RESEARCH ARTICLE

Trends and patterns of deaths, injuries and intentional disabilities within the Libyan armed conflict: 2012-2017

Mohamed A. Daw1*, Abdallah H. El-Bouzedi2, Aghnyia A. Dau3

1 Department of Medical Microbiology & Immunology, Faculty of Medicine, University of Tripoli, Tripoli, Libya,
2 Department of Laboratory Medicine, Faculty of Biotechnology, Tripoli University, Tripoli, Libya,
3 Department of Surgery, Tripoli Medical Centre, Faculty of Medicine, University of Tripoli, Tripoli, Libya

* mohamedadaw@gmail.com

Abstract

Background

The consequences of armed conflicts impose considerable burdens on the economy and health care services, particularly in countries that are not equipped to deal with them, such as in the Middle-East, and North African countries. Little is known about the burden of mortality and injury resulting from the Libyan armed conflict. This study aimed to determine the trends and patterns of mortality, injury and disabilities directly associated with the Libyan armed conflict and analyze the geographic variation within the country during 2012–2017.

Methods

Data on conflict-related deaths, injuries, and disabilities were obtained from the national registry offices. The information included date, place, and demographic information. A questionnaire was also used to obtain information from the affected individuals and their families. National and regional trends of mortality, injury and disabilities were calculated. Spatial analysis was performed using geographic data available on all documented cases to analyze clustering of mortality and injury.

Results

A total of 16,126 deaths and 42,633 injuries were recorded with complete information during the Libyan conflict from 2012 till 2017. The overall mortality rate was 2.7/1000 population and injury rate was 7.1/1000. The overall male-to-female ratio of mortality and injury was 4.4:1; 42.3% were single and aged 20–30 years old, and 26.4% were aged 31–40 years. Moreover, injuries resulted in death in 20.1% of cases and disability in 33.5% of the cases. Most of the disabilities were caused by blasts, while gun shots resulted in more deaths. The overall mortality and injury rates were highest during 2015–2017. These rates were highest in the eastern region. Injuries were most concentrated in Benghazi and Derna in the east, followed by Sert and Musrata in the central region.
Conclusions
Conflict-related mortality, injury and disability has inflicted a heavy burden on the Libyan society that may persist for a long time. The rates of these casualties varied in time and place. National, well-planned efforts are needed to address this serious situation and its consequences.

Introduction
Many parts of the world are involved in armed conflicts, the most prominent of which are in Arab countries, including Syria, Iraq, Yemen and Libya. Armed conflicts always impose heavy burdens of death, injury and disability [1]. Globally, it has been estimated that in 2013, 800,000 people sustained war-related injuries that warranted hospital admission, and approximately 310,000 people died as a consequence of collective violence [2,3]. This however resulted in over 9% of deaths worldwide with over five million deaths annually [4]. It has been projected that armed conflict will become the eighth most important cause of death by 2020 [5].

Africa contributes more to conflict-related deaths than any other region. The United Nations reported 21 neglected crises in the world, of which 17 were in Africa and though, but only a few reports are available on deaths and injuries during armed conflicts in this continent [6]. Studies in eastern Congo (2000 and 2001) have reported millions of deaths among injured individuals, but the specifics are not clear [7].

Elsewhere, the Arab spring uprising is one of the deadliest conflicts in recent history and has been characterized by a human security crisis of extraordinary dimensions. A report published in February 2016 by the Syrian Centre for Policy Research suggests that more than 470,000 people have died in Syria due to the conflict; this number has likely increased but no recent reports seem to exist [8,9]. A report commissioned by the United Nations found that in Yemen, over 30,000 deaths were reported over nearly two years [10]. A recent study carried in Iraq has shown that the fatality rate was 39.1% among individual with intentional injuries. Similar results were also reported in the Syria [11]. Disability subsequent to war-related injury is considered high in countries plagued by years of conflict, which will have a great negative impact on the country’s health perspectives [11]. A cross sectional study carried in Iraq showed that injury incurred more than 4,100 disability-adjusted life-years per 100,000 persons. Most individuals who experience injuries due to armed conflicts usually sustain some kind of temporal or permanent disability; almost 16% of all disabilities reported were due to injury [11,12].

After the NATO leaded war that ousted Colonel Muammar Gaddafi in 2011, Libya entered into a long-standing internal armed conflict. The major armed conflicts between 2011 and 2017 are shown in Table 1. The casualty figures from the conflict and its aftermath are not well

### Table 1. Major operations and armed conflicts in Libya from 2011 to 2017 [46,47,48].

| Period        | Description                                                                 |
|---------------|-----------------------------------------------------------------------------|
| March- November 2011 | Operation Odyssey Dawn: NATO military intervention in coordination with Jordan, Qatar, Turkey and United Arab Emirates. |
| 2012–2013     | Internal fighting between Libyan militias in most Libyan regions              |
| 2014–2015     | Operation Libyan Dawn: Western region                                        |
| 2016          | Operation Odyssey Lightning: Battle of Serte                                |
| 2014–2017     | Operation Dignity: Eastern region                                            |

https://doi.org/10.1371/journal.pone.0216061.t001
documented and debate on conflict-related casualties in Libya continues to this day [13–15]. In 2011, a survey was conducted to determine the mortality, injury and population displacement that occurred during the first year of the conflict. The survey estimated that 21,490 (0.5% of the population) were killed, 19,700 (0.47%) were injured, and 435,000 (10.3%) were displaced. The high rates were reported during May-June, particularly in Tripoli in the western region of the country [16]. Those injured were found to be particularly infected with multi-resistant bacteria such as *Acinetobacter* and *Pseudomonas aeruginosa* [17]. Furthermore, the conflict caused major damage to the health care system. Structural damage was evident in 62 (28.7%) of the health care facilities, 11 (5.1%) were completely destroyed, and 51 (23.6%) suffered partial damage. Primary health care centers accounted for 49 (22.7%) of the damaged facilities, followed by emergency & accident hospitals [18]. However, studies on the consequences of the Libyan armed conflict after 2011 are lacking and there are no adequate data on the burden of the continued conflict on the health care system. Additionally, no studies have been reported on the geographic and spatiotemporal variation of mortality and injury in the country. Hence, studies are needed to assess the burden of the Libyan conflict and to propose appropriate public health action. This study provides an overall assessment of the patterns and trends of mortality, injury and consequent disability related to the Libyan conflict. It also assesses the geographic density of these parameters to show the magnitude and severity of these problems to enable the rational allocation of resources.

**Methods**

**Setting**

This comprehensive national survey was guided by our previously published studies and guidelines [16,17]. Data were collected from all the provinces in the four official regions of Libya. The geographical location, provinces and total population of each region are shown in supplementary S1 Table, S1 Fig.

**Definitions**

The individuals included in the study were categorized as dead, injured or disabled according to the following definitions:

**War mortality:** Direct conflict-related deaths caused by weapons and other violent methods strictly used in warfare and reported during the conflict period.

**War-Injury:** Intentional physical harm resulting from fire arms (gun, explosion, air bombardment, etc.) that required medical care, whether received or not, and which resulted in loss or reduction in normal activities for a period of time (i.e., study period from 2012 to 2017).

**Intentional disability:** Limitation of normal activities caused by intended deliberate harm, such as gunshots or blasts/explosions reported during the conflict period.

**Exclusion criterion:** Mortality, injuries and disability not related to the war. Detainees, missing persons, deaths consequent to siege conditions (e.g., starvation) or inability to seek medical care, and injuries and disability caused by road accidents, falls, domestic violence, work-related injuries, and the like. We also excluded any casualties that occurred before or after the study period (2012–2017).

**Study population, data collection and analysis**

This study covered individuals aged 15 years or more who have been confirmed as killed or injured as a direct result of the conflict between January 1, 2012 and December 31, 2017. Civilian casualties were excluded. Inclusion criteria were death, injury or disability as a direct
effect of the armed conflict, and availability of information on date, district, cause of death and
demographic characteristics (sex, age and educational level).

Information was collected from the National Death Registry offices in the four Libyan
regions, and the Ministry of State for Families of Martyrs, Injuries and Missing Persons
[19,20]. Other sources of information were the local authorities in each region. Official govern-
ment reports and reports of the Libyan Red Crescent were consulted, and accounts were
obtained from eyewitnesses and combatants. The information included locations, event types,
groups involved, fatalities, injuries, disabilities, demographics, and cause of death or injury.
Based on our previously published experience [16,17], an anonymous handwritten question-
naire was developed to collect information from the families of the affected persons; the inter-
views were conducted by physicians and trained social workers under the supervision of a
senior clinical epidemiologist. The purpose was to confirm the data collected from the sources
if there was suspicion of inaccuracy or to complete the data if they were incomplete. These
data were used to confirm the information on affected people when the available information
was incomplete. Moreover, to improve the accuracy of the survey, the final data were discussed
with and approved by the local social leaders, revolutionary commanders, and government
officials who supported and agreed to assist with the study. The number of deaths and injuries
recorded from the different sources is shown in Table 2.

Geographic mapping

Geospatial analysis was carried out by applying the data of the individuals to the most recently
updated electronic map of Libya and its districts showing the municipalities’ borders, on the
basis of which distribution maps were constructed. The main spatial descriptive statistics (spa-
tial mean center and spatial standard distance ± 2 standard deviations) were illustrated on
these maps. The geographic data from each district involved in the armed conflict were classified
according to location, timing and intensity of the Libyan armed conflict from 2012 until
2017. Geo-spatial analysis of mortality and injury were analyzed at the district level as previ-
ously described [21].

ArcGIS 10.1 software, Environmental Systems Research Institute Inc., 1999 (ESRI Inc.,
Redlands, CA, USA) was used to create electronic maps. SPSS18.0 software (IBM Inc.,
Armonk, NY, USA) was used to analyze the data.

Statistical analysis

The data were entered in Microsoft Excel and analyzed by SPSS version 12.0 and STAT version
8. Mortality, injury and intentional disability rates per 1000 population per year were calculated
on the basis of med-intervals population and we applied long linear regression models in

| Table 2. Data collection sources of the Injured and dead persons during the Libyan armed conflict (2012–2017). |
|---------------------------------------------------------------|
| Data source                                                   | No. of cases reported |
| Regional offices of the National Death Registry               | 7259                 |
| Ministry of State for Families of Martyrs, Injuries and Missing Persons [19,20] | 5312 | 17523 |
| Local authorities in each region                              | 721                  |
| Official government reports                                   | 1251                 |
| Reports of the Libyan Red Crescent                            | 830                  |
| Eyewitnesses and combatants                                   | 371                  |
| Families of the affected persons                              | 382                  |

https://doi.org/10.1371/journal.pone.0216061.t002
The rates were consistent among the regions studied over the study period and an additional sensitivity analysis was used to assess the differences in mortality, injury and disability across regions. Mortality and injury rates were compared between the regions for the individual years. As an additional sensitivity analysis, we assessed the effect of differences across regions by extending models to allow the baseline mortality rate to vary by regions and districts. We provide descriptive statistics on cause of death by weapons type. We used R software (version 3.3.2) to calculate proportions and \( \chi^2 \) testing.

**Ethical considerations**

The approval granted by the Libyan National Ethics Committee (No. LY2012/997/WCS) was credited by the Ethics Board of the Faculty of Medicine, Tripoli. The study was conducted in accordance with the Helsinki Declaration [22]. Written informed consent was obtained from all the participants before the interview and witnessed by the local health officer.

**Results**

**Demographic analysis**

A total of 16,126 individuals were reported to have been killed and 42,633 injured during the Libyan conflict from 2012 till 2017, as described demographically in Table 3. That translates into a national average mortality rate of 2.7/1000 of the population and an injury rate of 7.1/1000. Males accounted for 81.4% of the conflict-related deaths (CI 95%: 77.3–85.2%) and the difference between the sexes was highly significant (p < 0.001). Mortality was highest among those aged 20–30 years, who accounted for 42.3% of all deaths (CI 95%: 38.1–46.3) (p < 0.001), followed by those aged 31–40 years (26.4% of all deaths; CI 95%: 21.9–30.6; p < 0.001) and then by those aged below 19 years old. The lowest rate was among those aged above 50 years (6.9% of deaths; CI 95%: 3.7–14.2). Those with secondary and primary levels of education were more likely to be injured (p < 0.001). The table below summarizes the demographic characteristics of those injured and killed during the Libyan conflict from 2012 till 2017.

**Table 3. Demographic and population characteristics of deaths and injuries during the Libyan conflict (2012–2017).**

| Demographic | Deaths | | | Injuries | | |
|-------------|--------|--------|--------|--------|--------|--------|
|             | Number | % of total (C95%) | p  | Number | % of total (C95%) | p  |
| **Sex**     |        |                    |    |        |                    |    |
| Male        | 13,120 | 81.4 (77.3–85.2)   | <0.001 | 34,380 | 80.6 (76.2–85.1)   | <0.001 |
| Female      | 3,006  | 18.6 (13.9–22.4)   | 0.001 | 8,253  | 19.4 (15.1–23.7)   | 0.001 |
| **Age**     |        |                    |    |        |                    |    |
| 15–19       | 2,547  | 15.8 (11.3–19.5)   | 0.001 | 12,435 | 29.2 (23.9–34.1)   | <0.001 |
| 20–30       | 6,819  | 42.3 (38.1–46.3)   | <0.001 | 6,981  | 16.4 (12.3–21.1)   | 0.001 |
| 31–40       | 4,250  | 26.4 (21.9–30.6)   | <0.001 | 7,137  | 16.7 (11.2–20.6)   | 0.001 |
| 41–50       | 1,390  | 8.6 (5.3–12.4)     | 0.001 | 14,521 | 34.1 (30.9–38.3)   | <0.001 |
| >51         | 1,120  | 6.9 (3.7–14.2)     | 0.001 | 1,559  | 3.7 (2.9–11.3)     | 0.001 |
| **Educational level** |        |                    |    |        |                    |    |
| Primary     | 6,112  | 37.9 (34.1–41.5)   | <0.001 | 19,598 | 46 (42.1–50.9)     | <0.001 |
| Secondary   | 6,907  | 42.8 (39.7–46.2)   | <0.001 | 17,719 | 36.9 (31.9–41.2)   | <0.001 |
| Above       | 3,107  | 19.3 (14.7–21.9)   | 0.001 | 7,319  | 17.2 (15.8–21.3)   | 0.001 |
| **Marital status** |        |                    |    |        |                    |    |
| Single      | 8,890  | 55.1 (51.7–59.3)   | <0.001 | 20,696 | 48.5 (44.3–52.2)   | <0.001 |
| Married     | 4,124  | 25.6 (21.4–29.2)   | 0.001 | 12,718 | 29.8 (24.1–33.2)   | 0.001 |
| No reported | 3,109  | 19.3 (14.3–24.1)   | 0.001 | 9,219  | 21.6 (18.9–25.7)   | 0.001 |
| **TOTAL**   | 16,126 | 100.0              |      | 42,633 |                    |      

https://doi.org/10.1371/journal.pone.0216061.t003
education had the highest rates of mortality (42.8% of deaths; CI 95%: 37.9–46.2; < 0.001) and 37.9% of deaths (CI 95%: 34.1–41.5; p < 0.001) respectively. Mortality rate was lower among those with a higher level of education (19.3% CI 95%: 14.7–21.9). Furthermore, 55.1% were single (CI 95%: 51.7–59.3; p < 0.001) and 25.6% were married (CI 95%: 21.4–29.2; p = 0.001).

The highest rate of injury was among males (80.6% of all injuries; CI 95%: 76.2–85.1; p < 0.001) particularly among those aged between 41–50 years (34.1%; CI 95%: 30.9–38.3; p < 0.001) followed by those aged below 19 years (29.2% of injured males; CI 95%: 23.9–34.1; p < 0.001). Those above 51 years of age accounted for only 5.1% of injuries CI95%: 2.9–11.3). Most of the injured individuals had primary education (46%) or secondary education (36.9%) (p = 0.001), and only 17.2% had higher education. The injury rate was also higher among single person as it reached (48.5%) though it was only (29.8%) among non-married (p > 0.001).

**Trends in mortality and injury**

Countrywide, the number of deaths increased steadily from 2012 to 2016, and then decreased slightly. Of all mortalities, 4.9% occurred in 2012, 24.6% in 2016, and 18.6% in 2017.

There was considerable variation in mortality between the regions as shown in Fig 1. The largest number of deaths was reported in the eastern region of the country, which accounted for 7164 (44.4%) deaths, followed by the western region with 3713 deaths (23%) and then the central and southern regions, which accounted for 3120 (19.3%) and 2129 deaths (13.2%), respectively.

Fig 2 shows the temporal evolution of the injury rates in each region. The highest incidence of injury was reported within 2014 (21.1%)-2016(27%) which was 2–5 times that of 2012 (4.9%) and 2013(11.9%).
Geographic patterns of mortality and injury

The mortality and injury rates varied substantially between regions and between parts of each region as illustrated in Fig 3. In general, the rate ranged between >1 death per 1000 to 4 deaths per 1000 (Fig 3A). Districts located in the eastern region experienced the largest increase in death rate during the study period. Benghazi and Derma had the highest rate of mortality (4/1000 population) followed by Jdabia, Mustrata and Sert (2/1000).

The injury rates were about 6/1000 in 10% of the districts, particularly in the eastern and central regions. Though it reached 4/100 in the subcoastal districts which accounted for 20% and 70% of the districts showed a rate of <1/1000 particularly in Southern and Eastern regions as shown in Fig 3B.

Consequences of intentional injury

Intentional injury resulted in large numbers of deaths and disabilities during the Libyan conflict as shown in Fig 4. The disability rate increased from a little over 1/1000 population in 2012 to slightly over 6/1000 in 2016. Table 4 shows the relation between the different types of weapons on the one hand and deaths and sustained disability on the other. Most deaths (4721; 55.0%) were caused by gun shots, but sustained disability was associated with blasts and explosions (8710; 61.1%). Survival without disability was higher among those injured by gun shots (10,326; 52.2%) compared with those injured by blasts (3434; 17.4%).
Fig 3. The national geographic patterns of the casualties associated with the Libyan armed conflict. (A) Mortality. (B) Injury. (per 1000 population).
https://doi.org/10.1371/journal.pone.0216061.g003

Fig 4. Intentional injury and consequent outcomes from the Libyan armed conflict 2012–2017.
https://doi.org/10.1371/journal.pone.0216061.g004
Discussion

Armed conflicts have heavy, direct and long-lasting impacts, particularly in developing countries, which are ill-equipped to deal with the consequences, and where most wars occur. Armed conflicts are a major cause of mortality, injury and disability, imposing heavy burdens on populations, governments, economies, and health care systems worldwide [23,24]. Documentation of the impact of armed conflict on health is one of the most difficult and most important public health challenges [25]. Injuries and fatalities related directly to the Libyan conflict pose a major challenge to the health care services of the country, in which the already fragile infrastructure has been largely disrupted. Reliable data on the extent, types and geographic distribution of casualties are needed in order to develop rational, targeted health care strategies [26,27].

This study describes the mortality, injury, and disabilities patterns that have resulted from the Libyan armed conflict between 2012 and 2017. The overall mortality and injury rates were 2.7 and 7.1 per 1000 population, respectively. The number of direct conflict-related deaths among men accounted for 81.4% of all conflict deaths. Most of the deaths were among young unmarried people with primary or secondary education levels. Eighty-five percent of them were aged below 40 years, and the highest rate (42.3%) was among those aged 20–30 years. This resembles the pattern in the Iraqi conflict, in which 86% of the deaths were among young males. However, a different pattern was observed in the Syrian conflict, in which the mortality rates among children and women increased as the conflict escalated [28,29]. However, the rates of deaths and injuries among Libyans were higher in 2011 than during the study period of 2012–2017, as it reached over 5/10,000 and 7.2/10,000, respectively.

In contrast to the death rate, the highest rate of injury was among adults over 40 years of age, who accounted for 34.1% of all injuries, followed by young unmarried people below 19 years old (29.2%). Our results resemble those from the Gaza Strip of the Palestinian territory, where males represented 75.5% of the war-related injuries. Almost half (49.5%) of the injured victims were ages 20–39 years, followed by adolescents accounting for 31.4%. More than half of victims were single (53.6%). Similar results were also reported on the Iraqi conflict, in which 51% of injured people were males aged 20–39 (29.6%) and 33.3% aged 15–19 years [12,30].

Mortality estimates in our study indicate that over 16,000 people were killed during six years. The lowest mortality rate was reported in 2012 and 2013, after which the number of deaths increased, reaching a peak during 2015 and 2016. This varied from one region to another within the country. The largest number of deaths was reported in the eastern region, followed by western and central regions. This finding validates our previous study, which reported the mortalities during the anti-Gaddafi war in 2011.

Logically, the temporal trend in injury rates followed that of the mortality rate, being lowest in 2012–2013 and peaking in 2016. The combined results show that the conflict has been escalating, particularly in the eastern region. The largest number of injured persons was in the eastern region and the lowest was in the southern region. These results are similar to those
Intentional or conflict-related injuries are associated with high rates of mortality and disability. A population-based study of war-related deaths in Kosovo in 1999 [33] showed that 64% of the total mortality (8.64/1000 annually) was due to intentional injury. During the 1994 civil war in Afghanistan, war-related injury was the leading cause of death, with 43% (9.4/1000 annually) [34]. There are few reports on injury-related deaths and disability during war or civil conflict in Africa [35]. Our study findings show that intentional injuries resulted in 20.1% death and 33.5% disability. During the Libyan conflict, gunshots were responsible for 33.1% of the injuries and were responsible for 55% the deaths and 22.2% of disability cases. Blasts or explosions were responsible for 45.6% of the injuries and resulted in 30.5% fatality and 61.1% disability. This is similar to reports from Baghdad and the Palestinian territory. Hence then studying the association between weapon types and victim characteristics in armed conflicts could increase understanding of the nature and practices of war and improve individuals’ protection [36,37].

Mapping the extent of damages, population displacement and tense of killing are rarely reported [38]. The uniqueness of this study, it applied for the first time, a geographic mapping approach for an army conflict area, which is rarely reported before. We efficiently visualized the patterns of mortality and injury during the Libyan conflict. The analysis showed that certain districts have been plagued by the conflict for a longer period. Spatial variation is noticeable within these regions, particularly Derna, Ajdabia and Benghazi, followed by Sert, Musrata, Tripoli and Jufra. The heaviest clusters of conflict-related mortality were in Benghazi and Derna in the east of the country and Sert in the central region. This could be related to socioeconomic factors and the ideological beliefs of the fighting groups in these areas. However, further studies are needed to understand such speculations. Our study indicates that there are important opportunities to more closely examine districts and regions with notably high mortality and injury rates. Such information is an important input for developing an effective public health response policy to combat the consequences of the conflict [39,40]. [38,39]

Limitations

Though this study attempted to be comprehensive and was based on documented registry data, it might not fully represent the actual situation. First, many cases might not have been reported because of the vast area of the country and the lack of security [41]. Second, as the study lasted for six years, the registration cannot be easily sustained particularly for minor and short cases of injury and disability. Moreover, the study did not highlight the severity of injuries, degrees and duration of disabilities, and whether injured victims had recovered. This may have affected the accuracy of the number of deaths and injuries reported. Fourth, locations were frequently estimated, which could have led to imprecision. Fifth, civilian deaths and injuries are not well illustrated because the use of heavy weapons blocked roads and turned certain urban areas into no-go zones [42]. “We are pursuing this line of research by investigating civilian casualties, and particularly children.”

Conclusions

The Libyan war has inflicted a grave toll on the country’s population and public health system. The overall fatality and injury rates increased from 2012 to 2017, with a peak in 2016. Young men comprised more than 80% of the dead and injured. Analyzing mortality and injury
burdens on even narrower geographic scales is important for guiding public health responses and allowing more effective targeting.

Future directions
The Libyan armed conflict has and will continue to impose heavy burdens on the demography and quality of life of Libyan society. The country faces serious and unprecedented challenges. No single policy can be addressed in a complex and relapsing conflict environment such as Libya [43,44]. Hence, the country should be alerted to deal with such ongoing consequences particularly within the health care settings. The Libyan health care system has to be re-organized to deal with these consequences by adopting short-term and long-term strategies [45]. These may include the following:

- Establishment of a national electronic registry system for persons injured or disabled as a consequence of the conflict.
- Data collection and follow up should be carried as the conflict consequences goes beyond parameters estimates and more likely that Injury and disability outcomes to be reflected and felt by the society for many years ahead.
- The pervasive impact of Libyan armed conflict is long-term and not confined to combat-related deaths. Injured and disabled victims are largely young males, making rehabilitation and integration programs a necessity.
- Further studies are needed to assess the advancement in the complications and the new perspectives of the Libyan armed conflict.

Supporting information
S1 Table. Libyan regions, districts, administrative boundaries and population density. (RAR)
S1 Fig. Map of Libya showing the geographical locations and administrative boundaries of the regions and districts covered in the study. (RAR)

Acknowledgments
We are deeply grateful to all those who helped us in conducting this study. Particular acknowledgement goes to the efficient staff of the Ministry of Planning and the National Registry Office, as well as the families of deceased, injured and disabled people. Special thanks should go to Dr Amin Breadan, www.editor.com for his comprehensive editing of the paper.

Author Contributions
Conceptualization: Mohamed A. Daw.
Formal analysis: Mohamed A. Daw.
Methodology: Mohamed A. Daw, Abdallah H. El-Bouzedi, Aghnyia A. Dau.
Supervision: Aghnyia A. Dau.
Writing – original draft: Mohamed A. Daw.
Writing – review & editing: Abdallah H. El-Bouzedi.

References
1. Moro A. Understanding the dynamics of violent political revolutions in an agent-based framework. PLOS one. 2016 Apr 22; 11(4):e0154175. https://doi.org/10.1371/journal.pone.0154175 PMID: 27104855
2. Ahmad J, Ahmad A, Ahmad MM, Ahmad N. Mapping displaced populations with reference to social vulnerabilities for post-disaster public health management. Geospatial Health. 2017 Nov 27; 12(2).
3. GBD 2015 Mortality and Causes of Death Collaborators. Global, regional, and national life expectancy, all-cause mortality, and cause-specific mortality for 249 causes of death, 1980–2015: a systematic analysis for the Global Burden of Disease Study 2015. Lancet. 2016; 388(10053): 1459–1544. https://doi.org/10.1016/S0140-6736(16)31012-1 PMID: 27733281
4. World Health Organization. The injury pyramid, Violence and Injury Prevention:The Facts. http://www.who.int/violence_injury_prevention/key_facts/VIP_key_fact_5.pdf?ua=1. Accessed 1 August 2014.
5. Haagsma JA, Graetz N, Bolliger I, Naghavi M, Higashi H, Mullany EC. The global burden of injury incidence, mortality, disability-adjusted life years and time trends from the Global Burden of Disease study 2013. Inj Prev. 2015; 22(1): 3–18.159 https://doi.org/10.1136/injuryprev-2015-041616 PMID: 26635210
6. Chol C, Negin J, Garcia-Basteiro A, Gebrehiwot TG, Debru B, Chimpolo M, et al.2018. Health system reforms in five sub-Saharan African countries that experienced major armed conflicts (wars) during 1990–2015: a literature review. Global health action, 11(1), p.1517931. https://doi.org/10.1080/16549716.2018.1517931 PMID: 30270772
7. Coghlan B, Ngoy P, Mulumba F, Hardy C, Bemo VN, Stewart T, et al. Update on mortality in the Democratic Republic of Congo: results from a third nationwide survey. Disaster medicine and public health preparedness. 2009 Jun; 3(2):88–96. https://doi.org/10.1097/DMP.0b013e3181a6e952 PMID: 19491603
8. Diggle E, Welsch W, Sullivan R, Alkema G, Warsame A, Wafai M, et al. The role of public health information in assistance to populations living in opposition and contested areas of Syria, 2012–2014. Conflict and health. 2017 Dec; 11(1):33.
9. Mowafi H, Leaning J. Documenting deaths in the Syrian war. The Lancet Global Health. 2018 Jan 31; 6 (1):e14–5. https://doi.org/10.1016/S2214-109X(17)30457-6 PMID: 29226822
10. Elzahar O. Framing the forgotten war of Yemen: A comparative study.2018, Msc thesis, The American University in Cairo School of Global Affairs and Public Policy
11. Levy BS, Sidel VW. Adverse health consequences of the Iraqi war. Lancet. 2013; 381(9870):949–58. https://doi.org/10.1016/S0140-6736(13)60254-8 PMID: 23499043
12. Lafta R, Al-Shataari S, Cherewick M, Galway L, Mock C, Hagopian A, et al. Injuries, death, and disability associated with 11 years of conflict in Baghdad, Iraq: a randomized household cluster survey. PLoS one. 2015 Aug 7; 10(8):e0131834. https://doi.org/10.1371/journal.pone.0131834 PMID: 26252879
13. Saba A, Akbarzadeh S. The Responsibility to Protect and the Use of Force: An Assessment of the Just Cause and Last Resort Criteria in the Case of Libya. International Peacekeeping. 2018 Mar 15; 25 (2):242–65.
14. Gaub F. Libyen: Warum die NATO nicht ein allem Schuld ist. SIRIUS-Zeitschrift für Strategische Analysen.; 1(3):254–63.
15. Levy BS, Sidel VW. Documenting the effects of armed conflict on population health. Annu Rev Public Health 2016; 37: 205–18. https://doi.org/10.1146/annurev-publhealth-032315-021913 PMID: 26998827
16. Daw MA, El-Bouzedi A, Dau AA. Libyan armed conflict 2011: mortality, injury and population displacement. African Journal of Emergency Medicine. 2015 Sep 1; 5(3):101–7.
17. Dau AA, Tloba S, Daw MA. Characterization of wound infections among patients injured during the 2011 Libyan conflict.
18. Daw MA, El-Bouzedi A, Dau AA. The assessment of efficiency and coordination within the Libyan health care system during the armed conflict-2011. Clinical Epidemiology and Global Health. 2016 Sep 1; 4 (3):120–7
19. Ministry of State for Families of Martyrs, Injuries and Missing Persons https://www.mafmm.gov.ly/
20. Bureau of Statistics and Census Libya- Vital statistics. http://www.bsc.ly/—Access, on October 21,2019
21. Daw MA, Ali LAB, Daw AM, Sifennasr NE, Dau AA, Agnan MM, et al. The geographic variation and spatiotemporal distribution of hepatitis C virus infection in Libya: 2007–2016. BMC Infectious Diseases. 2018; 18(1), p.594. https://doi.org/10.1186/s12879-018-3471-4 PMID: 30466399

22. World Medical Association Ethics Unit. WMA Declaration of Helsinki–Ethical Principles for Medical Research Involving Human Subjects http://www.wma.net/en/30publications/10policies/b3/index.html (accessed 13 may 2015).

23. Aboutanos MB, Baker S. Wartime civilian injuries: epidemiology and intervention strategies. J Trauma. 1997; 43:719–726. PMID: 9356079

24. Mokdad AH, Forouzanfar MH, Daoud F, El Bcheraoui C, Moradi-Lakeh M, Khalil I, et al. Health in times of uncertainty in the eastern Mediterranean region, 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013. Lancet Glob Health 2016; 4: e704–13. https://doi.org/10.1016/S2214-109X(16)30168-1 PMID: 27568068

25. Li SJ, Flaxman A, Lafta R, Galway L, Takaro TK, Burnham G, et al. A Novel method for verifying war mortality while estimating Iraqi deaths for the Iran-Iraq war through operation Desert Storm (1980–1993). PloS one. 2016 Oct 21; 11(10):e0164709. https://doi.org/10.1371/journal.pone.0164709 PMID: 27768730

26. Daw MA. Libyan healthcare system during the armed conflict: Challenges and restoration. African J Emerg Medicine, 2017; 7: 47–50

27. Burki T. Libya’s health crisis looks set to worsen. The Lancet. 2016 Apr 2; 387(10026):1363

28. Guha-Sapir D, Schlüter B, Rodriguez-Llanes JM, Lillywhite L, Hicks MH. Patterns of civilian and child deaths due to war-related violence in Syria: a comparative analysis from the Violation Documentation Center dataset, 2011–16. The Lancet Global Health. 2018 Jan 31; 6(1):e103–10 https://doi.org/10.1016/S2214-109X(17)30469-2 PMID: 29226821

29. Homan T, Shoaib M, de Rosa A, Alfadell IA, Stein S, Khalaila F, et al. Morbidity, healthcare needs and barriers to access medical care amongst local and displaced populations in west Dar’a and Quneitra, Southern Syria.

30. Mosleh M, Dalai K, Aljess Y, Svanström L. The burden of war-injury in the Palestinian health care sector in Gaza Strip. BMC international health and human rights. 2018 Dec; 18(1):28. https://doi.org/10.1186/s12914-018-0165-3 PMID: 29954389

31. Price M, Gohdes A, Ball P. Updated statistical analysis of documentation of killings in the Syrian Arab Republic. Commissioned by the UN High Commissioner for Human Rights.Aug 2014. www.ohchr.org/Documents/Countries/SY/HRDAGUpdatedReportAug2014.pdf.

32. Shaak K, Lafta R, Stewart BT, Fowler TR, Al-Shatari SA, Burnham G, et al. Sex differences in civilian injury in Baghdad from 2003 to 2014: results of a randomized household cluster survey. Annals of surgery. 2018 Jun 1; 267(6):1173–8. https://doi.org/10.1097/SLA.0000000000002140 PMID: 28151803

33. Baraybar JP. Variation of gunshot injury patterns in mortality associated with human rights abuses and armed conflict: an exploratory study. Science & Justice. 2015 Sep 1; 55(5):355–62.

34. Gawande A. Casualties of war—military care for the wounded from Iraq and Afghanistan. New England Journal of Medicine. 2004 Dec 9; 351(24):2471–5. https://doi.org/10.1056/NEJMp048317 PMID: 15590948

35. Coghlan B, Brennan RJ, Ngoy P, Dofara D, Otto B, Clements M, et al. Mortality in the Democratic Republic of Congo: a nationwide survey. The Lancet. 2006 Jan 7; 367(9504):44–51.

36. Bodalal Z, Mansor S. Gunshot injuries in Benghazi–Libya in 2011: The Libyan conflict and beyond. the surgeon. 2013 Oct 1; 11(5):258–63. https://doi.org/10.1016/j.surge.2013.05.004 PMID: 23743179

37. Elmontsri M, Banarsee R, Majeed A. Key priority areas for patient safety improvement strategy in Libya: a protocol for a modified Delphi study. BMJ open. 2017 Jun 1; 7(6):e014770. https://doi.org/10.1136/bmjopen-2016-014770 PMID: 28674137

38. Wagner Z, Heft-Neal S, Bhutta ZA, Black RE, Burke M, Bendavid E. Armed conflict and child mortality in Africa: a geospatial analysis. The Lancet. 2018 Sep 8; 392(10150):857–65.

39. Dewachi O, Skelton M, Nguyen VK, Fouad FM, Sitta GA, Maasri Z, et al. Changing therapeutic geographies of the Iraqi and Syrian wars. the Lancet. 2014 Feb 1; 383(9915):449–57. https://doi.org/10.1016/S0140-6736(13)62299-0 PMID: 24452046

40. Elmontsri M, Almashrafi A, Dubois E, Banarsee R, Majeed A. Improving patient safety in Libya: insights from a British health system perspective*. International Journal of Health Care Quality Assurance, 2018; Vol. 31 Issue: 3; pp.237–248, https://doi.org/10.1108/IJHCQA-09-2016-0133

41. Peters K, Peters LE. Disaster Risk Reduction and violent conflict in Africa and Arab states.

42. Guha-Sapir D, Rodriguez-Llanes JM, Hicks MH, Donneau AF, Coutts A, Lillywhite L, et al. Civilian deaths from weapons used in the Syrian conflict. BMJ, 2015 Sep 29; 351:h4736. https://doi.org/10.1136/bmj.h4736 PMID: 26419494
43. Bowsher G, Bogue P, Patel P, Boyle P, Sullivan R. Small and light arms violence reduction as a public health measure: the case of Libya. Conflict and health. 2018 Dec; 12(1):29

44. Jaspars S, O’Callaghan S. Livelihoods and protection in situations of protracted conflict. Disasters. 2010 Apr; 34:S165–82. https://doi.org/10.1111/j.1467-7717.2010.01152.x PMID: 20132269

45. Walch C. Disaster risk reduction amidst armed conflict: informal institutions, rebel groups, and wartime political orders. Disasters. 2018 Oct; 42:S239–64. https://doi.org/10.1111/disa.12309 PMID: 30113712

46. Gertler J. Operation Odyssey Dawn (Libya): Background and Issues for Congress. 2011; Congressional Research Service, Library of Congress.

47. Greiner F. La crisis mundial del desplazamiento forzoso: un análisis del sistema de protección de las Naciones Unidas para personas desplazadas internamente y su aplicación en el contexto de la intervención militar en Libia en 2011 y la guerra civil desde 2014. 2018

48. Quartararo J Sr, Rovenolt M, White R. Libya’s Operation Odyssey Dawn: Command and Control. *Prism*, 201: 3(2), pp.141–156.