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Original Article

Paediatric Traumatic Brain Injury: A retrospective review of the Pattern and Outcomes in a Resource-poor setting.

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Abstract

Background: Traumatic brain injury (TBI) is defined as an injury to the head and ultimately to the underlying brain caused by an external force, resulting in impaired brain function. Aetiologies of Paediatric TBI include sporting events, falls, and road traffic accidents. Morbidities following TBIs include cognitive impairment and physical disabilities. Outcomes are exacerbated in resource-poor settings where access to timely and adequate healthcare services, including intensive neurosurgical care and rehabilitation, is limited. **Objectives:** To study the demographics and management outcomes of Pediatric traumatic brain injuries (TBIs) in a resource-poor setting. **Methodology:** A retrospective study was conducted to investigate traumatic brain injury (TBI) among children aged 0-–17 years in our setting. **Results:** TBI constituted 14% of Paediatric trauma, ages between 1 day and 17 years old, mean age of 9±3.24 years, mode of 8. Mainly boys with M: F of 2.5:1. The Main cause of TBI is RTA involving pedestrians (81, 51.9%). Severities were mild (77.3%), moderate (20.4%), and severe (2.3%). CT scan was available for 36.4% only, abnormal in 96.9%, revealing fractures (68.8%), oedema (28.1%), normal (3.1%), haematoma (5.7%), and haemorrhagic contusions (29.7%). The main associated injuries were superficial wounds (80.7%) and limb fractures (12.5%). Surgery was performed on 13.6%. Hospital stay was 1 to 65 days (mode of 8 days). The outcome was good (90.9%), with 6 mortalities: mild GCS (2.2%), moderate GCS (5.5%), and severe GCS (25%), respectively. **Conclusions:** Pedestrians were mainly affected by RTA. Proactive preventive measures, accessible brain Imaging, and intensive care improve the outcomes.

Keywords: *Brain injury, Children, Outcome. Pedestrians, Resource-poor.*

Introduction

Traumatic brain injury (TBI) is defined as an injury to the head and ultimately to the underlying brain caused by an external force, resulting in impaired brain function.[1] In 2017, approximately 224,000 people in the United States were hospitalized due to TBI, and 7.8% of these people were children aged 0–17 years old. Within this period, TBI-related deaths were estimated to be around 61,000, and around 4.5% of these deaths were in children.[1] From a Korean study, about 31.9% of children were admitted to hospitals with TBI between June 2008 and May 2009.[2] A study has shown that TBI contributed to more than half (>50%) of Paediatric injuries in Iran, about 20% of traumatic Paediatric admissions in India, and 30% of Paediatric Injuries in Korea.[3] It has been found that very young children (0–2 years old) and adolescents (15–18 years old) are the most likely to experience TBI, while children whose ages are in between are less likely to experience

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TBI by comparison.[4,5] Compared with their adult counterparts, children suffering brain injury warrant particular concern given the developmental consequences of early brain damage.[6] Common aetiologies of Paediatric TBI include sporting events, falls, and motor vehicles collisions.[7] In low and middle-income countries (LMIC), TBIs among children account for 95% of the global burden of TBI, for which 90% of the injuries were non-intentional.[8] According to a Million Death Study Collaborators of 2017, pedestrian-related TBIs are said to be a leading cause of morbidity and mortality among children globally, particularly in resource-poor settings characterised by congested urban environments and insufficient road safety measures.[9]

Morbidities associated with pedestrian accidents include severe long-term consequences such as cognitive impairment and physical disabilities. These outcomes are exacerbated in resource-poor settings where access to timely and adequate healthcare services, including neurosurgical care and rehabilitation, is limited.[10] TBI is typically classified as mild, moderate, or severe based on the Glasgow Coma Scale Score (GCS).[11] Most Paediatric TBI cases tend to be mild injuries with better outcomes compared to adult TBI.[12]

According to Paediatric Research in Emergency Departments International Collaborative (PREDICT), non-contrast cranial computed tomography (CT) of the head is the imaging modality of choice for patients with TBI, especially those with low GCS.[13] However, guidelines have been validated that can be applied to determine which child with a normal or near-normal GCS can safely avoid CT. Based on the Paediatric Emergency Care Applied Research Network (PECARN) algorithm, recommendations for obtaining head CT in Paediatric patients after identifying children with a mild TBI (GCS 14–15) with a very low risk of clinically significant brain injuries have been spelled out.[14]

Despite the CT's utility in initial TBI evaluation, there is little supporting evidence for its routine repeat of the imaging in children.[15] It has been reported that the duration of hospitalisation was 1 to 30 days for 90% of the children.[6] The overall mortality was 13.18% and increased to as high as 61.04% among those with severe TBI.[6]

Materials and Methods

This retrospective study was conducted over five years, between January 2018 and December 2022. Our hospital, the Modibbo Adama University Teaching Hospital (MAUTH), Yola, is located in northeastern Nigeria. We reviewed the medical records of children whose ages were 17 years or less who were managed for traumatic head injury. Data on the patient's demography, aetiology of injury, associated injuries, available investigations, and treatment, as well as outcomes for both surgically and non-surgically managed, were extracted from the case notes. Data was analysed using SPSS (Statistical Package for the Social Sciences) version 25, and results were presented as charts and tables. The age limit of 17 years was set for pediatrics in our centre.

Results

A total of 1,257 Paediatric trauma patients were admitted via the Accident and Emergency department of our hospital, with 176 Paediatric TBIs, accounting for 14 % of the patients. Their ages ranged between 1 day – 17 years old. With a mean age of 9 ± 3.24 years and a mode of 8. There were 126 boys and 50 girls, with a male-to-female ratio of 2.5:1.

Road Traffic Accident (RTA) related causes involved 156 (88.6%) patients, various falls, including domestic ones, accounted for 19 (10.8%) cases, while 1 (0.6%) birth trauma. Motor Vehicle Accidents (MVA) accounted for 83 (53.2%) of the victims. Eighty-one (81) pedestrians (51.9%) were involved. The demographic findings are shown in Table 1.

The severity of the patients' TBIs, assessed from their post-resuscitation Glasgow Coma Scale Score (GCS), indicated that 136 were mild, 36 were moderate, and 4 (2.3%) were severe TBIs, as shown in Figure 1.

All patients had their Packed Cell Volume (PCV) assessed, from which 21 were found to be anaemic and promptly transfused (anaemia was in patients with a femoral fracture in 9, scalp bleeding in 6, hookworm infestation in 2, while 4 had nutritional anaemia predating the trauma).

None was found to have an abnormal blood sugar. Regarding head imaging, all had Skull X-rays, but a Computed Tomography Scan (CT scan) was available in 64 only. Skull X-ray showed a variety of fractures and foreign bodies of metallic fragments in one patient and multiple gravel in the other. Findings from the imaging modalities are shown in Table 2 below.

Associated injuries among them include Skull fractures (55.7%), Superficial wounds on the head and other parts of the body (80.7%), Fracture of the limbs (12.5%), Blunt Abdominal injury (2.8%), Blunt Chest injury (1.1%), and Cervical spine injury (0.6%) as shown in the histogram below, Figure 2. Some clinical and radiological findings are shown in Figure 3 below. After adequate resuscitation, all had routine supportive care, including measures aimed at preventing/reducing any raised intracranial pressure.

All the 'Ping-Pong' fractures except for 1 resolved spontaneously within 3 to 12 months of watchful waiting with skull X-ray assessments during the follow-up period. Surgeries were appropriately indicated and performed on 24 (13.6%) patients, as shown in Table 3 below. Duration of Hospital stay ranged between 1 to 65 days, with a mode of 8 days. Mean hospital stay depended on the severity (GCS) of the head injury. Mild TBI patients had a Mean of 6.5±4, Moderate TBI had a Mean of 12.64±10.1, while severe TBI patients had a Mean stay of 20.69±14.0. Among those who had surgical intervention, the Mean Hospital stay was 14.57±12.6 while the stay among the non-operated group was 11.35±9.2. Worthy of note was a boy with severe head injury and bilateral femoral fracture whose CT scan was normal, managed as diffuse axonal injury.

Outcome was assessed using the Glasgow outcome score (GOS), which was good in 160 (90.9%) patients, with residual neurological deficits in 10 (5.7 %), consisting of speech, hemiparesis, monoparesis, and frontal lobe syndrome. Apathy was the major frontal lobe symptom that presented as refusal of the kids to play with their peers, which was managed conservatively by advising parents to encourage their children to play with their peers. Overall, we recorded 6 (3.4%) mortalities. Among these 3(2.2%) were in the mild, 2 (5.5%) were in the moderate, and 1 (25%) were in the severe GCS groups, respectively.

TABLE 1: Demography Characteristics and Aetiologies of the Traumatic Brain Injury in the Study Population. **(N = 176).**

Parameters	Number (%)
Age ranges	
0 – 4	5 (2.8%)
5 – 8	62 (35.2%)
9 – 12	77 (43.8%)
13 – 16	32 (18.2%)
Aetiologies	
Road Traffic Accident (RTA)	**N=156**
Motor vehicle Accident (MVA):	
Occu pant	29 (18.6%)
Pedestrian	54 (34.6%)
Tricycle:	
Occupant	16 (10.25%)
Pedestrian	12 (7.69%)
Motorcycle:	
Passenger	24 (15.38%)
Pedestrian	14 (8.97%)
Bicycle:	
Passenger	6 (3.84%)
Pedestrian.	1 (0.64%)
Falls	**N=19**
Trees	10 (52.63%)
Back of human	2 (10.5%)
Arm	5 (26.3%)
Bed/seat(cushion).	2 (10.5%)
Birth trauma ; forceps	**N=1**
	1(100%)

Table 2 : Below showing the Skull X -ray findings and the morphological findings on the Computed Tomography Scan of the Head.

Imaging modalities	Number (%)
Skull Xray	**N=176(100%)**
Fractures:	
Linear fracture	12 (6.8%)
Comminuted fracture	14 (8.0%)
Foreign bodies	2 (1.1%)
Normal	148 (84.1%)
Head CT scan.	**N=64 (%)**
Fractures:	
Linear fracture	12(18.8%)
Comminuted fracture	14(21.9%)
Indriven skull fracture	2(3.1%)
Depressed / "Ping pong " Fracture	9(14.0%)
Elevated skull fracture	1(1.6%)
Growing skull fracture	2 (3.1%)
Skull base fractures	4 (6.3%)
Normal (? diffuse axonal injury):	2 (3.1%)
Cerebral Oedema only:	18(28.1%)
Haematomas:	
Subdural	1(1.6%)
Extradural	3 (4.1%)
Haemorrhagic contusion:	19(29.7%)

Table 3: Showing the various surgical interventions. **N= 24**

Nature of Surgery	Number (%)
Removal of indriven bone fragment	6 (25%)
Elevation of depressed skull fracture	3 (12.5%)
Reduction of elevated skull fracture	1 (4.2%)
Debridement and duraplasty	8 (33.3%)
Elevation of 'ping pong' fracture	1 (4.2%)
Evacuation of Extradural haematoma	2 (8.3%)
Surgical repair of CSF rhinorrhoea	1 (4.2%)
Ventriculoperitoneal shunt	2 (8.3%)

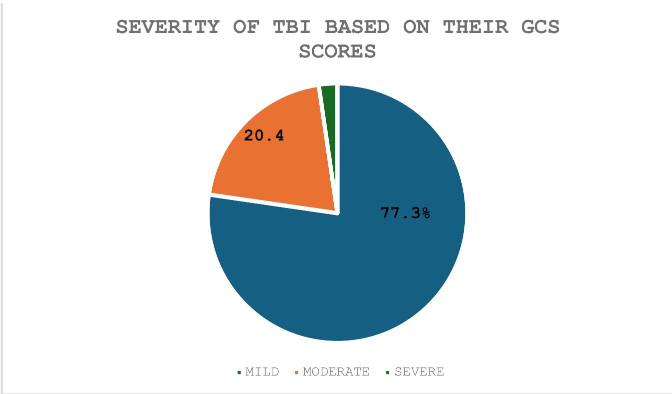

Figure 1: The pie chart above shows the severity of the head injuries based on the Glasgow Coma Scale Score of the patients.

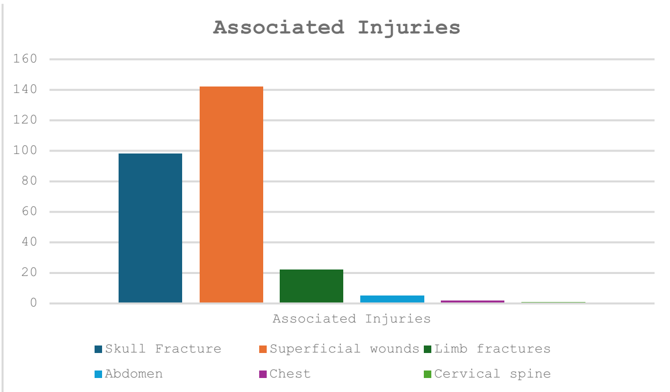

Figure 2: Histogram above showing the various associated injuries.

Figure 3: Above showing some of the clinical pictures. A right occipital depressed skull fracture (white arrowed) shown from above **(A)**, Bilateral 'racoon eye' (white arrowed) in a patient with anterior skull base fracture **(B)**, a Scalp laceration with underlying cephal haematoma **(C)**, A frontal Craniotomy scar (white arrowed) following a Cerebrospinal Fluid (CSF) rhinorrhoea repair **(D)**, Computed Tomography, bone window in coronal reconstruction showing an elevated fracture (green arrowed) on the vertex **(E)**, Computed Tomography, bone window in sagittal reconstruction showing a coexisting elevated (green arrowed) and a depressed fracture (blue arrowed) on the vertex **(F)**.

Discussion

From a total of 1,257 Paediatric trauma cases admitted via the Accident and Emergency Department, TBIs accounted for 176 patients, which is approximately 14% of all traumas. Our finding of 14% is slightly less than the Lagos findings (19.7%) by Adeleye.[16] This slight difference may be because the population of Lagos is denser than Yola, more cosmopolitan, and hence has more vehicular and human traffic. A study by Taopheeq[17] in Nigeria also found more (20%) involvement of children than ours. However, a United States study [1] reported a much lesser (7.8%) involvement of children. The mean age of our patients was 9 years with a standard deviation of 3.24 years. Younger mean ages were found by Bahloul[18] (7.54 ± 3.8 years), as well as Kpelao [19] in Dakar (7.5 years). The mode of the age distribution was 8 years. Chikani [20] found a peak incidence at younger ages of 3–5 years. In contrast, another Nigerian study by Taopheeq [17] found more adolescent (29%) involvement. Our mode of 8 years may be attributed to developmental factors and increased activity levels in children of this age group, also corresponding to school enrolment age after attaining some level of Quranic studies at home.

We had more boys than girls, with a male-to-female ratio of 2.5:1. This ratio is in concordance with the findings by Chikani [20], Taopheeq [17], Romuald et al.[6,] and a multi-Centre study conducted by Murgio and collaborators [21] from Brazil, France, Hong Kong, and Spain. A much higher involvement of boys, with a ratio of 5.8:1, has been reported by Adeleye. [16] The predominance of TBIs in boys aligns with broader epidemiological trends, suggesting higher rates of injuries and risky behaviour among boys than girls. Road Traffic Accidents (RTA) accounted for 156 cases (88.6% of all cases). RTA as a leading cause has been described by other authors.[22, 17] And likewise from an Ethiopian study by Tuji[23], though to a lesser degree than ours.

Motor Vehicle Accidents (MVA) were responsible for about half of the cases. The finding by Chikani [20] is nearly that of ours (42.3%), though slightly lower. In contrast to ours, Taopheeq [17] reported only about 25%. Pedestrians were most affected in RTA, with 81 cases (51.9% of all RTA cases). These pedestrian involvements are very similar to the ones reported by Taopheeq[17] (51%), Chikani [20] (61.3%), Dewan [5], and Bradshaw. [24] While Adeleye [16] reported higher (72%) pedestrian involvement. Falls of various types, including domestic falls, accounted for 19 cases (10.8%). This is lower than the finding of Taopheeq [17] (21%), though mostly among toddlers. But higher than 4.3% reported by Chikani [20] from low-height falls. Much higher findings (33%) were reported in Ethiopia by Tuji.[23] Our findings have to do with seasonal tree climbing to pluck ripe fruits (mangoes), and Baobab leaves for animal and human consumption.

We found birth Trauma to be a rare cause, accounting for only 1 case (0.6%). This underscores the improvements in obstetric and neonatal care to minimize potential complications during delivery. Based on severity, we found that the majority of our patients had a mild TBI (77.3%), then moderate (20.4%), and severe, as the least (2.3%), respectively. Findings nearly similar to ours have been reported by Danning [25], Mitra [26], Simon [27], and Louise.[28] Although Chikani [20] and Kouitcheu [6] have reported a similar trend, they recorded fewer mild cases with higher severe forms than our findings. In contrast, the finding of Taopheeq [17] revealed mild TBI to be the commonest (61%); he also observed that severe TBI was more numerous (21%) than moderate (18%) ones. The possible reason why mild cases predominate in our setting could be attributed to the limited centres with computed tomography and neurosurgical expertise; as such, all cases of TBI are referred to our facility regardless of the severity.

Regarding imaging of the head, all had plain skull X-rays. Our skull X-ray availability is about thrice the report by Tuji [23] from Ethiopia (31.2%), where quite a number had no skull X-ray (44.5%). Despite its availability in all of our patients, we found that it was normal in 84.1%, corresponding to about 3.5 times more of an Ethiopian finding.[23] We found various types of fractures in 92.9% of the skull X-rays. This is about double the number reported by Taopheeq[17] (54%) in southwestern Nigeria. A CT scan was available in only 36.4% of our patients. Our availability of CT scans is nearly similar to that of Adeleye [16] (39%), but about half of the reports in the southeastern region of Nigeria by Chikani [20] (74.7%). While Taopheeq's [17] finding of 31% is consistent with the findings in this study. These few numbers that had CT scans have to do with the peculiarity of our set-up, where the majority of patients pay out of pocket for medical services, as found in most low-income countries [6] thereby necessitating selective requisitions. This is further compounded by the fact that CT scans are not readily available in most of the other Hospitals.

We found abnormalities on CT scans in 96.9% of the patients that had it, consisting mainly of various fractures (68.8%), oedema (28.1%), and normal findings in 3.1%. Chikani's [20] abnormal findings on CT scans were in tandem with data in the index study, with skull fractures constituting the major findings just as in the current study, but with higher normal findings in as much as 16.8%. While in Ethiopia[23], it was found to be normal in 15.8%, with fewer skull fractures (29.7%) in comparison to the index study.

We found haemorrhagic contusion in about 30%, nearly similar to the finding of Kouitcheu [6] et al., whose finding is 33.9%. In contrast to the index findings, contusions were the most numerous lesion (70%) found on CT scans by Taopheeq [17] in southwestern Nigeria. Patients with brain contusion do not require surgical evacuation as contusions heal without the need for operative evacuation, and these proportions of children with brain contusions significantly add to the number of patients managed non-operatively in our setting.

We found 4 (5.7%) cases of intracranial haematomas: Extradural (3, 4.1%), Subdural (1,1.6%), as brain CT was done in a few patients (36.4%) due to poor health insurance coverage, especially of rural dwellers. However, an Australian [28] study found Extradural haematomas similar to ours (5.9%) despite better health insurance coverage, probably due to fewer cases of paediatric TBI when compared to our setting. Tuji[23] in Ethiopia found much fewer cases of Extradural (0.9%) and Subdural (1.89%). Taopheeq [17] in Nigeria found a very high (28%) number of Extradural haematomas when compared to the current study, as most patients did brain CT, as opposed to a few patients in the index study.
We found normal CT scans in 2 patients (3.1%) only. While Chikani [20] (16.8%) and Taopheeq[17] (20%) found a larger number of normal scans. This difference may likely be from non-selective requisitions, and availability of CT scanners, least likely to be from regional variations in financial status among Nigerians. Associated injuries were mainly superficial wounds (80.7%), followed by skull fractures, limb fractures (12.5%), and blunt abdominal, chest, and cervical (0.6%) injuries in descending order. Kouitcheu [6] found lesser limb trauma at 9.3%, while Chikani [20] found more long (limb) bone fractures at 14.1%. Our finding of 0.6% cervical injury is much less than the finding in Enugu, [20], Nigeria, where he reported 1.2%. Kouitcheu [6] found a much higher number (5.4%). Surgeries were indicated and carried out on 24(13.6%) of our patients. This number is much lower than 36.9% [6] and 19.6% [20] patients who had some form of operative care, respectively.

A large number of our patients (86.4%) did not have any surgical lesions and were therefore managed non-operatively. Also, it could be that a certain number of patients requiring operative interventions were missed because of the unavailability of a CT scan. Similarly, non-operative treatment was employed in the care of 80.4% of patients, nearly similar to ours, by Chikani. [20]

Generally, our patients' duration of Hospital stay ranged from 1 to 65 days, with the mode of 8 days. Based on their GCS, their mean stays were shorter than those of Chikani [20], with the longest found among the severe TBI group. We also found that the mean Hospital stay among the ones operated was 14.57±12.6. This is equally shorter than the Enugu [20] Hospital stay. Mean Hospital stay was shorter among the non-operated children (11.35±9.2) compared to Chikani's [20] finding of 13.37±11.3. Only 1 of our patients with Diffuse Axonal Injury stayed for 65 days.

Our patient outcomes were assessed using the Glasgow Outcome Score (GOS) at the point of discharge. The majority (90.9%) of our patients had good outcomes, with residual neurological deficits in 5.7%, and had 6 mortalities comprising 3 in the mild TBI group (2.2%), 2 in the moderate TBI group (5.5%), and 1 in the severe TBI group (25%).

Good functional outcomes of 92.1%, similar to ours, were reported by Nnadi [29] in Nigeria. A lesser, functional outcome was documented among the Ethiopians [23], South Africans, [30,] and Chinese. [31]

We report an overall mortality of 3.4%, similar to the ones from Ethiopia[23] (3.2%) and South African[30] reports. Other studies from China [31] and Nigeria [16,32] have reported much higher mortalities compared to ours. While in Tunisia, Hassen [33] has reported a lower mortality of 2.1%. Mortalities were highest (25%) among those with severe TBI in our study. This is, however lower when compared with the reports of 37.5% by Hassen [33] and 34.8% by Kpelao.[19]

Conclusion

TBI is an important cause of admission to Paediatric emergencies at our institution. Road traffic accidents were the main causes, especially among pedestrians. The mortality of severe TBI was high because of the insufficiency and inaccessibility of intensive care and imaging units. The significant number of pedestrian accidents calls for proactive measures aimed at protecting children by instituting and enforcing appropriate traffic regulations. There is also the need to increase accessibility in Nigeria and the other LMICs to essential neurodiagnostic studies and neurocritical care equipment and personnel.
Effective strategies to mitigate the burden of Paediatric TBIs among pedestrians in resource-poor settings include improving road infrastructure, implementing educational programs on road safety, and strengthening healthcare systems to enhance access to emergency care and rehabilitation services.

Conflict of interest: None

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