



Syrian Civil War: a systematic review of trauma casualty epidemiology

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ABSTRACT

Background The Syrian Civil War has caused over 400 000 traumatic deaths. Understanding the nature of war casualties is crucial to deliver healthcare improvement. Historic regional conflicts and Syrian mortality data have been characterised by blast injuries. The aim of this novel review is to assess the trauma epidemiology of Syrian Civil War casualties from the perspective of healthcare facilities.

Methods This review was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses method. Studies addressing Syria, trauma and war were investigated. Eligibility criteria included being conducted from a healthcare facility, published in English and peer reviewed. The outcomes were demography, mechanism of injury and anatomical injury site.

Results 38 papers satisfied the eligibility criteria. 13 842 casualties were reported across the entire data set. Casualties were 88.8% male (n=4035 of 4544). Children contributed to 16.1% of cases (n=398 of 2469). Mortality rate was 8.6% (n=412 of 4774). Gunshot wound was the most common mechanism of injury representing 66.3% (n=7825 of 11799). Head injury was the most common injured site at 26.6% (n=719 of 2701).

Conclusions This conflict has a distinct trauma profile compared with regional modern wars. The prevalence of gunshot wounds represents a marked change in mechanism of injury. This may be related to higher mortality rate and proportion of head injuries identified. This review cannot correlate mechanism of injury, demographics or injuries sustained to outcomes. The quality of data from the included studies lacked standardisation; future research and consistent reporting tools are required to enable further analysis.

INTRODUCTION

The Syrian Civil War (SCW) has been ongoing since 2011. This humanitarian crisis has resulted in significant suffering and death across the region. The United Nations (UN) estimates a death toll of more than 400 000 people over the last 7 years.¹ The UN states that 2017 had been the deadliest year of the SCW so far; supported by the Syrian Observatory for Human Rights estimating 19 811 paediatric deaths since the beginning of the conflict.^{1,2} The demographic patterns of trauma related to the civil war and the nature of injuries incurred are important to understand.

Trauma already represents a significant burden of healthcare for low-income and middle-income countries (LMICs), contributing to more than 90% of worldwide injury related deaths.³ Syria is a LMIC and the effect of the SCW has driven

life expectancy down by 27% as well as resulting in the death of 6% of the population.⁴ The Lancet Global Health Commission identified that data on healthcare quality of care for injuries in LMICs do not reflect the current disease burden.⁵ The WHO Bulletin states that epidemiological data in LMIC for injuries and their management are sorely lacking.³ There are no systematic reviews of the trauma burden of the SCW. The largest published study is from analysed data from the Violation Documentation Center (VDC); it only includes fatalities of the conflict and does not address the anatomical site of injury.⁶

The lack of holistic data from this conflict necessitates further study. Specifically, there are no review publications addressing the casualties of the SCW which present to healthcare facilities. Previous studies from recent regional wars can aid the comparison of this conflict. A systematic review conducted on the NATO battle casualties from the Afghanistan and Iraq wars demonstrated that the most commonly injured anatomical site was the extremities followed by the head and neck.⁷ It also demonstrated that explosion was the most commonly reported mechanism of injury.⁷ In contrast, civilian data from the Iraq war suggested execution and small arms fire were the most common mechanism.⁸ A study of mortality and weaponry for 78 769 SCW deaths showed shelling was the most common mechanism, with women and children contributing to almost 25% of casualties.⁹ Understanding the trauma profile of the SCW will further the knowledge about military conflict fought within the urban and civilian environments. Furthermore, epidemiological data from this conflict could be used as a reference for the evolving nature of asymmetric warfare.

The aim of this systematic review is to demonstrate and evaluate the unique trauma epidemiology of the SCW. This study will specifically address the mechanisms of injury, anatomical distribution of injuries and the demographics of the casualties presenting to healthcare facilities.

METHODS

This systematic review was achieved by using the PubMed, OVID MEDLINE and EMBASE databases on 8 January 2018. The search terms used were (Syria OR Syrian) AND (trauma OR injury) AND (war or conflict). Studies predating 2011 were excluded as this was prior to the beginning of the civil war. Studies not published in peer-reviewed journals, not in English and not reported from a healthcare facility were excluded. Publications without specific patient numbers or no clear



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timeline when the study was conducted were excluded due to inaccuracy.

Of the papers included, the following was recorded: demographic, mortality, mechanism of injury and anatomical injury site data. The extracted data were analysed using Microsoft Excel. Analysis of the data aimed to demonstrate a representative trauma profile; therefore, specific papers were excluded from subcategory analysis depending on their inclusive criteria. Analysed mortality data excluded postmortem studies as this was not representative of the trauma profile. This same methodology was repeated for paediatric analysis excluding paediatric only studies, site of injury data excluding studies with injury specific criteria and mechanism of injury data sets excluding mechanism specific studies. Site of injury papers were further stratified into those which allowed their data to be recorded according to the Abbreviated Injury Scale (AIS) categories; case studies were also excluded. Application of exclusion criteria and data extraction were all performed by the author.

RESULTS

In total, 38 publications met the inclusion criteria of this systematic review as shown in Figure 1.¹⁰⁻⁴⁷ There was no other systematic review on this area of research found. Of the included publications, 26 were cohort studies and 12 were case studies/series. One paper was excluded due to an indeterminable results section.⁴⁸

Demographics

The demographics of traumatically injured patients are shown in Table 1. A total of 13 842 patients were reported across the

Table 1 Demographics of traumatically injured patients in the Syrian Civil War

Demographics		
Total	n	13 842
	%	–
Male	n	4035
	%	88.8
Female	n	509
	%	11.2
<18 years old	n	398 of 2469
	%	16.1
Mortality	n	412 of 4774
	%	8.6

38 publications. Seven papers did not indicate the gender of the casualties.^{10 11 15 23 26 29 40} Eight papers met the eligibility criteria and had specific data for children aged less than 18 years.^{12 13 19 24 27 44-46} Nine other papers were excluded due to being specific to childhood trauma.^{18 30-33 47} Postmortem publications would have given a disproportionate mortality rate and so were excluded from the table; they accounted for a further 326 casualties.^{31 43}

Mechanism of injury

Mechanism was divided into gunshot wound (GSW), blast, stabbing/assault and other. The results are shown in Table 2. Twenty-nine papers recorded the mechanism of injury, of which 18 were

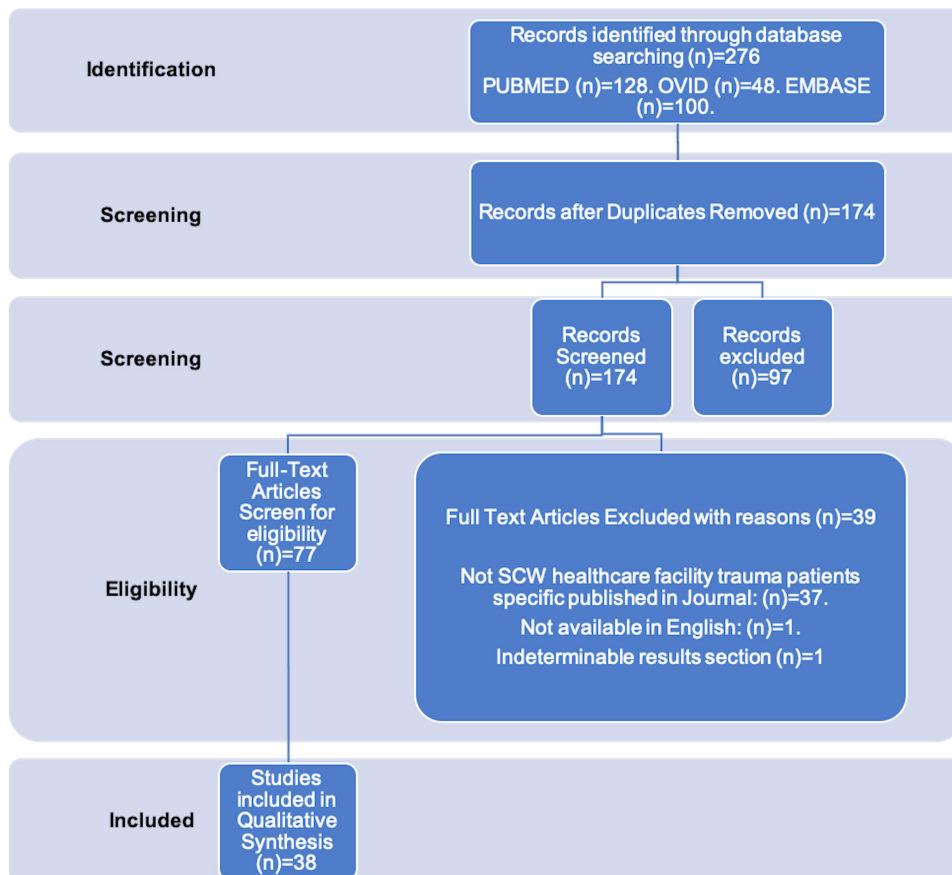


Figure 1 Preferred Reporting Items for Systematic Reviews and Meta-Analyses flow diagram. SCW, Syrian Civil War.

Table 2 Mechanism of injury from Syrian Civil War trauma casualties

Mechanism of injury		
Gunshot wound	n	7825
	%	66.3
Blast	n	3688
	%	31.3
Stabbing/assault	n	162
	%	1.4
Other	n	116
	%	1.0

not exclusive to the mechanism therefore allowing comparison.^{4 5 9 10 12 15 17–19 22 24 26 32 34–37}

Site of injury

Of the 30 papers which documented the site of injury, only three were not specific to the injured anatomical region, allowed subcategorisation according to the AIS regions and were not case studies.^{12 16 27} Eighteen papers were site specific.^{10 13 18–22 24–26 28 29 33 38 39 42 44 46} Four could not be categorised in relation to the AIS.^{14 31 43 45} Five were single-patient case studies.^{30 32 34 36 37} These results are shown in Table 3.

DISCUSSION

This review portrays the unique trauma epidemiology of the SCW for casualties presenting to healthcare facilities. It advances our understanding of this population in order to facilitate medical preparation and adaption to this enduring asymmetric warfare.

The demographics of this conflict are polarised towards injured males rather than females. The causation for this difference is likely multifactorial. Typically, this may be due to males being the likely fighting component in war. However, it may represent self-presenting characteristics or the nature of casualties themselves which have the means or capability attend healthcare facilities. This distinct ratio is similar to other civil wars such as the 1991–1992 Croatian War, for which men accounted for 91% of deaths, as well as the Libyan Conflict with 81.4%.^{49 50} This study did not account for whether casualties were combatants or civilians. Syrian data accounting for this demonstrated 71.9% of

Table 3 Anatomical site of injury of patients traumatically injured in the Syrian Civil War according to Abbreviated Injury Scale⁶²

Anatomical site of injury		
Head	n	719
	%	26.6
Face	n	240
	%	8.9
Neck	n	37
	%	1.4
Chest	n	613
	%	22.7
Abdomen/pelvis	n	316
	%	11.7
Extremity	n	508
	%	18.8
Spine	n	89
	%	3.3
Other	n	179
	%	6.6

civilian deaths were male, while only 0.01% of combatant deaths were female.⁶

Injuries to children during conflict are intrinsically linked to the nature of warfare and where the fighting occurs. This review demonstrated almost one in six injuries were to children (defined for this study as less than 18 years old). Urban environments such as in Syria lead to significant civilian casualties and thus paediatric. Save the Children reports Syria to be in the top 10 worst conflict-affected countries to be a child.⁵¹ This is supported by data analysed from the Syrian VDC which reported 17.2% of civilians killed were children. Croatian Civil War data recorded paediatric fatalities to be similar at 16%.^{6 49} In contrast, the proportion may be as low as 2.9%, reported from a British Field Hospital during the Iraq War, or as high as 39% at a Rwandan Surgical Facility during the Rwandan Civil War in 1994–1995.^{52 53} The requirement to understand the likelihood of paediatric trauma is vital to plan from a healthcare provision perspective. Not all papers used the same age cut-off for injuries to children; in the paper 'A Series of Civilian Fatalities During the War in Syria' by Çelikel *et al*, 20 years old was the upper age limit and therefore was not included in the results.⁴³ The accuracy of patient-reported ages is subjective and may be skewed in a conflict zone healthcare setting.

Mortality was defined as any documented death. All mortality data are therefore in-hospital mortality. The duration of follow-up was variable depending on the individual studies. Factors influencing mortality rates are multifactorial and may include mechanism of injury, proximity to healthcare facility as well as facility capabilities. The mortality rate for this study was greater than observed from other regional and historic conflicts. Compared with regional conflicts, an Erbil-based study from the Mosul Offensive in 2016–2017 demonstrated an inpatient mortality rate of 0.5%; data from the Second Lebanon War showed a rate of 0.4%.^{54 55} A more comparable inpatient mortality rate of 5.3% is demonstrated from a Bosnian War Hospital analysing the outcomes of 1703 casualties.⁵⁶ The higher mortality rate in this review may be due to the included studies and their related mechanisms or anatomical injury site. For example, two studies specific to cranial GSW with mortality rates of 31.7% (n=59) and 36.5% (n=38).^{28 44} It could also be influenced by many of the studies being conducted from neighbouring regions around Syria, therefore relying on casualties surviving to reach these locations. More published data from within Syria would give a more accurate portrayal.

Mechanism of injury was categorised into GSW, blast, assault/stabbing and other; shrapnel injuries were incorporated into blast. This review has shown a distinct mechanism of injury pattern that differs from recent regional wars in Afghanistan and Iraq. American trauma data demonstrated 74.4% of traumatic casualties resulted from 'Explosion', with 19.9% 'Gunshot Wound'.⁵⁷ British Data from Op HERRICK Afghanistan demonstrated 52% of injuries 'Explosive' and 42% 'Small Arms Fire',⁵⁸ thus contrasting to the predominance of firearms as the mechanism in this paper. This review is perhaps more similar to Lebanon (49% GSW, 38% explosive), Bosnia (49% GSW, 46% explosive), Somalia (55% GSW, 31% fragmentation) or The Second Palestinian Intifada (63.5%–14.6%).^{59–61} Mortality data from the VDC reported only 20% of civilian deaths were due to shootings while 57.3% were due to wide area explosive weapons.⁶ This difference may suggest there is a cohort of casualties catastrophically injured due to an explosive mechanism which do not survive to reach the healthcare facilities. The two postmortem studies in this review are the only papers to include casualties dead on arrival. This contributed 18 casualties in the

adult study; the childhood study did not record these data.^{31 43} Recording mechanism of injury is subject to interpretation, especially if a casualty has been injured in multiple instances. The paper 'Analysis of the First 100 Patients from the Syrian Civil War Treated in an Israeli District Hospital' by Biswas *et al* was the only study specifically listing 'Multiple' as a separate category with others incorporating those numbers into their data.⁴⁵

Head injuries were the most commonly recorded injury. This is contrasting to data from other regional conflicts and historic wars. The Joint Theatre Trauma Registry for Iraq and Afghanistan showed 51.9% of injuries were extremity, while only 28.1% were head and neck.⁵⁷ Extremity injury was also the most commonly injured site in the Bosnian, Croatia and Lebanon Wars.^{56 59} The higher rates of head-and-neck injury could be related to the difference in mechanism of injury being predominantly GSW. However, even in the Second Palestinian Intifada with 63.5% GSW, 50% of injuries were to extremities and 34.4% to head and neck.⁶¹ Another factor to consider is that studies such as the Iraq and Afghanistan Trauma Registry as well the Second Palestinian Intifada are military based, and therefore personnel are likely equipped with personal protective equipment such as body armour and helmet.^{57 61} The VDC data show 70.6% of fatalities in Syria are civilian and therefore this may contribute to the different trauma profile demonstrated.⁶ This theory would also explain the greater proportion of chest and abdominal injuries within this study. However, a study from the Mosul Offensive which categorised casualties between combatants and civilians only found a significant difference in the percentage of abdominal injuries (16% of civilians and 7% of combatants).⁵⁴

Only three papers were not specific to anatomical injury site and could have their data extracted according to AIS region. Due to the small sample of papers, this result is skewed towards the largest study by Er *et al*; n=1591 of 1776.^{12 16 27} These three papers were also conducted outside of Syria (in Jordan and Turkey). Therefore, this cohort of patients is one which has survived to attend out-of-country facilities or has been injured severely enough to be transferred from an initial facility. Thus, this may not be an accurate representation of the trauma profile. Hospital capability can also influence which injuries are recorded. Data from a French Surgical Team recorded no craniocerebral or spinal trauma due to the proximity of a neurosurgeon elsewhere in the region.²⁷

A number of limitations are recognised in the writing of this paper. This review relies on the availability of data from a region with ongoing civil war. The majority of included papers were conducted in countries bordering Syria. This limitation is compounded by the likelihood that patients may attend multiple healthcare facilities across the region and their results be double counted. There is also the risk of double counting from within this review. Multiple papers have been conducted from the same healthcare facility and have also had overlapping timelines of data collection. There is no standardised method by which studies presented their data or provided information on casualties complete with mechanism and injuries sustained. Therefore, it is not possible to generate a correlation between demographic, mechanism of injury or site of injury. This is a vital area of future research. This study is not able to demonstrate the changing nature of conflict across the years of the Syrian War. Data from the VDC show initially GSW being the most common mechanism of civilian fatality, progressing to an increasing proportion of shelling and bombardment over the course of the war.⁶

This review demonstrates a holistic profile of the trauma burden for healthcare facilities due to the SCW. This has not

been researched before for this conflict. Healthcare facility data strengthen this study as these are from multiple independent sources and are less likely to be influenced by reporting groups. This paper thus attempts to address the data gap identified by The Lancet Global Health Commission and WHO.^{3 5} To enable greater analysis, standardisation across the region for reporting is key. This would allow correlation between mechanisms and injury patterns to be established. Region-specific third-party data recording could aid potentially unreliable reporting of casualties. Understanding the injury patterns and demographics would allow tailored services to the regional areas in order to improve healthcare outcomes and delivery. Future research should also be aimed at investigating the difference between civilian and combatant casualties.

CONCLUSION

The SCW has a unique trauma profile. Traumatic healthcare presentations across the region show a predominance of male casualties. Injuries to children contribute a significant proportion to the burden of trauma, and this is similar to historic civil conflicts. The mortality rate demonstrated in this review is greater than recent conflicts across the region. GSW was the most commonly reported mechanism of injury which is in contrast to the recent regional wars. This trend back to ballistic injury draws similarities with wars and civil conflict fought in the urban environment. Head injury was the most commonly injured anatomical site. Understanding this distinct pattern of trauma across this region is vital. This review specifically demonstrates trauma data from the perspective of a healthcare facility. Understanding this burden of trauma may aid the delivery of trauma services across the region.

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