

The Patterns of Complications among Diabetic Patients in Kordofan, Sudan

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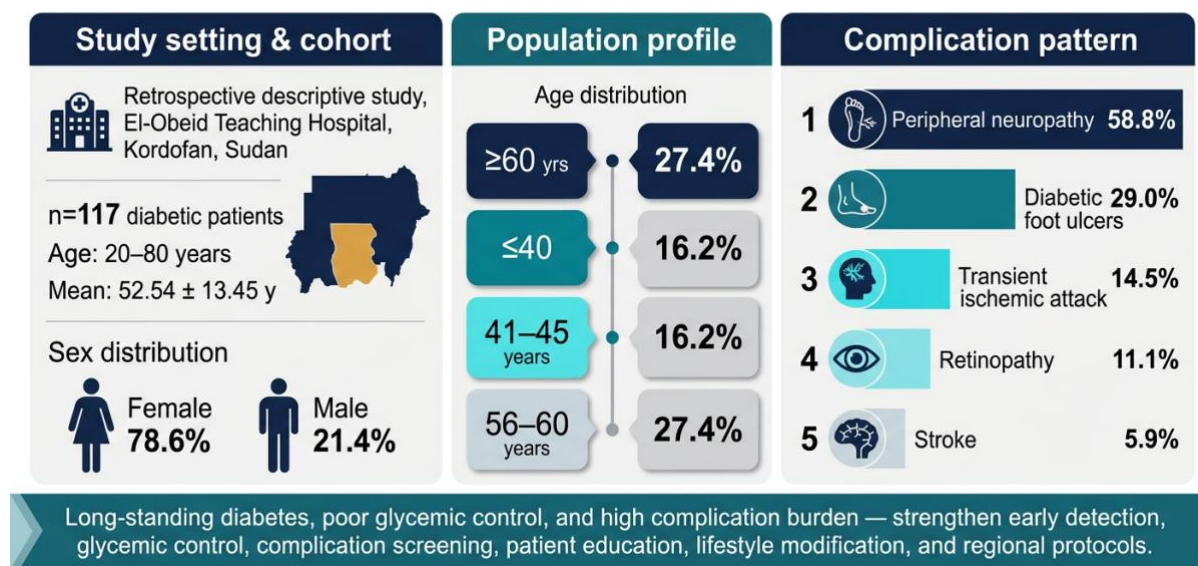
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ABSTRACT

Background: Despite the recent advances of diabetes mellitus (DM) management, a gap in overall diabetic patient care prevails; consequently, the burden of serious and devastating disease complications is in progress. Therefore, the current research seeks to investigate the limited data concerning DM complications in Kordofan, Sudan. **Methodology:** This is a retrospective descriptive study conducted at El-Obeid Teaching Hospital spanning the period from July 1, 2026, to September 3, 2026. The hospital is located in El-Obeid City, which is the largest city in Kordofan and the capital of the North Kordofan State. The sample size encompasses all the individuals admitted to the hospital with DM complications during the designated time frame without any demographic characteristics. **Results:** We studied 117 patients with diabetes, ranging in age from 20 to 80 years, with a mean age of 52.54 and standard deviation (SD) of 13.45 years. This comprises 25/117 (21.4%) males and 92 (78.6%) females. The dominant age group of the individuals was ≥ 60 years, represented by 32/117 (27.4%), followed by ≤ 40 years, 41-45, and the age group 56-60 at equal representation, 19 (16.2%). The most frequent complications observed were peripheral neuropathy (58.8%), diabetic foot ulcers (29%), transient ischemic attack (TIA) (14.5%), retinopathy (11.1%), and stroke (5.9%). **Conclusion:** diabetic patients in Kordofan generally presented with long-standing disease, poor glycemic control, and a high rate of complications. The most common complications observed were peripheral neuropathy, diabetic foot ulcers, retinopathy, transient ischemic attack (TIA), and stroke. These results emphasize the significance of early detection, optimal disease management, and timely detection and intervention for complications. In addition, regional protocols should be developed to support patient education, lifestyle changes, and standardized treatment strategies.

Keywords: Diabetes mellitus, complications, retinopathy, neuropathy, foot ulcer, stroke, TIA, Sudan.

Diabetic Complications in Kordofan States, Sudan



Introduction

Diabetes mellitus (DM), which affects over 537 million individuals in the world, remains a global health issue with a rising prevalence, alongside serious complications, disability, and mortality. Nevertheless, the disease remains poorly managed, highlighting a significant gap in overall diabetic patient care, despite recent advances in diagnosis and treatment. The global burden amounts to approximately 0.22% of the annual worldwide gross domestic product (\$10.2 trillion in 2017 dollars). DM is recently ranked as the ninth foremost cause of global mortality, with approximately one in every eleven adults suffering from the disease, with 90% of the total cases being type 2 diabetes (T2DM). T2DM affects over 400 million people globally. The disease is due to the shared effects of genetics and environmental factors. The relative deficiency of insulin, the principal pathological characteristic of T2DM, is intricately linked to both insulin resistance and B-cell dysfunction and is closely associated with the pancreatic insulin resistance and B-cell dysfunction. These mechanisms involve the dedifferentiation of B-cells, along with

mitochondrial dysfunction and oxidative stress. The Asian continent represents an emerging region of increasing global endemicity of T2DM, particularly in countries like China and India. The determinants of the recent global epidemic are many factors that interacted together to influence an individual susceptibility to T2DM; these include genetics, unhealthy diets, and sedentary lifestyles with increasing weight and reduced regular physical activity. However, the genetic components of the individual constitute the main determinants of increasing vulnerability to T2DM [1-5]. Chronic hyperglycemia that is not properly controlled and managed can lead to serious metabolic dysfunctions affecting important organs in the body, resulting in damage to tissues and organs throughout the body. Microvascular complications include diabetic neuropathy, retinopathy, and nephropathy, while macrovascular complications include diabetic heart disease and stroke. Both type 1 and type 2 diabetes have macrovascular problems such as diabetic heart disease and stroke, as well as other macrovascular issues. Diabetic

microangiopathy and macroangiopathy of the vascular system exemplify the severe long-term consequences of poor metabolic control [6,7]. Sudan, like other Sub-Saharan African countries, continues to have a high prevalence rate of DM [8, 9]. Given the ongoing armed conflict, we expect an

Materials and Methods

This is a retrospective descriptive study conducted at El-Obeid Teaching Hospital spanning from the period July 1, 2026, to September 3, 2026. The hospital is located in El-Obeid City, which is the largest city in Kordofan and the capital of the North Kordofan State. Due to the ongoing Sudanese armed conflict, the hospital serves as the primary access point for health services and caters to a large number of people from various states across the country. The sample size encompasses all the individuals admitted to the hospital with DM complications during the designated time frame without any demographic characteristics. The relevant data of the

Results

We studied 117 patients with diabetes, ranging in age from 20 to 80 years, with a mean age of 52.54 and a standard deviation (SD) of 13.45 years. This comprises 25/117 (21.4%) males and 92 (78.6%) females. The dominant age group of the individuals was ≥ 60 years, represented by 32/117 (27.4%), followed by ≤ 40 years, 41-45, and the age group 56-60 at equal representation, 19 (16.2%). Concerning the marital status of the participants, most of them were married at 98/117 (83.8%), followed by widowed and

increase in disease complications and poor metabolic control due to high treatment costs and an ill-equipped health system. Therefore, the current research seeks to investigate the limited data concerning DM complications in Kordofan, Sudan.

patients concerning the research was retrieved from the records of the hospital through a well-structured self-administered questionnaire.

Statistical analysis

After the relevant data were retrieved, we put them in the data sheet prior to being entered into the Statistical Package for Social Sciences (SPSS, version 31, IBM, Chicago, USA). Data was computed, and analysis of the variables and crosstabulations and the Pearson's square test were all done through SPSS. The 95% confidence level and interval were used with a P-value of < 0.05 , which was deemed statistically significant.

single status, constituting 9 (7.7%) and 6 (5.1%), respectively. Regarding the education level, the bulk of the patients had a primary level of education, followed by illiterate and secondary education levels with incidence rates of 50/117 (42.7%), 44 (37.6%), and 15 (12.8%), respectively. Table 1 and Figure 1 illustrated that most of the individuals were housewives, followed by unemployed and free workers, represented by 48/117 (41%), 28 (23.9%), and 18 (15.4%), respectively.

Table 1: Illustrations of the demographic characteristics of the individuals

Variable	Males n= 25	Females n= 92	Total n= 117
Age			
≤ 40 years	2	17	19
41-45	2	17	19
46-50	3	11	14
51-55	2	12	14
56-60	5	14	19
≥ 60	11	21	32
Total	25	92	117
Marital status			

Single	1	5	6
Married	22	76	98
Divorced	0	4	4
Widowed	2	7	9
Total	25	92	117
Education			
Illiterate	10	34	44
Primary	9	41	50
Secondary	2	13	15
University	3	4	7
Other	1	0	1
Total	25	92	117
Occupation			
Employee	3	10	13
Free workers	10	8	18
Farmers	4	3	7
Housewife	1	47	48
Student	0	1	1
Retired	1	1	2
Unemployed	6	22	28
Total	25	92	117
Refugees			
Yes	6	21	27
No	19	71	89
Total	25	92	117

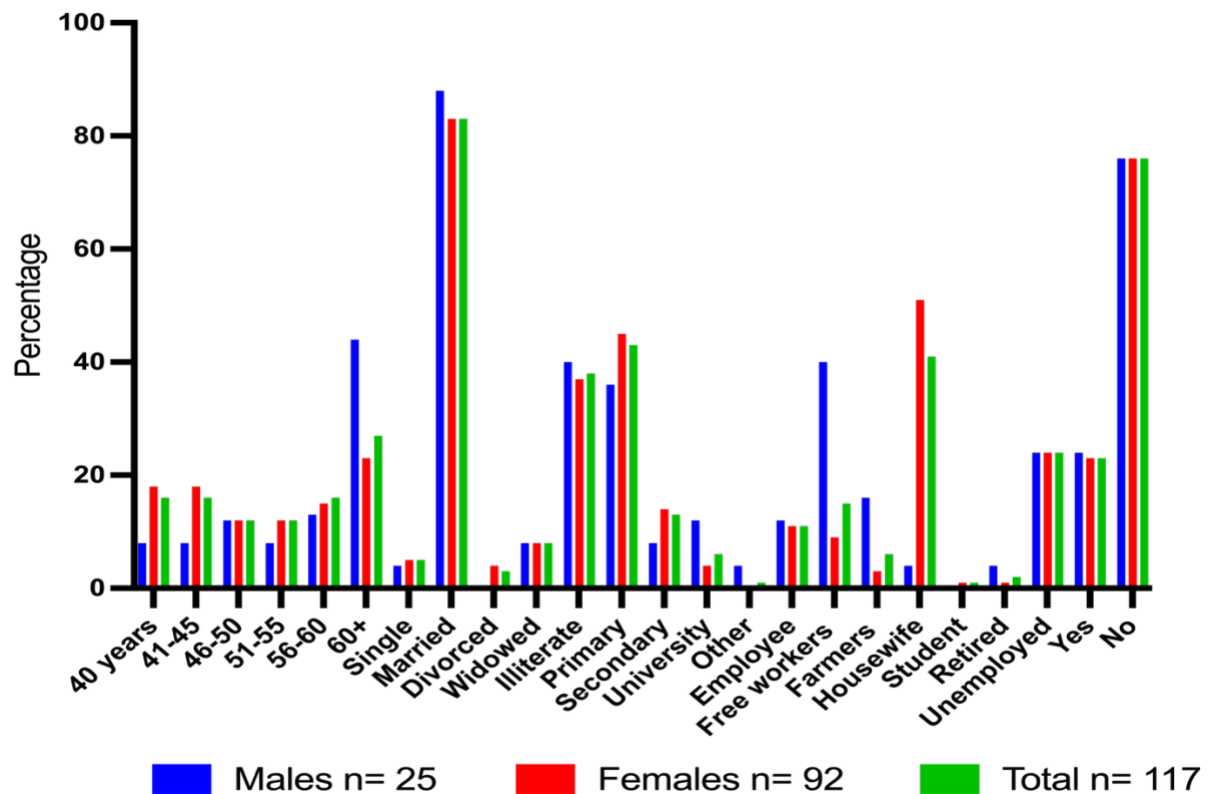


Figure 1 depicts the demographic features of the individuals.

Regarding the duration of DM, most of the individuals had a disease duration of > 10 years, followed by those with a duration of 5-10 years and < 5 years, representing 56/117 (47.9%), 34 (29%), and 19 (16.2%), respectively. Regarding the treatment strategies, most patients received oral antidiabetic medications, accounting for 75 out of 117 (64.1%), followed by insulin at 28 (23.9%), and combination therapy and dietary control, each representing 7 (5.98%).

Regarding metabolic control, the majority of participants were poorly controlled, with FBG levels > 180 mg/dl, followed by those with FBG levels in the ranges of 131-180 mg/dl and 80-130 mg/dl, constituting 48/117 (41%), 34 (29%), and 28 (23.9%), respectively. As indicated in Table 2 and Figure 2, the bulk of the patients, 75/117 (64%), had their regular medical checkups within 3 months.

Table 2 describes the relationship between the duration of DM, treatment strategies, control, and the frequency of medical checkups.

Variable	Males n= 25	Females n= 92	Total n = 117
DM duration			
Newl DM	1	7	8
< 5 years	3	16	19
5-10	2	32	34
>10	19	37	56
Total	25	92	117
Treatments			
Dietary control	2	5	7
Oral drugs	13	62	75
Insulin	7	21	28
Combination (oral + Insulin)	3	4	7
Total	25	92	117
FBG level			
< 79 mg/dl	2	5	7
80-130	6	22	28
131-180	7	27	34
>180	10	38	48
Total	25	92	117
Medical check up			
First check up	1	5	6
< 3 months	13	62	75
> 3 months	11	25	36
Total	25	92	117

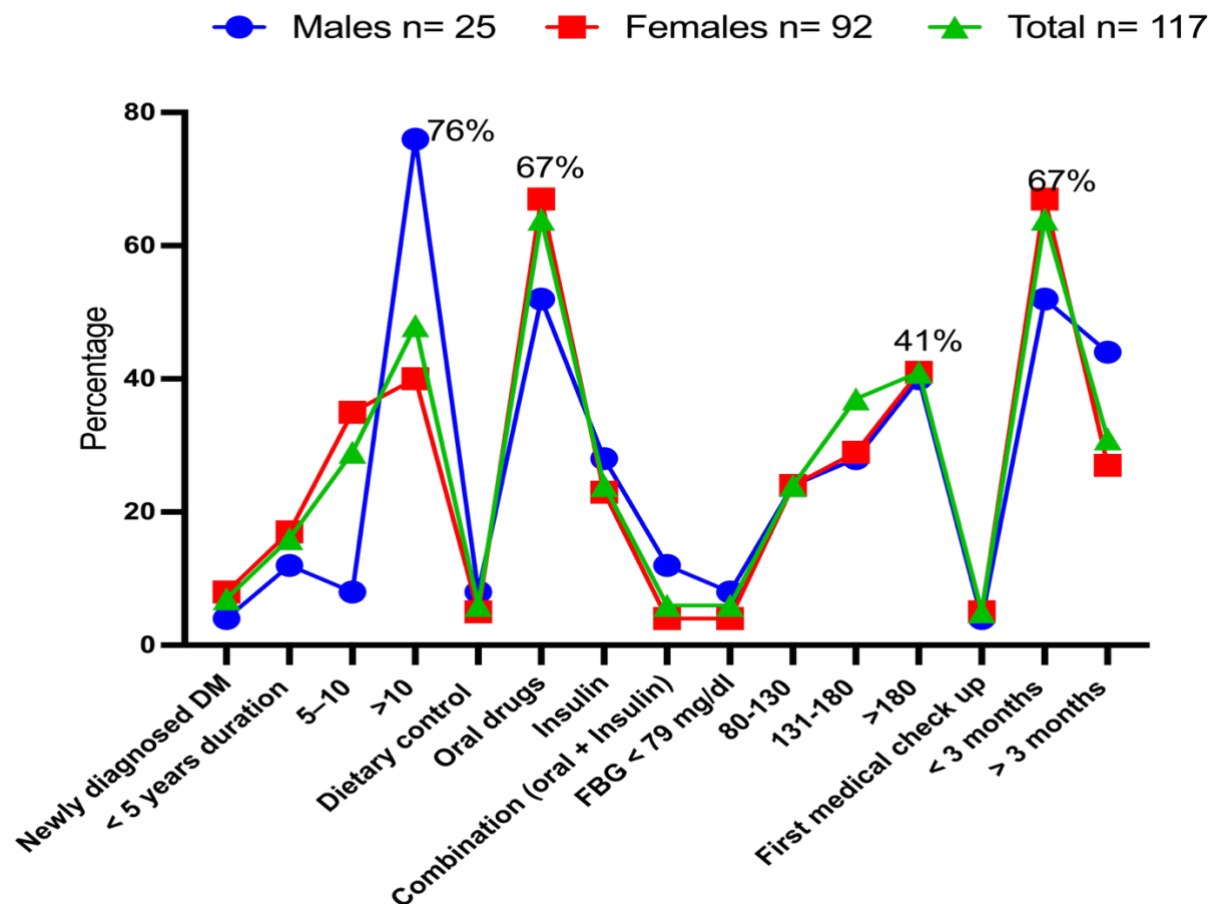


Figure 2 depicts the relationship between the duration of the disease, treatment strategies, control, and the frequency of medical checkups.

In this cohort, 19 out of 117 participants (16.2%) had a fundal examination; among these, 4 out of 19 (21%) were males and 15 (78.9%) were females, with retinopathy reported in 13 individuals (11.1%); of these, 6 out of 13 (46.1%) were males and 7 (53.8%) were females. Peripheral neuropathy was seen in 70/117 (60.5%); 14/70 (20%) of them were males and 56 (80%) were females. Of the 30/117 (25.6%) individuals with

peripheral arterial disease (PAD), males were 4/30 (13.3%) and females were 26 (86.7%). Diabetic ulcers were found in 34/117 (29%); males constituted 14/34 (41%) of them, while females were 20 (58.8%). Amputation was seen in 8/117 (6.8%) of the patients; 5/8 (62.5%) of them were males and 3 (37.5%) were females, as indicated in Table 3 and Figure 3.

Table 3 explains the relationship between sex, fundal examination, retinopathy, neuropathy, PAD, leg ulcer, and amputation.

Variable	Males n = 25	Females n= 92	Total n = 117
Fundal exam			
Yes	4	15	19
No	21	77	98
Total	25	92	117
Retinopathy			
Yes	6	7	13
No	17	78	95

Don't know	2	7	9
Total	25	92	117
Neuropathy			
Yes	14	56	70
No	11	36	47
Total	24	92	117
PAD			
Yes	4	26	30
No	21	66	87
Total	25	92	117
Diabetic foot			
Yes	14	20	34
No	11	72	83
Total	25	92	117
Amputation			
Yes	5	3	8
No	20	89	109
Total	25	92	117

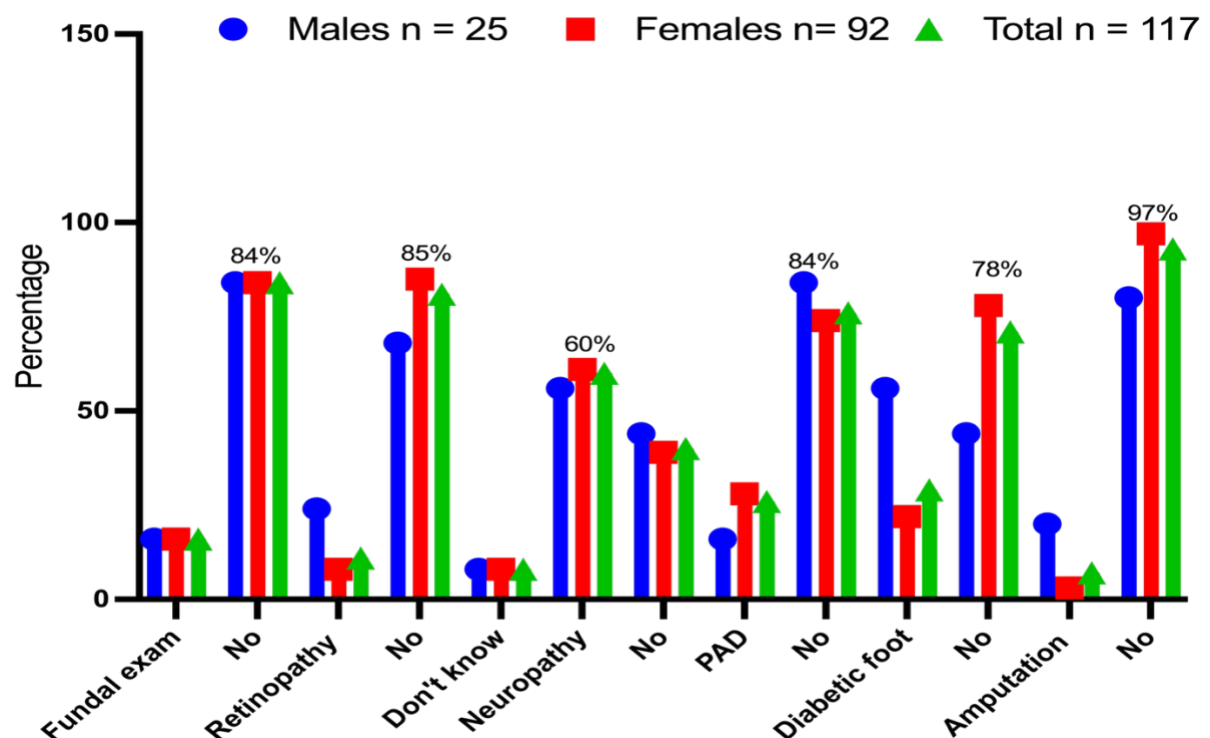


Figure 3: Demonstration of the relationship between sex, fundal examination, and DM complications.

Of the 4/117 (3.4%) patients with chronic kidney disease (CKD), 1/4 (25%) were males and 3 (75%) were females. Coronary artery disease was seen in 3/117 (2.6%); 2/3 (66.6%) of them were males, and one-third

(33.3%) of them were females. Table 4, Fig 4, demonstrated that stroke and TIA were reported in 7/117 (5.98%) and 17 (14.5%), respectively.

Table 4, illustration of the relationship between sex, CKD, CAD, stroke, and TIA.

Variable	Males n = 25	Females n= 92	Total n = 117
CKD			
Yes	1	3	4
No	24	89	113
Total	25	92	117
CAD			
Yes	2	1	3
No	23	91	114
Total	25	92	117
Stroke			
Yes	3	4	7
No	22	88	110
Total	25	92	117
TIA			
Yes	9	8	17
No	16	84	100
Total	25	92	117

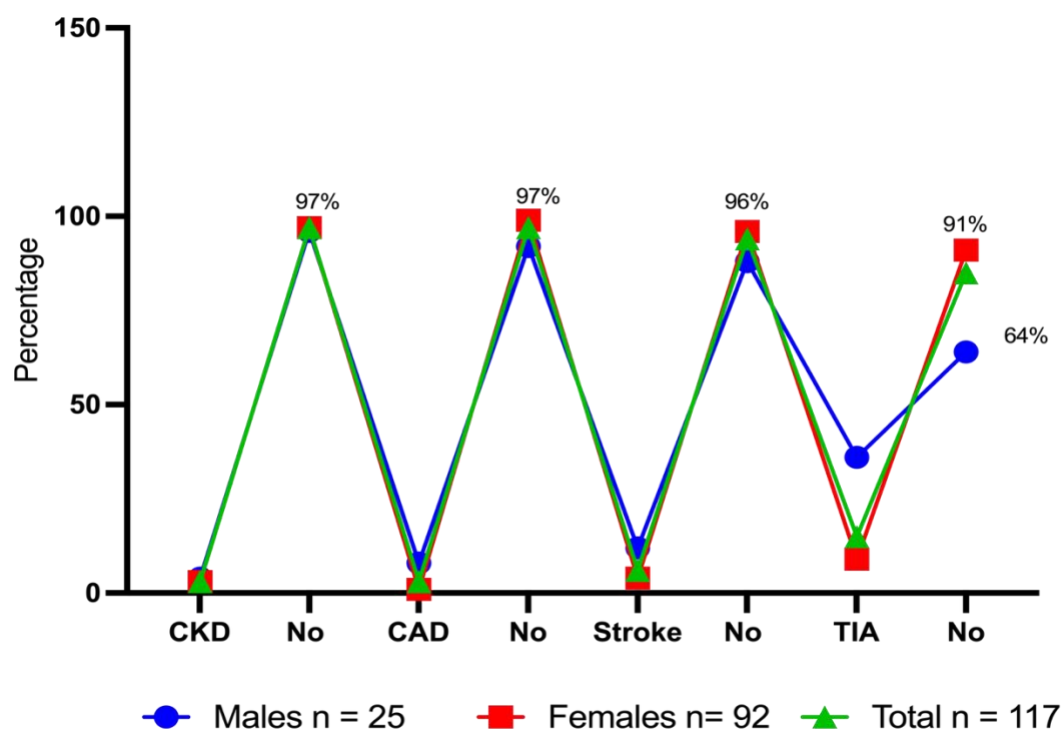


Figure 4 depicts the relationship between sex and DM complications.

Of the 13 out of 117 patients (11.1%) with retinopathy, 10 (76.9%) had a disease duration of more than 10 years, 2 (15.4%) had a duration of 5-10 years, and none were new patients. Additionally, most neuropathy

patients, specifically 36 out of 70 (51.4%), were reported to have a disease duration of more than 10 years, followed by 18 patients (25.7%) with a duration of 5-10 years. Table 5 and Figure 5 demonstrated that PAD,

diabetic leg ulcers, and amputations were all encountered more commonly in disease durations of more than 10 years,

represented by 12/30 (40%), 23/34 (67.6%), and 7/8 (87.5%), respectively.

Table 5 demonstrates the relationship between the DM duration and complications.

Variable	New DM	< 5 years	5-10 years	>10 years	Total
Fundal exam					
Yes	0	0	6	13	19
No	8	19	28	43	98
Total	8	19	34	56	117
Retinopathy					
Yes	0	1	2	10	13
No	7	17	29	41	95
Don't know	0	1	3	5	9
Total	7	19	34	56	117
Neuropathy					
Yes	5	11	18	36	70
No	3	8	16	20	47
Total	8	19	34	56	117
PAD					
Yes	3	4	7	12	30
No	5	15	25	42	85
Total	8	19	36	54	117
Diabetic foot					
Yes	1	5	5	23	34
No	7	14	29	33	83
Total	8	19	34	56	117
Amputation					
Yes	0	1	0	7	8
No	8	18	34	49	109
Total	8	19	34	56	117

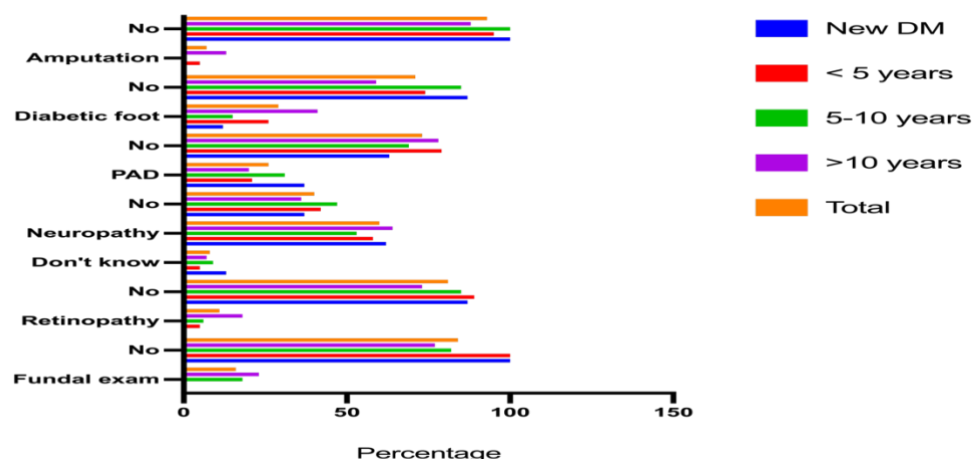


Figure 5 depicts the relationship between DM duration and complications.

Of the 4 patients with CKD, $\frac{3}{4}$ (75%) had a disease duration of more than 10 years,

while 2/3 (66.7%) of individuals with CAD were found in the disease duration 5-10 years category. Table 6 and Figure 6 showed

that the majority of individuals with TIA, 14 out of 17 (82.4%), had a disease duration of more than 10 years.

Table 6 provides a description of the relationship between the duration of diabetes mellitus (DM) and its complications.

Variable	New DM	< 5 years	5-10 years	>10 years	Total
CKD					
Yes	0	1	0	3	4
No	8	18	34	53	113
Total	8	19	34	56	117
CAD					
Yes	0	1	2	0	3
No	8	18	32	56	114
Total	8	19	34	56	117
Stroke					
Yes	1	3	1	2	7
No	7	16	34	53	110
Total	8	19	35	55	117
TIA					
Yes	0	3	0	14	17
No	8	16	34	42	100
Total	8	19	34	56	117

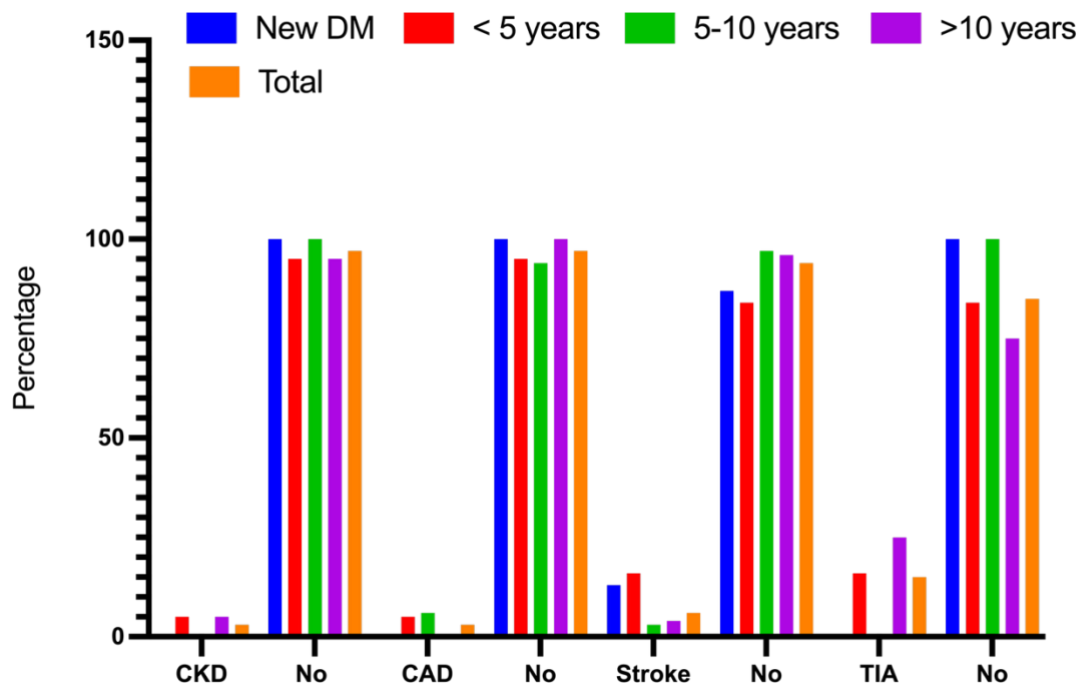


Figure 6, illustration of the relationship between DM duration and complications

Discussion

The majority of the patients with DM-related complications in this research had DM durations of more than 10 years. Previous

research confirmed the associations of the prolonged DM duration and the development of certain complications like

diabetic retinopathy and also reported that it carries a poor prognosis after coronary artery bypass graft (CABG) for the treatment of individuals with acute myocardial infarction [10, 11]. Although the prolonged duration of the disease and the poor metabolic control observed in this cohort may explain the high rate of complications, other factors, such as the demographic characteristics of the individuals and specific patient profiles like racial and genetic factors, may also contribute to this issue. In this cohort, 70% of the individuals had their fasting blood glucose exceeding 130 mg/dl and 41% exceeding 180 mg/dl. The standard for assessing metabolic control is glycated hemoglobin (Hb A1C), but it was not used in this study because not all participants had it. This finding of poor metabolic control highlights the tragic effects of the ongoing Sudan armed conflict, with millions of people displaced from their homes. The disrupted, fragile, existing health system, together with the unavailability and high cost of the medications, added insult to the injury, resulting in poor metabolic control and a high prevalence rate of the complications. Previous research from Sudan demonstrated the devastating effect of this ongoing tragic armed conflict on the glycemic control and increase in the prevalence rate of DM complications, notably diabetic foot and retinopathy [12]. In the current study, the most frequently reported complication is diabetic peripheral neuropathy (DPN), which constituted 58.8%; 51.4% of them had a disease duration of more than 10 years. Previous research from Sudan reported a prevalence rate of diabetic peripheral neuropathy of 43%. Worldwide, DPN is the most common complication of DM, and the prevalence is more than 50% in individuals with longstanding disease; however, a range of about 8% was reported in newly diagnosed individuals [9]. Research from China, recruiting 14,908, reported a prevalence of DPN of 67.6% [13]. Another study from

Saudia Arabia, including 187 patients, reported a 37.4% prevalence of DPN [14]. This wide variation of the magnitude of DPN may be related to the disease duration and the metabolic control, but the scoring systems adopted in the workup of the conditions, besides the demographics and environmental factors, may be implicated. The most important scoring systems used for DPN assessment include the Toronto clinical scoring system, the neuropathy symptoms scoring system, and the neuropathy disability score [13, 15]. In this cohort, diabetic foot emerged as the second most common complication, affecting 29% of individuals, with 67.6% of them having long-term diabetes. This finding is higher than previous research from Sudan. In a cross-sectional study recruiting 648 adult Sudanese T2DM patients, diabetic foot ulcer (DFU) was reported in 10.6% of the cases [16]. However, in the world, the lifetime incidence of DFUs in patients with DM is 19-34%. Research links DFU's pathophysiology to the direct effect of the interrelations of peripheral neuropathy and peripheral arterial disease or a combined structural abnormality of the foot beside the ongoing physical pressure. It is a major preventable cause of lower limb amputation worldwide, and it also significantly increases the risk of disability and premature death in individuals with DM [17, 18].

In this series diabetic retinopathy (DR) was found in 11.1% of the cases. DR is one of the major causes of preventable blindness in the world. Chronic hyperglycemia, which is the hallmark of DM, plays a pivotal role in the pathogenesis and progression of DR. The ocular immune activation and early retinal neurodegenerative changes seen in patients with DR are linked to chronic hyperglycemia, inflammation, oxidative stress, and gut microbiota dysregulation and their metabolites. Research demonstrated that early detections of DM and appropriate metabolic control have beneficial roles in the prevention and progression of DR. Moreover, evidence suggests that

implementing strict dietary control and dietary modifications, along with regular physical activity, can slow or prevent the early progression of DR, reduce the disease burden, and ultimately prevent blindness [19, 20].

In the current research, stroke and TIA were reported in 5.9% and 14.5%, respectively. DM is known to affect the microvascular and macrovascular circulations of many systems, including the central and peripheral nervous systems. Research demonstrated the association of T2DM and a significant risk of stroke, which was reported in the range of 1.5 to 3 times higher than people with normal blood sugar. Research confirmed the poor prognosis and recovery of diabetic individuals with acute ischemic stroke through unknown mechanisms. Although the traditional concept of controlling the risk factors is the basic foundation of primary and secondary prevention, the risk of recurrent stroke in these patients is still high. Recent research shows the effect of the antidiabetic medications glucagon-like peptide 1 receptor agonist (GLP1-RA) and pioglitazone in the primary and secondary prevention. Therefore, the American Heart Association (AHA) and the American Stroke Association (ASA) recommend GLP1-RA for adults with

T2DM and an HbA1c of $\geq 7\%$ who are at high risk for atherosclerotic cardiovascular disease (ASCVD) [21-25].

Limitations: This study is limited by its retrospective design, short study time frame, and the absence of glycated hemoglobin (HbA1c) measurements to more accurately assess glycemic control. Furthermore, the relatively small sample size may limit the generalizability of the findings. These limitations emphasize the necessity of future large-scale, prospective longitudinal studies to provide a more robust evaluation.

In conclusion: diabetic patients in Kordofan generally presented with long-standing disease, poor glycemic control, and a high rate of complications. The most frequent complications observed were peripheral neuropathy, diabetic foot ulcers, retinopathy, transient ischemic attack (TIA), and stroke. These findings point out the importance of early detection, optimal disease management, and timely identification and intervention for complications. Furthermore, regional protocols should be implemented to support patient education, lifestyle modifications, and standardized treatment strategies.

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Ethical approval: The Prof. Medical Research Consultancy Center's Human Research Ethics Committee (HREC) has approved the study proposal. Approval #: HREC 0020/MRCC.7/25. Also, ethical considerations were obtained from the El-Obeid teaching hospital authority.

Conflict of interest: authors declare no conflict of interest.

Data available: data concerning this research are available from the corresponding author.

References

Author contributions:

All authors approved the final version of the publishable manuscript.

Galal SA: Concept and design, Acquisition, analysis, or interpretation of the data, drafting of the manuscript.

Mohammed AKY: Critical review of the manuscript for important intellectual content.

Hamid NA: Drafting of the manuscript.

Humida EHM: Supervision, Concept and design, Drafting of the manuscript.

1. Stafford LK, Gage A, Xu YY, et al. Global, regional, and national cascades of diabetes care, 2000-23: a systematic review and modelling analysis using findings from the Global Burden of Disease Study. *Lancet Diabetes Endocrinol.* 2025 Nov;13(11):924-934. doi: 10.1016/S2213-8587(25)00217-7. PMID: 40934935.
2. Chen S, Cao Z, Chen W, et al. The global macroeconomic burden of diabetes mellitus. *Nat Med.* 2026 Jan;32(1):126-138. doi: 10.1038/s41591-025-04027-5. Epub 2025 Dec 29. PMID: 41466063.
3. 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 Jan 27;26(3):1094. doi: 10.3390/ijms26031094. PMID: 39940862.
4. Chen K, Zhang H, Wu N, Li B, Li S, Mu Y. Global risk factors, epidemiology, and disease burden of type 2 diabetes. *Sci China Life Sci.* 2026 Feb;69(2):384-395. doi: 10.1007/s11427-024-3036-4. PMID: 41107661.
5. Idrees T, Castro-Revoredo I, Dhatariya KK, Hernandez L, Umpierrez GE. Advances in the management of hyperglycaemia and diabetes mellitus during hospitalization. *Nat Rev Endocrinol.* 2025 Dec;21(12):757-768. doi: 10.1038/s41574-025-01157-1. PMID: 40760269.
6. He J, Li Z, Xia P, et al. Ferroptosis and ferritinophagy in diabetes complications. *Mol Metab.* 2022 Jun;60:101470. doi: 10.1016/j.molmet.2022.101470. PMID: 35304332.
7. Zhao L, Yuan J, Yang Q, et al. Diabetes and its complications: molecular mechanisms, prevention and treatment. *Signal Transduct Target Ther.* 2026 Jan 19;11(1):22. doi: 10.1038/s41392-025-02401-w. PMID: 41549124.
8. Hajomer H, Elkhidir O, Ali K, et al. The economic burden of managing diabetes mellitus in children in Sudan: a cross-sectional study. *Cost Eff Resour Alloc.* 2026 Mar 17;24(1):55. doi: 10.1186/s12962-026-00740-1. PMID: 41845361.
9. Ali AMM, Babiker MY, Elkheir HK, et al. Prevalence and associated factors of peripheral neuropathy in individuals with type 2 diabetes mellitus: a cross-sectional study in Khartoum State. *BMC Endocr Disord.* 2025 Dec 9;26(1):8. doi: 10.1186/s12902-025-02124-7.
10. Liu Y, Meng Y, Duan R, et al. Risk Factors for Diabetic Retinopathy Change With Diabetes Duration: Synergistic Effect of Long Duration and Anemia. *J Diabetes Res.* 2026;2026(1):e8611325. doi: 10.1155/jdr/8611325. PMID: 42087387.
11. Lee JH, Kim YJ, Cho YH, Kim JB, Kim HJ. Preoperative diabetes duration and long-term outcomes in patients with acute myocardial infarction undergoing coronary artery bypass grafting. *J Thorac Cardiovasc Surg.* 2025 Dec;170(6):1650-1658.e9. doi: 10.1016/j.jtcvs.2025.01.020. PMID: 39894070.
12. Babiker N, Noor S, Abdelgadir E. Tragic impact of armed conflict on glycemic control among displaced people living with diabetes in Sudan. *J Diabetes Metab Disord.* 2026 Jul 17;25(2):202. doi: 10.1007/s40200-026-02009-z. PMID: 42472058.
13. Wang W, Ji Q, Ran X, et al. Prevalence and risk factors of diabetic peripheral neuropathy: A population-based cross-sectional study in China. *Diabetes Metab Res Rev.* 2023 Nov;39(8):e3702. doi: 10.1002/dmrr.3702. PMID: 37490047.
14. Jatooi NA, Alsulaiman ASA, Alromaih NJ, et al. Prevalence of diabetic peripheral neuropathy among type II diabetic patients in King Fahd University Hospital, Khobar, Kingdom of Saudi Arabia. *Hosp Pract (1995).* 2021 Apr;49(2):63-70. doi: 10.1080/21548331.2020.1853995. PMID: 33216654.
15. Regai I, Bose M, Hazari A, Kandakueti PK. The Need for Early Screening of Diabetic Peripheral Neuropathy and Diabetic Foot in MENA Region: A Review. *Curr Diabetes Rev.* 2024;20(3):e120623217893. doi: 10.2174/1573399820666230612141250. PMID: 37309772.
16. Imamaldin MG, Omer SM, Alarfaj RM, Ali SA, AlGadaa AH, Adam I. Prevalence and associated factors of diabetic foot ulcer among patients with diabetes mellitus in Eastern Sudan: A cross-sectional study. *Sci Rep.* 2026 May

- 28;16(1):24600. doi: 10.1038/s41598-026-54936-9. PMID: 42204213.
17. Abdulrahman EAM, Wedatalla MAE, Mohammed AAY, et al. Improving Early Identification and Documentation of High-Risk Diabetic Foot Complications Through a Closed-Loop Clinical Audit at Almanagil Teaching Hospital. *Cureus*. 2026 Apr 3;18(4):e106403. doi: 10.7759/cureus.106403. PMID: 42088796.
18. Gadora WAA, Abdalla E, Eltayeb M, et al. A Closed-Loop Quality Improvement Intervention to Enhance Diabetic Foot Risk Assessment Compliance at Atbara Teaching Hospital. *Cureus*. 2026 May 31;18(5):e110000. doi: 10.7759/cureus.110000. PMID: 42388546.
19. Niu J, Liu Y, Peng H, Chen J, Chen L. Early-stage diabetic retinopathy: gut-metabolic triggers, immune-neurodegeneration, and interventions. *Graefes Arch Clin Exp Ophthalmol*. 2025 Oct;263(10):2723-2736. doi: 10.1007/s00417-025-06906-6. PMID: 40728573.
20. Chronopoulos A, Garzone D, Finger RP. Risikomodifikation durch Ernährung und Nahrungsergänzungsmittel bei diabetischen Augenerkrankungen [Diabetic retinopathy and risk modification through diet and dietary supplements]. *Ophthalmologie*. 2025 Nov;122(11):880-887. German. doi: 10.1007/s00347-025-02328-1. PMID: 41128848.
21. Jerkins TW, Bell DSH. Stroke in the Patient With Type 2 Diabetes. *Endocr Pract*. 2025 Apr;31(4):547-553. doi: 10.1016/j.eprac.2025.01.010. PMID: 39914491.
22. Prentza V, Pavlidis G, Ikonomidis I, et al. Treatment and Prevention of Ischemic Stroke: A Systematic Review. *J Clin Med*. 2024 Sep 28;13(19):5786. doi: 10.3390/jcm13195786. PMID: 39407846.
23. Bradley SA, Spring KJ, Beran RG, Chatzis D, Killingsworth MC, Bhaskar SMM. Role of diabetes in stroke: Recent advances in pathophysiology and clinical management. *Diabetes Metab Res Rev*. 2022 Feb;38(2):e3495. doi: 10.1002/dmrr.3495. PMID: 34530485.
24. Inikori E, Yang DC, Elahi A, Elokour M, Ho J, Simpkins AN. Guidelines in Action: The Role of GLP-1 (Glucagon-Like Peptide-1) Receptor Agonists in Primary Stroke Prevention. *Stroke*. 2025 Oct;56(10):e307-e309. doi: 10.1161/STROKEAHA.125.051441. PMID: 40982602.
25. Wilson LM, Anderson TS. Use and Eligibility for Glucose-Like Peptide-1 Receptor Agonist Treatment for Primary Prevention of Stroke. *Neurology*. 2025 Jun 24;104(12):e213739. doi: 10.1212/WNL.0000000000213739. PMID: 40408626.