

Conflict-related excess mortality and disability in Northwest Syria

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ABSTRACT

Introduction The Syrian conflict that started in 2011 has been ongoing for over a decade without an end in sight. Estimates regarding excess mortality and conflict-related disability vary widely, and little field research has been done to address this topic.

Methods A population-based field survey was conducted from 10 to 18 November 2020 in Northwest Syria. Forty-nine clusters were selected using staged sampling based on predefined population distribution maps. Data were collected for the period from 2000 to 2020 and were divided into pre-conflict (2000–2010) and conflict (2011–2020) periods. Mortality rates were compared using the Mann-Whitney U test, and $p < 0.05$ was considered statistically significant.

Results A total of 1483 households were surveyed, for a population of 12 268 people. The crude mortality rate increased 3.55 times between the two periods ($p > 0.001$). In total, 54.3% of war-related deaths were caused by aerial attacks. Despite the continued increase in mortality rates during the conflict period, most deaths from 2017 onwards were related to non-violent causes. Overall, directly and indirectly, the conflict seems to have caused approximately 874 000 excess deaths. A total of 14.9% of households reported having at least one substantial violence-related disability since 2011.

Conclusion The conflict caused the tripling of mortality rates in Syria. The estimated excess mortality in our study is higher than previous estimates. From 2017 onwards, most conflict-related deaths were due to non-violent causes. There is a high prevalence of violence-related disabilities in the studied communities. Our data could prove useful for health policymakers.

INTRODUCTION

The Syrian conflict has been ongoing for over a decade without an end in sight. It has been described as one of the worst man-made disasters the world has seen since World War II.¹ More than half of the Syrian population before 2011 (21.3 million) has been displaced by conflict (6.7 million internal refugees and 5.5 million refugees in other countries).² In March 2011, peaceful protests erupted in many Syrian cities and were met with a harsh response by the authorities. The situation escalated, and by 2012, the peaceful protests

WHAT IS ALREADY KNOWN ON THIS TOPIC

- ⇒ There has been a significant lack of research published in Syria particularly during the armed conflict and in the war-torn territory of Northwest Syria.
- ⇒ Mortality estimates had a lot of uncertainty and were commonly reliant on media estimates and contradicting reports.

WHAT THIS STUDY ADDS

- ⇒ This study is the first of its kind to be conducted in Syria.
- ⇒ Crude mortality rate increased from 16.07 to 57.12 per 10 000 annually in the periods 2000–2010 (pre-conflict) and 2011–2020 (conflict period), respectively.
- ⇒ There is an epidemiological transition in mortality aetiology after 2017, as from that point onwards, most conflict-related mortality was caused by non-violent causes.
- ⇒ Total conflict-related excess deaths in Syria are 874 000; this is significantly higher than previous estimates.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE AND/OR POLICY

- ⇒ The study adds to the historical narrative of the Syrian conflict and highlights the consequences of the failure of the international community to intervene more proactively to end the conflict and protect civilians.
- ⇒ It also draws attention to the fact that despite a reduction in hostilities, mortality rates remain high and are now dominated by non-violent causes.
- ⇒ This has significant implications for healthcare policymaking and humanitarian aid provisions.

had shifted to an armed conflict that became the leading cause of death for Syrians³; however, the numbers of mortalities and injuries have been poorly documented.⁴

Northwest Syria (NWS) is an opposition-controlled area with a population of 4.2 million, over 2.8 million of whom are internally displaced people (IDP) from across the country.² This territory is bordered by Turkey and is composed of parts of the Idlib, Aleppo, Hama, and Latakia governorates and includes

nine districts. The region became a gathering point for Syrians fleeing regime advances, which accelerated after Russia joined the conflict in 2015. The last large wave of refugees was generated in late 2019. Healthcare in NWS is provided by multiple non-governmental organisations (NGOs), some of which work as proxies for international partners. Healthcare in NWS is hampered by a multiplicity of factors: it is fragmented and lacks central coordination,⁵ aid is politicised and weaponised, healthcare facilities are under-resourced and understaffed, and these facilities have also been frequently and deliberately attacked by the Syrian regime and its allies as a tactic of war.⁶ All this has resulted in difficulties accessing regular health services,⁷ leading to both short-term and long-term effects on the population.⁸

Official information systems collapsed during armed conflict,⁹ and in NWS in particular, the civil registry stopped functioning, leading to significant uncertainty in the measurement of mortality and disability. There are limited reliable data available about these essential health indicators. Additionally, thousands of Syrians have died in detention after forced disappearance by the Syrian government and other forces according to the United Nations (UN) estimates,¹⁰ but these estimates are particularly problematic when ascertaining deaths. Multiple mortality estimates of the Syrian conflict have been reported over the years by the media and NGOs. The reported figures vary in terms of the geographical areas included, sources used to report and ascertain deaths and the period covered. Forecasting methods have also been used to estimate the death toll.¹¹ Up to 2016, the Syrian Centre for Policy and Research estimated that 470 000 Syrians died from all causes.¹² The UN envoy to Syria reported the figure over the same period to be around 400 000.¹³ The Violations Documentation Centre in Syria reported conflict-related deaths to be 143 630 at the end of the same year.¹⁴ The Syrian Observatory for Human Rights (SOHR) reported that over 606 000 people were killed across Syria since the beginning of the 'Syrian Revolution' and until June 2021, including 495 000 documented by SOHR.¹⁵ This discrepancy could potentially be due to the absence of a clear methodology, transparency and the multiplicity of local sources. So far, no field-based survey has been attempted to estimate true excess mortality. From October 2020 onwards, the newly established Health Information System unit (established 2018) in NWS started producing prospective mortality reports every 3 months. These reports are not, however, meant to be comprehensive and are largely based on in-hospital mortalities.¹⁶

There is very limited information on disabilities related to the Syrian conflict. Globally, approximately 15% of the world's population has a moderate or severe disability, with the proportion increasing in conflict-affected areas.^{17 18} As of 2016, the WHO estimated that 30 000 people each month were injured by the Syrian conflict and that almost one-third of them were likely to suffer from permanent disabilities requiring long-term

rehabilitative care.¹⁹ A report by the K4D Helpdesk, commissioned by the UK Department for International Development, estimated 1 million injuries in Syria as of 2017.²⁰ Another report by the SOHR in 2020 estimated the figure to be 2 million.²¹

To date, no field-based survey has attempted to estimate true excess mortality. A survey that was conducted in Iraq in 2006 still serves as a good reference point and could potentially provide an analogy as to how mortality in Syria can be estimated.²² We conducted a retrospective cross-sectional survey to estimate the crude mortality rate (CMR), the cause-specific mortality rate and the prevalence of substantial violence-related disabilities (SVRDs) and their characteristics in NWS. This was the first time such a survey had been performed in this region, and it posed significant logistical and security challenges.

METHODS

Study design

The study design followed the criteria delineated in the Strengthening the Reporting of Observational Studies in Epidemiology guidelines. A retrospective (recall) cross-sectional field study among the population of the NWS region was conducted.

Sample size

The results from a pilot study conducted at Idlib University in 2018 showed a tripling of the mortality rate from before compared with after 2011. Based on this finding and assuming a pre-2011 CMR of 25 per 10 000 annually, we assumed the conflict-time mortality to be between 25 and 75 per 10 000 annually, with a 95% CI of 25 per 10 000. Given an average of 5 people per household, the sample size was calculated to be 600 households. Given a design effect of 2 (due to the staging of cluster sampling and the heterogeneity of the population studied), the sample size was increased to 1200. This was expanded further to 1750 to account for the anticipated non-response rate (35%).

Selection criteria

Participants meeting the inclusion criteria were identified as having Syrian nationality and either residing in the NWS region or being recently displaced to this territory. The head of the household had to provide verbal consent to take part in the study.

We excluded households in which the head of the household did not provide consent or no adult member existed at the time of visit by the survey team. Due to logistical and security constraints, a resurveying of empty households at that time was not feasible; thus, the team moved to the next household selected by our systematic sampling method.

Sampling

The sampling was conducted using staged cluster sampling based on predefined population distribution maps. Communities in the NWS region were classified as either camps for the displaced or pre-existing built-up

communities. We could not divide the latter category further into villages, towns and cities due to the mass demographic shifts that resulted from internal displacement. This led to significant changes in the relative size of towns and villages, and older definitions held little to no relationship to the current population distribution. After March 2020, a fragile ceasefire was implemented, which reduced displacement to the lowest level ever since 2011. Data were gathered at the end of 2020 when the humanitarian situation has somewhat stabilised.

In March 2020, the Humanitarian Needs Assessment Program (HNAP), a joint UN assessment initiative that tracks displacement and returns movements, estimated the population of NWS to be 4 183 213, including nine districts in both Idlib (Ariha, Harim, Idlib Centre, Jisr Alshougour) and Northern Aleppo (A'zaz, Jabal Samaan, Afrin, Albab, Jarablus), which were further divided into geographical units including camps, towns and villages.²³ We aimed to collect 50 clusters from the NWS region with 35 households per cluster. Therefore, each cluster represented approximately 80 000 people. According to the UN Office for the Coordination of Humanitarian Affairs estimates, 1.2 million in NWS live in camps²⁴; therefore, one-third of our clusters were selected from camps of IDP.

Fifty clusters with 35 households per cluster were chosen according to a two-stage cluster random sampling method as follows:

- ▶ First stage (cluster selection): a probability proportional to population size was used to randomly select the clusters via ENA for SMART 2020 software (online supplemental file 1).
- ▶ Second stage (household selection): households were chosen randomly within each cluster using systematic random sampling depending on the size and geographical distribution of the cluster with the assistance of Google Maps software.

The majority of the NWS territory was considered to be rural areas, with few urban locations, and a list of households and the national census were unobtainable.

Households were selected according to the standard WHO Extended Program on Immunization cluster sampling proximity method.²⁵ The team leader estimated the distance (d) between the centre of the unit and its border, and the interval was calculated by dividing (d) by the number of households in the cluster (n). The first household was selected randomly by choosing a number between 1 and (n) and in a random direction. The following households were selected by adding the measured interval sequentially until the completion of the cluster. [Figure 1](#) is a map of the NWS region with the location of sampled geographical units.

Data collection

Data were collected via interviews between 10 and 18 November 2020. Interviews were conducted by 79 trained medical students from three universities in the NWS region: Idlib University, Free Aleppo University, and International University of Science and Renaissance. Twenty-eight female and 51 male students were allocated to 25 teams and had online training for 2 weeks by two senior doctors. Each team was tasked with completing two clusters. The teams ensured that COVID-19 prevention measures were followed during their visits and contributed to a COVID-19 awareness campaign that was run concurrently.

Surveyors immediately entered and uploaded data electronically in the field using Kobotoolbox software, which was run on smartphones. Data could be entered offline and then automatically uploaded to the server once an internet connection became available. Data collectors were provided with daily feedback and support to ensure data reliability. In addition, where possible, additional means of communication with the household were obtained for later remote verification of the data (usually a WhatsApp number). This process ensured maximum confidentiality and accuracy of collected data.

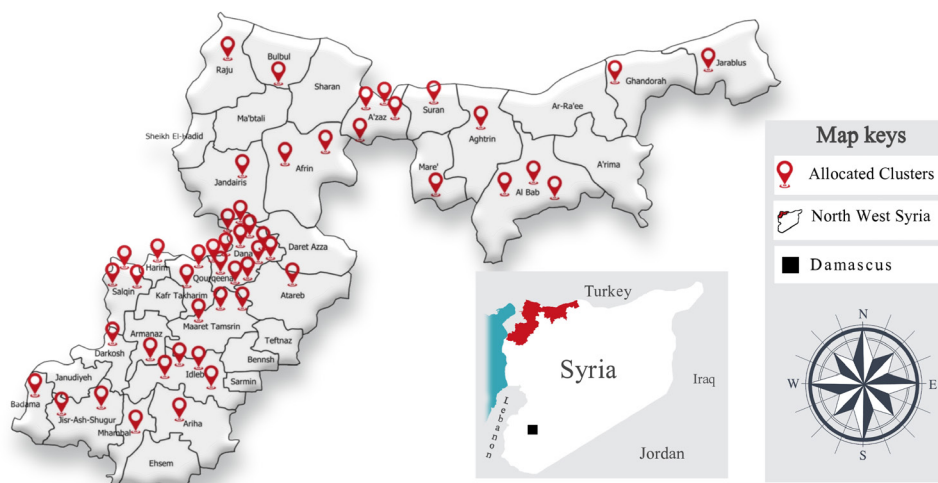


Figure 1 A map of the Northwest Syria region. Districts and subdistricts that had clusters allocated.

Questionnaire tool

The questionnaire used for collecting mortality information was adapted from the Nutrition and Retrospective Mortality Survey, which was implemented in similar circumstances.^{26 27} Mortality data were collected for a 20-year recall period between 2000 and 2020. We added questions related to sociodemographic characteristics, mortality causes and features of war-related disabilities.

Definitions

A household was defined as a group of people who eat and sleep together. The head of the household was defined as any member aged 18 years or older who could provide the required information, resided in the household for the last 12 months and was present at the time of the interview.

A violence-related death (VRD) was defined as any death caused by any of the following: interpersonal violence, war, suicide, execution and collective violence. Meanwhile, a non-violence-related death (NVRD) was defined as any death caused by vehicle accidents, communicable diseases, non-communicable diseases (NCDs), malnutrition, cancer, perinatal death or other causes.

An SVRD was defined as any disability that was more than minor and interfered with the victim's daily tasks, that is, 'substantial' and 'long-term'. It was categorised as any physical and/or cognitive limitations due to neurotrauma, paralysis due to spinal cord trauma, partial or complete amputation of limbs, physical limb deformation resulting in mobility impairments, psychological trauma, and burns and sensory disability such as blindness and deafness.

Patient and public involvement

The situation in Syria affected millions of people and despite much media attention, little ground research has been done to document its true impact. The results of our study add to the historical narrative of the Syrian conflict and can be quite useful for organisations involved in providing healthcare and humanitarian relief.

Study participants were not involved in the design of the study. However, a pilot study previously done on local university students did inform the study design. This aided in predicting the increase in mortality rate and the non-response rate. These two parameters were important for calculating sample size. Due to the nature of the survey, participants could not be recruiters, however, they had to give explicit consent.

The study results will be made available to the media through the publishing journal. It will also be made available to humanitarian relief NGOs and other stakeholders.

Data analysis

Mortality rates were calculated with their respective 95% CIs using SPSS V.23 and Microsoft Excel software. They were estimated as the number of deaths/10 000 persons/year. In the calculation of the annual mortality rates, the denominators were adjusted to include only

the population at risk in that specific year (removing all subjects who died before or were born after that year). The annual CMRs were then averaged for the pre-conflict period (2000–2010) and post-conflict period (2011–2020).

The annual excess mortality rate was calculated by subtracting the average pre-conflict CMR from the average post-conflict CMR. Excess conflict-related mortality was then extrapolated by multiplying the excess mortality rate by the Syrian population before the conflict (21.3 million)²⁸ and by the length of the conflict in years (10 years).

Data were summarised and presented as histograms, frequencies, percentages, means (\pm SD) or medians (with IQRs) as appropriate. Comparisons between variables were performed using the Mann-Whitney U test, t-test and χ^2 test, as appropriate.

RESULTS

Demographics

We initially approached 1750 households, out of which 267 (15.2%) declined participation or were inaccessible, leaving 1483 households included in the survey. A total of 1252 (84.4%) households provided electronic means of communication (WhatsApp number) for later verification and/or completion of data.

Two clusters (42 and 43) were replaced with similar clusters within the same district due to inability to obtain security clearance for teams to enter the area, while two others (40 and 41) had limited data collected for the same reason. Cluster 33 was abandoned completely due to the extremely high risk involved in accessing the cluster and the lack of similar clusters within proximity to replace it. All five clusters were within the Northern Aleppo countryside sector, which had 13 other clusters completed.

The sample included 6225 (50.7%) males and 6043 (49.3%) females. The population was predominantly composed of young people; 50.3% were 20 years old or younger. The median household size was 6 persons (IQR 5–8). The median number of children under 5 in the household was 1 child (IQR 0–2). The age population pyramid distribution is shown in online supplemental file 2.

Among the participating households, 921 were displaced in total. The previous residence place was known for 920 households, and the majority were originally from other parts of the Idlib governorate. The head of the household at the time of the survey was mostly one of the parents. The median household income (including food baskets supplied by relief organisations) was 80 dollars (IQR 50–125). The basic sociodemographic characteristics of the surveyed population are listed in [table 1](#).

Mortality analysis

We recorded 698 deaths over the total recall period; 499 (71.5%) were males, and 199 (28.5%) were females. There was a peak in approximately 2015. VRDs

Table 1 Sociodemographic characteristics

	Frequency	Per cent
Gender		
Female	6043	49.3
Male	6225	50.7
Residency status of the household		
Displaced and live-in camps	413	27.8
Displaced and live-in houses (villages/cities)	508	34.3
Indigenous	562	37.9
Household members' status		
Alive elsewhere	1778	14.5
Alive in the household	9739	79.4
Dead	705	5.7
Unknown	46	0.4
The head of the household at the time of the survey		
Brother or sister	94	6.3
Father	880	59.3
Mother	476	32.1
Other	33	2.2
Completed education of the head of the household		
Non-educated	271	18.3
Elementary school	388	26.2
Middle school	422	28.5
High school	150	10.1
Academic	252	17.0
Monthly household income in dollars		
100 or less	1066	73.2
101–299	307	21.1
300 or more	84	5.8
Previous residence before 2011, if displaced		
Aleppo	190	20.7
Damascus	26	2.8
Daraa	3	0.3
Deir ez-Zur	24	2.6
Hama	147	16.0
Hasaka	1	0.1
Homs	24	2.6
Idlib	471	51.2
Latakia	20	2.2
Quneitra	1	0.1
Raqqa	3	0.3
Rif Dimashq	10	1.1

represented 41.4% (n=289) of deaths, while NVRDs represented 58.6% (n=409). The most frequent type of VRD was war related (92.4%). More than half (54.3%) of the war-related deaths were due to aerial bombardments

Table 2 Cause-specific mortalities

	Frequency	Per cent
Violence-related death causes		
Collective violence (combating between local military groups)	7	2.4
Interpersonal violence	8	2.8
Execution	6	2.1
Suicide	1	0.3
War	267	92.4
War-related death causes		
Airstrike	94	35.2
Barrel bomb	51	19.1
Another explosion	15	5.6
Bombing car	9	3.4
Gunshot	82	30.7
Unknown	16	6.0
Non-violence-related death causes		
Non-communicable diseases (NCDs)	163	39.9
Cancer (NCDs)	41	10.0
Malnutrition	6	1.5
Communicable diseases	21	5.1
Perinatal	33	8.1
Vehicle accident	38	9.3
Unknown	107	26.2

(airstrikes with missiles and helicopter-dropped barrel bombs). Almost half (49.9%) of NVRDs were due to NCDs, including cancer. A description of the causes of mortality is shown in [table 2](#).

The CMR differed significantly between the periods before and after the conflict (2000–2010 and 2011–2020, respectively). The overall CMR was 35.62 per 10 000 annually. The CMRs for the pre-conflict and conflict periods were 16.07 and 57.12, respectively. This difference was statistically significant ([table 3](#)).

In the comparison of other parameters of mortality during the two periods, the mean age of death did not differ (35.75 ± 29.13 vs 34.28 ± 25.08 years; $p=0.55$), despite the significant increase in total mortality rates. Males represented 62% of mortalities pre-conflict and 73% of conflict mortalities, and the difference was statistically significant ($p=0.01$). There was a statistically significant difference ($p<0.001$) in VRDs between females (20.6%) and males (42.4%).

The excess mortality rate post-conflict was 41.05/10.000 per year. By extrapolating this to the whole country, we found that 87 436 excess mortalities occurred annually; this means that since 2011, approximately 874 000 excess deaths might have occurred in Syria related directly or indirectly to the conflict. [Figure 2](#) and online

Table 3 Detailed CMR values for the pre-conflict and the conflict periods

Compared group	Overall CMR (95% CI)	Pre-conflict CMR (95% CI)	Conflict CMR (95% CI)	Statistical test and significance
All deaths	35.62 (45.56 to 25.68)	16.07 (22.23 to 9.91)	57.12 (65.30 to 48.95)	Mann-Whitney, p<0.001
Violent deaths	14.14 (21.90 to 6.39)	0.34 (5.14 to -4.46)	29.33 (38.45 to 20.22)	Mann-Whitney, p<0.001
Non-violent deaths	21.47 (24.86 to 18.08)	15.73 (17.83 to 13.63)	27.78 (30.86 to 24.71)	Mann-Whitney, p<0.001
Under 1 mortality rate	3.81 (4.83 to 2.80)	2.95 (3.58 to 2.32)	4.76 (6.25 to 3.27)	Mann-Whitney, p=0.051
Under 5 mortality rate	5.93 (7.61 to 4.26)	3.93 (4.97 to 2.89)	8.14 (10.04 to 6.23)	Mann-Whitney, p<0.001

CMR, crude mortality rate.

supplemental file 3 show the temporal trends in mortality rates for different groups.

Of the 12 268 individuals living in the participating households since the beginning of the recall period, 6162 (50.2%) were born after 2000, and 3220 (26.2%) were born after 2011. Overall, there were 8.8 times the number of births as the number of deaths, and the ratio for 2011–2020 was 5.6.

Disability analysis

A total of 14.9% of households reported having at least one person with an SVRD, of whom 17.1% were females and 82.9% were males. Online supplemental file 4 shows the chronological distribution of the time when disability occurred, which suggests a peak in 2015. Most disabilities occurred in young adults; the median age of disability occurrence was 23.5 years (IQR 17–37).

The main type of SVRD was physical limb deformities resulting in movement impairment (n=64; 28.6%), followed by physical or cognitive limitations due to neurotrauma (n=46; 20.5%) and paralysis due to spinal cord trauma (n=17; 7.6%). Online supplemental file 5 lists the details of the war-related disability census.

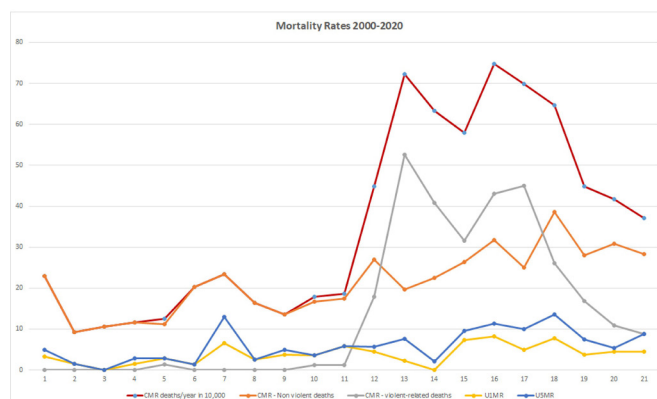


Figure 2 Annual mortality trends for different groups as per legend. Numbers are mortality per 10 000 per annum. Red: crude mortality rate (CMR); orange: the mortality rate for non-violent deaths; grey: violent-related deaths; yellow: under 1 mortality rate (U1MR); blue: under 5 mortality rate (U5MR).

DISCUSSION

The findings of this survey clearly highlight the direct and indirect consequences of the violent conflict on the civilian population in Syria between 2011 and 2020, mainly: the significant surge in mortality and SVRDs. Several factors might explain these findings: first, the protracted conflict and its tragic impact on sociodemographic characteristics; second, the forcible mass internal displacement of the Syrian population; and third, the weakened, politicised, and fragmented health-care systems in Syria and the insufficient numbers of healthcare workers remaining after that many years of conflict. The last factor was further aggravated by the deliberate and frequent attacks on healthcare facilities by the Syrian government and Russian warplanes, which has been a hallmark of the Syrian conflict in explicit violation of International Humanitarian Law and the Geneva Conventions.

The data presented in our findings show a tripling of mortality rates in Syria after 2011 and the estimated excess mortality is higher than that of previous estimates. From 2017 onwards, most conflict-related deaths were due to non-violent causes. Furthermore, there is a high prevalence of SVRD in our studied communities.

Demographics

Our data showed that the median monthly household income was 80 dollars (IQR 50–125). The World Bank updated the International Poverty Line (IPL), a global absolute minimum, to \$1.90 per person per day,²⁹ which equates to \$57 for each person per month. For a household of 6.6 persons, this would be 376 dollars monthly. Among the surveyed population, only 5.8% of the households earned more than 300 dollars a month. This means that nearly 95% of our sample was under the IPL.

Despite the protracted conflict, the annual births were still approximately 5 times the deaths during the conflict period and 8.8 times the deaths for the whole study period. This finding highlights the importance of providing paediatric and maternity healthcare in such a hostile environment. The studied population seems to have increased by 26.2% due to new births since 2011. These individuals born since 2011 can be considered ‘the war generation’, and their childhood has been marked

by deprivation, a lack of security, and poor education and healthcare. Our figures are compatible with the data from the World Bank, which indicated that the fertility rate in Syria declined from 4.07 in 2000 to 3.29 in 2011 to 2.78 in 2019.³⁰ The NWS population pyramid revealed a youth bulge, which is a known factor in increasing social tensions and the possibility of uprisings and non-ethnic civil wars.³¹

According to the UN, there are no data related to the size of the household within Syria.³² However, our data show that the average Syrian household size is in line with that of neighbouring countries, including those that had an armed conflict: Somalia and South Sudan (5.9), Libya (5.6), Afghanistan (8.0) and Iraq (7.7).³² A study in Northern Jordan revealed that the average household size of Syrian refugees was 6.30 persons.³³

Mortality

Our data show that the CMR increased by 3.55 times after 2011 compared with that in the previous decade. This figure is much higher than the World Bank estimate of 1.5 times.³⁴ According to a systematic review of trauma epidemiology in Syria, the mortality rate has been greater than that of recent conflicts across the region.³⁵ In our study, the mortality peak was identified in 2015. This might be related to the violence against healthcare facilities committed by the Syrian regime forces and Russian intervention in Syria around that year.⁸ Our data demonstrated that the mean age of death did not differ before and during the conflict despite the significant increase in total mortality rates. This is likely because under 1 and under 5 mortalities formed a sizeable proportion of total mortalities for both periods.

Our results revealed an epidemiological transition point in mortality patterns during the conflict, as in 2017, deaths became predominantly due to non-violent causes (see online supplemental file 6). In 2019, the global burden of diseases and injuries revealed that conflict mortality was the third leading cause of death in Syria and that there was a notable increase in NCD-related death, which was in the top 10 leading causes of death.³⁶ Data by the World Bank in 2016 demonstrated that 45% of deaths in Syria were caused by NCDs.³⁷ In our results, 27% of all deaths were related to NCDs, and the proportion might be higher, considering the absence of a system that issues death certificates confirming the exact cause of death. A total of 12.3% of deaths in our results had unknown causes. During the armed conflict, the focus of relief efforts has been on trauma and war-related injuries,³⁸ while NCDs have not been prioritised; this could contribute to our findings and indicates a need to reconsider relief effort priorities.

Spiegel and Salama reported that mortality surveys may serve to document atrocities committed during emergency situations.³⁹ The results demonstrated in this work provide a new perspective on the importance of creating a no-fly zone over Syria, which was vetoed by Russia in the UN Security Council,⁴⁰ and that many lives could

have been saved with this strategy. We found that more than half (54.3%) of war-related deaths came from the sky (airstrikes and barrel bombs). It is estimated that at least 70 000 indiscriminate barrel bombs were dropped on Syria over the last decade.⁴¹ These figures might prove useful when considering the impact of current conflicts, such as the one in Ukraine.

Disabilities

There was approximately one SVRD in every seven households. The prevalence of disabilities in our results is less than the HNAP estimates,⁴² estimates from other conflict countries⁴³ and even estimates from Syria before the conflict.⁴⁴ This could be related to the fact that our definition of SVRD is restricted to severe, significant and war-related injury causing the disability. The majority of persons with disability (PWDs) in our study were males and young, which is similar to other armed conflicts, such as in the Palestine and Croatia wars.^{45 46}

PWDs require comprehensive, multidisciplinary and intersectoral care and collaboration.⁴⁷ The conflict is likely to have caused inequalities in healthcare access and social exclusion for PWDs. It has also magnified the burden on healthcare services they require, as most facilities have already been devastated by the conflict.

In 2018, a report by the Syria Relief Organisation identified over 10 000 Syrian children with disabilities living without access to most essentials.⁴⁸ The injury age-standardised disability-adjusted life year rate in Syria was 26.3 per 100 000 individuals in 2014 and 16.34 in 2017, which is considerably higher than other countries in conflict, such as Libya and Yemen.⁴⁹

Limb deformation resulting in movement impairment was the most recorded injury in our study. This is similar to data from other regional conflicts, such as those in Iraq and Afghanistan.⁵⁰ Limb deformation was also the most commonly recorded injury in the Bosnian, Croatian and Lebanese wars.^{51 52} Physical and/or cognitive limitations due to neurotrauma and head injury were the second most common causes of disabilities. While this finding differs from a previous study done in Syria,⁵³ it is similar to data from other conflict zones, particularly Iraq.⁵⁰ Paralysis due to a spinal cord injury constituted 7.6% of disabilities in our study, which is higher than an estimate of a previous study conducted in NWS⁵⁴ and higher than estimates for Korea, Vietnam, Gulf and Panama wars⁵⁵ but lower than the rate recorded in the wars in Afghanistan and Iraq.⁵⁶

Strengths and limitations

This survey is the first of its kind conducted in Syria. It endeavours to address the knowledge gap created by a lack of research about the humanitarian crisis.⁵⁷ This study may have several influential implications for health policies, and authorities could use our results when planning and implementing interventions and programmes. Nevertheless, this study has several limitations.

Although the survey covered 49 clusters, the majority of displaced people in our sample were from the Idlib, Aleppo and Hama governorates, with the rest from all other Syrian governorates except As-Suwayda and Tartus. This has multiple possible explanations: displaced people usually stay as close as possible to the places they fled in the hope the situation could improve and therefore permit their return, so those who are too far away from their original communities and displaced to NWS are more likely to use the region as a stepping-stone for onward migration to Turkey and Europe. Additionally, IDP tend to aggregate according to their place of origin, so those from the same city or village usually reside within close geographical proximity. IDP from places originally close to NWS could potentially be over-represented in our study. This might be a lesson for future researchers in such war-torn territory, that is, increase the number of clusters to obtain a more representative population. However, since the conflict involved almost all Syrian regions with different peaks in violence at different time points for each region, data from the NWS original population alone could still be generalisable to the whole of Syria.

The long recall period (20 years) could have affected the accuracy of the recorded information. However, a long recall period was necessary, as the conflict had gone on for a decade; we needed a similar length of time for historical comparison. This also allowed a smaller sample size and therefore reduced logistical difficulties.⁵⁸ We implemented a ‘multiround’ approach by recontacting available participants’ numbers via electronic means a week later to validate our data and reduce the effect of recall bias.

The surveyors investigated cause-specific mortalities according to explicit definitions. However, in such war zone, and with collapse of civil-governing institutions, death certificates were either deficient or non-existent. While some approached households refused to participate, others might have hidden some facts due to fear of consequences, especially those related to people disappearing in detention. Many of our participants could have had post-traumatic stress disorder, which is known to affect short-term memory.⁵⁹ We restricted the definition of mental disabilities in our survey to those who had been previously diagnosed by a professional or treated with psychoactive drugs. This could have potentially underestimated their true prevalence. Due to the extensive use of indiscriminate shelling, airstrikes and barrel bombs against civilian structures,⁴¹ the death of whole families has been a frequent occurrence during the Syrian conflict. These households would have been missed by our methodology and therefore an important potential source of survival bias, which unfortunately is unavoidable.

CONCLUSION

Conducting research in the settings of ongoing conflict is very challenging. The CMR tripled in Syria due to the conflict. Despite the reduction in violent deaths, conflict-related non-violent deaths have continued to increase and constituted most of the conflict-related excess mortality since 2017. Fifteen per cent of households reported at

least one SVRD. Our results could potentially help policymakers and relief organisations adapt their planned interventions in Syria.

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