Research Article ISSN 2689-1093

Surgical Research

The Influence of Sudan Armed Conflict on the Presentation of Diabetic Patients and Subsequent Surgical Intervention

ShamesEldeen Amara Amer[1,2,3], Esra Altayeb Massry[2], Hassan Mahgoub Hassan Khalifa[4], Yousif Hamid Mahmoud[5], MuhamdElhafiz Ahmed Sahal[2], Mohamed Elmustafa AbdElrazag[3,6,7], Maged Elebeid Musa[4], Mohammedbabalrahma Bashier Koko[1,2,3], Jowaireia Gaber Al-Basheer Al-Hassan[3,8], Sara Abubaker Abdallbasit[9], Eldisugi Hassan Mohammed Humida[10,11] and Hussain Gadelkarim Ahmed[12,13*]

[1]*Department of Surgery, Faculty of Medicine and Health Sciences, University of Kordofan, El-Obeid, Sudan.*

[2]*Department of General Surgery, El-Obeid Teaching Hospital, El-Obeid, Sudan.*

[3]*Sheikan College, Medicine Program, El-Obeid, Sudan.*

[4]*Department of Urology, El-Obeid Teaching Hospital, El-Obeid, Sudan.*

[5]*Department of internal Medicine, Faculty of Medicine and Health Science, University of Dalanj, Dalanj, Sudan.*

[6]*Department of Pediatrics and Child Health, Faculty of Medicine and Health Sciences, University of Kordofan, El-Obeid, Sudan.*

[7]*Department of Pediatrics and Child Health, El-Obeid Teaching Hospital, El-Obeid, Sudan.*

[8]*Department of Hematology, Faculty of Medical Laboratory Science, University of Kordofan, El-Obeid, Sudan.*

[9]*Medical student, Faculty of Medicine and Health Sciences, University of Kordofan, El-Obeid, Sudan.*

[10]*Department of Medicine, Faculty of Medicine, University of Kordofan, El-Obeid, Sudan.*

[11]*Cardiac Catheterization Laboratory, El-Obeid International Hospital, El-Obeid, Sudan.*

[12]*Prof Medical Research Consultancy Center, El-Obeid, Sudan.*

[13]*Department of Histopathology and Cytology, FMLS, University of Khartoum, Sudan.*

***Correspondence:**

Hussain Gadelkarim Ahmed, Prof Medical Research Consultancy Center, El-Obeid, Department of Histopathology and Cytology, FMLS, University of Khartoum, Sudan.

Received: 02 Sep 2025; **Accepted:** 07 Oct 2025; **Published:** 19 Oct 2025

Citation: Amara Amer SE, Altayeb Massry E, Hassan Khalifa HM, et al. The Influence of Sudan Armed Conflict on the Presentation of Diabetic Patients and Subsequent Surgical Intervention. Surg Res. 2025; 7(5): 1-5.

ABSTRACT

Background: *Surgical intervention for diabetic complications is typically performed when conservative therapies are ineffective or when significant health risks arise for the patient. This study assessed the influence of the armed conflict in Sudan on the clinical manifestations of diabetic patients and the consequent interventions.*

Methodology: *This study presents a prospective descriptive analysis conducted at El-Obeid Teaching Hospital in North Kordofan State, Sudan, over a period from May 2023 to May 2025, during a time characterized by conflict and considerable challenges in a hot zone region. Ninety-nine patients experiencing complicated diabetes due to war-related challenges were enrolled in this study.*

Results: *Most males experienced toe amputations, followed by below-knee and above-knee amputations, representing 29% and 19%, respectively. Most females underwent debridement, followed by below-knee amputation and toe amputation, accounting for 33.3%, 20%, and 16.7%, respectively. Amputation was performed on 15.2% of patients, including 17.4% of males and 10% of females.*

Conclusion: *The armed conflict in Sudan has adversely affected diabetic patients, leading to complications that require surgical intervention. The majority of surgical procedures were observed in the peri-knee and toes, mostly performed on older males.*

Keywords
Diabetes, Diabetic foot, Amputation, Surgical intervention, Sudan.

Introduction
Diabetes mellitus (DM) represents a significant health concern, emerging as a rapidly growing global epidemic characterized by an annually increasing prevalence [1]. Type 2 DM (T2DM), the most common form of the disease, is estimated to impact over 400 million individuals globally, accounting for approximately 14% of the world's population. T2DM is thought to be linked to both genetic and environmental risk factors [2,3]. DM was estimated to result in 1.66 million deaths in 2021, with age-standardized mortality increasing by 7.95% since 1990 [4].

DM is the most common endocrine disorder in surgical patients, affecting 10% of the general population and potentially reaching 25% in the surgical population. Historically, patients with diabetes undergoing surgery were categorized as high risk and often denied the benefits of day surgery. The integration of care pathways with perioperative pharmacotherapy management has markedly enhanced surgical outcomes for patients with diabetes. Notwithstanding these advancements, dysglycemia-related harm continues to be relatively prevalent. It is essential for clinicians and patients to mitigate the risks linked to hypo- and hyperglycemia [5].

Effective perioperative diabetes therapy is essential due to the increased prevalence of diabetes and the associated increase in surgeries. Diabetes must be controlled before, during, and after surgery to avoid complications. Hyperglycemia following surgery predicts worse results in diabetics and non-diabetics. Hyperglycemia slows wound healing and increases infection, ICU admissions, hospital stays, and surgical death. Diabetes—blood glucose levels exceeding 140 mg/dL—is common in general surgery (20%–40%) and cardiac surgery (80%–90%). Surgery, anesthesia, and disease stress trigger cortisol, glucagon, growth hormone, and catecholamine production. This leads to an increase in lipolysis, proteolysis, and insulin resistance, as well as a decrease in insulin secretion and peripheral glucose intake. Increased gluconeogenesis and glycogenolysis aggravate stress hyperglycemia.

Uncontrolled hyperglycemia causes osmotic diuresis, electrolyte imbalance, ketogenesis, and proinflammatory cytokines. Endothelial malfunction, mitochondrial damage, and immunological dysregulation result. Postoperative outcomes improve with proper glycemic management [6].

According to the International Diabetes Federation (IDF), 19% of Sudanese people aged 20 to 79 had diabetes as of 2024. Studies show regional differences, with higher rates in the North and significant differences between urban and rural areas; however, some statistics suggest similar rates in the past. Major risk factors for the development of diabetes in Sudan include advanced age, obesity, genetic predisposition, and hypertension [7]. This study assessed the impact of the armed conflict in Sudan on the presentation of diabetic patients and the need for subsequent surgical intervention.

Materials and Methods
This study is a prospective descriptive analysis carried out at El-Obeid Teaching Hospital, located in North Kordofan State, Sudan, spanning from May 2023 to May 2025, a period that witnessed armed conflict and significant challenges in this part of Sudan. A total of ninety-nine patients suffering from complicated diabetes, exacerbated by the challenges posed by war, were enrolled in this comprehensive study (which included a full coverage sample). All participants were patients with a prior diagnosis of diabetes who subsequently developed septic wounds as a result of complications associated with the ongoing Sudan war challenges. Patients with diabetes who required surgical interventions due to trauma and other conditions were excluded from the study. The determination to proceed with surgical intervention was informed by established guidelines from other sources [8]. After each patient gave their verbal agreement, the hospital settlement records were used to record the patients' key identifying information.

Statistical analysis
All collected data variables were organized in a designated data sheet and subsequently input into the Statistical Package for Social Sciences (SPSS) software (Version 27, IBM Inc., Chicago). Frequencies, percentages, cross-tabulations, and chi-square tests were computed. A P-value of less than 0.05 was deemed statistically significant, utilizing a 95% confidence interval (95% CI).

Results
This study included 99 individuals with diabetes aged 18-95 years, with a mean age ± standard deviation of 58.34 ± 14.58. The majority of patients were 70 years old or over, followed by those between 50 and 55 years old, accounting for 24/99 (24.2%) and

23/99 (23.2%), respectively.

Of the 99 patients, 69 (69.6%) were men, while the remaining 30 (30.4%) were women. The majority of males were over 70 years old, with age groups 50-55 and <50 years accounting for 18/69 (26%), 16 (23%), and 13 (18.8%), respectively. Table 1 and Figure 1 show that the majority of females were between the ages of 56 and 61, followed by 50-55 and ≥70 years, with 8/30 (26.6%), 7 (23.3%), and 6 (20%), respectively.

The vast majority of the patients lived in metropolitan regions, accounting for 57/99 (57.5%), with the remainder, 42/99 (42.5%), being rural residents, as shown in Table 1 and Figure 1.

Table 1: Shows the distribution of patients by gender, age, and residence.

Category	Variable	Males n=69	Females n=30	Total n=99
Age	<50 years	13	5	18
	50-55	16	7	23
	56-61	10	8	18
	62-69	12	4	16
	≥70	18	6	24
Residence	Rural	31	11	42
	Urban	38	19	57

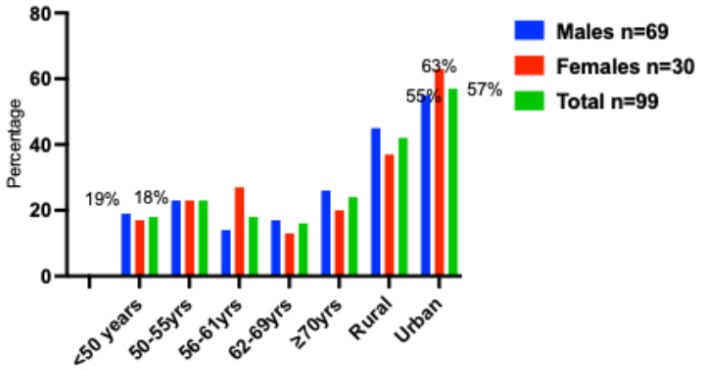

Figure 1: Depicts the patients' gender, age, and residence.

Table 2 and Figure 2 summarize the distribution of surgical intervention types based on glucose levels at the initial presentation. The majority of patients in this series received toe amputation, followed by debridement and below-knee amputation, representing 25/99 (25.3%), 21/99 (21.2%), and 19/99 (19.2%), respectively. The majority of patients with blood glucose levels <200 mg/dl had toe amputation (8/23, 34.8%). Those with blood glucose levels between 200 and 299 mg/dL had their toes amputated 10 out of 42 times (23.8%). Those with blood glucose levels of 300 mg/dl or above required debridement 10/34 (29.4%).

HbA1c was available for 17 patients, of whom 8/17 (47%) were with A1c <10%, 4/17 (23.5%) with 10.1-12%, and 5/17 (29.5%) with >12%, as indicated in Table 3.

Table 2: Shows the distribution of surgical intervention types by glucose level at initial presentation.

Type of Surgical Intervention	<200 mg/dl	200-299	300+	Total
Below Knee Amputation	6	9	4	19
Above Knee Amputation	3	5	8	16
Hand Amputation	0	0	1	1
Above Elbow Amputation	0	1	0	1
Fingers amputation	1	3	2	6
Debridement	5	6	10	21
Abscess drainage	0	3	0	3
Toes amputation	8	10	7	25
Foot amputations	0	5	2	7
Total	23	42	34	99

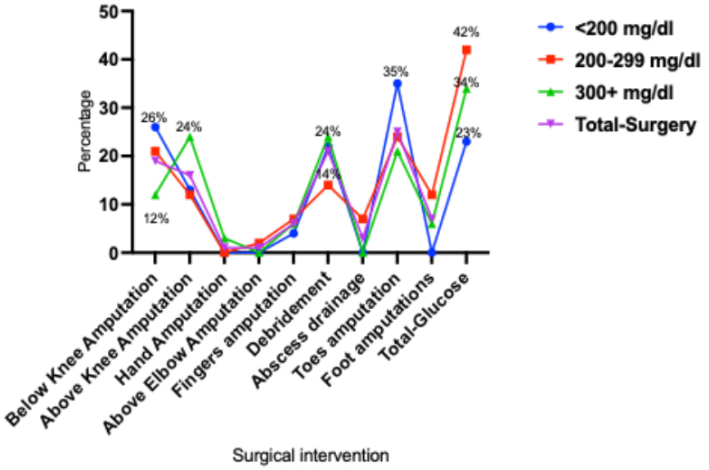

Figure 2: Surgical intervention type by glucose level at the initial presentation.

Table 3: Distribution of surgical intervention type by HbA1c level at the initial presentation.

Type of Surgical Intervention	<10%	10.1-12	>12	Total
Below Knee Amputation	3	0	2	5
Above Knee Amputation	0	0	1	1
Fingers amputation	0	0	1	1
Debridement	1	3	0	4
Toes amputation	3	1	0	4
Foot amputations	1	0	1	2
Total	8	4	5	17

Table 4, Figure 3 summarize the patient distribution according to gender and surgical intervention. The majority of males had their toes amputated first, followed by below- and above-knee amputations, which accounted for 20/69 (29%) and 13/69 (19%), respectively. The majority of females received debridement, followed by below-knee amputation and toe amputation, which accounted for 10/30 (33.3%), 6/30 (20%), and 5/30 (16.7%), respectively. Previous amputation was performed on 15/99 (15.2%) patients, including 12/69 (17.4%) men and 3/30 (10%) females. 7/15 patients (46.7%) had their toes amputated, as seen in Table 4 and Figure 3.

Table 4: Distribution of Patients by Gender and Surgical Intervention.

Variable	Males	Females	Total
Type of Surgical Intervention			
Below Knee Amputation	13	6	19
Above Knee Amputation	13	3	16
Hand Amputation	1	0	1
Above Elbow Amputation	1	0	1
Fingers amputation	3	3	6
debridement	11	10	21
Abscess drainage	2	1	3
Toes amputation	20	5	25
Foot amputations	5	2	7
Total	69	30	99
Type of Previous Amputation			
Above Knee Amputation	1	2	3
Fingers amputation	1	0	1
Debridement	3	0	3
Abscess drainage	1	0	1
Toes amputation	6	1	7
Total	12	3	15

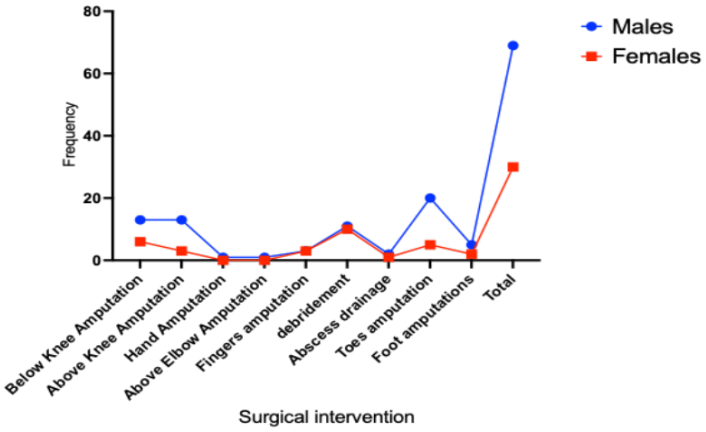

Figure 3: Depicts the patients by gender and surgical operation.

Of the 99 individuals, 97 had T2DM, while just two had T1DM. The majority of patients were diagnosed with diabetes 11-20 years ago, followed by <5 years and 6-10 years, accounting for 29/99 (29.3%), 28 (28.3%), and 27 (27.3%), respectively. Of the 99 patients, 13/99 had a history of amputation, as shown in Table 5.

Table 5: Distribution of the study population by gender and DM-related factors.

Variable	Males	Females	Total
Type of Diabetes			
Type 1 Diabetes Mellitus	1	1	2
Type 2 Diabetes Mellitus	68	29	97
Total	69	30	99
Duration with DM disease			
<5 years	19	9	28
6-10	20	7	27
11-20	17	12	29
<20	13	2	15
Total	69	30	99
Previous History of Amputation			
No	59	27	86
Yes	10	3	13
Total	69	30	99

Discussion

Diabetic patients in Sudan are in a dangerous situation due to the continuous violence, which has resulted in the collapse of medical infrastructure, drug shortages, and substantial disruptions to care. Significant obstacles include inadequate access to important medications such as insulin, power outages affecting storage capacities, financial limits, limited transit options, and diminishing food security, all of which contribute to increased complications and mortality risk [9].

This study evaluates the effects of armed conflict in Sudan on the clinical presentation of diabetic patients and the subsequent surgical interventions conducted. The results of this study indicated that the majority of patients underwent peri-knee amputation, followed by toe amputation. Diabetes may result in nephropathy, retinopathy, neuropathy, cardiovascular disease, and diabetic foot ulcers (DFUs), potentially culminating in amputation. The WHO characterizes diabetic septic foot (DSF) as an infection, ulceration, or tissue damage in the lower leg, frequently accompanied by neurological abnormalities, peripheral vascular disease, and metabolic complications associated with diabetes. In Sudan, the incidence of lower limb amputations related to diabetic foot syndrome is increasing. Various healthcare institutions employ differing management strategies, complicating the identification of the factors most strongly correlated with the highest rates [10]. DFUs represent the primary cause of amputations. DFU can lead to infections, limb dysfunction, hospitalization, amputation, and mortality. Following injury, macrophages, regulatory T cells, fibroblasts, and other cells involved in damage repair collaborate to restore and establish a healthy skin barrier. Immune dysregulation in wound healing may lead to chronicity. Hyperglycemia associated with diabetes impairs immune function, facilitates neuropathy, and delays wound healing. The production of matrix metalloproteinases, reactive oxygen species, and pro-inflammatory cytokines in the chronic wound microenvironment leads to inflammation and delayed healing. Therapies utilizing growth factors, nano formulations, microRNA, and skin grafting have enhanced therapeutic efficacy in clinical applications. Local and invasive treatments, such as wound dressings, stem cell applications, and immunomodulatory therapy, have addressed the complex pathogenesis of chronic wounds [11].

The findings of this study reveal that older males constitute the majority demographic of patients requiring surgical procedures due to diabetes-related complications. Similar findings have been previously documented in Sudan. The study identified key risk factors linked to amputations in patients with diabetic septic foot (DSF). The factors include elevated HbA1c levels, male gender, age over 50, and a history of non-healing ulcers, with poor foot care practices increasing the risk of amputation.

The findings highlight the importance of glycemic control, foot care, and patient education in preventing amputations. The research highlights the importance of metabolic regulation and foot care management in resource-constrained environments. The findings can guide local healthcare strategies regarding prevention, early intervention, and resource allocation to mitigate diabetic complications and improve patient outcomes [10].

Preventing diabetic foot surgery necessitates proactive foot health and problem avoidance strategies. Diabetes patients can significantly reduce their risk of serious foot problems that may necessitate surgery by consistently using these preventive measures. Always seek specific health advice from a professional.

The current study offers vital information about diabetic complications in Sudan during these difficult times; yet, it has limitations, including a lack of follow-up and the unavailability of specific investigations, such as HbA1c.

Conclusion

The armed conflict in Sudan adversely affects diabetic patients, leading to complications that require surgical intervention. Surgical interventions primarily involved the peri-knee and toes and were predominantly conducted on older males. Timely measurements are crucial to mitigate or eliminate the necessity for surgical procedures due to complications arising from diabetes. This treatment involves a combination of proactive management strategies aimed at maintaining diabetic control and reducing the progression of complications that could necessitate surgical intervention.

Acknowledgement

The authors extend their gratitude to the students at the Faculty of Medicine, University of Kordofan, for their invaluable assistance in the data collection process.

References

1. Tegegne BA, Adugna A, Yenet A, et al. A critical review on diabetes mellitus type 1 and type 2 management approaches: from lifestyle modification to current and novel targets and therapeutic agents. Front Endocrinol (Lausanne). 2024; 15: 1440456.
2. Młynarska E, Czarnik W, Dzieża N, et al. Type 2 Diabetes Mellitus: New Pathogenetic Mechanisms, Treatment and the Most Important Complications. Int J Mol Sci. 2025; 26: 1094.
3. Kalyani RR, Neumiller JJ, Maruthur NM, et al. Diagnosis and Treatment of Type 2 Diabetes in Adults: A Review. JAMA. 2025; 334: 984-1002.
4. Pan C, Cao B, Fang H, et al. Global burden of diabetes mellitus 1990-2021: epidemiological trends, geospatial disparities, and risk factor dynamics. Front Endocrinol (Lausanne). 2025; 16: 1596127.
5. Levy N, Rayman G. Perioperative management of diabetes mellitus and hyperglycaemia. Perioperative Medicine 2025; 53: 29-33.
6. Dogra P, Anastasopoulou C, Jialal I. Diabetic Perioperative Management. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan. 2024 Jan 25.
7. Awadalla H, Noor SK, Elmadhoun WM, et al. Diabetes complications in Sudanese individuals with type 2 diabetes: Overlooked problems in sub-Saharan Africa? Diabetes Metab Syndr. 2017; Suppl 2: S1047-S1051.
8. American Diabetes Association Professional Practice Committee. 16. Diabetes Care in the Hospital: Standards of Care in Diabetes-2025. Diabetes Care. 2025; 48(1 Suppl 1): S321-S334.
9. Alamin MH, Mamoun M, Elomeiri LESMA, et al. Exploring diabetic patients experiences during war in Sudan: insights from a multi-city study. Confl Health. 2025; 19: 35.
10. Elmubark M, Fahal L, Ali F, et al. Assessment of Risk Factors Leading to Amputation Among Diabetic Septic Foot Patients in Khartoum, Sudan. Cureus. 2024; 16: e75517.
11. Mohsin F, Javaid S, Tariq M, et al. Molecular immunological mechanisms of impaired wound healing in diabetic foot ulcers (DFU), current therapeutic strategies and future directions. Int Immunopharmacol. 2024; 139: 112713.