ORIGINAL ARTICLE

# Sudden Death Among Sudanese Civilians Displaced to Egypt During the Sudan War (April 2023–November 2024): A Retrospective Case Series

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## Abstract

**Background.** The Sudanese war, which began in April 2023, resulted in substantial population displacement and disruption of healthcare services. Sudanese civilians displaced to neighboring countries, including Egypt, experienced major changes in access to healthcare and continuity of management of chronic diseases. Sudden and unexpected deaths were observed among displaced Sudanese civilians during this period.

**Objective.** To describe the demographic characteristics, previous medical conditions, and selected risk factors among Sudanese civilians who died suddenly after displacement to Egypt during the Sudanese war from April 2023 to November 2024.

**Methods.** This retrospective descriptive case-series study reviewed medical records of Sudanese civilians who died unexpectedly in Egypt during the study period. Information regarding demographic characteristics, previous medical conditions, presenting complaints, examination findings, and available investigation results was collected. Associations between age, sex, and selected medical conditions were analyzed using the chi-square test or Fisher's exact test, as appropriate.

**Results.** The final statistical analysis included 141 individuals, comprising 73 males (51.8%) and 68 females (48.2%). The age distribution ranged from younger than 20 years to 80 years or older, with the largest proportion aged 60–69 years (33, 23.4%). Hypertension was the most frequently documented medical condition (74, 52.5%), followed by diabetes mellitus (46, 32.6%), a family history of sudden death (42, 29.8%), ischemic heart disease/angina pectoris (35, 24.8%), and smoking (32, 22.7%). A significant association was observed between sex and previous brain hemorrhage (Fisher's exact test, $p = 0.0025$). Smoking was also significantly associated with sex ($\chi^2 = 21.16$, $p < 0.001$). Age was significantly associated with hypertension ($\chi^2 = 27.56$, $p < 0.001$), smoking ($\chi^2 = 18.78$, $p = 0.009$), and reported drug abuse ($\chi^2 = 19.82$, $p = 0.006$).

**Conclusion.** This case series demonstrates a substantial burden of cardiovascular, metabolic, cerebrovascular, and other chronic medical conditions among Sudanese civilians who died suddenly after displacement to Egypt during the war. The findings emphasize the vulnerability of displaced populations, particularly those with chronic diseases, during periods of conflict and disruption of healthcare services. Further studies using standardized definitions and systematic determination of causes of death are needed.

**Keywords:** *Sudden death; Sudan; War; Displacement; Egypt; Hypertension; Diabetes mellitus; Cardiovascular disease; Epilepsy; Cerebrovascular disease.*

## 1. Introduction

On 15 April 2023, armed conflict erupted in Khartoum between the Sudanese Armed Forces (SAF) and the Rapid Support Forces (RSF). The conflict subsequently spread to other parts of Sudan, resulting in extensive loss of life, destruction of property, internal displacement, and large-scale migration to neighboring countries [1–3].

The conflict also placed considerable pressure on the Sudanese healthcare system. Healthcare facilities were disrupted, healthcare workers were displaced, and access to medications and routine medical follow-up became increasingly difficult. These consequences were particularly important for individuals living with chronic diseases requiring continuous treatment and monitoring [2,4–7].

Egypt became one of the major destinations for Sudanese civilians seeking safety and medical care. During this period, the investigators observed a number of sudden and unexpected deaths among Sudanese civilians displaced to Egypt. The humanitarian response in Egypt was therefore confronted with the health needs of a displaced population with substantial pre-existing medical requirements [4,6,8,9].

Sudden death may result from a wide range of cardiovascular, cerebrovascular, neurological, metabolic, toxicological, and other causes. Cardiovascular disease remains an important cause of sudden death, particularly among individuals with hypertension, diabetes mellitus, dyslipidemia, smoking, atherosclerosis, and established ischemic heart disease [10,11]. Cerebrovascular disorders may also result in sudden or rapidly progressive death. Other recognized causes include pulmonary embolism, epilepsy-related death, drug toxicity, and acute organ failure [11,12].

The relationship between armed conflict and mortality is complex. War may cause direct mortality through trauma and injury, while its indirect effects may include psychological stress, disruption of chronic disease management, interruption of medications, nutritional problems, and reduced access to emergency and preventive healthcare [2,4–7].

The investigators therefore sought to characterize sudden deaths occurring among Sudanese civilians displaced to Egypt during the Sudanese war and to describe the demographic and medical characteristics of this population.

## 2. Problem Statement and Justification

The investigators observed what appeared to be an increase in sudden and unexpected deaths among Sudanese civilians during the period of war and displacement. However, reliable data describing the characteristics and medical background of such deaths among displaced Sudanese populations are limited.

Sudden death is a major clinical and public health concern because it may occur without warning and may result from multiple underlying conditions [10–12]. Identifying the demographic and medical characteristics of affected individuals may help healthcare providers

recognize vulnerable groups and improve continuity of care during humanitarian crises.

The displacement of individuals with chronic diseases may be particularly important because interruption of regular treatment and follow-up can potentially increase the risk of adverse outcomes [2,4–7].

## 3. Objective

To describe the demographic characteristics, previous medical conditions, and selected risk factors among Sudanese civilian, non-military individuals who died suddenly after displacement to Egypt during the Sudanese war from April 2023 to November 2024.

## 4. Methods

### 4.1. Study Design and Setting

This was a retrospective descriptive case-series study of Sudanese civilians who died unexpectedly in Egypt during the Sudanese war between April 2023 and November 2024.

### 4.2. Study Population

The study population consisted of Sudanese civilian, non-military individuals who died unexpectedly from non-violent causes during the study period.

A total of 141 individuals were included in the final statistical analysis.

### 4.3. Definition of Sudden Death

For the purposes of the study, sudden death was defined as an unexpected death occurring within 24 hours of the onset of symptoms of the final clinical presentation.

### 4.4. Data Collection

Information was retrospectively obtained from available medical records. The collected variables included:

1. Demographic characteristics.
2. History of pre-existing diseases.
3. Major presenting complaints.
4. Clinical examination findings.
5. Available laboratory and other investigation results.
6. Selected cardiovascular, neurological, metabolic, and other risk factors.
7. Family history of sudden death.

### 4.5. Statistical Analysis

Data were entered and analyzed using SPSS for Windows, version 13.0. Descriptive statistics were used to summarize demographic characteristics and medical conditions.

Associations between categorical variables were examined using the chi-square test or Fisher's exact test when expected cell counts were small. Cross-tabulation was used to assess associations between sex, age, and selected medical conditions.

A p-value of <0.05 was considered statistically significant.

## 5. Results

### 5.1. Demographic Characteristics

A total of 141 individuals were included in the final statistical analysis. There were 73 males (51.8%) and 68 females (48.2%).

The age distribution ranged from younger than 20 years to 80 years or older. The largest age group was 60–69 years, comprising 33 individuals (23.4%), followed by 50–59 years with 30 individuals (21.3%) and 70–79 years with 26 individuals (18.4%).

### 5.2. Medical History and Risk Factors

Hypertension was the most frequently documented medical condition, affecting 74 individuals (52.5%). Diabetes mellitus was reported in 46 individuals (32.6%), while a family history of sudden death was documented in 42 (29.8%).

Ischemic heart disease/angina pectoris was documented in 35 individuals (24.8%). Smoking was reported in 32 (22.7%), atherosclerosis in 29 (20.6%), and high serum cholesterol in 28 (19.9%).

Kidney disease was documented in 24 individuals (17.0%), autoimmune disease in 17 (12.1%), epilepsy in 15 (10.6%), and brain hemorrhage in 13 (9.2%). Drug abuse was reported in 6 individuals (4.3%).

### 5.3. Association Between Sex and Previous Medical History

A statistically significant association was observed between sex and a history of brain hemorrhage. Brain hemorrhage was reported in 12 males and one female. Fisher's exact test demonstrated statistical significance ($p = 0.0025$).

Smoking history was also significantly associated with sex. Smoking was reported in 28 males and 4 females. The association was statistically significant ($\chi^2 = 21.16$, $p < 0.001$), and Fisher's exact test confirmed the statistical significance.

### 5.4. Association Between Age and Previous Medical History

Age at death was significantly associated with hypertension ($\chi^2 = 27.56$, $p < 0.001$). Hypertension was more frequently documented among individuals aged 50 years and older.

Age was also significantly associated with smoking history ($\chi^2 = 18.78$, $p = 0.009$).

A significant association was observed between age and reported drug abuse ($\chi^2 = 19.82$, $p = 0.006$). Although the number of individuals reporting drug abuse was small, the cases were distributed predominantly among younger participants and selected older age groups.

No statistically significant association was reported between age and some other medical conditions, including angina pectoris and brain hemorrhage.

***Table 1. Demographic Characteristics of the Study Population***

| Variable | Group | Frequency | Percentage |
|---|---|---|---|
| Sex | Male | 73 | 51.8% |
| | Female | 68 | 48.2% |
| Age at death | <20 years | 5 | 3.5% |
| | 20–29 years | 9 | 6.4% |
| | 30–39 years | 15 | 10.6% |
| | 40–49 years | 12 | 8.5% |
| | 50–59 years | 30 | 21.3% |
| | 60–69 years | 33 | 23.4% |
| | 70–79 years | 26 | 18.4% |
| | ≥80 years | 11 | 7.8% |

*Table 2. Previous Medical Conditions and Selected Risk Factors*

| Medical Condition / Risk Factor | Frequency | Percentage |
|---|---|---|
| Hypertension | 74 | 52.5% |
| Diabetes mellitus | 46 | 32.6% |
| Family history of sudden death | 42 | 29.8% |
| Angina pectoris / ischemic heart disease | 35 | 24.8% |
| Smoking | 32 | 22.7% |
| Atherosclerosis | 29 | 20.6% |
| High serum cholesterol | 28 | 19.9% |
| Heat stroke | 25 | 17.7% |
| Kidney disease | 24 | 17.0% |
| Autoimmune disease | 17 | 12.1% |
| Epilepsy | 15 | 10.6% |
| Brain hemorrhage | 13 | 9.2% |
| Transient ischemic attacks | 9 | 6.4% |
| Drug abuse | 6 | 4.3% |

*Table 3. Association Between Sex and Previous Brain Hemorrhage*

| Sex | Brain Hemorrhage: Yes | No | Total |
|---|---|---|---|
| Male | 12 | 61 | 73 |
| Female | 1 | 67 | 68 |

*Fisher's exact test: $p = 0.0025$.*

*Table 4. Association Between Sex and Smoking History*

| Sex | Smoker | Non-smoker | Total |
|---|---|---|---|
| Male | 28 | 45 | 73 |
| Female | 4 | 64 | 68 |

*$\chi^2 = 21.16$; $p < 0.001$.*

*Table 5. Association Between Age and Previous Hypertension*

| Age Group | Hypertension : Yes | No | Total |
|---|---|---|---|
| <20 years | 0 | 5 | 5 |
| 20–29 years | 2 | 7 | 9 |
| 30–39 years | 4 | 11 | 15 |
| 40–49 years | 3 | 9 | 12 |
| 50–59 years | 16 | 14 | 30 |
| 60–69 years | 21 | 12 | 33 |
| 70–79 years | 18 | 8 | 26 |
| ≥80 years | 10 | 1 | 11 |

*$\chi^2 = 27.56$; $p < 0.001$.*

*Table 6. Association Between Age and Smoking History*

| Age Group | Smoker | Non-smoker | Total |
|---|---|---|---|
| <20 years | 3 | 2 | 5 |
| 20–29 years | 2 | 7 | 9 |
| 30–39 years | 2 | 13 | 15 |
| 40–49 years | 1 | 11 | 12 |
| 50–59 years | 4 | 26 | 30 |
| 60–69 years | 6 | 27 | 33 |
| 70–79 years | 7 | 19 | 26 |
| ≥80 years | 7 | 4 | 11 |

*$\chi^2 = 18.78$; $p = 0.009$.*

*Table 7. Association Between Age and Reported Drug Abuse*

| Age Group | Drug Abuse: Yes | No | Total |
|---|---|---|---|
| <20 years | 2 | 3 | 5 |
| 20–29 years | 0 | 9 | 9 |
| 30–39 years | 0 | 15 | 15 |
| 40–49 years | 0 | 12 | 12 |
| 50–59 years | 2 | 28 | 30 |
| 60–69 years | 0 | 33 | 33 |
| 70–79 years | 1 | 25 | 26 |
| ≥80 years | 1 | 10 | 11 |

*$\chi^2 = 19.82$; $p = 0.006$.*

## 6. Discussion

This retrospective case series describes the demographic characteristics and medical history of Sudanese civilians who died suddenly after displacement to Egypt during the Sudanese war. The principal findings were the predominance of older individuals and the high frequency of hypertension, diabetes mellitus, cardiovascular disease, smoking, and a family history of sudden death. Significant associations were also identified between sex and smoking, sex and previous brain hemorrhage, and age and hypertension, smoking, and reported drug abuse.

The age distribution is an important finding. The largest proportion of participants was aged 60–69 years, followed by those aged 50–59 and 70–79 years. Thus, a substantial proportion of the study population consisted of older adults. This finding suggests that sudden deaths in this case series occurred frequently among individuals with a considerable background burden of chronic disease. However, because the study did not include a control group or a population denominator, it cannot establish that older age was an independent risk factor for sudden death in this displaced population.

Hypertension was the most frequently documented medical condition, affecting 52.5% of the study population. Diabetes mellitus was present in 32.6%, while ischemic heart disease/angina pectoris was reported in 24.8%. These findings indicate a substantial burden of cardiovascular and metabolic disease among the deceased. The coexistence of hypertension, diabetes, dyslipidemia, and atherosclerosis is particularly relevant because these conditions may contribute to cardiovascular and cerebrovascular morbidity [10,11].

Nevertheless, it is important to distinguish between a pre-existing medical condition and the established cause of death. The presence of hypertension or diabetes in an individual who died suddenly does not, by itself, establish that the disease caused the terminal event. Therefore, the findings of this study should be interpreted as describing comorbidities and potential risk factors rather than confirmed causes of death unless the medical records provide adequate evidence of a specific terminal diagnosis.

The significant association between age and hypertension is consistent with the higher burden of hypertension observed in the older age groups. Individuals aged 50 years and older accounted for most of the participants with documented hypertension. In the context of war and displacement, the management of hypertension may be further complicated by interruptions in medical follow-up, difficulty obtaining medications, financial constraints, and changes in living conditions. However, these factors were not systematically measured in the present study and therefore cannot be considered demonstrated mechanisms [2,4–7].

Diabetes mellitus was documented in nearly one-third of the study population. Diabetes may contribute to cardiovascular and cerebrovascular risk, particularly when associated with hypertension, dyslipidemia, and atherosclerosis. The simultaneous presence of these conditions in the study population may indicate a substantial burden of vascular risk. However, the retrospective nature of the study and the absence of detailed information regarding glycemic control, duration of diabetes, treatment adherence, and complications limit interpretation of their contribution to individual deaths [10,11].

Smoking was reported in 22.7% of participants and was significantly more common among males than females. Twenty-eight males and four females were reported to be smokers. The statistical association between sex and smoking was strong. However, the analysis was unadjusted and therefore cannot establish smoking as an independent determinant of sudden death. Age and other cardiovascular risk factors may act as confounding variables [10,11].

A family history of sudden death was reported in 29.8% of participants. This is a potentially important observation because a family history of sudden death may occasionally indicate an inherited predisposition to cardiovascular or other disorders associated with sudden mortality [12]. However, the study did not provide sufficient information regarding the age, circumstances, or documented cause of death of affected relatives. Consequently, the finding should be interpreted cautiously.

Previous brain hemorrhage was documented in 13 individuals and was significantly more frequent among males than females. Although the association was statistically significant, the number of affected participants was small. The finding therefore requires cautious interpretation and confirmation in larger studies. In addition, the present study cannot determine whether previous brain hemorrhage contributed directly to the final death.

Epilepsy was documented in 15 individuals (10.6%). Epilepsy deserves specific consideration in any study of sudden unexpected death because sudden unexpected death in epilepsy (SUDEP) is a recognized cause of mortality among people with epilepsy [13,14]. However, the available data in this case series are insufficient to classify these deaths as SUDEP. Such classification generally requires exclusion of another cause of death and adequate information concerning the circumstances of the death [13,14].

The present manuscript does not provide sufficient information regarding seizure type, seizure frequency, medication adherence, nocturnal seizures, circumstances of death, or postmortem findings. Accordingly, epilepsy should be regarded as an important pre-existing neurological condition in this study rather than a confirmed cause of death. Future investigations should specifically evaluate seizure control, generalized tonic-clonic seizures, antiseizure medication use, medication interruption, nocturnal seizures, and the circumstances surrounding death in individuals with epilepsy [13,14].

The association between age and reported drug abuse was statistically significant. However, the total number of individuals reporting drug abuse was only six. Consequently, the statistical finding should be interpreted cautiously, particularly because small cell counts can produce unstable estimates and increase the possibility of chance findings. Further studies with larger samples are required to clarify the relationship between substance use and sudden death in displaced Sudanese populations.

The war and displacement context is an important component of interpreting these findings. Armed conflict can influence mortality directly through trauma and indirectly through disruption of healthcare systems and deterioration of living conditions. Displaced individuals may experience interruptions in treatment, reduced access to medications, delayed presentation to healthcare facilities, psychological stress, nutritional challenges, and reduced social support [2,4–7].

However, the present study cannot establish a causal relationship between displacement or the war and the individual deaths observed. There was no comparison group of Sudanese civilians who remained in Sudan or of Sudanese civilians living in Egypt before the war, and no population denominator was available. The study therefore describes a series of deaths occurring during the period of displacement rather than estimating the excess mortality attributable to war or displacement.

The findings nevertheless have important implications for humanitarian healthcare. The high frequency of hypertension, diabetes, cardiovascular disease, and other chronic conditions among the deceased emphasizes the importance of maintaining continuity of care for chronic diseases among displaced populations. Humanitarian health programs should not focus exclusively on acute trauma and infectious diseases; they should also ensure access to essential medications, blood pressure and glucose monitoring, cardiovascular care, neurological care, and emergency services [5–7].

### *6.1. Strengths and Limitations*

The principal strength of this study is that it describes an understudied population of Sudanese civilians who died suddenly after displacement to Egypt during a major humanitarian crisis. The study also provides information on a broad range of cardiovascular, neurological, metabolic, and other medical conditions.

Several limitations should be considered. First, this was a retrospective case-series study without a control group or population denominator; therefore, incidence rates, relative risks, and causal relationships cannot be established. Second, the study depended on available medical records, which may have been incomplete or inconsistently documented.

Third, the available data do not consistently distinguish between pre-existing comorbidities, risk factors, immediate causes of death, and underlying causes of death. Fourth, the available information is insufficient to establish specific diagnoses such as SUDEP in individuals with epilepsy. Fifth, potential confounding factors were not controlled for through multivariable statistical analysis. Finally, important contextual variables such as medication adherence, access to healthcare, socioeconomic status, duration and control of chronic diseases, and circumstances surrounding death were not systematically analyzed.

## 7. Conclusion

This retrospective case series describes sudden deaths among Sudanese civilians displaced to Egypt during the Sudanese war and demonstrates a substantial burden of chronic cardiovascular, metabolic, cerebrovascular, neurological, and other medical conditions in this population.

Hypertension was the most frequently documented medical condition, followed by diabetes mellitus and ischemic heart disease/angina pectoris. Significant associations were observed between sex and smoking, sex and previous brain hemorrhage, and age and hypertension, smoking, and reported drug abuse.

The findings highlight the vulnerability of displaced populations with chronic diseases during armed conflict and disruption of healthcare services. However, the present study does not establish causal relationships between the documented medical conditions, displacement, the war, and individual deaths.

Future multicenter studies should use a standardized definition of sudden death, systematically determine the immediate and underlying causes of death, include an appropriate comparison population, and evaluate the effects of healthcare disruption, medication interruption, and displacement on mortality among Sudanese civilians.

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