Research Article

Traumatic brain injury patient characteristics and outcomes in Lebanon: a multicenter retrospective cohort study

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Background

This study aims to assess the prevalence of traumatic brain injuries (TBI) and understand the underlying risk factors for their occurrence in Lebanon through examining TBI patient demographics, TBI types, mechanisms and clinical outcomes. It further discusses the treatment and management of the TBI burden in Lebanon, in the economic and political context.

Methods

We conducted a multicenter, retrospective chart review of TBI patients of all ages who presented with TBI-related complaints to the emergency departments (EDs) at six medical centres in Lebanon from January 2012 to December 2014. Patients' charts were screened, and data were abstracted into a collection sheet, including patient's demographics, injury-related information, ED clinical management, and hospital course and discharge information.

Results

1042 charts were reviewed; 67.2% of cases were men. The leading causes of TBI were falls (44.3%), followed by road traffic injuries (37.8%), violence (10%), and bombs and cluster munition injuries (4%). Most TBI patients had a Glasgow coma scale (GCS) ranging from 13 to 15 (84.1%). TBI management at ED consisted of neurosurgical consultation and procedures to decrease intracranial pressure. Short-term adverse outcomes included CSF leak in 15 patients (6.1%), papilloedema in 3 (1.3%), and haemotympanum in 13 (5.4%).

Conclusions

Evidence generated from this study serves as a leading point to bridge research and enhance the policy-making process, despite the prevailing economic and political restrictions. It further advocates setting guidelines to improve TBI prevention, diagnosis, management, and rehabilitative treatment in Lebanon and the entire Middle East and North Africa (MENA) region.

Traumatic brain injury (TBI) is an important global public health concern, affecting an estimated 69 million people worldwide annually.[1] The incidence rate of TBI is predicted to surpass a myriad of diseases and become a leading cause of death and disability by 2030.[2] TBI is defined as an injury to the head caused by a bump, blow, jolt, or a penetrating wound that alters brain pathology due to the external force and disrupts normal brain functions.[2] The severity spectrum of brain trauma ranges from 'mild' (mTBI) to 'severe' (severe TBI). mTBI or concussion contributes to most TBI cases worldwide, causing a brief change in mental status or consciousnes[3–6] compared to severe TBI, resulting in an ex-

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tended period of unconsciousness, post-traumatic amnesia, and irreversible brain injury.[7–9] TBI occurs in higher frequencies tri-modally among the pediatric population (0-4 years), the adolescent and youth population (15-24 years), and the elderly population (65 years and above).[10] Men are at a disproportionately higher risk of sustaining traumatic brain injuries than women with a male to female (M: F) ratio of 2:1.[11] Global estimates show that male TBI related mortality is three to four times higher than women,[8,12] often secondary to interpersonal violence and motor vehicle collisions.[13] The geriatric population experiences a reversed pattern, with women sustaining a higher TBI-related incidence than men.[14]

Falls and firearms are the leading causes of closed and penetrating TBI.[15] TBI leads to an excessive number of emergency visits (58%) and hospitalisations (70%), most notably associated with falls and motor vehicle-traffic collisions.[8] Other causes of TBI are related to war, assault/violence and domestic abuse.[16–18] Many TBI survivors suffer from permanent disabilities that impact their physical and psychosocial well-being. Furthermore, there exists a substantial financial burden that TBI imposes on survivors, their caregivers and the healthcare system.

Similar to other types of injuries, TBI disproportionally burdens low- and middle-income countries (LMICs) with nearly three times more reported TBI cases compared to high-income countries.[1] Estimates on the actual prevalence of TBI in the Eastern Mediterranean Region (EMR) is potentially underestimated due to the lack of accurate TBI surveillance and reporting. In addition, perpetual regional wars across several Mediterranean countries and ongoing political instability contribute to many TBI-related war traumas. Road traffic injuries constitute another significant contributor to head trauma in the EMR. Nevertheless, a limited number of studies address the epidemiology and respective outcomes of TBI in the EMR.[16,19,20]

In Lebanon, TBI studies are limited in scope and impact. Previous research has focused on reporting war-related TBI injuries,[21] and assessing the neurological repercussions of cluster munitions and detonation of sub-munitions on TBI victims.[22–24] Other studies have addressed motor vehicle accidents (MVA),[25] reporting low helmet compliance (45%) among motorcycle users at crash time. A more recent TBI study identified falls as the leading mechanism of TBI (42.1%) among emergency department (ED) patients, followed by motor vehicle collisions (20.7%).[26] In addition, government reports revealed a steady rate of head traumas among hospital admissions from 2007 (N=1,526) to 2019 (N= 1,565) based on the International Classification of Diseases (ICD – 10) codes for head injuries (S00 – S09). However, a limited description of case details and severity is reported, clearly highlighting the lack of proper TBI documentation and the extensive knowledge gap of the current status of TBI in Lebanon.[27]

This study aims to describe the epidemiology, characteristics, clinical management, and outcomes of TBI patients presenting at six hospitals' EDs throughout Lebanon over three years from January 2012 to December 2014. Findings from this study will help estimate the magnitude of the TBI burden in Lebanon and accordingly design strategies to improve TBI management and treatment and ultimately prevent avoidable deaths and disabilities.

We hypothesise that most TBI cases in Lebanon will be mild TBI, with an increased incidence in men and a high percentage of cases due to RTAs and violence.

METHODS

STUDY SETTING

We conducted an observational multicenter retrospective chart review of patients presenting with a TBI chief complaint to EDs at six participating hospitals in Lebanon: American University of Beirut Medical Center (AUBMC) (376-bed tertiary care centre), Rafik Hariri University Hospital (RHUH) (190 beds), Makassed General Hospital (MGH) (200 beds two-tier public hospital), Al Zahraa University Hospital (ZUH) (225 beds), Sahel General Hospital (SGH) (100 beds), and Mount Lebanon Hospital (MLH) (250 beds). The study period was three years, from January 1st, 2012, to December 31st, 2014. AUBMC was the leading site where collected data were pooled from the different collaborating sites, compiled and managed by the study's principal investigator.

This study was approved by the Institutional Review Board (IRB) at the American University of Beirut (IRB# IM.HT.07) and by hospital committees at each participating hospital. Due to the study's retrospective nature, informed consent was not required. CITI-certified research assistants carried out chart reviews. Collected data was de-identified and stored on password-locked computers to ensure patients' privacy and confidentiality.

DATA COLLECTION AND STUDY POPULATION

The research team screened patients' trauma cases of all age groups presenting to the ED with a TBI-related chief complaint including head trauma, major trauma, multiple trauma, polytrauma, fall on face/head, scalp/forehead laceration, fall from a height, MVA, Road Traffic Injury (RTI), war-related trauma, violence and assault-related trauma. Identification and confirmation of cases with TBI were filtered using a list of ICD – 10 codes: S00 - Superficial injury of head to S09 - Other and unspecified head injuries.

Patients meeting the study criteria were included in the database. Patients' details were abstracted into a data collection form developed for this study. The detailed information included: (i) *patient demographics* (date of birth, gender, nationality, marital status, educational level, residence, smoking and alcohol consumption were collected); (ii) *injury related information* (hospital presentation date and time, injury date and time, alcohol intoxication, injury mechanism); (iii) *patient ED information* (chief complaint, patient's stability, reported symptoms, past medical and surgical histories and medication history); (iv) *patient management and workup* (vital signs, TBI severity, Glasgow coma scale (GCS), post-traumatic amnesia and abbreviated injury scale, pain severity, laboratory and radiological workup); (v) *hospital course* (performed procedures, i.e. nasogastric tube

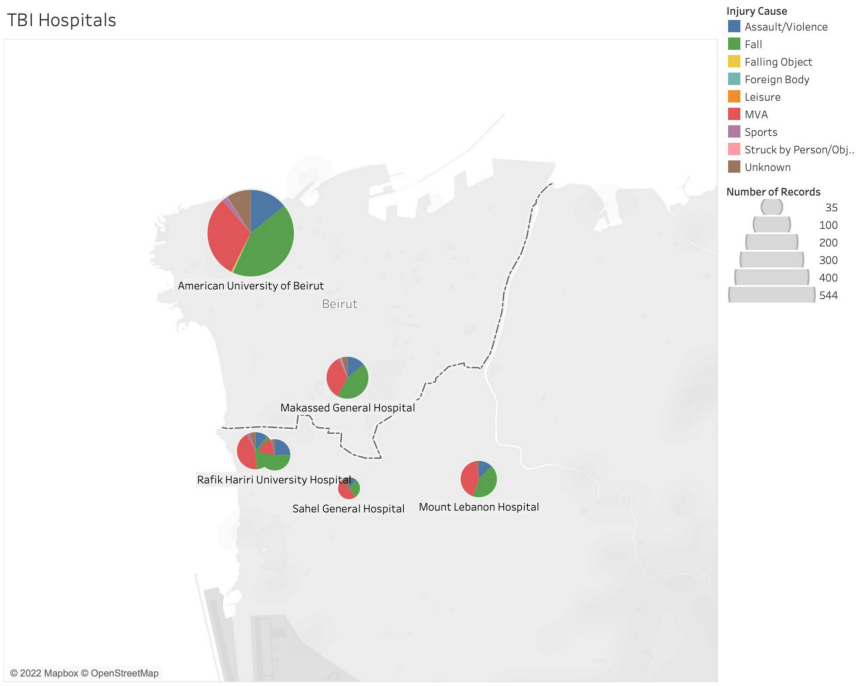


Figure 1. TBI cases distributed by hospital and cause of injury.

placement, ventilation, central line, etc. and all significant adverse effects and complications such as infections, renal failure, etc.); (vi) discharge information (GCS at discharge, functional health status at discharge, i.e. independent, partially dependent or dependent, disposition (home, another hospital, rehabilitation centre), and date of discharge).

The study population encompasses samples from each hospital proportional to the respective hospital bed size. Exceptionally, one-third of cases were taken from AUBMC because of its nature as the primary site.

STATISTICAL ANALYSES

We entered data into a RedCap data collection interface designed specifically for this study. Upon completion, we uploaded data into the Statistical Package of Social Science (IBM SPSS, version 22) and performed data cleaning, management, and analyses. We conducted descriptive analyses by calculating the mean and standard deviation for continuous variables and number and percent for categorical ones.

RESULTS

A total of 1,030 medical record charts were reviewed from the six participating hospitals between 01 January 2012 and 31 December 2014 (**Figure 1**).

PATIENT DEMOGRAPHICS

Out of the total number of admitted TBI patients, approximately 686 (67.2%) were men, and 335 (32.8%) were women. The average age for TBI patients at presentation was 36.37 ± 24.77 years. Nearly 497 (55.6%) of the admitted patients were single, 364 (40.7%) were married, 25 (2.8%) were widowed, and 8 (0.9%) were divorced.

The majority of the patients (N=451, 62%) were non-smokers, 233 (32%) were smokers, and 43 (5.9%) were past smokers. Approximately 85.3% of patients reported no alcohol use, while 46 (6.6%) reported regular alcohol consumption and 57 (8.1%) reported occasional alcohol consumption. Alcohol intoxication was noted in 29 patients (3.3%) at presentation, and seven patients (1.2%) reported drug use. **Table 1** further summarises the demographics and characteristics of TBI patients.

Most reported injuries were blunt, making up 803 (92.7%) of the total reported mechanisms of injury, and 63 (7.3%) were penetrating injuries. Falls from a height were the most frequently recorded injury causes, with 321 (44.3%) of the cases, followed by Motor Vehicle Accidents (MVA) 287 (37.8%), violence 74 (10%), and 30 (4%) were due to exposure to explosions such as bombings and cluster munitions (**Figure 2**). **Table 2** outlines the mechanism & cause of injury.

PATIENT HISTORY

Past medical history was collected from patients' charts. One hundred eighty-eight patients (18%) had a history of cardiac conditions (including hypertension), 117 (11.2%) had diabetes, 18 (10.3%) had a psychiatric condition, 58 (5.6%) had a neurological disease, and 32 (3.1%) had pulmonary disease. Approximately 14 patients (1.3%) had renal conditions, 2 (0.2%) had a malignancy, and 1 (0.1%) had liver disease. 4 patients were pregnant at the time of injury.

As for the medications used by patients at home, 108 (10.4%) reported using antiplatelets, 22 (2.1%) were using

Table 1. Demographics of the TBI study population included in the study

Demographics (N)= Total entry responses		Responses recorded
Age (1030, 100%)		36.55 ± 24.95
Gender (1021, 99.1%)	Male	686 (67.2%)
	Female	335 (32.8%)
Marital Status (894, 84.6%)	Single	497 (55.6)
	Married	364 (40.7)
	Widowed	25 (2.8)
	Divorced	8 (0.9)
Smoking status (727, 70.6%)	Non-smoker	451 (62)
	Current smoker	233 (32.1)
	Past smoker	43 (5.9)
Alcohol use (701, 68.1%)	No	598 (85.1)
	Yes	46 (6.6)
	Occasional	57 (8.1)
Alcohol intoxication at presentation		29 (3.3)
Drug misuse		7 (1.2)
Level of education (84, 8.2%))	Elementary school	20 (23.8)
	Middle school	15 (17.9)
	High school	25 (29.8)
	University	21 (25)
	Illiterate	3 (3.6)

anti-coagulants, 4 (0.4%) were using steroids, and none were using anti-thrombotic medication.

In terms of patients' surgical history, 75 patients (8.9%) had undergone cardiac surgery, and 10 (1.2%) had neurological surgery.

EMERGENCY DEPARTMENT PRESENTATION

Patients' presentations at the triage area were classified as stable, guarded, critical, or very critical. Among the 686 patients, 273 (70.9%) presented in a stable condition to the ED, 60 (15.6%) were guarded, 37 (9.6%) were critical, and 15 (3.9%) were in a very critical condition. The average reported GCS on ED presentation was 13.65 with 521 (84.1%) of patients receiving a GCS of 13-15, 38 (6.2%) had a GCS of 9-12, and 61 (9.9%) had a GCS of 8 or lower. Among patients who sustained TBI, approximately 60% were mild TBI, 12.3% were moderate, and 27.7% were severe (**Figure 3**). Patients' Level of Consciousness (LOC) was documented on presentation; 655 (62.9%) of the patients were fully conscious, 73 (7%) were confused, 2 (0.2%) were delirious, 17 (1.6%) were somnolent, 17 (1.6%) were obtunded/stuporous, 40 (3.8%) were comatose, and the remaining 73 (7%) had missing LOC from patient's chart.

Reported symptoms at presentation ranged from localising and diffuse pain to generalised system complaints (e.g. cardiac). The most documented symptoms were neurological, namely headache (N= 422, 42.4%) and pain (N =298, 40.7%), while 239 (23.2%) patients reported nausea and/or vomiting; 88 (8.5%) patients reported cardiac symptomatology. Nearly 50 patients (4.9%) had psychiatric complaints and 18 (1.8%) had head, eyes, ears, nose & throat (HEENT) related symptoms (e.g. tinnitus and otorrhea).

Upon physical examination, 2819 patients (0.4%) had normal reactive pupils, 8 (2.6%) had miosis (punctiform pupils), 14 (4.5%) had mydriasis and 8 (2.6%) had anisocoria. **Table 3** outlines patients' past medical, surgical, and medication history in addition to ED presentation and initial examination.

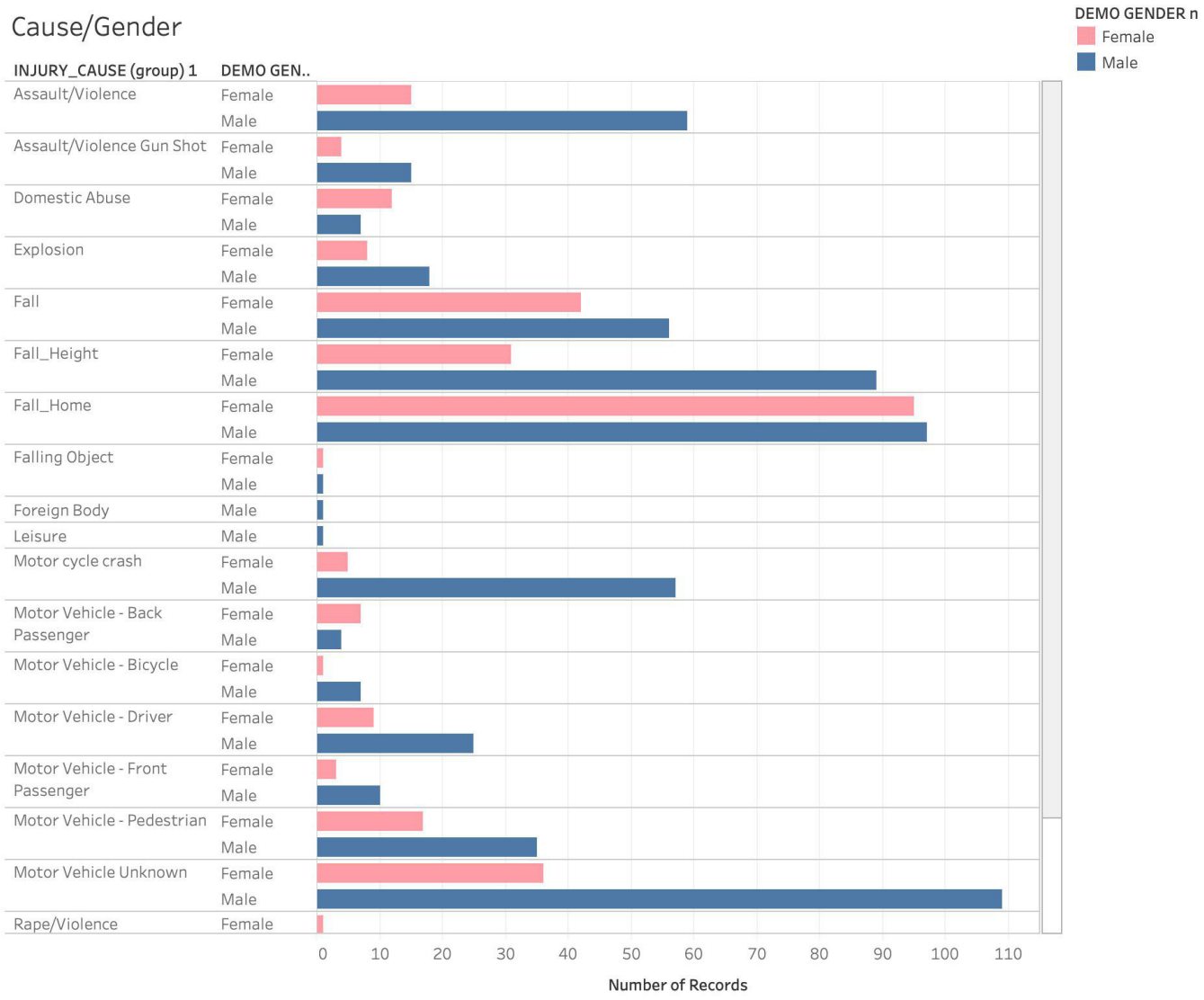
EMERGENCY DEPARTMENT WORKUP AND MANAGEMENT

As part of ED recommended workup, 752 patients (80.9%) received a brain computed tomography (CT) scan, 49.6% X-ray, 2.2% ultrasound, and 1.7% magnetic resonance imaging (MRI).

TBI management at the ED consisted of neurosurgical consultation and procedures to decrease intracranial pressure (e.g. head elevation, hyperventilation, and intravenous osmotic therapy) when indicated. Neurosurgical consults were requested for 521 patients (54.8%). In addition, head elevation was needed for 113 patients (17.5%), hyperventilation was induced for 12 (2%), and 49 (8%) patients needed intravenous osmotic therapy to decrease their intracranial pressure. Among the 1,024 patients, 71 required one blood transfusion or more.

SHORT- AND LONG-TERM OUTCOMES

The primary outcomes assessed in this study were cerebrospinal fluid (CSF) leak, papilledema, hemotympanum, and death. In the ED, 15 patients (6.1%) had a CSF leak, 3



(1.3%) had papilledema and 13 (5.4%) had a recorded hemotympanum event. In terms of post-ED disposition, 67.3% of patients were treated and released from the ED, 2.5% were transferred to another hospital, 0.3% were transferred to a rehabilitation centre, and 1.4% passed away in the ED.

Hospital-reported patients' adverse events were abstracted. These complications were acquired by admitted patients during their hospital stay and range from pneumonia to epilepsy and other long-term complications. Thirty-one patients (3%) developed pneumonia, 1 patient (0.1%) had a pulmonary embolism, 4 (0.4%) developed acute respiratory distress syndrome (ARDS), 7 (0.7%) developed acute renal failure, 8 (0.8%) developed a UTI, 5 (0.5%) sustained a cerebrovascular accident, none developed an MI, 3 (0.3%) developed deep vein thrombosis, and 11 (1.1%) had sepsis.

Additional long-term outcomes were abstracted from patients' medical charts; 4 patients (0.4%) developed hydrocephalus, 1 (0.1%) developed an abscess, 6 (0.6%) had epileptic seizures, and none developed osteomyelitis, fistulous tracts, PTSD, nor psychological complications. TBI patients' initial ED workups and management are outlined in **Table 4** in addition to short- and long-term complications.

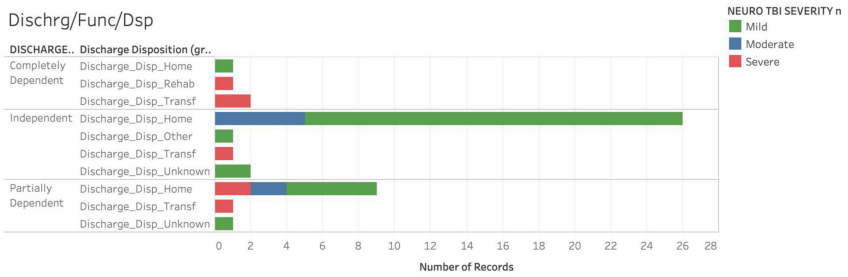
DISCUSSION

This study is the first multicenter TBI cohort study that characterises the magnitude, management and outcomes of patients sustaining traumatic brain injuries at six medical centres across Lebanon over three years. Our findings confirm our hypothesis, with mild TBI being the most common TBI severity and an almost double incidence rate of TBI among men compared to women. However, RTAs/MVCs were the second most common cause of TBI, following falls. The incidence of TBI in Lebanon from 2012-2014 is 116 per million population, or 38.67 per million population annually.

With the scarcity of TBI literature in Lebanon, we compared our study results with regional and international studies. Consistent with exiting TBI studies, this study confirms that most TBI patients are young men with an M: F

Table 2. Mechanism and cause of injury in patients presenting to the emergency department with a chief complaint of TB

			Number (%)
Mechanism of injury (866, 84.1%)		Blunt	803 (92.7)
		penetrating	63 (7.3)
Cause of injury	**Fall (321)**	Home	139 (19.2)
		Stairs	39 (5.4)
		Bathroom	22 (3)
		Fall from a height	121 (16.7)
	Violence (74)	Domestic abuse	18 (2.4)
		Gun shot	18 (2.4)
		Other	38 (5.1)
	Explosion (30)		
	Road traffic accident (287)	Motor vehicle – pedestrian	53 (7)
		Motor vehicle – driver	34 (4.5)
		Motor vehicle – front passenger	13 (1.7)
		Motor Vehicle – back passenger	11 (1.5)
		Motor vehicle – unknown	106 (14)
		Motor cycle crash	62 (8.2)
		bicycle	8 (1.1)



ratio of 2:1, similar to what is described in the literature.[11] Similar to regional studies, our findings show a high prevalence of TBI in older adults; the average age for TBI patients is 36.37 years old. El-Menyar et al. reported a high prevalence of TBI among young and middle-aged patients (20-40 years) in the Middle Eastern region; they argued that patients suffering from combat-related TBI belong to the younger age group 22-24 years while the vast majority (80%) of occupation-related TBI patients were younger than 35 years of age.[28] This argument was further supported by regional studies that confirmed the high prevalence of TBI among youth, particularly those below 18 years of age.[20,29] Most of our reported results have demonstrated similarities with findings from the existing literature, suggesting that individuals presenting to the ED with TBI-related injuries are overwhelmingly male individuals, sus-

Table 3. Past medical history of patients and initial parameters at presentation to the emergency department

		Number (%)
Past medical history (1030, 100%)	Diabetes mellitus type II	117 (11.4)
	Pulmonary disease	32 (3.1)
	Cardiac disease	188 (18.3)
	Liver disease	1 (0.1)
	Renal disease	14 (1.4)
	Neurological disease	58 (5.6)
	Malignancy	2 (0.2)
	Psychiatric history	18 (10.3)
	Currently pregnant	4 (4.8)
Past surgical history (844, 81.9%)	Cardiac surgery	75 (8.9)
	Neurological surgery	10 (1.2)
Medication history	Anti-platelets	108 (10.5)
	Anti-coagulants	22 (2.1)
	Anti-thrombotics	0 (0)
	Steroids	4 (0.4)
Condition at triage (380, 36.9%)	Very critical	13 (3.4)
	Critical	37 (9.7)
	Guarded	60 (15.8)
	Stable	270 (71.1)
Glascow Coma Score on Initial Examination (n=620, 60.2%)	3 – 8	62 (10.1)
	9 – 12	38 (6)
	13 – 15	523 (83.9)
Consciousness on Initial examination (1030, 100%)	Fully conscious	655 (63.6)
	Confused	73 (7.1)
	Delirious	2 (0.2)
	Somnolent	17 (1.7)
	Obtunded	7 (0.7)
	Stuporous	10 (1)
	Comatose	40 (3.9)
	Unknown	73 (7.1)
Presenting symptoms (1030, 100%)	Neurological	442 (42.9)
	Psychiatric	50 (4.9)
	Cardiac	88 (8.5)
	Nausea/Vomiting	239 (23.2)
	HEENT	18 (1.8)
	Pain	298 (40.7)
Initial examination of the pupils (311, 30.2%)	Miosis	7 (2.3)
	Mydriasis	14 (4.5)
	Aniscoria	8 (2.6)
	Pontiform	1 (0.3)
	Normal, Reactive	281 (90.4)

HEENT - head, eyes, ears, nose, and throat.

taining common injury types, mainly falls and road traffic injuries.

This study identifies blunt TBI as the most common TBI mechanism compared to penetrating injury, aligning with international literature where blunt TBI constitutes most cases (88-95%).[30] Falls from a height was the most prevalent cause of TBI reported in this study, agreeing with a review of 125 local and international studies.[30] It was evident from the analysis that motor vehicle accidents (MVA) was another major cause of TBI. Our results contradict those generated from existing regional studies that ranked MVA as the leading most common cause of TBI-related injuries

Table 4. Workup, findings and complications in the emergency department and long term complications post-emergency department dispatch

		Number (%)
Brain CTs ordered		752 (81)
Imaging requested	X-Ray	511 (49.6)
	CT scan	301 (29.2)
	MRI	17 (1.7)
	Ultrasound	23 (2.2)
Neurosurgical consultations requested		521 (54.8)
Complications in the ED	CSF Leak	15 (6.2)
	Papilledema	3 (1.3)
	Hemotympanum	13 (5.4)
	Death	9 (1.4)
Elevated ICP management in the ED	Head elevation	113 (17.6)
	Hyperventilation	12 (2)
	Osmotic IV therapy	49 (8)
Transfusions provided		71 (12.4)
Adverse events	Wound infection	6 (0.6)
	Pneumonia	33 (3.2)
	Pulmonary embolism	1 (0.1)
	Acute respiratory distress syndrome	10 (1.0)
	Renal insufficiency	3 (0.3)
	Acute renal failure	7 (0.7)
	Urinary tract infection	8 (0.8)
	Cerebro-vascular accident	5 (0.5)
	Cardio-pulmonary resuscitation needed	10 (1)
	Myocardial infarction	0 (0)
	Deep vein thrombosis	3 (0.3)
	Sepsis	11 (1.1)
	Hydrocephalus	4 (0.4)
	Osteomyelitis	0 (0)
	Abscess	1 (0.1)
	Epilepsy	6 (0.6)
	Fistula	0 (0)
	Post-traumatic stress disorder	0 (0)
	Other psychological symptoms	0 (0)

CSF – cerebrospinal fluid, CT – computed tomography, ICP – intracranial pressure, IV – intravenous, MRI – magnetic resonance imaging.

followed by falls.[20] Falls from a height were commonly sustained by the young and geriatric population alike. Among the young age groups, occupational injuries were mainly sustained by adults working on construction sites without the appropriate use of protective gear or proper safety measures. Falls sustained by the elderly population reflect their potential physical restrictions (i.e. diminished sight and hearing), which places them at an increased risk of suffering from fall injuries at home, particularly with the absence of fall safety precautions and hazard-proofing elderly homes (e.g. safety rugs or bathroom rails).

Patients with a GCS of less than nine should undergo decompressive craniectomy and CSF drainage, prophylactic hypothermia, hyperosmolar treatment, prophylaxis (infectious, deep vein thrombosis, and seizure), steroids, adequate nutrition, and appropriate analgesia and ventilation with airway protection.[31] In addition, these patients require continuous monitoring for their vital signs, intracranial pressure, cerebral perfusion pressure, advanced cerebral monitoring, and complete blood work in addition to inspection for other systemic traumas as per the Advanced Trauma Life Support (ATLS) protocol.[31,32]

In this present study, approximately 81% of the patient population received a brain CT, indicating a possible overuse of radiological assisted diagnosis, compared to existing studies in which only 23.9% of mild TBI patients underwent non-extremity and non-chest x-rays.[33] Treatment mainly focused on wound care, intravenous fluid adminis-

tration, and pain assessment with 17.1%, 14.1%, and 43.8%, respectively.[33]

TBI mortality rate from our study was recorded at 1.4% in the ED, not falling within the international range of 7-23%. However, one systematic review in the Middle East and North Africa (MENA) region showed that severe TBI mortality ranges between 9-46% prevalence across different studies in the region.[20] A potential reason for this discrepancy may be due to the low sample size used in our study or the proximity of the ED to the injury site and to the relatively short time acquired for patients initiating and receiving care.[20]

STRENGTHS AND LIMITATIONS

This study has several strengths and limitations. One of the significant strengths of this study is being the first study to collect TBI data from multiple trauma centres in Lebanon. Another strength of this study is its large sample size collected from six participating medical institutions, a factor that demonstrates the representativeness of the study. Moreover, the protracted time for data cleaning enhances variable accuracy and eliminates all missing data.

The study has some limitations. First, it is worth mentioning that the data collection for several variables was below optimal (i.e. less than 30% of the data for certain variables), which reflects poor documentation and charting of patients' records. This sheds light on the vital need for proper and reliable documentation of TBI patients at the ED level. Missing data presents a threat to the reliability and accuracy of the data analyses, leading to skewed results. Harmonisation and homogeneity across sites were not closely monitored, potentially creating a source of bias. Furthermore, the study is limited in reporting the prevalence of many long-term adverse events post TBI, namely depression, neuropsychiatric disorders, and the extended-spectrum of sleep disorders.[34] These findings were highlighted in the literature but were absent from the database, mainly due to the possible loss of follow-up and the absence of such data in patients' charts. Lastly, long-term complication follow-up was not ideal with results from a limited number of patients. This is mostly due to patients being lost to follow-up, except those who were admitted.

LESSONS AND RECOMMENDATIONS

This paper acts as a stepping stone for initiating future TBI research in Lebanon. Evidence from this study provides a powerful tool for health professionals and policymakers to inform TBI prevention, treatment, and rehabilitation programs for all causes of TBI-related injuries. A TBI registry is warranted to record all prospective cases of brain injury and examine TBI prevalence to understand its actual burden in Lebanon. Moreover, the compiled database will serve as a platform to conduct multiple analyses that aim at tackling the various aspects of the TBI health problem, including its economic and political aspects.

This paper calls upon a series of recommendations within the context of three main entities:

1. **From a health policy perspective**: This study calls for equity in access to healthcare services among all residents of Lebanon. The vulnerable population, namely Syrian refugees, have limited access to many health services, restricting them from receiving timely TBI treatment. Many refugees tend to neglect or delay treatment, which will consequently affect their TBI long-term outcome and management. The provision of specialised services (i.e. neurosurgical procedures following TBI) is not available at all healthcare centres and hospitals and is mostly not subsidised by the government. In many cases, NGOs facilitate access to care to underprivileged Lebanese based on a sectarian political system. This study advocates for government policy changes that aim to inform policies that enhance safety and prevent TBI occurrences, such as improving working conditions for construction workers (mostly notably Syrians and foreign workers), while providing them with adequate insurance coverage. Other needed policy changes include strict regulations and enforcement of road traffic laws to ensure compliance with helmet use among motorcyclists and pillions. Governments to cooperate with policymakers and advocates to ensure proper law enforcement and accountability to reduce head traumas in traffic-related injuries is warranted. Moreover, policymakers should advocate for the development of accessible TBI rehabilitation centers. Over and above, the supportive role of governments in funding TBI research and for initiating TBI rehabilitation centers in Lebanon is vital for accomplishing these goals.
2. **From a health economics perspective**: TBI diagnosis, management, and treatment are costly. This study advocates for the reduction of TBI-related injuries that overburdens the healthcare system. Many TBI patients cannot afford ED visits and their associated procedures that are essential for accurate TBI diagnosis and treatment. Access to advanced neurology and neurosurgical interventions and procedures for TBI patients is limited to a few university teaching hospitals in Lebanon and transfer between hospitals is restricted due to various challenges related to financial clearance in a healthcare system that relies on private hospitals. Besides, several insurance companies refuse to admit TBI patients, claiming that TBI is classified as minor trauma does not warrant hospital admissions. While timely and adequate TBI care is critical in preventing neuropsychiatric health problems, its provision is crucial to reducing incurring health expenditures and excess payment at a later stage on individuals and the healthcare system. Long-term neuropsychiatric disorders are neglected despite the fact that minor TBI or concussion can significantly increase the risk of dementia. Hence early rehabilitation and close observation are required. In Lebanon, rehabilitation services are nearly absent - lacking this service will affect the long-term outcome of TBI patients and their return to a normal produc-

tive life, presenting an economic burden on family members due to cumulative financial expenditures and for being less productive members of the family.

3. **From a health system perspective:** This study urges healthcare professionals and policymakers to actively participate and cooperate with respective parties on a multi-sectorial level to enhance TBI data collection at the emergency department level. Cooperation with researchers is needed to document incidences of TBI and to establish a TBI registry to generate evidence and serve as a nidus for policy-making. In addition, it is pivotal for healthcare professionals to enhance their skills in detecting and classifying TBI using the GCS through courses and training programs. Government support to enhance TBI research is vital. Many healthcare systems lack monitoring and regulation for treatment and delivery of care for TBI patients.

CONCLUSIONS

Traumatic brain injury is a major public health problem in Lebanon, increasing preventable morbidity and mortality among individuals of all age groups with various short and long-term sequelae. Although the prevalence of TBI in Lebanon aligns with existing literature, it remains unique to the characteristics of the Lebanese population. This highlights the need to understand the political and economic spectrum of improving TBI research in Lebanon and advancing TBI work to incorporate biomarkers and clinical drug trials tailored to the population. Furthermore, concerted efforts warrant the translation of evidence derived from this study to set guidelines for improving TBI diagnosis, management, and rehabilitative treatment in Lebanon as well as to inform preventive policies and programs to enhance individuals' safety and promote health and well-being.

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All authors contributed to the design, draft and final manuscript.

COMPETING INTERESTS

The authors completed the Unified Competing Interest form at http://www.icmje.org/disclosure-of-interest/ (available upon request from the corresponding author), and declare no conflicts of interest.

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