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Epidemiology and clinical characteristics of traumatic brain injury in Lebanon

A systematic review

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Abstract

Background: Traumatic brain injury (TBI) is a debilitating medical and emerging public health problem that is affecting people worldwide due to a multitude of factors including both domestic and war-related acts. The objective of this paper is to systematically review the status of TBI in Lebanon – a Middle Eastern country with a weak health system that was chartered by several wars and intermittent outbursts of violence - in order to identify the present gaps in knowledge, direct future research initiatives and to assist policy makers in planning progressive and rehabilitative policies.

Methods: OVID/Medline, PubMed, Scopus databases and Google Scholar were lastly searched on April 15th, 2016 to identify all published research studies on TBI in Lebanon. Studies published in English, Arabic or French that assessed Lebanese patients afflicted by TBI in Lebanon were warranting inclusion in this review. Case reports, reviews, biographies and abstracts were excluded. Throughout the whole review process, reviewers worked independently and in duplicate during study selection, data abstraction and methodological assessment using the Downs and Black Checklist.

Results: In total, 11 studies were recognized eligible as they assessed Lebanese patients afflicted by TBI on Lebanese soils. Considerable methodological variation was found among the identified studies. All studies, except for two that evaluated domestic causes such as falls, reported TBI due to war-related injuries. Age distribution of TBI victims revealed two peaks, young adults between 18 and 40 years, and older adults aged 60 years and above, where males constituted the majority. Only three studies reported rates of mild TBI. Mortality, rehabilitation and systemic injury rates were rarely reported and so were the complications involved; infections were an exception.

Conclusion: Apparently, status of TBI in Lebanon suffers from several gaps which need to be bridged through implementing more basic, epidemiological, clinical and translational research in this field in the future.

Abbreviations: AUBMC = American University of Beirut Medical Center, CDC = Centers for Disease Control and Prevention, GCS = Glasgow Coma Scale, LOC = loss of consciousness, mTBI = mild traumatic brain injury, PTSD = post-traumatic stress disorder, TBI = traumatic brain injury, WHO = World Health Organization.

Keywords: head injuries, Lebanon, mTBI, public health, systematic review, traumatic brain injury

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1. Introduction

Traumatic brain injury (TBI) is a staggering health issue that imposes serious threats and medical concerns to public health[1,2] not only in Lebanon but also worldwide.[3] As defined by The Working Group on Demographics and Clinical Assessment of the International Interagency Initiative toward Common Data Elements for Research in TBI and Psychological Health, TBI is "an alteration of brain function, or an evidence of brain pathology, that is caused by an external force."[4] TBI affects individuals of all age groups with a bimodal distribution in adolescents and elderly,[5] with a major predominance in male population.[6] It is estimated that the annual TBI incidence rate is 558 cases per 100,000 persons in the United States alone.[7] Interestingly, TBI is projected by the World Health Organization (WHO) to become the third leading cause of global mortality and disability by the year 2020.[8]

Blunt trauma accounts for about 88%–95% of TBI cases, whereas the remaining, 5%–12% of cases, are the result of penetrating injuries.[9] Traumas owing to falls, motor vehicle accidents,[10] war assaults,[11] domestic abuse,[12] and sport-related injuries[13] constitute the major causes of TBI worldwide. Based on Glasgow coma scale (GCS), TBI is classified into mild (14–15), which is termed as concussion, moderate (9–13), and severe (3–8).[14] In 2014, a new approach was proposed by the Centers for Disease Control and Prevention (CDC) for TBI classification,[15] where new parameters have been added to account for the deficits in GCS that only includes in its assessment the level of consciousness (LOC), and disregards clinical signs such as pupil reflexes, sedation, among others.[16] The new parameters projected have included the Abbreviated Injury Scale, LOC and its duration, post-traumatic amnesia, and evidence of brain involvement on structural imaging.[15]

A worldwide interest in mild TBI (mTBI) is currently trending as it has been shown that its consequences are not only limited to the acute postinjury phase, but chronic sequelae and severe long-term adverse outcomes, such as cognitive impairment and early onset dementia may develop. Guidelines followed to manage cases of TBI vary according to the severity, with most controversy lying on the proper way to deal with mTBI cases.[17] Some of the prompt consequences that TBI victims suffer from, involve the enormous disability and mortality rates. Mortality was reported to reach up to 31% in elderly TBI victims in the United States, most of which sustain severe TBI, and similar rates were described in the Arab world as well.[18,19] Long-term sequelae that mTBI patients exhibit include, but are not limited to, neuropsychological disorders, such as post-traumatic stress disorders (PTSD), depression, anxiety, and increased risk of developing neurodegenerative diseases such as Alzheimer disease.[20,21] It is noteworthy mentioning that the long-term sequelae of TBI, and mTBI in specific, do not affect the TBI survivor alone but also the community they live in, as well as their families and caregivers both psychologically and economically.[22]

Lebanon, a small Middle Eastern country that is known for its religious and ethnic diversity, was devastated by several war conflicts that chartered the country into parts; including over 15 years of civil war and several external invasions with occasional outbursts of violence acts.[23,24] Nonetheless, it was able to regain its strength in the past few years, but this come back did not reflect on the weak, sectarian health system.[25,26] One of the major health challenges that are currently being faced include the under estimated injury rates owing to these wars and their long-term consequences, and in particular TBI rates.[27] Recently, there has been an increased interest in assessing the neuropsychological outcomes, such as PTSD and depression, following traumas in the Lebanese population; however, these studies have not attempted to investigate the upstream instigators that lead to the occurrence of these disorders, such as TBI in specific.[28–30] Additionally, current TBI studies suffer from major flaws pertaining to appropriate demographic reporting, lack of appropriate TBI categorization and case ascertainment, incomplete supporting medical charts documentation, and biochemical and clinical testing. Hence, the current systematic review aimed to identify, appraise, evaluate and summarize the available data regarding the status of TBI in Lebanon. With these aims in mind, we assessed the epidemiological, clinical characteristics, management, and outcomes of patients inflicted by TBI in Lebanon.

2. Methods

2.1. Data sources and searches

The review was conducted and reported in accordance with Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Supplement 1, http://links.lww.com/MD/B416). A comprehensive search strategy was developed to assess the burden of TBI with the assistance of the medical information specialist at the Medical Library of the American University of Beirut, Lebanon. MeSH terms, keywords, and combinations related to TBI words were used to search the databases comprehensively. Complete search strategy is provided in Supplement 2, http://links.lww.com/MD/B416. Articles in English, Arabic, and French were retrieved, both of observational or nonlaboratory experimental studies, from OVID, PubMed, Cochrane, Scopus, and Google Scholar since inception. Databases were last searched on April 15th, 2016.

2.2. Selection criteria

Articles were considered eligible if they assessed Lebanese patients of any age, sex, and ethnicity who have suffered a TBI or any situation in which TBI might be implicated or suspected. Abstracts, reviews, case reports, biographies, conference lectures, and editorials were excluded.

2.3. Study review

The screening stage was divided into 2 phases. In the first phase, 2 reviewers assessed study titles and abstracts for relevance. If any of the reviewers considered an article potentially relevant, the full text of the article was retrieved. Similarly, during the second phase, another 2 reviewers assessed the full texts of the remaining articles for eligibility of inclusion. Both screening phases were done, in duplicate and independently, by each of the reviewers. In case of disagreement, a third reviewer was consulted. Studies that failed to meet the inclusion criteria were excluded. Reasons for the excluded articles are discussed in Supplement 3, http://links.lww.com/MD/B416.

2.4. Data extraction and quality assessment

For studies that fulfilled the inclusion criteria, data abstracted included the manuscript title, first author(s), year of publication, study design, time period, site of the study, sample size, patient characteristics (age, sex, mechanisms, and severity of injury (documented severity, GCS, LOC, and computerized tomography findings), treatments and clinical outcomes were also retrieved. Lastly, systemic-associated injuries and complications,

such as infections, were also extracted and abstracted into a specifically designed and piloted data extraction form. Supplement 4, http://links.lww.com/MD/B416 presents the data of all the articles abstracted. List and definitions of abstracted data are found in Supplement 5, http://links.lww.com/MD/B416.

To achieve best use of the yield of information, whenever duplicate studies or companion articles of a parent study were identified; evaluation of all available data was done.

Studies that met the inclusion criteria were assessed for methodological quality using the Downs and Black criteria checklist.[31] The checklist contains 27 items that evaluate the quality of reporting, external validity, internal validity (bias and confounding), and power with a maximal quality index (QI) of 32. The QI highly correlated with previously established instruments for quality assessment in both randomized and nonrandomized studies.[32] Quality of the included studies can be found in Supplement 6, http://links.lww.com/MD/B416.

2.5. Data analysis and synthesis

The kappa statistic was calculated to assess the intrarater agreement between reviewers for full-text screening.[33,34] Meta-analysis could not be meaningfully performed because of the insufficient data and the heterogeneity among the included studies. Consequently, the data were summarized qualitatively in summary tables and descriptive text.

2.6. Ethical considerations

This systematic review is considered minimal risk and since no actual data collection was done, no IRB approval was required to complete the work.

3. Results

3.1. Results of the search

In total, 152 articles were retrieved through database search. Additionally, one article, and one master's thesis discussing mTBI were manually retrieved. After removal of duplicates, 90 articles were eligible for screening. Of those, 35 were selected for full-text review and 11[24,27,30,35–42] were included in the final review, of which 5 studies were prospective and 6 were retrospective. Figure 1 presents the study flow. Kappa statistic for full-text screening was found to be almost perfect in agreement at 0.81. The average Quality Index of the reported studies was found to be 12.36 of a total of 32, ranging between 8 and 17 (Supplement 6, http://links.lww.com/MD/B416).

3.2. Study settings, participants, and time periods

In 6 of the 11 retrieved studies, data were collected from the American University of Beirut Medical Center (AUBMC),[24,35,37,38,40,41], one study was conducted at Hotel-Dieu de France[39], and one at different local Beirut hospitals.[36] The other 3 studies were conducted by the division of neurosurgery at the Lebanese University and its affiliated medical centers.[27,30,42] Three studies evaluated trauma patients from South Lebanon,[27,30,42] whereas the other studies included patients from Beirut city.[24,35–41] The oldest study was conducted in 1980,[35] 4 studies were performed before the year 2000,[35–39] and 4 studies were relatively recent having been conducted between 2010 and 2014.[27,30,41,42] Most of the studies evaluated TBI patients and victims from the Lebanese civil war or Lebanese–Israeli conflict up till the year 2000.[39,40] Later studies also evaluated TBI patients owing to the Lebanese–Israeli conflict in 2006 and consequences of cluster munitions after end of the war.[27,30,42] Two studies only assessed domestic injuries,[40,41] but only one of them performed at AUBMC[41] elaborated on the causes of TBI such as falls, motor vehicle accidents, sport-related injuries, among others, whereas the other study showed no detailed information and only reported that 297 cases were owing to domestic injuries without any further description.[40] Characteristics of the eligible studies can be found in Table 1.[24,27,30,35–42]

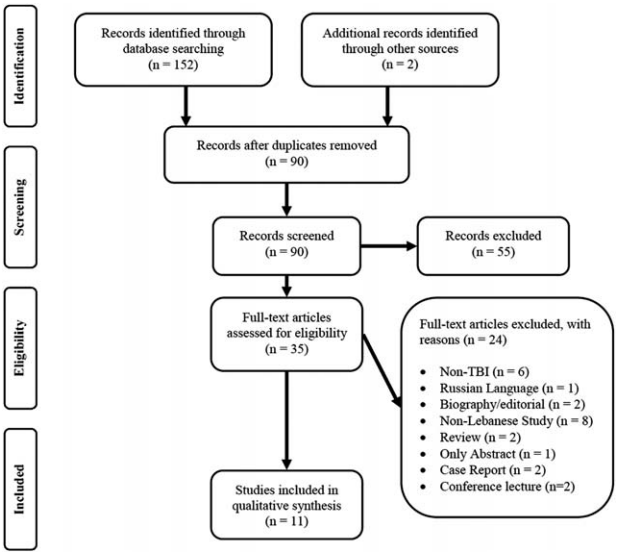

Figure 1. PRISMA flow diagram depicting study flow process.

3.3. Epidemiology and causes of traumatic head and brain injuries

Causes and mechanisms of TBI in Lebanon can be classified into 2 major categories, the first related to war and blast injuries, and the second to domestic causes; hence, our reporting of available literature will be stratified according to this classification. War and blasts-related injuries were the main causes of TBIs, probably because of the war-inflicted zone (Middle East region) where Lebanon resides in. Those included penetrating, shrapnel, and bullet war injuries,[35,37–40] injuries owing to cluster munitions[27,30,42] and bomb attacks.[24,36] Distribution by sex was not always reported in the studies, but when stated, unsurprisingly, a predominance of males was found.[24,37,38] Two studies reported that the mean age was 23 years with an age range of 3 to 51 years,[37] and 32 years with age range of 21 to 59 years, respectively.[24]

The first study to evaluate craniocerebral injuries was conducted by Achram et al,[35] where they reported 219 cases indirectly during their quest to evaluate rates of post-traumatic intracranial aneurysm.[35] Demographics, severity, and management were not reported (7 cases of post-traumatic intracranial aneurysms were reported).[35] Six years later, Scott et al[36] reported 346 cases of head injuries, of which 112 (32.2%) survived. Among the survivors, 20 had scalp lacerations, 13 had skull fractures, 6 had facial bone injuries, and 2 had ceresbrospinal fluid fistulae. Among them, 37 (28%) had concussions, 4 (3.5%) had cerebral contusions, 5 (4.4%) had dural lacerations, and 2 (1.7%) had intracranial hematomas. Of

Table 1

Characteristics of the eligible studies.

Author	Year	Study design	Study setting	Study time period	Cause of Injury
Achram et al[35]	1980	Retrospective	AUBMC	1983	War-related
Scott et al[36]	1986	Retrospective	Battalion Aid Stations, U.S.S. *Iwo Jima* amphibious assault ship, and Beirut Hospitals	October 23, 1983	Bombing
Taha et al[37]	1991	Prospective	AUBMC	1981–1988	War-related
Taha et al[38]	1991	Prospective	AUBMC	1981–1988	War-related
Nohra et al[39]	2002	Retrospective	Hotel-Dieu de France	1975–1990	War-related
Haddad et al[24]	2008	Retrospective	AUBMC	February 14, 2005	Bombing
Mansour et al[40]	2009	Retrospective	AUBMC	1980–1996	War-related and domestic injuries
Habre[41]	2012	Retrospective	AUBMC	February 1, 2010 to July 31, 2010	Domestic injuries
Fares and Fares[42]	2013	Prospective	Neurosurgery Division at the LU Hospitals	September 2006 to August 2012	War-related
Fares et al[30]	2013	Prospective	Neurosurgery Division at the LU Hospitals	14 August 2006 to 31 December 2011	War-related
Fares et al[27]	2013	Prospective	Neurosurgery Division at the LU Hospitals	14 August 2006 to 15 February 2013	War-related

AUBMC = American University of Beirut Medical Center, LU = Lebanese University.

the 234 (67.6%) victims who died immediately following trauma, 167 (71.3%) were found to have sustained head injuries, of which 93 (55.6%) had scalp laceration, 85 (50.8%) had skull fractures, and 24 (14.3%) had facial bone fractures. Likewise, Taha et al[37] stated that of 23 cases who experienced severe craniocerebral injuries, 7 had a GCS of <5, whereas 11 cases had GCS ranging between 6 and 8, and 4 cases with GCS of 9 and 12. Authors also reported that 6 sustained injuries to one brain lobe and 20 to 2 lobes. Besides, 8 other cases had a GCS >13, which were considered of mild severity. Nohra et al[39] also reported 272 craniocerebral traumas, of which 69 (25.3%) sustained closed TBI, 201 (73.8%) sustained penetrating TBIs, and 2 (0.7%) cases had no documentation of TBI mechanism. Last but not least, Fares et al[27,30,42] reported in 3 studies on cluster munitions, 18 TBI cases, of which 7 were penetrating and 11 were closed or nonpenetrating, whereas Haddad et al[24] reported 150 cases of injuries owing to a blast, 2 of which had brain injuries.

Of interest in 2012, Habre identified 121 cases of mTBI through a retrospective analysis performed at AUBMC.[41] Of those, most were caused by falls (42.1%), whereas other injury mechanisms included motor vehicle accidents (20.7%), head being struck by an object (16.5%), assaults (10.7%), and sport-related injuries (3.3%).[41] In the remaining 6.6%, the cause of injury was not documented. In this study, the majority of patients were males (62.8%). Age distribution revealed 2 peaks, one in young adults between 18 and 40 years (48.8%) of cases, and the other in elderly subjects aged 60 years and above (31.4%) of cases. The remaining middle-aged adults between 41 and 59 years represented 19.8% of the sample population. Severity of cases was evaluated by Habre as 98 (69.1%) having mild severity and 3 (2.9%) having moderate severity. It was assumed that severe cases of TBI were missing because of the nature of fatal injuries they sustained; hence, never reaching the emergency department.[41] Study details are listed in Supplement 4, http://links.lww.com/MD/B416.

3.4. Tools used in assessment and diagnosis of traumatic brain injuries

Different tools had been used to assess and diagnose TBI patients across the different studies. Achram et al[35] utilized arteriograms aiming to evaluate intracranial aneurysms post-TBI, whereas Taha et al[37,38] were the first to report the use of GCS in early 1990s. Computed tomography scans have been also used in the assessment of TBI, wherein Nohra et al[39] firstly reported its application in mid-1980s at Hotel-Dieu de France, after which all of the subsequent studies stated its use in their assessment of TBI. It is noteworthy mentioning that Fares et al[42] developed a specific scale, the Fares Scale, to assess the injuries after cluster munitions explosions, owing to the limitations of the already present scales (See Reference[27,42] for this detailed scaling). Hence, no single assessment tool (s) is yet accredited for classifying TBI patients in Lebanon, which is also the case worldwide. Unfortunately, Habre reported that in general 43% of the patients included in the study had an incomplete neurological assessment[41] (Table 2).[24,27,30,35–42]

3.5. Other systemic injuries associated with traumatic brain injuries

Only 4 of the eligible studies included in this review defined the rates of the systemic injuries associated with head or brain injuries. Scott et al[36] reported 2 spine injuries and 9 peripheral nerve injuries, of which one was facial nerve palsy. Nohra et al[39] reported 58 associated injuries, but none were specified. Mansour et al[40] reported that of 841 patients with domestic or war-related injuries during the Lebanese civil war, an injury to the right eye was associated in 345 cases, 378 had left eye injury, and 118 had both eyes injured. Additionally, 109 patients had other facial injuries. Severity and extent of injuries were not specified. Similarly, Fares et al[27] reported 7 (24%) facial nerve injuries, 7 (24%) eye injuries, 17 (59%) ear injuries, 2 (7%) oral injuries, and 29 (100%) scalp and soft tissue lacerations from the 29 pediatric patients included in his study. Therefore, it is common to encounter systemic injuries among cases of TBI, most of which are predicted to be related to the area of the face, and orbits in specific (Table 2).

3.6. Mortality outcomes post-traumatic brain injuries

Mortality post-TBI was reported in 4 studies. Scott et al[36] reported 234 (67.6%) immediate deaths owing to the blast

Table 2

Associated systemic injuries and rates of complication reported in the eligible studies.

Author	Assessment tools	Associated injuries
Achram et al[35]	Arteriograms	None reported
Scott et al[36]	None reported	2 spine injuries 9 peripheral nerve injuries 1 facial nerve palsy
Taha et al[37]	GCS score: 4–5: 7 cases 6–8: 11 cases 9–12: 4 cases 13–15: 8 cases	None reported
Taha et al[38]	CT GCS Range 10-15 Mean: 14	None reported
Nohra et al[39]	CT GCS	58 but not specified
Haddad et al[24]	Radiographs and non-enhanced CT scans	None reported
Mansour et al[40]	None Reported	Right eye: 345 Left eye: 378 Both eyes: 118 Face injuries: 109
Habre[41]	Arteriograms	None Reported
Fares and Fares[42]	None Reported	2 spine injuries 9 peripheral nerve injuries 1 facial nerve palsy
Fares et al[30]	GCS score: 4–5: 7 cases 6–8: 11 cases 9–12: 4 cases 13–15: 8 cases	None Reported
Fares et al[27]	CT GCS Range 10-15 Mean: 14	None Reported

CT = Computed tomography, GCS = Glasgow Coma Scale.

bombing, and additional 7 (6.3%) cases were reported dead of the 112 survivors.[36] Similarly, Taha et al[37] reported a mortality rate of 43%. Nohra et al went a step further and indicated not only crude mortality rate, but also specific mortality rates owing to noninfectious causes as a consequence of the severity of trauma in 33 (13.7%) cases of their sample.[39] In the same study, 7 (26.6%) of the 30 cases suffered infections and were reported dead.[39] Moreover, Fares et al[30] reported 10 (8.2%) deaths in the pediatric age group (122 in total), with a sex-specific mortality rate of 100% males. Collectively, and owing to the fact that Lebanon subsides within the Middle East region, which is considered among the most conflict-ridden region in the world,[43] high mortality rates following TBIs are to be expected hereby, especially among patients who sustain severe traumas as in wars and regional conflicts (Table 3).[24,27,30,35–37,39,41,42]

3.7. Rates of complications post-traumatic brain injuries

Few major complications were described in the eligible studies, prominently being infection rates post-TBI. Taha et al[37] reported 16 cases of intracranial infections, whereas Nohra et al[39] reported 7 cases of intracranial abscesses post-TBI. Moreover, Taha et al reported 30 cases of intracranial infections of 600 cases of TBI. Other than the 16 cases of abscesses reported in this study, 9 cases had cerebritis, 2 cases had infected intracranial hematomas and 5 cases had meningitis. Authors also reported that 2 cases suffered from recurrent infections.[37] Likewise, Nohra et al[39] reported another 20 cases of meningitis and 4 cases of abscesses with meningitis. They also reported development of 29 fistulae and 31 sinuses. However, Taha et al[38] solely reported seizures with 50% of cases. Interestingly, Fares et al[27] reported the psychological effects post-injury, and so did Scott et al[36]; however, none of them specified the rates post-TBI alone. Of interest to us, 7 of 28 cases reported by Scott et al suffered from postconcussion syndrome.[36] Fares et al[27] reported 29 cases of PTSD, in addition to 21 patients who developed major depressive disorder, 4 who experienced acute stress disorder, and 23 who suffered from generalized anxiety disorder. Time to development of the psychological illness was never reported by any (Table 3).

4. Discussion

This systematic review of literature evaluating the status of TBI in Lebanon, aimed to provide a better thorough understanding of the epidemiological trends, management and current challenges that Lebanon faces in the field of TBI. Considerable methodo-

Table 3

Studies with confirmed rates of TBI in Lebanon.

Study	Sample size	TBI cases	TBI severity	Mortality
Achram et al[35]	219	219	Not reported	Not Reported
Scott et al[36]	346	48	Concussions: 37 Cerebral contusions: 4 Dural lacerations: 5 intracranial hematomas: 2	240
Taha et al[37]	600	23	Mild TBI: 8 Moderate TBI: 15 Severe TBI: 7	285
Nohra et al[39]	500	271	Penetrating TBI: 201 Closed TBI: 69 Unknown: 2	40
Haddad et al[24]	150	2	Severe TBI: 2	Not Reported
Fares and Fares[42]; Fares et al[27,30]	417	18	Penetrating TBI: 7 Closed TBI: 11	10
Habre[41]	121	101	Mild TBI: 98 Moderate TBI: 3 Unknown: 3	Not Reported

TBI = traumatic brain injury.

Table 4

Inclusion and exclusion criteria and Quality Index of the eligible studies.

Author, Year	Inclusion	Exclusion	QI
Achram et al (1980)[35]	Intracranial Aneurysms following head injuries	Not reported	9
Scott et al (1986)[36]	Victims of Beirut airport bombing	Not reported	11
Taha et al (1991)[37]	Missile injuries to brain	Not reported	17
Taha et al (1991)[38]	Missile injuries to brain a. Patient is neurologically stable: GCS >10 b. Patient examined within 6 hours of injury c. Entry wound was <2 cm d. Absent exit wound e. Missile tract that do not pass the Sylvain fissure f. No epidural or subdural hematoma g. No enlarging intracerebral hematoma or >4 cm in diameter.	Not reported	14
Nohra et al (2002)[39]	1. Craniocerebral trauma owing to fire arms 2. Patient was operated 3. Patients who survived >1 week 4. Complete chart documentation 5. Hospital admission and treatment	Not reported	14
Haddad et al (2008)[24]	All victims of blast in 2005	Not reported	8
Mansour et al (2009)[40]	Ocular injuries admitted to the American University Hospital between 1980 and 1996	Not reported	17
Habre (2012)[41]	1. Age ≥18 years 2. AUBMC's ED between February 01 and July 31, 2010 3. Chief complaint related to brain injury	Non-TBI cases Incomplete charts Transfer patients	16
Fares et al. (2013)[42]	Injuries because of cluster bombs	Not reported	10
Fares et al (2013)[30]	Injuries due to cluster bombs between 14 August 2006 and 31 December 2011	Not reported	10
Fares et al. (2013)[27]	Injuries due to cluster bombs between 14 August 2006 and 31 December 2011	Not reported	10

GCS = Glasgow Coma Scale, AUBMC = American University of Beirut Medical Center, ED = Emergency department, QI = Quality Index of the Down and Black Quality Checklist, TBI = traumatic brain injury.

logical variations was found among the different studies, regarding the overlap in study populations being evaluated, the representation of the studied populations, methods and tools used in assessment, and last but not least the reported outcome measures.

Most of the studies were performed by the same teams and within the same time period and probably including the same patients such as Taha et al[37,38] and Fares et al[27,30,42] Therefore, it was relatively hard to obtain reliable estimates of the incidence of head injuries and/or TBIs in Lebanon. Inferentially, our team was able to confirm 682 TBI cases in Lebanon from all the eligible articles in this review (Table 3). Hence, we can deduce that the rates of confirmed and reported cases of TBI in the past 30 years as reported in Lebanese literature is very scarce and does not match the reported rates neither worldwide nor in nearby countries. Yet, from our clinical experience in Lebanese hospitals, it is extremely rare that a day passes without encountering individuals suffering from mTBI. In the United States alone, annually around 230,000 are hospitalized because of TBI and an additional 50,000 people died from their injuries.[15] Similarly in Oman, a nearby Arab country, 300 to 400 persons per 100,000 people are affected by TBI every year.[44] Interestingly, in Lebanon, Habre observed that severe cases of TBI in Lebanon rarely reach hospitals because of the stark nature of the injuries, and hence severe TBIs; in addition to mild and moderate severities are underestimated in Lebanon.[41]

Additionally, it is widely known that most of Beirut residents come from different Lebanese geographical locations and Beirut is considered a pool for the whole Lebanese population, but no specific data regarding residency of the patients afflicted by TBI was reported in any of the studies, except for the crude reporting by Fares et al[30] for Southern Lebanese suffering from TBI. Yet, no results were reported for other Lebanese governorates including Mount and North Lebanon or the Beqaa Valley; hence, rural versus urban rates could not be determined.

An additional factor that adds to the complexity of underestimation of TBI in Lebanon is the inclusion criteria of the conducted studies, as they only evaluated Lebanese individuals who have sustained a TBI (Table 4).[24,27,30,35–42] Nonetheless, the true situation is that non-Lebanese suffer a lot, if not more than Lebanese citizens, from TBIs. Syrian, Palestinian, and Iraqi refugees constitute the major component of the non-Lebanese afflicted by TBI. No single study was found in Lebanon to assess non-Lebanese TBI rates, but such situation can be demonstrated from nearby countries. A retrospective study from Turkey, that has similar rates of Syrian refugee as Lebanon, 140 post-mortem records of Syrian children who died during their treatment at Turkish hospitals were assessed for war-related deaths.[45] This study reported that >70% of the autopsied were males, half of which were between 13 and 18 years of age. The main causes of death were bombing, shrapnel injuries, and gunshot wounds, affecting in about 50% of cases multiple body parts, whereas head and neck injuries alone comprised 30% of the injured sites.[45] Similar results are expected to be found in Lebanese hospitals, yet no official documentation was found. A recently published review from the department of plastic and reconstructive surgery at the AUBMC reported that there is an increase in the rate of reconstructive surgeries for the hand and upper limb owing to blast injuries from nearby countries including Syria, where the resources to treat such complex injuries are scarce.[46]

On a separate note, although data presented by Haddad at 2 different conferences on the status of craniocerebral injuries in Lebanon did not meet our inclusion criteria for this review, these findings are worth mentioning. In the first conference, Haddad reported 287 cases of head injuries, albeit TBI was not specifically mentioned but instead it was reported that 87 (30.3%) subjects were fully conscious, 52 (18.1%) were agitated, 30 (10.4%) were not speaking spontaneously, 8 (2.7%) were not responding to spoken words, 24 (8.3%) responded to stimuli by appropriate movements and 26 (9.0%) by inappropriate movements, and 33

(11.4%) responded by decerebrate movements, whereas 31 (10.8%) did not respond to stimuli. Based on the LOC reported on these cases, it can be inferred that at least 202 (70.7%) of the aforementioned cases have sustained an injury to the brain.[47] Similarly, in 1989, Haddad at another conference reported 4162 trauma patients at AUBMC, of which 527 (12.7%) had skull fractures. Of these, 271 (19.7%) had penetrating brain injuries.

4.1. Implications for clinical practice

Mild TBI nowadays is considered as important as severe TBI, because of its documented long-term effects.[48] Lebanese physicians and neurosurgeons are urged to act more vigorously in recommending rehabilitation programs even for mTBI cases to avoid future physical and neuropsychological long-term disabilities. Hence, yearly follow-up and rehabilitation programs should be offered to any TBI survivor.

Additionally, proper and exact documentation of TBI patient information is the utmost important aspect that the emergency physician, the subsequent treating neurosurgeons, and nursing staff should complete. TBI victim or survivor's demographics, injury pattern, and mechanisms, site and location of injury, date of injury, and duration until arrival to medical care are not less important than the initial evaluation (ABC's, neurological examination, and GCS) and resuscitation measures. Assessment tools using CT imaging, TBI severity, and hospital course including operative and nonoperative management are as well crucial in the evaluation of a TBI patient. All these have to be recorded accurately in the course of TBI assessment and management. Outcomes as in-hospital death and new-onset complications such as infections should be documented also.

4.2. Implications for future research

Future research in the field of TBI should be addressed toward understanding the gap areas presented in this article both experimental as well as translational research. The lack of a TBI databases poses serious questions when it comes to the field of TBI, including demographics such as age and sex, nationality, causes and mechanism, and severity of TBI victims and survivors. Answers to these questions will provide a full picture for physicians, neurosurgeons, and policy makers on the proper, needed, and adequate measures that are required to face the TBI epidemic. Hence, setting a TBI registry is the key solution to answer many of these questions. In addition, there should be an initiative toward establishing biorepositories for collecting biofluids from TBI cases. Lebanon, owing to its geopolitical value, is considered a gold mine as being a central warzone area with numerous TBI cases and a source for valuable human biofluid that can be used for experimental work. Such biofluid samples can be assessed longitudinally for biomarker research as well as for identification and validation purposes. This last point is of an extreme importance as these numerous diverse TBI cases (mTBI, severe, closed vs. open, among others) can be used for confirmatory studies in conjunction with different international TBI research centers abroad.

4.3. Implications for policy makers

Policy interventions are urgently needed to reduce the burden of TBI in Lebanon, primarily through the development of a better surveillance system. Interventions targeting the causes of injuries are of paramount importance, where more strict regulations can be applied to avoid road traffic accidents, and to force Lebanese citizens to use road safety measures, such as putting on helmets and using seat belts. In addition, it is crucial to implement better geriatric health care programs to avoid falls, safer work atmospheres, and public campaigns to educate people about domestic assaults and of utmost importance to have control on illegal weapons. Moreover, more governmental support should be addressed toward initiation of rehabilitation programs through the whole country and not only in severe cases of disability post-TBI, but also for mTBI cases. Legislations should be also passed to improve the quality of life such as creating better job opportunities for TBI survivors.

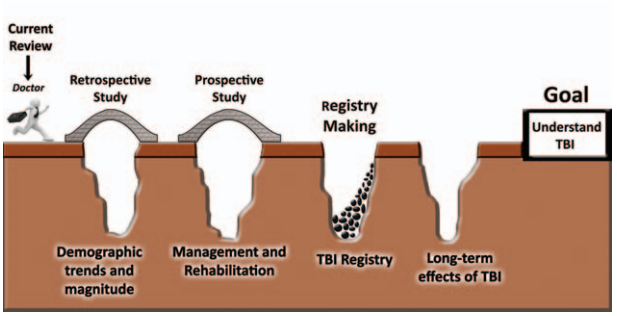

Figure 2. Identified gaps of knowledge and proposed future research proposed steps.

4.4. Strengths and limitations

To the best of our knowledge, this is the first published systematic review discussing the burden and clinical implications of TBI in Lebanon holding potential benefit for both the local health care system as well as for educational research purposes. The expertise of the multidisciplinary team of physicians, neuroscientists, and public health researchers behind this report adds to its value. Limitations reside in the heterogeneity and overlap of the data reported in the eligible studies and the populations studied, in addition to the fact that research data pertaining to burden of TBI during the period between 1991 and 2002 was never reported in literature, without mentioning the poor reporting and inadequate capture of data of the TBI victims, such as demographics, outcomes, among others.

5. Conclusion

This systematic review showed that there are considerable methodological variations among the reported studies evaluating TBI in Lebanon. Furthermore, it provide sufficient data to identify the potential gaps that Lebanon faces in the field of TBI not only in terms of burden and management, but also with respect to future research (Fig. 2).

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