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Neurotrauma from fall accidents in Ethiopia

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ABSTRACT

Background: Ethiopia is a fast-growing economy with rapid urbanization and poor occupational safety measures. Fall injuries are common and frequently result in traumatic brain injury (TBI) or spinal cord injury (SCI).
Methods: We prospectively included fall victims who were hospital-treated for neurotrauma or forensically examined in 2017 in Addis Ababa, Ethiopia. We registered sociodemographic factors, fall types, injuries, treatment, and outcome.
Results: We included 117 treated and 51 deceased patients (median age 27 vs. 40 years). Most patients were injured at construction sites (39.9%) and only one in three used protective equipment. TBI (64.7%) and SCI (27.5%) were the most common causes of death among the deceased patients, of which most died at the accident site (90.2%). Many patients suffered significant prehospital time delays (median 24 h). Among treated patients, SCI was more frequent than TBI (50.4% vs. 39.3%), and 10.3% of the patients had both SCI and TBI. Most SCIs were complete (49.3%), whereas most TBIs were mild (55.2%). Less than half of TBI patients and less than one in five SCI patients were operated. There were twice as many deaths among TBI patients as SCI patients. Among those discharged alive, at a median of 33 weeks, 50% of TBI patients had a good recovery whereas 35.5% of SCI patients had complete injuries.
Conclusion: Falls at construction sites with inadequate safety measures were common causes of SCI and TBI resulting in severe disability and death. These results support further development of prevention strategies and neurotrauma care in Ethiopia.

1. Introduction

Trauma is the primary cause of death and disability for young and productive individuals worldwide. Every year, nearly five million people succumb to injuries globally, with 90% of deaths occurring in low- and middle-income countries (LMICs) (Haagsma et al., 2016; Hofman et al., 2005). The leading causes of death and permanent disability among those who sustain injuries are traumatic brain injury (TBI) and spinal cord injury (SCI) (Laeke et al., 2021a; Eaton et al., 2017). These injuries are also costly to treat and pose a significant economic burden for affected countries.

By 2030, road traffic accidents (RTAs) and falls are projected to be the primary causes of injury-related deaths (Organization, 2014). This is of particular concern in LMICs due to the rapid urbanization and motorization of these regions, coupled with inadequate road and occupational safety measures. Studying injury patterns, causes, demographics, and treatment is crucial to developing prevention strategies and appropriate care (Hofman et al., 2005).

Ethiopia is the second most populous country in Africa, with 70% of its population below 30 years of age (World Population Review, 2022; Ethiopia Central Statistical Agency E, 2014). Trauma is a significant concern for the country, and its fast-growing economy may exacerbate the situation (Bank, 2020; James et al., 2020). Falls are the most common cause of unintentional injuries among all emergency outpatient visits in Addis Ababa, (Wolde et al., 2008) but falls receive less attention than RTAs (Ali et al., 2020). Assaults, followed by RTAs and falls, are the most common injury mechanisms requiring neurosurgical interventions in the country, with falls from height being the leading cause of SCI (Laeke et al., 2021b; Biluts et al., 2015). Despite SCIs being the most common neurotrauma types encountered after falls, there is no clear

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guideline governing healthcare professionals their management (Marchesini et al., 2022).

This study aims to identify the major types of fall mechanisms and the-related TBI and SCI, victims' sociodemographic characteristics, trauma impact, and treatment in Ethiopia. Knowledge on the patterns of neurotrauma due to fall injuries will be helpful for resource allocation and designing guidelines tailored to the specific settings (Marchesini et al., 2022; Demetriades et al., 2022). It particularly focuses on falls from construction sites and the use of protective measures to prevent such injuries thereby providing important data for the development of safety policies in Ethiopia and the sub-Saharan region at a larger scale.

2. .Material and methods

2.1. Study setting

Our study was conducted at five hospitals, including four neurosurgical teaching hospitals located in Addis Ababa, Ethiopia (Addis Ababa University (AAU) hospitals): Black Lion Hospital, Myung Sung Christian Medical Center, Zewditu Memorial Hospital, and Alert Trauma Center. These hospitals are affiliated with the neurosurgical training program at Addis Ababa University, and provide the majority of neurosurgical services in Ethiopia. The fifth hospital included in our study is Menelik II Hospital, the only hospital in Ethiopia that offers forensic pathology services.

Black Lion hospital is the largest tertiary hospital in Ethiopia providing specialty care. It is a public teaching hospital where neurosurgical and emergency medicine trainings were first established in the country. It receives patients requiring specialty care from the entire country. It provides 24-h of neurosurgical emergency services including intensive care for severely injured patients. Myung Sung Christian Medical Center is an affiliate private neurosurgical teaching hospital. It also provides a 24-h neurosurgical emergency services with fully equipped intensive care units. Alert trauma center and Zewditu memorial hospital started providing neurotrauma care as affiliate hospitals of Addis Ababa University since early 2016.This was an initiative to improve the access of treatment for neurotrauma patients in the capital city Addis Ababa and Ethiopia at a greater scale. Even though there were four centers with neurosurgical services outside of Addis Ababa during the study period, majority of neurotrauma patients from the entire country were referred to the study hospitals as the hospitals were betterequipped to handle neurosurgical emergencies.

Menilik II Hospital is the only hospital in the country providing forensic pathology services for the entire country. The hospital receives bodies for autopsy exams from the different corners of the country.

This study is part of a collaborative research project between Addis Ababa University and University of Bergen on neurotrauma, approved by the institutional review board, Addis Ababa University, Ethiopia (#003/16/surg), and by the Regional Ethical Committee, University of Bergen, Norway (#2018/53). (Laeke et al., 2021c, 2021d, 2023).

2.2. Standard of care

Fall injury victims presenting at the emergency department of the study hospitals are first seen by emergency physicians. Severity of injury was scored by using the Injury Severity Score (ISS). Patients with head or spinal cord injuries or both were classified as having neurotrauma. Patients were diagnosed to have traumatic brain injury if they had history of direct impact to the head, post-traumatic headache, loss of consciousness, focal neurologic deficit, abnormal body movement, amnesia, or signs of basal skull fracture. CT scan was done according to the Canadian head CT rule. Patients with normal CT having headache were followed for 4–6 h at the emergency department for any deterioration. Patients with moderate TBI were admitted to the wards and treated surgically or medically. They were serially followed by neuro sign chart which included the vital signs of the patients, presence of seizure, the GCS, motor and sensory examinations.

Patients with point tenderness along the spine, neurologic deficit or sensory impairment were suspected to have a spinal cord injury and subsequently x rayed followed by a Ct scan and/or MRI based on the x ray findings. Fall victims were diagnosed to have spinal cord injury if they had radiologically proven spine fracture, dislocation or spinal cord contusions. Patients with cervical injuries were classified based on the sub axial injury classification (SLIC) while those having thoracolumbar injuries were classified based on the thoracolumbar injury classification score (TLICS). Spine CT or MRI were mostly used for SLIC/TLICS scoring.When either of the imaging modalities were unavailable due to cost issues, plain X-ray was used to score patients.

2.3. Patients and data collection

We prospectively included all fall victims who presented to the emergency department of our study hospitals from January 1 to December 31, 2017 after sustaining fall down accidents which resulted in either traumatic brain or spinal cord injury or both regardless of their time to presentation and severity of injury. Moreover, fall victims who succumbed and brought to Menilik II hospital for autopsy examination during the study period were also included. Patients who first lost consciousness due to other medical conditions and afterwards sustained fall injury were not included in the study.

Neurosurgical residents collected data using standardized case report forms (CRFs), which were reviewed by the first and second authors. The CRFs recorded data on demographics, fall mechanism, injury type, and severity, prehospital care, hospital treatment, and outcomes. Fall mechanisms were categorized according to the International Classification of Diseases (ICD)-10 (World Health Organization, 1999). Falls at construction sites (all fall types related to construction work) and use of personal protective equipment (PPE) such as helmets or ropes were also registered. Glasgow coma scale (GCS), American Spinal Injury Association (ASIA) Impairment Scale (AIS), and thoracolumbar injury and severity (TLICS) and sub axial cervical spine injury (SLIC) classifications were used to classify injury severity. Consent-based follow-up interviews and examinations were conducted using the Glasgow Outcome Scale-Extended (GOS-E) and AIS. In the same time period, we also included victims of fall accidents who were brought to Menilik II Hospital for forensic investigations, and their data included demographics, fall types, treatment, and causes of death.

2.3.1. Forensic data

We included data from succumbed individuals after sustaining neurotrauma from fall accidents to identify and compare the common fall types and neurotrauma mechanisms between those who succumbed and those who survived to be treated in our four study hospitals. As we mentioned earlier, the forensic data was collected from Menilik II hospital the only hospital receiving autopsy evaluation requests from the entire country.

2.4. Statistics

The collected data was analyzed using SPSS version 21 (SPSS Inc., Chicago, IL, USA). Descriptive statistics were used to summarize the demographics, injury types, clinical presentations, and outcomes of patients. The normality of distribution for continuous variables was tested using the Kolmogorov-Smirnov and Shapiro Wilk tests. Parametric variables were compared using independent *t*-test while nonparametric variables were compared using Mann-Whitney *U* test. The significance of associations between categorical variables was tested using chi-square test. A p-value <0.05 was considered significant.

3. Results

3.1. Socio demographics and types of falls

We included 168 fall victims, of which 117(69.6%) were admitted alive and 51(30.4%) died before hospitalization (Table 1). Male patients were overrepresented in both groups:102(87.2%) in the treated and 40 (78.4%) in the succumbed patients. Patients who died before admission were older with a median (IQR) age of 27(27) years when compared to the hospital-treated patients whose median age was 40(30) years. More than 50% of study population in both groups,94(55.9%) of the 168,were either construction workers or farmers. The most common injury location in both groups was a construction site (39.9%). Among the 67 fall victims from construction sites, 50 (74.6%) received hospital treatment and 17 (25.4%) succumbed before hospitalization (Table 1). Falls from trees, cliffs, and animals were also common, and many of these accidents were related to farming.

The study hospitals were documented for 86(73.5%) of 117 treated patients. Majority of the patients,60(51.3%) of the 117, were treated at Black Lion Hospital while 14(12%),4(3.4%),8(6.8) were treated at MCM, Zewditu and Alert respectively.

3.2. Site and cause of death for forensically examined fall victims

Most of the forensically examined fall victims,46(90.2%), died at the accident scene while the remainder died at local health centers or local hospitals (Table 1). TBI was the major cause of death among forensically examined fall victims; more than twice as common as SCI (Fig. 1).

Table 1
Sociodemographics and types of falls. Abbreviation: IQR, interquartile range; y.o.a., years of age.* Site of death for forensically examined patients.

	Hospital-treated patients	Forensically examined patients	Total	P-value
	N = 117	N = 51	N = 168	
Males, n (%)	102 (87.2)	40 (78.4)	142 (84.5)	0.149
Age, median (IQR)	27 (27)	40 (30)	30 (27)	0.029
Children (<13 y.o.a.)	6 (5.1)	1 (2.0)	7 (4.2)	
Occupation, n (%)				0.202
Construction worker	30 (25.6)	14 (27.5)	44 (26.1)	
Farmer	29 (24.8)	21 (41.2)	50 (29.8)	
Student	19 (16.2)	7 (13.7)	26 (15.5)	
Housewife	4 (3.4)	3 (5.9)	7 (4.2)	
Other	19 (16.2)	2 (4.0)	21 (12.5)	
Unrecorded	10 (8.5)	3 (5.9)	13 (7.7)	
Fall types, n (%)				0.012
Fall related to construction work	50 (42.7)	17 (33.3)	67 (39.9)	
Fall on and from stairs	7 (6.0)	7 (13.7)	14 (8.3)	
Fall from tree	17 (16.2)	4 (7.8)	21 (12.5)	
Fall from cliff	14 (12.8)	15 (29.4)	29 (17.3)	
Fall from animals	8 (6.8)	6 (11.8)	14 (8.3)	
Fall from, out of, or through a building or structure	2 (1.7)		2 (1.2)	
Fall on same level	6 (5.1)	0	6 (3.6)	
Fall from transport vehicle	2 (1.7)	0	2 (1.2)	
Unrecorded	11 (9.4)	2 (3.9)	13 (7.7)	
Site of deat*,**n (%)**				
Accident scene		46(90.2)		
Local health facility		5(9.8)		

3.3. Treatment before admission to neurosurgical care

Only 12(10.2%) of the hospital-treated fall victims were admitted directly to the AAU hospitals (Table 2). Among 105 patients coming in via other hospitals or health centers, 55(52.4%) had received one or more first-line treatments such as spinal immobilization, urinary catheter, intravenous fluid, or wound care. No patients were intubated.

3.4. Clinical status at admission and neurosurgical treatment

At admission to one of the AAU hospitals, only 13.7% of patients had hypoxia or hypotension (Table 2). ISS was documented for 81(69.2%) of patients. The median (IQR) ISS of the treated patients was 9(12).

SCI was more frequent than TBI (59(50.4%) vs. 46(39.3%)), and 12 (10.3%) of the patients had both SCI and TBI. Most SCIs were complete (AIS grade A; 35(49.3%) of 71, whereas most TBIs were mild (GCS score 14–15; 32(55.2%) of 58. In TBI patients, there were a range of different CT findings, but the most common were epidural hematomas (EDHs), acute subdural hematomas (ASDHs), and contusions (Supplementary Table 1). Most SCIs were located at the cervical level (42.3%; Supplementary Table 2). Among SCI patients, 25(83.3%) of 30 cervical injuries had a SLIC score >4, and 29(70.7%) of 41 thoracolumbar injuries had a TLICS score >4 (Supplementary Table 2). Other injuries were present in 22(18.8%) of patients, most commonly thoracic injuries (Table 2). A surgical procedure was carried out in less than half of TBI patients (26/58) and in less than one in five SCI patients (14/71; Supplementary Table 3).

3.5. Falls at construction sites

Only one third of fall victims, 22(32.8%) of the 67,fall victims from construction sites used PPE (Table 3). Falls at construction sites were more often associated with SCI and the time between accident and admission was shorter compared to other types of fall accidents. There were no significant differences in age or TBI distribution.

3.6. Outcome at discharge and follow-up for hospitalized patients

Nine (7.7%) of the 117 hospitalized fall victims died before discharge; six were TBI patients and three were SCI patients (Table 4). At discharge, most TBI patients had a GCS score of 15 whereas most SCI patients had AIS grade A (complete injury). Length of hospital stay was documented for 72(61.5%) of the 117 treated patients. The median duration of hospital stay was 4 days with IQR of 4.

Five (83.3%) of the six TBI patients who died had severe TBI while

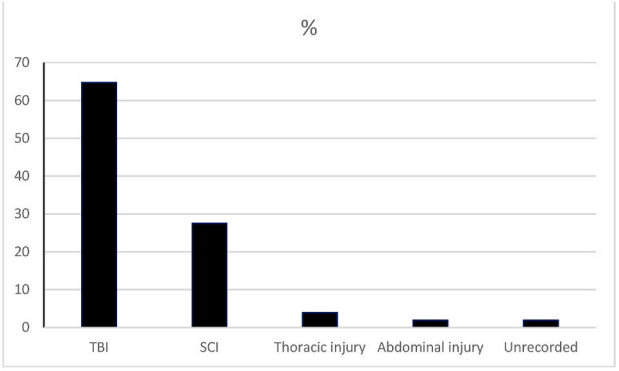

Fig. 1. Cause of death in forensically examined fall victims.

Table 2
Injury characteristics of the hospital-treated fall victims. Some patients were categorized in more than one subgroup (*). Abbreviations: TBI, traumatic brain injury; SCI, spinal cord injury; GCS, Glasgow coma scale; AIS, American Spinal Injury Association (ASIA) Impairment Scale.

	Hospital-treated patients
	N = 117
Admission category, n (%)	
Via other hospitals or health centers	105 (89.8)
Directly to AAU hospitals	12 (10.2)
Treatment before admission, n (%)	55*
Cervical collar	36 (30.8)
Spine board	28 (23.9)
Nasogastric tube	2 (1.7)
Urinary catheter	37 (31.6)
Wound care	10 (8.5)
Intravenous fluids	33 (28.2)
Endotracheal intubation	0
Vital sign derangement at admission, n (%)	16*
Hypoxia	12 (10.3)
Hypotension	4 (3.4)
ISS, Median (IQR)	9(12)
Injury types, n (%)	
TBI	46 (39.3)
SCI	59 (50.4)
TBI and SCI	12 (10.3)
TBI classification, n (%)	58
Mild (GCS 14–15)	32 (55.2)
Moderate (GCS 9–13)	13 (22.4)
Severe (GCS 3–8)	13 (22.4)
SCI classification, n (%)	71
AIS A (complete)	35 (49.3)
AIS B	8 (11.3)
AIS C	5 (7.0)
AIS D	9 (12.7)
AIS E (normal)	12 (16.9)
Unrecorded	2 (2.8)
Other injuries, n (%)	22*
Thoracic	17 (77.3)
Abdominal	4 (18.2)
Pelvic	1 (4.5)
Long bone fracture	6 (27.3)
Maxillofacial fracture	1 (4.5)

one (16.7%) patient had moderate TBI. Increased intracranial pressure with brain herniation was the cause of death for three of the severe TBI patients while sepsis was the cause for the remining two patients. Brain tumor hemorrhage with increased ICP was found to be the cause for the moderate TB patient. All three SCI patients who died had cervical spine injuries with two of them having complete SCI while the other had ASIA B SCI. The cause of death in all three of the patients was respiratory arrest.

We obtained follow-up data on 104(96%) of discharged patients (42 TBI and 62 SCI cases) with a median follow-up time of 33 weeks (Table 4). At follow-up, most TBI patients discharged with a GCS score of 14–15,24 (88.9%) of 27 patients, had a GOS-E score of 7–8 (lower to upper good recovery), whereas patients with a GCS score of 9–13 either did very well (GOS-E score 8) or were dead (GOS-E score 1; Table 4 and Supplementary Table 4). Among the 52 TBI patients at follow-up, there were nine (17.3%) more deaths (Table 4). Among SCI patients at follow-up, most patients with AIS grade A (complete injury) at discharge remained neurologically unchanged or were dead (Table 4 and Supplementary Table 5). At follow-up, the relative frequency of patients with AIS grade E (normal function) was almost doubled compared to admission and discharge.

4. Discussion

The study was undertaken by a collaborative effort of authors from Ethiopia and Norway as part of the strong collaboration between the University of Bergen, Haukeland University Hospital and Addis Ababa University. The collaboration between the two institutes resulted in the opening of the first neurosurgical residency program in Ethiopia and start of a PhD project to the faculty of Addis Ababa University. This study is part of a PhD project entitled Neurotrauma care in Ethiopia: Building for the Future.

In this study, we investigated the various aspects of neurotrauma

Table 3
Characteristics of patients who suffered fall accidents at construction sites versus other types of fall accidents. Only hospital-treated patients are included in the figures on severity of traumatic brain injury and spinal cord injury (*). One traumatic brain injury patient and six spinal cord injury patients had missing data on type of fall accident and are not included. Abbreviations: IQR, inter-quartile range; PPE, personal protective equipment; NA, not applicable; TBI, traumatic brain injury; GCS, Glasgow coma scale; AIS, American Spinal Injury Association (ASIA) Impairment Scale, SCI: Spinal cord injury.

	Fall at construction sites	Other types of falls	Total	P-value
	N = 67	N = 101		
Age, median (IQR)	28 (12)	25 (27)	30 (27)	0.696
Time between accident and admission, hours (IQR)	6 (19)	48 (62)	24 (66)	0.001
PPE, n (%)	22 (32.8)	NA	NA	
Hospital-treated	18/50	NA	NA	
Forensically examined	4/17	NA	NA	
TBI, n (%)*	18	39	57	0.353
Mild (GCS 14–15)	11 (61.1)	20 (51.3)	31	
Moderate (GCS 9–13)	2 (11.1)	11 (28.2)	13	
Severe (GCS 3–8)	5 (27.8)	8 (20.5)	13	
SCI, n (%)*	20	45	65	0.024
AIS A (complete)	8 (40)	27 (58.7)	35	
AIS B	2 (10.0)	5 (10.9)	7	
AIS C	0	5 (10.9)	5	
AIS D	2 (10.0)	5 (10.9)	7	
AIS E (normal)	8 (40.0)	3 (6.5)	11	

Table 4
Outcomes at discharge and follow-up of hospitalized fall victims. Abbreviations: TBI, traumatic brain injury; GCS, Glasgow coma scale; GOS-E, Glasgow outcome scale-extended; AIS, American Spinal Injury Association (ASIA) Impairment Scale, SCI: Spinal cord injury.

		Outcome at discharge n (%)	Outcome at follow-up n (%)
TBI	**GCS score**	N = 58	
	14-15 (mild)	38 (65.5)	
	9-13 (moderate)	9 (15.5)	
	3-8 (severe)	2 (3.4)	
	Dead	6 (10.3)	
	Unrecorded	3 (5.2)	
	GOS-E score		N = 52
	8 (upper good recovery)		26 (50)
	7		2 (3.8)
	6		3 (5.8)
	5		1 (1.9)
	4		0
	3		1 (1.9)
	2		0
	1 (dead)		9 (17.3)
	Unrecorded		10 (19.2)
SCI	**AIS grade**	N = 71	N = 62
	AIS A (complete)	32 (45.1)	22 (35.5)
	AIS B	5 (7.0)	3 (4.8)
	AIS C	6 (8.5)	11 (17.7)
	AIS D	7 (9.9)	2 (3.2)
	AIS E (normal)	13 (18.3)	19 (30.6)
	Dead	3 (4.2)	5 (8.1)
	Unrecorded	5 (8.5)	0

caused by falls in Ethiopia, including demographic data, fall types, injury severity, and causes of mortality. To our knowledge, no previous studies in Africa have focused on fall-related neurotrauma. The study results provide important input to policy makers in planning the improvement of neurotrauma care from prevention to treatment (Aukrust et al., 2022).

We found that falls related to construction work were the most common types of falls leading to TBI and SCI, and few fall victims used PPE which could have reduced the number of severe neurotrauma. A European multinational study revealed lower prevalence of high energy falls from a height and higher prevalence of falls from a ground level.[21]Safety hazards in construction works have previously been found to be 10–20 times higher in LMICs than in high-income countries (HICs) due to limited use of protective measures (Rantanen, 1996). Construction site falls have also been reported as a major cause of fall injuries in other studies from Ethiopia and Benin (Alamneh et al., 2020; Osifo et al., 2010). Eucalyptus scaffolds (Fig. 2) are typically used at most construction sites in Ethiopia and these are more prone to collapse compared to standard systems (Kelemework, 2017). The low utilization of PPE has also been described in previous studies from Ethiopia and Uganda,(Alemu et al., 2020; Izudi et al., 2017) and is not in accordance with guidelines put forward by the International Labor Organization (ILO) (Organization IL, 1992). Taken together, many construction site falls could be attributed to scaffold collapse, poor utilization of protective equipment, and noncompliance with safety measures.

Those who succumbed to fall-related injuries and were brought in for forensic examination were older, more often fell from cliffs, most frequently died of a TBI, and usually died at the accident scene. Many of these individuals were farmers in more rural areas outside of Addis Ababa. Other reports from Ethiopia have also reported a relatively high incidence of fall accidents among older patients in rural communities (Zhang et al., 2019).

Neurosurgical care for fall victims was characterized by significant delay, and the majority of patients were referred from local hospitals or health centers. Comparable findings have been reported in other studies from Ethiopia and Nigeria (Laeke et al., 2019; Adeleye, 2017). In an Ugandan study, the authors found a median delay of 4 h from accident to admission, (Vaca et al., 2019) which is considerably less than reported herein, and more in line with international recommendations (Barthélemy et al., 2019). The temporal delay among the fall victims in our study is related to a wide range of barriers to neurosurgical care in LMICs (Schenck et al., 2023), as reviewed by Mediratta and colleagues (Mediratta et al., 2021) and previously reported by us. (Laeke et al., 2021c, 2021d, 2023) Interestingly, fall victims from construction sites reached the study hospitals earlier than other fall victims. This was probably facilitated by observant colleagues, better transportation possibilities, and shorter distances to the neurosurgical hospitals. Moreover, this might have contributed to a larger fraction of construction site falls in our study as more of these patients survived the prehospital phase.

Fig. 2. Building under construction in Ethiopia showing weak wooden scaffoldings.

We found a higher proportion of severe TBI compared to a previous Ethiopian study,(Laeke et al., 2019) and a higher rate of surgical intervention (44.8%) than in a previous Tanzanian study (Elahi et al., 2019). This is probably mostly related to patient selection with less mild to moderate TBI after falls than with all causes combined, but possibly also associated with development and access to neurosurgical care (Laeke et al., 2021c, 2021d, 2023). The mortality rate in our study was similar to that reported in an Ugandan study, in which they found fall accidents to be a predictor of mortality in TBI patients (Kuo et al., 2017). Monitoring of severe TBI patients for deterioration after fall accidents was limited to serial clinical evaluation and control Ct scans if any neurologic deterioration was noticed. Following widely recommended neurotrauma guidelines in our set up and other similar settings is challenged by the availability of resources.[14,38]Innovative ways of monitoring severe TBI such as improvisation local resources to measure intracranial pressure can be a good alternative to continuously monitor patients and decide on surgical intervention as early as possible (Usuah et al., 2023).

There were more SCIs than TBIs in our hospitalized fall victims, and most patients with SCIs had AIS grade A (complete injuries). Other studies have also reported a similar high frequency of complete injuries after falls from height, and that these injuries are often work-related (Chen et al., 2016). Previous studies have also shown that falls from height are relatively common in LMICs like Ethiopia whereas ground level falls are more common in HICs (Chen et al., 2016). Similar to previous studies, the patients in our study were younger than the patients in comparable studies from HICs (Lee et al., 2014).

Notably, we obtained follow-up data on 96% of patients that were discharged alive. This is relatively unique in an LMIC context where there is a significant challenge of collecting follow up data (Smith et al., 2022). The high follow up rate can be attributed to the prospective nature of the study and direct patient counselling about follow up evaluations that they have to be compliant with. Our findings are encouraging to other similar studies which plan to improve follow up clinical data collection. It also showed that phone call follow up is a promising feasible alternative for collection of follow up data as was shown in a similar study (Laytin et al., 2018). Most TBI patients did well with a GOS-E score of 7–8 (lower to upper good recovery). Most SCI patients with AIS grade A (complete injury) were either neurologically unchanged or dead, but the relative frequency of patients with AIS grade E (normal function) was almost doubled from discharge. Most SCI patients had SLIC or TLICS scores of more than four, indicating surgical treatment, but less than one in five SCI patients were operated. Together, these data suggest strong patient selection based on survivability, rehabilitation potential, and availability of surgical resources, as indicated in previous studies (Laeke et al., 2021c, 2021d, 2023).

Our study included a relatively small sample size and was conducted in Addis Ababa only, which may affect the generalizability and limit the representativeness of the findings to the larger population of the country. Moreover, we had a large number of missing data especially in the length of hospital stay for those patients treated in the study hospitals. However, our study was carried out prospectively and provided important data on an Ethiopian patient group which has been largely unexplored in the literature.

In conclusion, construction site falls were common causes of SCI and TBI, and the utilization of protective equipment and other safety measures were inadequate. Many patients were severely injured or died, and there were significant temporal delays in the chain of care. This study provides important insights into the safety of construction sites, the utilization of protective equipment, and the timing of neurosurgical care for fall victims in Ethiopia, which can have important implications for injury prevention and public health policy in Ethiopia and other LMICs. Thus, neurotrauma from fall accidents especially from construction sites can be prevented by implementing policies that enforce the strict utilization of PPEs and providing trainings on occupational safety.

Moreover, access to neurotrauma care should be improved and further studies to assess the long term follow up of patients should be done.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.bas.2024.102792.

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