Original article:

Relationship between Armed Conflict and Sudden Death: An Analysis of Causes and Consequences, Sudan 2025

Elaf Mohammed Ali Mohammed[1], Nasrin Abu Yousif Hamid[1], Abeer Osman Hussein Mohamed[1], Ammar Mohammed Ali Fadol[2], Firass Faisal Magzoub Abdelrhman[1], Asmaa Ahmed Dawood[1]

1. Research and Publication Office, Dental Alumni and Students Affairs Office, Karary University.
2. Department of Anatomy, Faculty of Medicine, International University of Africa, Khartoum, Sudan.

Received on Mar 14, 2025, accepted for publication on May 24, 2025, dx.doi.org/10.5455/mjhs.2026.01.016

Corresponding author:
Elaf Mohammed Ali Mohammed, Research and Publication Office, Dental Alumni and Students Affairs Office, Faculty of Oral and Dentl Medicine, Karary University, sudan.
Email: dr.elafmohammed@gmail.com

OPEN ACCESS Distributed under Creative Commons CC BY-NC-ND 4.0

Abstract:

Background and aim:
The ongoing conflict between the Rapid Support Forces and Sudanese Armed Forces since April 2023 has triggered a severe humanitarian crisis, displaced over 8.4 million people and rendered 70% of hospitals in conflict zones non-functional.

Methods:
A cross-sectional survey was conducted, involving 412 family members or acquaintances of individuals who experienced sudden death during the war. Data were collected through structured questionnaires, covering demographic characteristics, causes of death, psychological factors, healthcare access, and family impact. Statistical analyses involved descriptive and inferential methods to examine associations between mortality determinants, healthcare accessibility, and psychological distress.

Results:
The highest mortality rates were observed among males (60.9%) and older adults (45.6% aged ≥56 years). Cardiovascular events, including heart attacks (35.2%) and strokes (5.3%), were the leading medical causes of death, while psychological trauma was reported in 78.9% of cases. Healthcare access was severely restricted, with 37.4% of individuals receiving no medical care, and 47.8% experiencing delays in emergency services. Soldiers and employees faced higher physical and psychological trauma, whereas teachers and freelancers encountered the most significant healthcare barriers. Families of the deceased reported severe emotional distress (71.6%) and financial instability (16.3%).

Conclusion:
War exacerbates sudden mortality through trauma, chronic disease aggravation, and healthcare collapse. Urgent interventions, including mental health support, improved emergency care, and mobile healthcare units, are essential to mitigating these crises. Further research is needed to address conflict-related health disparities and develop targeted health interventions. Key Words: Armed conflict, sudden death, healthcare access, psychological trauma.

Keywords:
Armed conflict, sudden death, healthcare access , psychological trauma

Introduction:

Armed conflict significantly impacts public health, leading to increased morbidity and mortality. The Sudanese conflict, which began in April 2023, has caused large-scale displacement and severe damage to healthcare infrastructure, leaving millions without access to essential medical services. Reports indicate that 60 attacks on healthcare facilities resulted in 34 deaths and 38 injuries, while 222 attacks between January and October 2023 led to the destruction of at least 49 health centers[1]. The direct targeting of healthcare facilities exacerbates the suffering of vulnerable populations.

This study aims to fill a critical gap in understanding the impact of war on sudden mortality in Sudan by analyzing socio-demographic factors, primary causes of sudden death, and healthcare accessibility challenges. Unlike previous research, this study focuses on how occupation and psychological trauma contribute to mortality risk, providing a foundation for policy interventions.

War is defined as combat between nations or within a nation and may also involve armed groups not recognized by the international community fighting against an occupying government or regime[2]. War directly and indirectly affects public health, leading to increased morbidity and mortality[3]. The consequences of war include physical, psychological, social, and economic distress, with many individuals exposed to conflict developing post-traumatic stress disorder (PTSD)[4].

Sudan's humanitarian crisis escalated following the rebellion of the Rapid Support Forces (RSF) against the Sudanese Armed Forces (SAF)[5]. Initially concentrated in Khartoum, the fighting soon spread to western and central Sudan[6]. Since April 2023, over 8.4 million people have been displaced, including 1.7 million who fled abroad[7]. According to the World Health Organization (WHO), between April 15 and December 15, 2023, 60 attacks were recorded on healthcare facilities, resulting in 34 deaths and 38 injuries[8,9]. Around 70% of hospitals in conflict zones became non-functional[9]. Unfortunately, the systematic targeting of medical facilities, which should serve as sanctuaries during crises, exacerbates the suffering of already vulnerable populations[10].The impact of conflict is not limited to increasing the demand for healthcare, but also severely restricts access due to the destruction of infrastructure and the loss of healthcare workers. In post-conflict phases, health systems often emerge fragmented and unsustainable, largely due to weak local capacities and limited investment in building resilient health structures[11].

The direct and traumatic nature of death in war is among its most distressing aspects[12]. War deprives individuals of the ability to prepare for death, often leaving no time for acceptance or farewells[13]. The immediacy of death, particularly with modern weaponry, results in mass casualties within seconds[14]. The unpredictability and scale of such deaths create widespread despair, stripping individuals of their final moments of consciousness and reinforcing the fragility of human existence[15].

In conflicts involving weapons of mass destruction, victims often die instantaneously, never having the opportunity to comprehend or respond to their fate[16]. The widespread devastation caused by war transforms the concept of death from an expected transition to an abrupt and disorganized tragedy[17]. War victims are denied their fundamental right to life, leaving survivors to bear the disproportionate burden of loss[18].

Materials and Methods:

Study Design:

A cross-sectional survey was conducted to collect quantitative data on the impact of war on sudden death in Sudan. The cross-sectional design was applied in this study as it is currently the most effective for establishing the relationship between conflict and sudden death. The cross-sectional design allows for direct and accurate data collection, providing a clear picture of the direct impact of conflict. Through this design, information related to the incidents can be analyzed in a timely manner without the need for long-term follow-up, as may be the case in the current Sudan crisis. This design also, enables the production of results that can be rapidly applied towards the formulation of intervention strategies to mitigate the impact of conflict on public health.

Study Population and Sampling: Total of 412 participants were included in the study. Inclusion criteria required participants to be adults (18 years and older) who had personally known or lived with the deceased and were willing to share information about the circumstances surrounding the death. Individuals who lacked direct knowledge of the deceased's experience or were unwilling to participate were excluded. While purposive sampling enables rich data collection,

Data Collection Method: A structured questionnaire was administered both online and in-person, ensuring voluntary informed consent was obtained from all participants. The survey included sections on general demographic information, circumstances of death, psychological effects, and healthcare access. The questionnaire was developed by the research team based on a review of relevant literature and study objectives.

To ensure clarity and content validity, it was assessed and validated by an external reviewer with expertise in the field.

Data Analysis: Descriptive and inferential statistics were used to analyze the data, employing SPSS for statistical computations. Chi-square tests were conducted to examine associations between key variables. The data were anonymized to maintain participant confidentiality and minimize potential biases.

Ethical Considerations: Approval for the study was obtained by the Ethics Committee of Research and publication office, Dental Alumni and Students Affairs Office,, Karary University. All participants provided informed consent, and confidentiality was maintained by anonymizing data and securely storing information. Measures were implemented to protect the mental well-being of participants during data collection, including access to psychological support services where necessary.

Results:

Socio-Demographic Characteristics of the Deceased

This study examines the characteristics of individuals who experienced sudden death during the war. The relationships between the deceased and the respondents in the survey include a variety of categories, such as 16.1% immediate family, 21.3% were parents and siblings, 8.8% were from the paternal family (uncles, aunts, and cousins), 6.7% were from the maternal family (uncles, aunts, and cousins), 6.1% were in-laws, 9.4% were grandparents and extended relatives, 5.6% were other relatives or close acquaintances, and 26% were neighbors, friends, work colleagues, and companions.

In terms of age, the majority of the deceased were aged 36 to 55 years (31.8%), followed by those aged 56 years and above (45.6%), with younger age groups being less represented. Regarding gender, 60.9% were male, while 39.1% were female. In terms of occupation, nearly half were employees (49.3%), while 29.9% were displaced individuals or refugees, and smaller proportions were soldiers, doctors, housewives, or worked in other professions. Concerning residence during the war, the majority of the deceased lived in urban areas within Sudan (58.6%), followed by 28.7% in rural areas, and 10.8% had moved outside Sudan. In terms of education, 49.6% had a university degree, 29.5% had secondary education, and the rest had primary or no formal education. The timing of sudden deaths varied, with the highest occurrence within the first year of the war (42.8%), followed by deaths occurring immediately after the war began (29.1%). The remaining 28.1% of cases occurred more than a year into the conflict.

Causes and Circumstances of Sudden Death

The study explored various aspects

related to the sudden death of individuals during the war, focusing on the causes, healthcare access, emotional and financial impact on families, and delays in medical care. The primary contributing factor to the death was psychological trauma, reported by 54.4% of respondents. Other factors included pre-existing health conditions (23.8%) and physical injury during the war (12.4%). A large majority, 76.5%, believed that the death was directly related to the trauma of the war or stress resulting from it.

Regarding healthcare, 35% of respondents received general medical care, 19.7% accessed emergency services, and 1.7% sought mental health services. However, 43.7% of respondents stated that healthcare was not applicable to their situation. Access to healthcare during the war was limited for many, with 37.4% having no access, while 35% had limited access and only 15.8% had continuous access.

The emotional impact on families was significant, with 71.6% reporting a severe impact, and 19.9% reporting a moderate impact. Financially, 38.6% experienced minor or no impact, while 16.3% faced severe financial challenges.

Finally, 47.8% of respondents reported a delay in receiving emergency medical care at the time of death, while 35.4% received timely care, and 16.7% were unsure about the timing of care. These findings underline the multifaceted effects of the war on both the physical and psychological well-being of families.

Table 1:Suspected cause of the sudden death:

	Frequency	Valid Percent
Tumor	4	1.0
Panic	2	.5
Acute circulatory collapse	3	.7
Heart attack or heart problem	145	35.2
Malaria	4	1.0
Hypertension complications	1	.2
Diabetic complications	7	1.7
Sudden kidney failure	3	.7
Respiratory failure	22	5.3
Stroke	22	5.3
Hemorrhagic fever	1	.2
Shot gun	16	3.9
Explosion of a shell	5	1.2
Alling from a height	1	.2
Electric shock	2	.5
Psychological/Emotional Causes	12	2.9
Unknown cause	162	39.3
Total	412	100.0

Table 1 presents the most common cause was heart attack or heart problems, accounting for 35.2%. Other significant causes included stroke (5.3%), respiratory failure (5.3%), and hemorrhagic fever (3.9%).

Table 2: Experience of Significant Physical Stress or Injuries During the War.

	Frequency	Valid Percent
Yes	126	30.6
No	236	57.3
Unknown	50	12.1
Total	412	100.0

The table2 shows that, the 30.6% of respondents indicated that the deceased experienced Physical stress or injuries, 57.3% reported they did not, and 12.1% were unsure.

Table3: Psychological or Emotional Trauma Experienced by the Deceased Due to the War.

	Frequency	Valid Percent
Yes	325	78.9
No	85	20.6
Unknown	2	.5
Total	412	100.0

The table 3 shows that, the 78.9% of respondents indicated that the deceased experienced psychological or emotional trauma

Table 4: Pre-War Illness Diagnosis of the Deceased.

	Frequency	Valid Percent
Yes	127	30.8
No	283	68.7
Unknown	2	.5
Total	412	100.0

The table 4 shows that, the 30.8% of respondents reported that the deceased had been diagnosed with an illness, while 68.7% stated they had not. Only 0.5% were unsure. The total number of valid responses were 412.

Table5: Pre-War Disease Diagnosis Among the Deceased.

	Frequency	Valid Percent
Hypertension and Diabetes	13	3.2
Hypertension	32	7.8
Diabetes	22	5.3
Rheumatism	1	2.
Neurological Disorders (Alzheimer's, Parkinson's, Stroke and Epilepsy)	10	2.4
Systemic Lupus Erythematosus	1	2.
Renal Failure	3	7.
Thyroid disorders	1	2.
Cancer	4	1.0
Cardiac disorders	16	3.9
Asthma	4	1.0
Prostatic disorders	3	7.
Psychological disorders	4	1.0
Other	12	2.9
N\A	286	69.4
Total	412	100.0

The table 5 shows that most of the diseases diagnosed in the deceased before the war were hypertension and diabetes (3.2%), hypertension alone (7.8%), and diabetes alone (5.3%). Other conditions included cardiac disorders (3.9%), neurological disorders (2.4%), and cancer (1.0%). A significant portion of respondents (69.4%) indicated that no disease diagnosis was known.

Table 6: Post-War Disease Diagnosis Among the Deceased.

Physical Disease Diagnosis		
	Frequency	**Valid Percent**
Yes	71	17.2
No	327	79.4
Unknown	14	3.4
Total	412	100.0
Psychological Conditions Diagnosis		
Yes	46	11.2
No	246	59.7
Unknown	120	29.1
Total	412	100.0

The table 6 shows that, the 79.4% of respondents reported that the deceased had not been diagnosed with a disease after the war began.For psychological conditions, the majority (59.7%) stated that the deceased were not diagnosed with any psychological condition.

Table 7: Psychological Stress Symptoms Among the Deceased.

	Frequency	**Valid Percent**
Yes	211	51.2
No	92	22.3
Unknown	109	26.5
Total	412	100.0

The table 7 that, 51.2% of the deceased experienced symptoms of psychological stress such as depression, anxiety, or PTSD.

Table 8: Factors Associated with Sudden Death: Analysis of Age, Gender, Occupation, and Psychological, Health, and Social Impacts".

age and the cause of sudden death.			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	79.270[a]	48	.003
age and the cause of sudden death			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	20.053[a]	6	.003
Age and Experience of Physical Stress or Injuries During War			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	20.053[a]	6	.003
Factors Contributing to Sudden Death Based on Gender			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	26.594[a]	8	.001
Emotional Impact of Sudden Death on Families			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	58.210[a]	21	.000
Financial Impact of Sudden Death on Families			
Pearson Chi-Square	55.646	21	.000
Occupation of the Deceased and Experience of Physical stress During the War			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	57.663[a]	26	.000
Occupation of the Deceased and Experience of psychological trauma During the War			
Pearson Chi-Square	250.912	26	. 000

12Occupation of the Deceased and Access to Healthcare During and After the War			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	74.168[a]	39	.001
Occupation and Contributing Factors to Sudden Death			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	236.286[a]	104	.000

Table 8 reveals statistically significant relationships between demographic and occupational factors and the causes of sudden death. Age is significantly associated with the cause of sudden death, as well as the likelihood of experiencing physical stress or injuries during the war ($p < 0.05$). Gender also plays a role, with males more frequently reporting physical injuries, while females emphasize healthcare deficiencies. Sudden death has a substantial emotional and financial impact on families. Occupation is strongly linked to experiences of physical stress and psychological trauma during the war, with statistically significant results for both physical (57.663) and psychological trauma (250.912) ($p < 0.05$). Additionally, occupation influences access to healthcare during and after the war, where employees and retirees had the highest levels of continuous access, while teachers and freelance workers faced the most difficulties. There is also a significant association between occupation and contributing factors to sudden death, with pre-existing health conditions and psychological trauma being the most reported causes. Employees and retirees exhibited high levels of psychological trauma, while soldiers and employees were notably affected by physical injuries sustained during the war.

Discussion:

This study expands on the socio-demographic profile, etiology, and risk factors for war-related sudden death, emphasizing the psychological and health consequences. The findings indicate that 60.9% of the deceased were male, and 77.4% were aged 36 years and above, aligning with previous studies that link war-related stress to higher cardiovascular disease risks in older populations[12]. Evidence suggests that older individuals are particularly vulnerable due to increased physical and psychological burdens associated with war exposure.

The study found that 35.2% of sudden deaths were attributed to cardiovascular diseases, 5.3% to strokes, and 5.3% to respiratory failure, confirming previous research on war-induced stress elevating cardiovascular events, displacement, and unaffordable medical care[13]. Psychological

trauma, reported in 54.4% of cases, plays a significant role in health deterioration, exacerbating chronic illnesses and increasing the risk of sudden death[14].

A major issue highlighted by the study is the lack of access to proper healthcare, with 37.4% of respondents reporting no available medical services during the war, consistent with data from other conflict zones, such as Syria, where infrastructure destruction led to preventable deaths[15]. Furthermore, 47.8% of respondents experienced delays in emergency care, mirroring global patterns in conflict-affected regions where logistical and security challenges prevent timely medical intervention[16].

The study found that 78.9% of the deceased experienced psychological trauma, while 30.6% endured physical stress. Research by Heszlein-Lossius supports these findings, indicating that war survivors frequently develop stress-related disorders that contribute to long-term health deterioration[17]. Additionally, 30.8% of the deceased had pre-existing illnesses, suggesting that war-related stress and inadequate medical care may have worsened pre-existing conditions[18].

A significant correlation was found between age, gender, occupation, and cause of sudden death ($p < 0.05$). Occupational factors played a major role, with employees and retirees showing higher levels of psychological trauma, whereas soldiers and manual workers exhibited greater physical stress. Findings from post-war Bosnia and Herzegovina support this, showing that individuals in economically unstable environments experience heightened psychological distress[19]. Furthermore, freelancers and teachers faced the greatest healthcare access challenges, reflecting structural inequities in conflict-zone healthcare systems[20].

Overall, this study strengthens the growing body of evidence linking war to increased mortality through psychological trauma, healthcare system failures, and exacerbation of chronic conditions. Additional research is needed to develop targeted mental health interventions and improve healthcare access for the most vulnerable populations in conflict settings[21].

Conclusion:

This study revealed the significant impact of armed conflict on sudden death in Sudan, with psychological trauma, limited healthcare access, and worsening chronic conditions being major contributing factors. Males, the elderly, and urban residents were the most affected, with cardiovascular diseases and strokes as leading causes. Occupational risks were also evident, especially among employees, retirees, and soldiers.

The study recommends urgent

interventions to expand emergency services, provide mental health support, and enhance mobile and telemedicine units. Special attention should be given to vulnerable occupational groups. Future research should explore long-term health effects and strategies for rebuilding healthcare systems in conflict-affected areas.

LIMITATIONS

This study acknowledges several limitations that may impact its findings. The use of purposive sampling, while effective for gathering in-depth information, may introduce sampling bias and limit the representativeness of the study population. Additionally, the inability to independently verify causes of death presents a challenge in ensuring data accuracy. Security risks and population displacement also posed significant constraints on data collection, restricting access to certain affected groups. Furthermore, recall bias may have influenced participants' responses, particularly regarding psychological distress and healthcare access. Lastly, the findings may not be fully generalizable to other conflicts or regions, as war-related health outcomes vary based on contextual factors.

ACKNOWLEDGMENT

Our heartfelt appreciation goes out to the Sudanese people who continue to endure the hardships of war, especially those who have lost loved ones or suffered greatly. Our commitment to tackling impactful problems is fueled by their resilience. It is with deep gratitude that we acknowledge the outstanding leadership and invaluable contribution of Dr. Henry V. Doctor, who is the Coordinator for Information Systems for Health at the World Health Organization, Regional Office for the Eastern Mediterranean. We have been guided by his guidance throughout our research. lastly, we thank everyone who supported us in bringing this work to fruition.

CONFLICT OF INTEREST

The authors declare no conflicts of interest related to this study. This research was conducted independently, without any financial, institutional, or personal affiliations that could influence the findings. The results presented are based solely on data analysis and objective interpretation, ensuring scientific integrity and neutrality

References:

1. Levy BS, Sidel VW, editors. War and Public Health. Oxford: Oxford University Press; 2008.
2. International Committee of the Red Cross. ICRC. In: How is the term "armed conflict" defined in international humanitarian law? [Internet]. 2024. p. 13–4. Available from: https://www.icrc.org
3. Murray CJL, King BA, Lopez AN,

Tomijima AE. Armed conflict as a public health problem. [Details missing—please provide journal name, year, volume, and pages].

4. World Health Organization. Sudan - WHO 2024 Health Emergency Appeal [Internet]. 2024. Available from: https://cdn.who.int/media/docs/default-source/documents/emergencies/2024-appeals/sudan---who-2024-health-emergency-appeal.pdf
5. EMRO. Sudan Health Emergency - Situation Report No. 4 - 15 December 2023 [Internet]. 2023. Available from: https://www.emro.who.int/images/stories/sudan/WHO-Sudan-conflict-situation-report-15-December_2023.pdf
6. Sapre AA, Singh S. Between war and peace: Exploring the role of refugee law in the context of Sudan political conflict. Int Migr. 2024;62(4):41–56.
7. Korinek K, Young Y, Teerawichitchainan B, Chuc NTK, Kovnick M, Zimmer Z. Is war hard on the heart? Gender, wartime stress, and late-life cardiovascular conditions in a population of Vietnamese older adults. Soc Sci Med. 2020;265:113380.
8. Al Sadig Al Mahdi T, Fahal AH, El Mardi AS. Health ramifications and recovery avenues for Sudan's April 2023 armed conflict: A review. Sudan J Med Sci [Internet]. 2024;19(1):132–48. Available from: https://www.ajol.info/index.php/sjms/article/view/269013/253922
9. Badri R, Dawood I. The implications of the Sudan war on healthcare workers and facilities: a health system tragedy. Confl Health [Internet]. 2024;18(1):22. Available from: http://dx.doi.org/10.1186/s13031-024-00581-w
10. Martineau T, Ensor T, Fustukian S, Ssengooba F, Chirwa Y, Vong S, et al. Leaving no one behind: lessons on rebuilding health systems in conflict- and crisis-affected states. [Details missing—please provide journal name, year, volume, and pages].
11. Haar R, Rayes D, Tappis H, Rubenstein L, Rihawi A, Hamze M, et al. The cascading impacts of attacks on health in Syria: A qualitative study of health system and community impacts. PLoS Glob Public Health. 2024;4(6):e0002967.
12. Papautsky EL, Rice DR, Ghoneima H, McKowen ALW, Anderson N, Wootton AR, et al. Characterizing health care delays and interruptions in the United States during the COVID-19 pandemic: Internet-based, cross-sectional survey study. J Med Internet Res. 2021;23(5):e25446.
13. Heszlein-Lossius H, Ismail A, Al-

Borno Y, Shaqqoura S, Skaik N, Al Hinnawi I, et al. Long-term health effects after conflict-related traumatic amputation among patients in Gaza. Lancet. 2021;398:S30.

14. Zeleke TK, Ayal BM, Chanie GS, Alemu MA, Limenh LW, Yismaw MB, et al. Worsening of medication non-adherence among patients with chronic diseases during times of armed conflict in the war-torn region of Ethiopia. Sci Afr. 2024;25:e02336.
15. Comtesse H, Powell S, Soldo A, Hagl M, Rosner R. Long-term psychological distress of Bosnian war survivors: An 11-year follow-up of former displaced persons, returnees, and stayers. BMC Psychiatry. 2019;19:1–10.
16. Bwirire D, Crutzen R, Ntabe Namegabe E, Letschert R, de Vries N. Health inequalities in post-conflict settings: A systematic review. PLoS One. 2022;17(3):e0265038.
17. Devakumar D, Birch M, Osrin D, Sondorp E, Wells JC. The intergenerational effects of war on the health of children. BMC Med. 2014;12:57.
18. 1Iqbal Z, Zorn C. The political economy of child soldiering. J Peace Res. 2010;47(5):537–47.
19. Catani C. War at home—A review of the relationship between war trauma and family violence. Trauma Violence Abuse. 2010;11(3):159–68.
20. Akbulut-Yuksel M. War during childhood: The long-run effects of warfare on health. J Health Econ. 2014;36:61–76.
21. Patel RB, Burkle FM Jr. Rapid urbanization and the growing threat of violence and conflict: A 21st-century crisis. Prehosp Disaster Med. 2012;27(2):194–7