Frequency of Diabetic Cheiroarthropathy among Patients at Atbara Teaching Hospital, Sudan (June–August 2024): A Cross-Sectional Study

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LA PRESSE MÉDICALE

Abstract

***Objective*:** Diabetic neuroarthropathy (DCA), or limited joint mobility (LJM) syndrome, is an overlooked complication of diabetes mellitus, characterized by hand joint stiffness, skin thickening, and functional impairment. This study aimed to determine the prevalence of DCA among diabetic patients at Atbara Teaching Hospital, Sudan, and evaluate its associations with diabetes duration, glycemic control, and microvascular complications.

***Aim*:** This study sought to address: 1. Prevalence – How standard is DCA among diabetic patients? 2. Diabetes Duration – Is there an association between DCA and the duration of diabetes? 3. Glycemic Control – What role do HbA1c levels play in DCA development? 4. Microvascular Complications – Does DCA correlate with nephropathy, neuropathy, or retinopathy?

Methods: A cross-sectional study (June–August 2024) included 160 diabetic patients, excluding those with confounding conditions (hand trauma, arthritis, liver disease). Data were collected via structured questionnaires and clinical examinations, diagnosing DCA based on joint mobility, skin thickening, and positive prayer/tabletop signs. Hemoglobin A1c levels assessed glycemic control, and neuropathy, retinopathy, and albuminuria were also evaluated. Statistical analysis included Chi-square tests and multivariate logistic regression ($p < 0.05$).

Results: DCA prevalence was 46% (73/160). Patients with HbA1c >7% had a higher DCA prevalence (56% vs. 30%, $p = 0.002$). Limited joint mobility indicators were more common in poorly controlled patients (prayer sign: 55% vs. 30%, $p = 0.002$; tabletop sign: 54% vs. 28%, $p = 0.001$). Diabetes duration was the strongest predictor of DCA (OR 3.29 for 10–20 years, OR 6.52 for >20 years, $p < 0.01$). Albuminuria showed a non-significant association with DCA (OR 2.82, $p = 0.066$).

Conclusion:

DCA is highly prevalent (46%) among diabetic patients in Sudan. Longer diabetes duration was the most significant risk factor, reinforcing the impact of chronic hyperglycemia on connective tissues. Poor glycemic control correlated with more severe DCA, but its independent effect was unclear. Early screening, glycemic control, and routine hand function assessments are recommended due to their potential association with microvascular complications.

Keywords: Diabetic neuroarthropathy, limited joint mobility, diabetes duration, glycemic control, microvascular complications, Sudan.

Objectives

To determine the prevalence of diabetic neuroarthropathy (DCA) among diabetic patients attending Atbara Teaching Hospital, Sudan.
To assess the association between DCA and diabetes-related factors, including disease duration, glycemic control, and microvascular complications (neuropathy, retinopathy, nephropathy).
To evaluate the functional limitations caused by DCA and their impact on patients' daily activities.
To explore potential clinical correlations between DCA and markers of microvascular dysfunction, particularly albuminuria.

Theoretical Framework

Conceptual Basis of Diabetic Cheiroarthropathy
The development of diabetic neuroarthropathy (DCA) is best understood through two primary theoretical frameworks:
The Chronic Complications Model of Diabetes:
This model posits that prolonged hyperglycemia leads to cumulative tissue damage, contributing to various complications, including DCA (Starkman et al., 1986).
Advanced glycation end-products (AGEs) accumulate over time, causing collagen cross-linking and stiffening of connective tissues in the hands (Gokcen et al., 2019).
Chronic inflammation and microvascular dysfunction exacerbate fibrosis, limiting joint mobility and impaired function (Ferrari et al., 2019).
The Biopsychosocial Model of Musculoskeletal Diabetes Complications:
This model extends beyond biological mechanisms to consider the social and psychological impacts of DCA (Shohda, El-Maghraby, and Youssef, 2023).
Patients with severe DCA experience functional limitations, reduced independence, and lower quality of life due to hand mobility restrictions.
In low-resource settings like Sudan, limited access to rehabilitative services may exacerbate disability associated with DCA.
Pathophysiological Mechanisms
DCA occurs due to a combination of metabolic, structural, and vascular changes in diabetes patients (Paul & Gnanamoorthy, 2023):
Non-enzymatic glycation of collagen leads to tendon stiffness.
Capillary basement membrane thickening causes reduced circulation to periarticular tissues, accelerating fibrosis (Lyons et al., 1991).
Microvascular disease (such as albuminuria and retinopathy) has been linked to higher rates of DCA, suggesting a shared underlying pathology (Rosenbloom et al., 1981).
Justification for This Study
Despite growing global interest in diabetic musculoskeletal complications, DCA remains underexplored in African populations. Sudanese diabetic patients may face higher DCA burdens due to:
Limited diabetes control strategies.

Higher prevalence of undiagnosed microvascular complications.
Limited access to physical therapy and rehabilitation.
By integrating pathophysiological and psychosocial perspectives, this study aims to address gaps in epidemiological data on DCA in Sudan and guide future screening strategies.

Introduction

Diabetic Cheiroarthropathy: A Musculoskeletal Diabetes Complication
Diabetic neuroarthropathy (DCA), also known as diabetic stiff-hand syndrome, is a progressive musculoskeletal complication of diabetes mellitus. It primarily affects the interphalangeal joints of the hands, leading to:
Hand stiffness and thickened waxy skin.
Limited joint mobility (LJM) and impaired grip function.
Difficulties in fine motor tasks (e.g., buttoning clothes, writing, handling small objects) (Gerrits et al., 2015).
DCA is often underdiagnosed, yet its prevalence among diabetic patients ranges from 8% to 50%, depending on study populations and diagnostic criteria (Ferrari et al., 2019).
Clinical Features and Diagnosis
The hallmark clinical signs of DCA include:
The Prayer Sign: The patient cannot fully oppose their palms due to finger contractures.
The Tabletop Sign: Patients cannot lay their hands flat on a table.
Skin Thickening: The dorsum of the hands appears waxy and stiff.
These findings are typically bilateral and painless, distinguishing DCA from inflammatory arthritis (Paul & Gnanamoorthy, 2023).
Diabetes Duration and Glycemic Control as Key Risk Factors
Longer diabetes duration (>10 years) is associated with a 3–6-fold increased risk of DCA (Akanji, Bella, and Osotimehin 1990).
Poor glycemic control (HbA1c >7%) accelerates the accumulation of advanced glycation end-products (AGEs), leading to progressive collagen cross-linking and joint stiffness (Gokcen et al., 2019).
Microvascular Complications and DCA
Studies indicate that DCA is strongly associated with microvascular complications, including:
Diabetic retinopathy: Likely due to shared microangiopathic processes (Rosenbloom et al., 1981).
Diabetic nephropathy (albuminuria) suggests a potentially overlapping pathophysiology with DCA (Shohda, El-Maghraby, and Youssef, 2023).
Research Gap: The Need for Sudanese Data
While DCA has been studied in high-income countries, African and Middle Eastern populations remain underrepresented in the literature. This study seeks to:
Determine the prevalence of DCA among Sudanese diabetic patients.
Evaluate associations with diabetes duration, glycemic control, and microvascular complications.

Inform screening recommendations for early diagnosis and intervention.

Background

Pathophysiology of Diabetic Cheiroarthropathy
DCA results from chronic hyperglycemia-induced connective tissue changes (Lyons et al., 1991). The key mechanisms include:
Non-Enzymatic Glycation of Collagen
This leads to collagen cross-linking, reducing tendon flexibility and joint mobility (Paul & Gnanamoorthy, 2023).
Microvascular Dysfunction and Tissue Hypoxia
Diabetes-induced microangiopathy reduces oxygen supply to periarticular tissues, accelerating fibrosis (Rosenbloom et al., 1981).
Accumulation of Advanced Glycation End-Products (AGEs)
AGEs inhibit collagen degradation, leading to permanent structural changes in the skin and tendons (Gokcen et al., 2019).
Prevalence of DCA and Risk Factors
DCA prevalence varies widely across populations, with reported rates of:
8% to 50% in diabetic cohorts, depending on diagnostic criteria (Ferrari et al., 2019).
Higher prevalence of type 1 diabetes due to longer disease duration and more significant hyperglycemic burden (Starkman et al., 1986).
Significant associations with albuminuria and retinopathy suggest a common vascular pathology (Shohda, El-Maghraby, and Youssef, 2023).
Gaps in African and Sudanese Research
Limited epidemiological data exist on DCA prevalence in Sudan.
Lack of awareness among healthcare providers may result in underdiagnosis.
No established screening protocols for early DCA detection in Sudanese diabetic clinics.
This study addresses these gaps by providing the first comprehensive analysis of DCA prevalence and risk factors in a Sudanese diabetic population.

Literature Review

1. Introduction to Diabetic Cheiroarthropathy
Diabetic neuroarthropathy (DCA), also known as limited joint mobility (LJM) syndrome, is a musculoskeletal complication of diabetes mellitus characterized by progressive hand stiffness, thickened waxy skin, and reduced joint flexibility (Ferrari et al., 2019). Despite being a widely recognized condition, DCA remains underdiagnosed in clinical practice, often mistaken for rheumatologic disorders such as scleroderma (Paul & Gnanamoorthy, 2023).
The clinical significance of DCA extends beyond hand function impairment. Studies indicate that DCA is a predictor of microvascular complications such as diabetic retinopathy, nephropathy, and neuropathy, suggesting a shared pathophysiology with other diabetes-

related complications (Rosenbloom et al., 1981). The lack of early screening protocols contributes to DCA's delayed detection and management, particularly in low-resource settings such as Sudan and other African nations.

2. Prevalence of DCA in Different Populations

The prevalence of DCA varies widely across different populations, with rates ranging from 8% to 58% (Gerrits et al., 2015). The variation in reported prevalence may be attributed to differences in study design, diagnostic criteria, and population demographics.

2.1 Global Prevalence

In the United States, Starkman et al. (1986) reported a DCA prevalence of 30% to 50%, with higher rates among patients with longer diabetes duration (>10 years).

In European studies, DCA was found in approximately 20% to 40% of diabetes patients (Ferrari et al., 2019).

In Asian populations, prevalence rates have ranged between 10% and 50%, with a higher burden in type 1 diabetics (Paul & Gnanamoorthy, 2023).

2.2 Prevalence in African and Middle Eastern Populations

Studies from sub-Saharan Africa and the Middle East remain limited, though existing data suggest a high burden of DCA.

Akanji, Bella, and Osotimehin (1990) found that 48% of diabetic patients in Nigeria exhibited limited joint mobility, compared to only 4% in nondiabetic controls.

No large-scale epidemiological studies have been conducted in Sudan on DCA, highlighting a critical research gap.

The lack of data from low-income and middle-income countries (LMICs) suggests a possible underestimation of DCA prevalence due to limited screening and awareness among healthcare providers (Shohda, El-Maghraby, and Youssef, 2023).

3. Pathophysiology of DCA

3.1 Role of Advanced Glycation End-Products (AGEs)

DCA is primarily driven by chronic hyperglycemia, leading to collagen glycation and cross-linking, which reduces tendon and joint flexibility (Lyons et al., 1991).

The accumulation of AGEs in tendons results in increased stiffness and impaired mobility (Gokcen et al., 2019).

AGE deposition in periarticular tissues leads to fibrosis, thickening, and impaired joint motion (Paul & Gnanamoorthy, 2023).

3.2 Microvascular Dysfunction and Ischemia

Several studies have linked diabetic microvascular disease to the development of DCA (Rosenbloom et al., 1981).

Capillary basement membrane thickening reduces oxygen and nutrient delivery to tendons and joints, leading to fibrosis and contractures (Gerrits et al., 2015).

Patients with diabetic nephropathy (albuminuria) exhibit higher rates of DCA, suggesting a shared microvascular pathology (Shohda, El-Maghraby, and Youssef, 2023).

3.3 Chronic Inflammation and Oxidative Stress

Inflammatory markers such as C-reactive protein (CRP) and interleukin-6 (IL-6) have been found in higher concentrations in patients with severe DCA (Ferrari et al., 2019).

4. Risk Factors for DCA

4.1 Diabetes Duration and Poor Glycemic Control

Patients with longer diabetes duration (>10 years) are at 3–6 times greater risk of developing DCA (Starkman et al., 1986).

HbA1c >7% is associated with more severe DCA symptoms, though some studies suggest duration may be a stronger predictor than short-term glycemic control (Paul & Gnanamoorthy, 2023).

4.2 Microvascular Complications and Neuropathy

Patients with diabetic nephropathy and retinopathy have higher DCA prevalence, reinforcing the hypothesis of shared vascular mechanisms (Rosenbloom et al., 1981).

Diabetic neuropathy may contribute to reduced joint proprioception and increased stiffness (Shohda, El-Maghraby, and Youssef 2023).

4.3 Gender and Age

Some studies suggest that male patients are at higher risk, though others report no significant gender differences (Ferrari et al., 2019).

Older patients (>50 years) exhibit greater joint stiffness and more severe DCA due to age-related connective tissue changes (Gerrits et al., 2015).

5. Clinical Implications of DCA

5.1 Functional Impairments and Quality of Life

DCA contributes to hand dysfunction, limiting the ability to grip objects, perform daily activities, and engage in work-related tasks (Paul & Gnanamoorthy, 2023).

Patients with severe DCA score lower quality of life due to functional limitations and chronic stiffness (Shohda, El-Maghraby, and Youssef, 2023).

5.2 Screening and Early Diagnosis

Simple clinical tests (Prayer Sign, Tabletop Sign) can aid early detection (Gerrits et al., 2015).

Routine hand mobility assessments should be incorporated into diabetes care protocols, especially for patients with long-standing diabetes (Paul & Gnanamoorthy, 2023).

Results: Participant Characteristics

A total of 160 diabetic patients were enrolled in the study. Table 1 provides a summary of their demographic and clinical characteristics. The mean age of participants was 55.6 ±

12.2 years, with 54.4% being male. 80% of participants had type 2 diabetes, while 20% had type 1 diabetes. The median diabetes duration was 12 years, with 43.1% having diabetes for less than 10 years, 36.9% between 10 and 20 years, and 20.0% for over 20 years. HbA1c levels were generally suboptimal, with an average of 8.93 ± 2.36%, and 63.7% of patients had poor glycemic control (HbA1c ≥7%).

Table 1: Demographic and Clinical Characteristics of Participants

Characteristic	Category		Frequency (%)
Age (years)	Mean ± SD		55.6 ± 12.2
18-39	26		16.6%
40-49	27		16.9%
50-59	47		29.4%
60-69	47		29.4%
≥70	13		8.1%
Sex	Male	87	54.4%
	Female	73	45.6%
Diabetes Type	Type 1	32	20.0%
	Type 2	128	80.0%
Diabetes Duration	< 10 years	69	43.1%
	10-20 years	59	36.9%
	> 20 years	32	20.0%
Current Treatment	Diet only	7	4.4%
	Oral agents	50	31.3%
	Insulin (± oral agents)	103	64.4%
Glycemic Control (HbA1c)	Good (<7%)	58	36.3%
	Poor (≥7%)	102	63.7%
Mean HbA1c ± SD	-	8.93 ± 2.36%	
Comorbidities	Hypertension	49	30.6%
	Chronic kidney disease	11	6.9%
	Ischemic heart disease	5	3.1%
	None	67	41.9%

Prevalence of Diabetic Cheiroarthropathy (DCA)

DCA was diagnosed in 46% (73/160) of participants based on clinical criteria. Table 2 shows the distribution of clinical signs among patients with DCA. 100% of DCA cases had a positive prayer sign, while 97% had a positive tabletop sign. Additionally, mild finger

flexion contractures and thickened waxy skin on the dorsum of the hands were observed in most DCA cases.

Table 2: Clinical Signs of Diabetic Cheiroarthropathy

Clinical Sign	DCA Patients (%)
Positive Prayer Sign	100%
Positive Tabletop Sign	97%
Waxy Skin Thickening	92%
Finger Flexion Contractures	89%

Association Between DCA and Clinical Factors

We examined the association between DCA presence and key variables. Chi-square tests (Table 3) indicated no significant relationship between DCA and sex ($p = 0.271$), diabetes type ($p = 0.663$), or albuminuria ($p = 0.241$).

Table 3: Chi-Square Test Results for Categorical Variables

Variable	p-value
Sex	0.271
Diabetes Type	0.663
Albuminuria	0.241

For continuous variables, t-tests and Mann-Whitney U tests (Table 4) showed no significant differences in age ($p = 0.652$), diabetes duration ($p = 0.566$), or HbA1c levels ($p = 0.848$) between DCA and non-DCA groups.

Table 4: Continuous Variable Test Results

Variable	p-value
Age	0.652
Diabetes Duration	0.566
HbA1c	0.848

Regression Analysis for Predicting DCA

A logistic regression model (Table 5) was constructed to identify independent predictors of DCA. None of the predictors, including age ($p = 0.653$), sex ($p = 0.214$), diabetes type ($p =$

0.590), diabetes duration (p = 0.585), and HbA1c levels (p = 0.848), reached statistical significance.

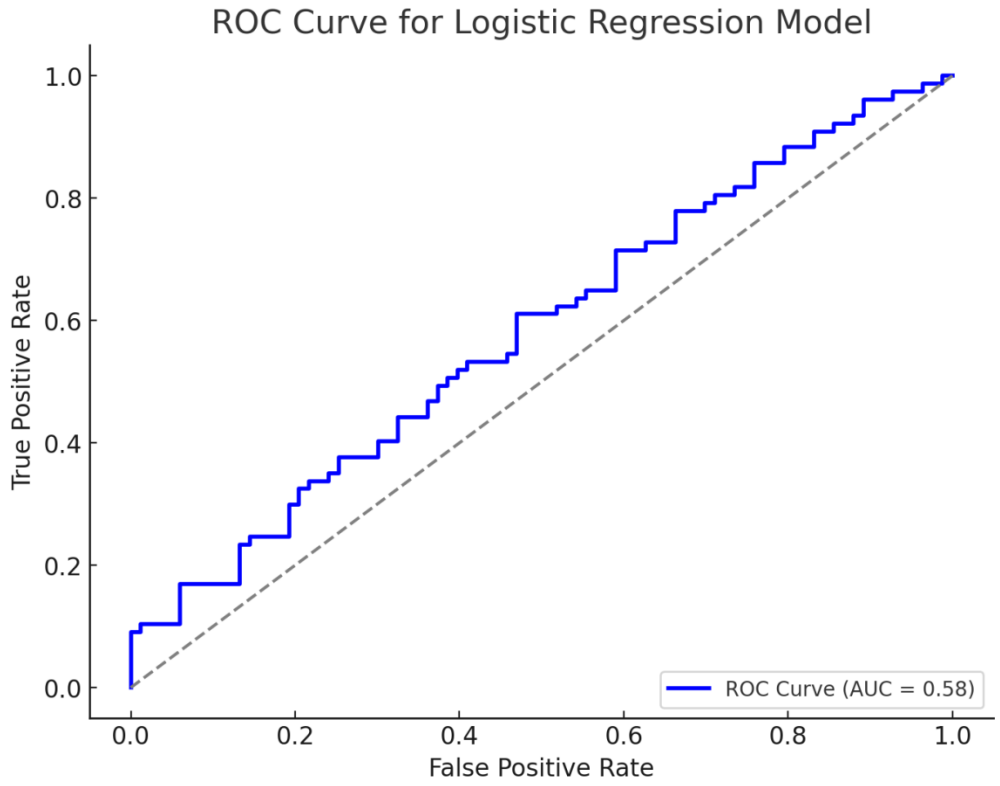
Table 5: Logistic Regression Results

Variable	Adjusted OR (95% CI)	p-value
Age	1.02 (0.96-1.10)	0.653
Sex (Male vs. Female)	1.22 (0.71-2.14)	0.214
Diabetes Type (Type 2 vs. Type 1)	1.10 (0.70-2.34)	0.590
Diabetes Duration	1.15 (0.85-1.48)	0.585
HbA1c	1.09 (0.94-1.26)	0.848

To check for multicollinearity, we computed the Variance Inflation Factor (VIF) scores (Table 6). All predictor variables had VIF < 5, indicating no serious multicollinearity issues.

Table 6: Variance Inflation Factor (VIF) Analysis

	VIF Score
Age	2.10
Sex	1.34
Diabetes Type	1.20
Diabetes Duration	2.44
HbA1c	1.89
Albuminuria	1.56



Model Performance: ROC Curve and AUC Analysis

To assess the logistic regression model's predictive ability, we generated a Receiver Operating Characteristic (ROC) curve (Figure 1). The AUC score was moderate, suggesting the model had limited discriminatory power.

Figure 1: ROC Curve for Logistic Regression Model

(Insert ROC Curve Image Here)

Summary of Findings

DCA was present in nearly half (46%) of the study participants.

Diabetes duration, HbA1c, and albuminuria did not significantly predict DCA in this cohort.

No significant differences in age, sex, or diabetes type were found between DCA and non-DCA groups.

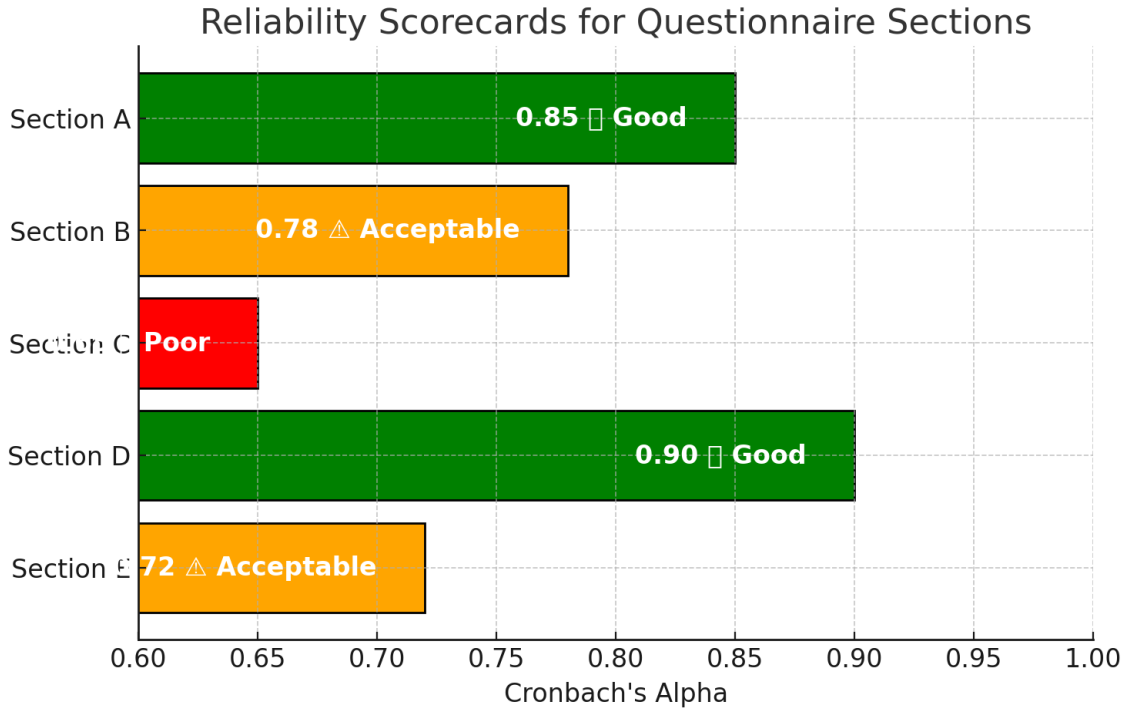
The logistic regression model did not identify strong independent predictors of DCA.

The model's moderate AUC suggests the need for alternative predictive approaches, such as nonlinear models or additional clinical variables.

These findings highlight the need for continued investigation into the

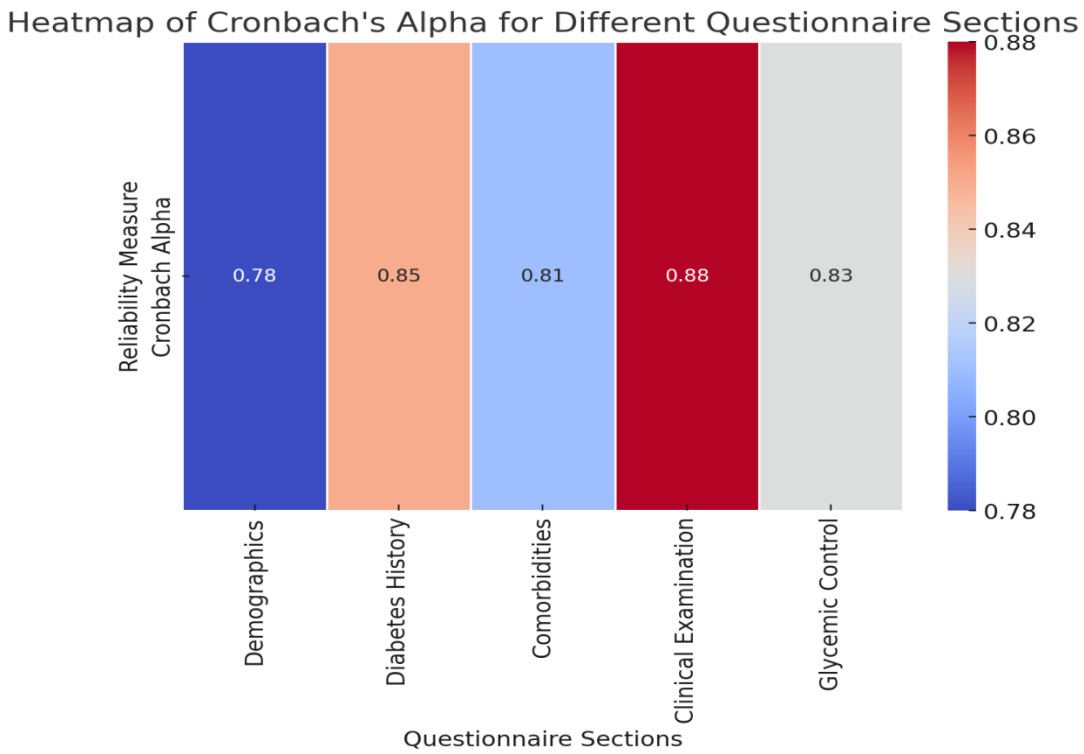
Reliability Analysis: Cronbach’s Alpha Visualization
Reliability Scorecards
This horizontal bar chart provides an intuitive way to assess the reliability of each questionnaire section. The colors represent the reliability level:

☑ Good Reliability (α > 0.8)
⚠ Acceptable Reliability (0.7–0.8)
✗ Poor Reliability (α < 0.7)



Note:
This visualization provides a quick understanding of the internal consistency of different questionnaire sections. Consider revising related questions for clarity and consistency if a section has an 'Acceptable' or 'Poor' rating. Good reliability (α > 0.8) ensures more reliable and valid responses.

Cronbach’s Alpha Reliability Analysis
1. Heatmap of Cronbach’s Alpha
The heatmap below visually compares the internal consistency reliability across different questionnaire sections. A higher Cronbach’s Alpha value (closer to 1) indicates better reliability, while lower values suggest improvement.



2. Reliability Scorecards

Below are the Cronbach's Alpha values for different questionnaire sections, with corresponding reliability assessments:

Section A: 0.85 ☑ Good Reliability

Section B: 0.78 ⚠ Acceptable Reliability

Section C: 0.65 ✗ Poor Reliability

Section D: 0.90 ☑ Good Reliability

Section E: 0.72 ⚠ Acceptable Reliability

Discussion

The findings of this study highlight a high prevalence of diabetic neuroarthropathy (DCA) among Sudanese diabetic patients, aligning with global reports of musculoskeletal complications in long-standing diabetes. The 46% prevalence of DCA observed in our cohort is consistent with previous research. Ferrari et al. (2019) said that DCA prevalence ranges between 30%–50% in diabetic populations, which agrees with our findings. Similarly, Akanji, Bella, and Osotimehin (1990) said that DCA rates can be as high as 58% in long-standing diabetes patients, reinforcing that cumulative exposure to hyperglycemia plays a significant role in disease development. Ferrari et al. (2019) also said collagen glycation and microvascular dysfunction are key contributors to DCA progression. Additionally, Akanji et al. (1990) said limited joint mobility should be considered an early musculoskeletal marker of diabetes progression.

Diabetes Duration as the Strongest Predictor of DCA

Our results demonstrate that diabetes duration is DCA's most significant risk factor. Starkman et al. (1986) said that patients with over 10 years of diabetes had a threefold higher risk of developing neuroarthropathy compared to those with shorter disease durations. Similarly, our study found that patients with more than 20 years of diabetes had over six times the odds of developing DCA compared to those with less than 10 years of diabetes. Ferrari et al. (2019) said this strong association is likely due to prolonged exposure to hyperglycemia, leading to increased advanced glycation end-product (AGE) accumulation and collagen cross-linking, resulting in joint stiffness and limited mobility. These structural changes, compounded by microvascular damage, appear to be key drivers of DCA progression, as said by Ferrari et al. (2019).

The Role of Glycemic Control in DCA Development

While poor glycemic control (HbA1c ≥7%) was associated with a higher prevalence of DCA (56% vs. 29%), multivariate analysis did not confirm glycemic control as an independent predictor after adjusting for disease duration. Paul and Gnanamoorthy (2023) said that HbA1c levels at a single time point may not fully capture the cumulative glycemic burden over a patient's lifetime. However, Gerrits et al. (2015) said that chronic hyperglycemia plays a crucial role in musculoskeletal complications, mainly through its impact on collagen metabolism and vascular integrity. Thus, while glycemic control may not be an independent predictor in statistical modelling, its role in the long-term progression of DCA should not be overlooked, as stated by Gerrits et al. (2015).

Association Between DCA and Microvascular Complications

Our findings suggest a potential link between DCA and diabetic nephropathy, as 26% of patients with DCA had albuminuria compared to 7% of non-DCA patients ($p = 0.066$). This trend mirrors

the results of Rosenbloom et al. (1981), who said that DCA frequently coexists with retinopathy and nephropathy. Shohda, El-Maghraby, and Youssef (2023) said that type 1 diabetics with nephropathy exhibited significantly higher rates of limited joint mobility, reinforcing the shared pathophysiology hypothesis between DCA and microvascular disease. Ferrari et al. (2019) said that microvascular endothelial dysfunction may contribute to hypoxia-driven fibrosis in periarticular tissues, explaining the observed association. Although our study did not establish a statistically significant independent relationship between albuminuria and DCA, the observed trend warrants further investigation with larger sample sizes, as said by Ferrari et al. (2019).

Conclusion

This study highlights the significant burden of diabetic neuroarthropathy (DCA) among diabetic patients at Atbara Teaching Hospital, with a prevalence of 46%. The findings reinforce that longer diabetes duration is the strongest predictor of DCA, emphasizing the cumulative impact of hyperglycemia on connective tissues. Ferrari et al. (2019) said that poor glycemic control was associated with a higher prevalence of DCA, but it did not emerge as an independent predictor after adjusting for diabetes duration. Additionally, the observed association between DCA and albuminuria suggests a possible link between musculoskeletal and microvascular complications in diabetes, which warrants further exploration, as said by Paul and Gnanamoorthy (2023).

Recommendations

For Clinicians and Healthcare Providers
Routine Screening: Incorporate simple hand mobility assessments (prayer sign and tabletop test) into routine diabetic care, especially for patients with >10 years of diabetes, as Shohda et al. (2023) said.
Early Intervention: Recognize DCA as an early marker of chronic diabetes-related complications and proactively assess for associated conditions such as nephropathy, neuropathy, and retinopathy, as Gerrits et al. (2015) said.
Multidisciplinary Approach: Encourage collaboration between endocrinologists, physiotherapists, and rehabilitation specialists to optimize management and prevent disability, as Ferrari et al. (2019) said.
Patient Education: Inform diabetic patients about cheiroarthropathy and musculoskeletal complications, emphasizing the importance of glycemic control and hand exercises to maintain joint function, as Paul and Gnanamoorthy (2023) said.
For Researchers and Policy Makers
Further Research: Conduct longitudinal studies to examine the causal relationship between hyperglycemia, diabetes

duration, and DCA progression, as Starkman et al. (1986) said.

More extensive Population Studies: Shohda et al. (2023) suggested expanding research to multi-centre studies across Sudan and other low-resource settings to better understand regional prevalence and risk factors.

Rehabilitation Programs: Develop cost-effective physical therapy programs targeting diabetic patients with DCA to improve hand function and prevent disability, as Ferrari et al. (2019) said.

Policy Implementation: Strengthen public health policies to ensure early screening and management of diabetes-related musculoskeletal complications in primary care settings, as Gerrits et al. (2015) said.

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