (20.3%, n=78).

Table 3: Treatment and Surgical Complications

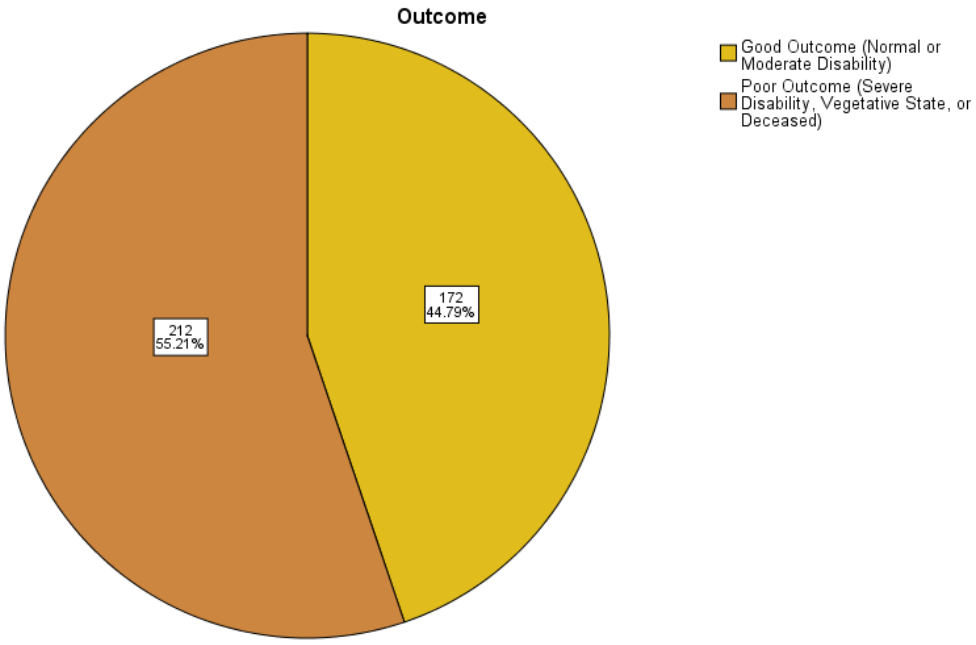
Variable	Category	Frequency	Percent
Mode of Treatment	Conservative Management	210	54.7
	Surgical Intervention	174	45.3
Surgical Complications	Aspiration/Pneumonia	86	22.4
	Cerebrospinal Fluid (CSF) Leak	61	15.9
	CNS Infection (e.g., meningitis, subdural abscess)	78	20.3
	Recollection of Hematoma	78	20.3

	Wound Infection	81	21.1

Table 4 summarizes patient outcomes, follow-up durations, and additional injury characteristics. Poor outcomes (severe disability, vegetative state, or death) were observed in 55.2% (n=212) of patients. Follow-up periods were distributed fairly evenly, with approximately one-quarter of patients followed for each of the intervals between 0 to more than 12 months.

Table 4: Outcomes, Follow-up, Associated Injuries, and Midline Shift

Variable	Category	Frequency	Percent
Outcome	Good Outcome (Normal or Moderate Disability)	172	44.8
	Poor Outcome (Severe Disability, Vegetative State, or Deceased)	212	55.2
Follow-up Duration	0-3 months	93	24.2
	4-6 months	103	26.8
	7-12 months	102	26.6
	More than 12 months	86	22.4



Discussion

This retrospective analysis of 384 pediatric patients with head injuries in South Punjab provides valuable insights into the clinical characteristics, management, and outcomes in this underreported region. This contrasts with other studies because females were found to predominate among our group of pediatric head injury patients, whereas males have been the most common before. According to Chiabi et al. (2023), males in Cameroon are more likely to have this disease, and it is commonly explained by greater male involvement in risky activities. This gender imbalance in violent deaths could be caused by local social and cultural differences or by problems with collecting data.

We found that the percentage of patients in our cohort who were 0–5, 6–10 and 11–14 was all quite similar. This result is in line with Aderibigbe and Ogunrewo (2022), who pointed out that head trauma can occur among children of any age. However, theirs indicated that children under 4 years old seem to experience it more often. We found that various risks affect the pediatric population in South Punjab, likely because children are injured by falls, assaults or participation in sports.

Out of all injury mechanisms, being struck by an object was the most common (18.5%). This was followed by sports-related injuries (15.6%) and assaults (15.1%). These results are consistent with data from other low- and middle-income countries, showing that violence between people and dangerous play activities often cause many childhood injuries (Aderibigbe & Ogunrewo, 2022). In high-income places, it is mainly traffic accidents that cause the most injury and death, which highlights the need for strategies created for the critical risks in that part of the world.

The injuries in our clinical setting varied widely in severity. One-third of patients (34.6%) experienced severe head injuries, according to GCS, and a number also had mild (51%) or moderate (19%) injuries. The findings in this study are comparable to those of Amiri et al. (2020), who also reported a variety of how severe head trauma was in children. In 36.7% of patients, the neurological tests showed fixed, dilated pupils, while 28.4% had anisocoria, two common signs of a significant brain injury that generally leads to poor outcomes (Kim et al., 2022).

Further testing with brain pictures showed just how much damage was inside the head. Studies worldwide on childhood brain injuries show a pattern similar to the main problems found in our research: a high amount of subarachnoid hemorrhage, brain edema, and extradural hemorrhage (Global Guideline, 2024). A midline shift exceeding 3.0 millimeters was noted in 37 percent of cases, which is often related to increased pressure within the skull and problems of the brain pushing against the skull (Kim et al., 2022). Therefore, quick diagnosis and treatment are necessary to protect the brain further.

Either conservative management (54.7%) or surgery (45.3%) was the strategy that this cohort included. Observing many surgical treatments in injured soldiers, our findings agree with the experience described by Islam et al. (2020) in a tertiary care military hospital. Even so, there was a possibility of surgical patients getting aspiration pneumonia, infections of the wound, and diseases of the brain or spinal cord. As a result, detailed care and measures to stop infections are necessary before, during and after surgery, as Jones et al. (2020) already discussed regarding the larger effects of injury and their consequences on children.

A brain injury that causes the brain to shift (midline shift) can increase the risk of acute ischemic stroke and intraparenchymal hemorrhage sharply. The results are consistent with those found by Klučka et al. (2021) and Rawanduzy et al. (2022), both of whom report that children with delayed recognition and treatment of stroke are at higher risk of death. Moreover, the many different ways a stroke can appear in children, according to Sun and Lynch (2023), can make it tough for clinicians to identify the condition quickly.

In summary, our research parallels and supplements previous studies by concentrating on distinct regional patterns of pediatric brain injuries in South Punjab. These results indicate that many strategies, including preventive measures, sophisticated diagnostic procedures, and postoperative care, are necessary to mitigate the impact of brain injuries in children.

Conclusion

This research provides a thorough analysis of pediatric head injuries in a South Punjabi tertiary care setting, providing important new information on treatment outcomes, clinical manifestations, and epidemiological trends over three years. The results emphasize an array of injury mechanisms, the significant impact of severe trauma, the high incidence of complications, and the unfavourable results, all of which point to structural issues in the treatment of pediatric trauma. The need for region-specific preventive measures and public awareness campaigns is highlighted by the prevalence of injuries brought on by falls, interpersonal violence, and unsafe play environments. Improved perioperative procedures and post-operative care are also essential, as evidenced by the high percentage of patients who need surgery and the prevalence of postoperative complications. The high proportion of unfavorable results emphasizes how crucial early diagnosis, prompt intervention, and organized rehabilitation services are. This study emphasizes the critical need for improved training for medical personnel in South Punjab, investment in pediatric trauma systems, and reform of health policies. To improve outcomes for children with traumatic brain injury, future initiatives should give top priority to the creation of trauma registries, standardized treatment pathways, and long-term follow-up systems.

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