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Clinical, Nutritional, And Management Characteristics Of Diabetes Mellitus Patients In Sudan

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Abstract

Background: Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia due to impaired insulin secretion, action, or both. The disease poses a significant global health burden with increasing prevalence, especially in low- and middle-income countries. **Objectives:** This study aimed to assess the sociodemographic profile, clinical characteristics, management practices, nutritional habits, and physical activity patterns among diabetic patients. It also sought to identify factors affecting glycemic control and overall disease management. **Methods:** A cross-sectional study was conducted among 100 diabetic patients attending outpatient clinics. Data were collected via structured questionnaires on demographics, disease history, medication adherence, dietary habits, physical activity, and supplement use. Laboratory tests assessed fasting blood glucose, HbA1c, and lipid profiles. **Results:** Type 2 diabetes predominated (80%), with most patients aged 41–70 years. Family history of diabetes was common (70%), and the majority had lived with the disease for over six years. Medication adherence was high (91%), yet only 34% achieved good glycemic control, while 52% had moderate and 14% poor control. Most participants regularly consumed fruits (98%), vegetables, lean meats, and low-fat dairy, though frequent consumption of sugary drinks (soft drinks 32%, sweets 87%) persisted. Physical activity was reported by 64%, primarily walking, but 36% cited barriers including lack of time and facilities. Supplement use was moderate (53%), mainly vitamin B12 and multivitamins. Comorbidities such as hypertension (94.5% post-diagnosis) and neuropathy (91.7%) were prevalent, and local herbal remedies were widely used (68%). Lipid profiles revealed elevated LDL in 43% and abnormal triglycerides in 27%. Nutritional knowledge and awareness of diabetes symptoms were moderate (77.3% correct responses), highlighting gaps in patient education.
Conclusion: Diabetes management in this population is challenged by suboptimal glycemic control despite high medication adherence, influenced by dietary patterns, physical activity limitations, comorbid conditions, and cultural practices. Integrated, culturally sensitive interventions focusing on lifestyle modification, education, and access to care are critical to improving health outcomes and reducing complications

Keywords: Diabetes Mellitus, Sociodemographic Factors, Nutritional Practices, Medication Adherence, Physical Activity, Biochemical Markers.

Introduction

Diabetes mellitus (DM) is a major public health challenge worldwide, especially in low- and middle-income countries where increasing urbanization and lifestyle changes have led to rising prevalence (International Diabetes Federation , 2022; James, Abate, & Abate, 2021). Sudan, like many African countries, is experiencing

a surge in diabetes cases linked to demographic transitions, dietary changes, and sedentary behaviors (Khalil, Elamin, & Nour, 2021). The chronic nature of DM and its associated microvascular and macrovascular complications impose substantial burdens on healthcare systems and patients' quality of life (Farooq & Hussain, 2020; Albrecht & Gordon-Larsen, 2021; Musa, Nour, & Ibrahim, 2021). Effective diabetes management requires a comprehensive understanding of patients' sociodemographic background, clinical profile, nutritional habits, and adherence to treatment regimens (Alwhaibi et al., 2021). Such information is essential to design culturally appropriate interventions and allocate resources efficiently. Despite the increasing diabetes burden in Sudan, data on patients' characteristics and management practices remain limited. Previous studies have highlighted poor glycemic control and suboptimal lifestyle practices in diabetic populations in similar contexts (Feleke & Wondimagegne, 2020; Ojo & Brooke, 2022). Nutrition education and physical activity are pillars of diabetes care but are often hampered by knowledge gaps, economic constraints, and environmental barriers (Lee & Chen, 2020; Khan, Ali, & Khan, 2023; de Souza & Morais, 2021; Park & Lee, 2021). Additionally, complications such as hypertension, neuropathy, and retinopathy frequently develop, necessitating integrated care approaches (Jones, Smith, & Taylor, 2022). Physical activity engagement remains suboptimal relative to global recommendations (World Health Organization ,2021; Chen, Wu, & Zhang, 2022; Khatri & Khatri, 2020; Qureshi & Zafar, 2022). Barriers such as lack of time and inadequate facilities reflect broader socio-environmental constraints faced by patients in resource-limited settings (Gupta & Singh, 2020; Nguyen & Tran, 2020; Rao & Balaji, 2021). Medication adherence is another critical factor influencing glycemic control but is often affected by socioeconomic and psychosocial determinants (Brown & Yaya, 2020; Hossain, Rahman, & Islam, 2020; Olowookere, Akinyemi, & Oyewole, 2020). The use of local herbal remedies is widespread and influenced by cultural beliefs (Liu, Chen, & Zhang, 2022; Williams & Patel, 2020; Farhat & Karam, 2023). Psychological distress can further complicate diabetes self-management (Moller & Johansen, 2023). This study aims to fill existing knowledge gaps by assessing the sociodemographic, clinical, nutritional, and management characteristics of diabetic patients attending healthcare facilities in Sudan. The insights will inform policymakers and healthcare providers to improve diabetes care quality and patient outcomes.

Materials and Methods

Study Type
This is a cross-sectional health facility-based study conducted to assess various aspects of diabetes mellitus patients.

Area of Study
The study was conducted at Abdallah Khalil Diabetes Mellitus Center and Ali Altoum Diabetes Mellitus Center, both located in Omdurman Locality, Sudan.

Population of Study
The study targeted adult diabetes mellitus patients attending Abdallah Khalil Diabetes Mellitus Center and Ali Altoum Diabetes Mellitus Center during the period 2020–2021. Inclusion criteria included patients diagnosed with Type I or Type II diabetes mellitus; patients with gestational diabetes were excluded.

Sampling Technique and Sample Size
A total coverage sampling method was employed, including all diabetes patients attending the referral centers during the study period. From this population, a random sample of 100 patients was selected for participation.

Data Collection
Data were collected through structured questionnaires and interviews. The questionnaires covered sociodemographic data, diabetes history, family history, medication use and adherence, supplementation, nutritional habits, physical activity, and participation in health programs. Additionally, clinical examinations and biochemical tests—including fasting blood glucose, HbA1c, and lipid profile—were performed.

Data Analysis
Collected data were entered and analyzed using SPSS software. Descriptive statistics such as frequencies, percentages, means, and standard deviations were calculated. Associations between categorical variables were

tested using Chi-square tests. Results were presented in tables and figures, with statistical significance set at $p < 0.05$.

Results:

Table 1: Sociodemographic Characteristics of Study Participants

VARIABLES	CATEGORY	FREQUENCY	PERCENT (%)
Gender	Male	44	44.0
	Female	56	56.0
Age	15–25	3	3.0
	20–40	15	15.0
	41–55	44	44.0
	56–70	30	30.0
	> 70	8	8.0
Resident	Own	74	74.0
	Rent	21	21.0
	Others	5	5.0
Marital Status	Single	8	8.0
	Married	78	78.0
	Divorced	4	4.0
	Widow	10	10.0
Mother Education Level	Illiterate	13	13.0
	Primary / Basic	27	27.0
	Secondary	30	30.0
	University	25	25.0
	Postgraduate	5	5.0
Family Monthly Income	Low	24	24.0
	Medium	76	76.0
Family Size	1–2	5	5.0
	3–4	28	28.0
	5–6	37	37.0
	6–7	16	16.0
	More than 7	14	14.0
Occupations (Males)	Worker	17	38.7
	Officer	10	22.7
	Free works	13	29.5
	Housewife	2	4.5
	Idleness	1	2.3
	Others	1	2.3
Occupations (Females)	Worker	1	1.9
	Officer	11	19.6
	Free works	1	1.9
	Housewife	38	67.9
	Idleness	3	5.4

As shown in **Table 1**, females comprised the majority of participants (56%), with the largest age group being 41–55 years (44%). Most were married (78%) and owned their residence (74%). Mothers' education was most commonly at the secondary level (30%), and the majority of families had a medium monthly income (76%) with 5–6 household members (37%). Among males, the most common occupation was worker (38.7%), whereas most females were housewives (67.9%).

Table 2: **Clinical Characteristics and Management Practices of Diabetes Mellitus Patients**

VARIABLES	CATEGORY	FREQUENCY	PERCENT (%)
Type of Diabetes Mellitus	Type 1	20	20.0
	Type II	80	80.0
	Gestational diabetes	0	-
Onset of Diabetes Mellitus	0–5 years	20	20.0
	6–10 years	36	36.0
	11–15 years	23	23.0
	> 15 years	21	21.0
DM Among Family Members	Yes	70	70.0
	No	30	30.0
Number of DM in Family	1–2	35	50.0
	3–4	23	32.9
	4–5	5	7.1
	> 5	7	10.0
Regular Check for DM	Yes	93	93.0
	No	7	7.0
Frequency of DM Check	Daily	3	3.0
	Weekly	6	6.0
	Monthly	76	76.0
	Yearly	7	7.0
Status of BG Control	Good	34	34.0
	Moderate	52	52.0
	Bad	14	14.0
Frequency of Visit to Doctor	Once	16	16.0
	Twice	22	22.0
	More than 2	58	58.0
	Never	4	4.0

As presented in **Table 2**, most participants had type II diabetes mellitus (80%), with the highest proportion reporting disease onset within 6–10 years (36%). A family history of diabetes was common (70%), and half of these had 1–2 affected relatives. The majority regularly checked their diabetes status (93%), most commonly on a monthly basis (76%). Blood glucose control was reported as moderate by over half of participants (52%). More than half visited a doctor more than twice annually (58%).

Table 3 : Medication Use, Adherence, Supplementation, and Comorbidities Among Diabetes Mellitus Patients

Variables		Frequent	Percent %
Type of Current Medication	Diet	3	3.0
	Diet and Tablet	28	28.0
	Tablet only	34	34.0
	Insulin and Diet	9	9.0
	Insulin	16	16.0
	Insulin and Tablet	4	4.0
	Insulin, Tablet and Diet	6	6.0
Extent of Obligation to Medication	Yes	91	91.0
	No	9	9.0
Causes for Not Being Obligated	New DM Patients	3	33.3
	Anxious	4	44.4
	No Money	2	22.3
Signs & Symptoms of Hypoglycemia	Yes	93	93.0
	No	7	7.0
Signs & Symptoms of Hyperglycemia	Yes	86	86.0

	No	14	14.0
Food Supplements/Vitamins with DM Treatment	Yes	53	53.0
	No	47	47.0
Type of Supplements/Vitamins *(n = 53)*	C + D	8	15.1
	B12	20	37.7
	Folic Acid	2	3.8
	Supral	2	3.8
	Others	21	39.6
Disease Type & Onset	Heart Disease (Before)	0	0.0
	Heart Disease (After)	1	100.0
	Hypertension (Before)	2	5.5
	Hypertension (After)	34	94.5
	Foot Numb/Nerves (Before)	2	8.3
	Foot Numb/Nerves (After)	22	91.7
	Eye Disease (Before)	2	12.5
	Eye Disease (After)	14	87.5
	Renal Disease (Before)	0	0.0
	Renal Disease (After)	1	100.0
Local Treatments for DM	Yes	68	68.0
	No	32	32.0
Type of Local Treatments *(n = 68)*	Tabaldi	15	22.1
	Hibiscus	7	10.3
	Gum Arabic	23	33.7
	Ginger	8	11.8
	Others	15	22.1
Triglycerides & Cholesterol	Yes	63	63.0
	No	37	37.0
Treatment for Hyperlipidemia *(n = 63)*	Yes	41	65.0
	No	22	35.0
Type of Hyperlipidemia Treatments *(n = 63)*	Atorvazal	28	68.3
	Mitanomet	9	21.9
	Others	4	9.8
Local Drinks for Lipid Control	Yes	20	20.0
	No	80	80.0
Type of Local Drinks *(n = 20)*	Tabaldi	6	30.0
	Carnation	5	25.0
	Others	9	45.0
Frequency of Lipid Check per Year	Every 3 Months	62	62.0
	Every 6 Months	29	29.0
	Once a Year	6	6.0
	More than Once a Year	3	3.0

As shown in **Table 3**, the most common diabetes management regimen was tablets alone (34%), followed by a combination of diet and tablets (28%). Most participants adhered to their prescribed medications (91%), with non-adherence mainly due to anxiety (44.4%). Hypoglycemia and hyperglycemia symptoms were reported by 93% and 86% of participants, respectively. Over half (53%) used dietary supplements, most commonly vitamin B12 (37.7%). Hypertension was the most frequent comorbidity after diabetes onset (94.5%), followed by foot numbness/neuropathy (91.7%) and eye disease (87.5%). Local treatments were used by 68% of participants, with gum Arabic being the most common (33.7%). Hyperlipidemia was reported by 63% of participants, of whom 65% received treatment—mainly atorvastatin (68.3%). Only 20% used local drinks for lipid control, such as tabaldi (30%) and carnation (25%). Lipid levels were most commonly checked every three months (62%).

Table 4 : Health, Nutrition, and Physical Activity Practices Among Diabetes Mellitus Patients

Variable	Category	Frequent	Percent %
Joined Health Nutritional Program	Yes	84	84.0
	No	16	16.0
Provider of the Program *(n = 84)*	Doctor	6	7.1
	Nutritionist	74	88.1
	Media	4	4.8
Last Time Attending Nutritional Program *(n = 84)*	0–1 year	76	90.5
	2–4 years	6	7.1
	>5 years	2	2.4
Practice Physical Exercise	Yes	64	64.0
	No	36	36.0
Type of Exercises *(n = 64)*	Walking	61	95.3
	Others	3	4.7
Frequency of Exercise per Week *(n = 64)*	1–2 times	30	46.9
	3–4 times	24	37.5
	5–6 times	10	15.6
Reasons for Not Exercising *(n = 36)*	No benefit	2	5.6
	No time	21	58.3
	No suitable place	3	8.3
	Not suitable	10	2.8
Relationship Between Sport and DM	Yes	82	82.0
	No	18	18.0
Body Weight Status Before DM	Normal	58	58.0
	Overweight	26	26.0
	Underweight	16	16.0
Relationship Between Weight and DM	Yes	76	76.0
	No	24	24.0
Smoking	Yes	10	10.0
	No	90	90.0
Number of Daily Meals	One	5	5.0
	Two	28	28.0
	Three	59	59.0
	Four	8	8.0
Meal Size	Little	35	35.0
	Medium	62	62.0
	Big	3	3.0
Snacks Between Meals	Yes	73	73.0
	No	27	27.0
Number of Snacks *(n = 73)*	One	32	43.8
	Two	35	47.9
	Three	6	8.3
Changing Nutritional System	Yes	77	77.0
	No	23	23.0
Type of Changes *(n = 77)*	Quantity	11	14.3
	Qualitative	4	5.2
	Cooking method	1	1.3
	Quantity and Qualitative	12	15.6
	All changes	49	63.6
Reasons for Not Changing Nutrition *(n = 23)*	No need	2	8.7
	Others	21	91.3

As shown in **Table 4**, most participants (84%) had joined a health nutritional program, predominantly provided by nutritionists (88.1%), with 90.5% attending within the past year. Physical exercise was practiced by 64%

of participants, mainly walking (95.3%), with 1–2 sessions per week being most common (46.9%). The main reason for not exercising was lack of time (58.3%). A large proportion recognized the relationship between sports and diabetes (82%). Before diabetes diagnosis, 58% had normal weight, 26% were overweight and 16% underweight; 76% believed weight was related to diabetes. Smoking prevalence was low (10%). Most consumed three meals daily (59%), with medium meal size (62%), and 73% reported eating snacks between meals—mainly two snacks per day (47.9%). Nutritional changes after diagnosis were reported by 77%, most often including all aspects (63.6%). The main reason for no dietary change was "other" factors (91.3%).

Tables 5 : Dietary Intake Patterns and Nutritional Knowledge Among Participants

FOOD / VARIABLE	FREQUENCY (%)	NOTES
Fruits & Vegetables Consumption	98% consume regularly	25.5% eat daily; 37.8% eat 1–2 times/week; essential sources of vitamins, minerals, fiber
Meat Consumption	94% consume	68% eat 1–2 times/week; 81.9% prefer fat removed to reduce saturated fat intake
Chicken Consumption	92% consume	75% prefer fat removed; lean protein source
Fish Consumption	87% consume	76% eat once/week; good source of omega-3 fatty acids
Milk Consumption	90% consume	Varied fat preference: ~37% no fat, 36.7% full fat; important for calcium and vitamin D
Egg Consumption	89% consume	Majority eat whole egg; rich in protein and essential nutrients
Legumes Consumption	90% consume	81% prefer boiled or cooked; good source of plant-based protein and fiber
Fat Used	85% use oil	Majority use vegetable oils; 25% follow specific fat/cholesterol control diets
Fat Control Method	Among those controlling fat: 68% low fat, 32% no fat	Indicates dietary modifications to reduce cardiovascular risk
Knowledge of Fat Effects	66% aware	Participants aware of impact of fats on health
Knowledge of Fat Type	37% aware	Mostly unaware or using unenriched fats; educational gap noted
Tea Consumption	92% drink tea	Majority drink 1-3 cups daily; common social and cultural beverage
Sugar in Tea	51% add 1 spoon	34% drink without sugar; sugar intake varies and impacts calorie consumption

As presented in **Table 5**, the majority of participants reported regular consumption of fruits and vegetables (98%), with over one-third eating them 1–2 times per week. Meat (94%) and chicken (92%) were widely consumed, with most preferring fat removed. Fish was consumed by 87%, mainly once per week. Milk (90%) and eggs (89%) were also common, with varied fat preferences and most consuming whole eggs. Legumes were eaten by 90%, predominantly boiled or cooked. Regarding dietary fats, 85% used vegetable oils, and 25% followed specific fat/cholesterol control diets; among these, 68% used low-fat and 32% no-fat approaches. Awareness of fat health effects was reported by 66%, but only 37% knew specific fat types. Tea consumption was high (92%), with most drinking 1–3 cups daily; sugar use varied, with 51% adding one spoon and 34% avoiding sugar.

Tables 6 : Frequency of Food Item Consumption and Associated Chi-Square Test Results

Item	Always		Sometimes		NO/NONE		(T)	P. VALUE
	Number	%	Number	%	Number	%		
Soft drinks	4	4.0	28	28.0	68	68.0	43.03	0.000
Juices	34	34.0	53	53.0	13	13.0	27.92	0.000
Ice-cream	4	4.0	28	28.0	68	68.0	44.68	0.000
Sweets	34	34.0	53	53.0	13	13.0	45.76	0.000

Pasta	6	6.0	61	61.0	33	33.0	40.10	0.000
Noodles	7	7.0	30	30.0	63	63.0	40.97	0.000
Sheireya	10	10.0	23	23.0	67	67.0	38.32	0.000
Cakes	7	7.0	47	47.0	46	46.0	38.68	0.000
Full fat meats	9	9.0	19	19.0	72	72.0	40.71	0.000
Removed fat meats	25	25.0	51	51.0	24	24.0	28.28	0.000
Full fat livestock	7	7.0	31	31.0	62	62.0	40.75	0.000
Removed fat livestock	23	23.0	49	49.0	28	28.0	28.63	0.000
Eggs	34	34.0	45	45.0	21	21.0	25.48	0.000
Porridge	44	44.0	33	33.0	23	23.0	22.51	0.000
Kissra	19	19.0	60	60.0	21	21.0	31.79	0.000
Breads	85	85.0	8	8.0	7	7.0	21.74	0.000
Others (carbohydrates)	14	14.0	11	11.0	75	75.0	36.08	0.000
Natural juices	39	39.0	47	47.0	14	14.0	25.46	0.000
Soft drinks (drinks)	7	7.0	23	23.0	70	70.0	42.84	0.000
Vegetables	72	72.0	28	28.0	0	0.0	28.36	0.000
Fruits	47	47.0	47	47.0	6	6.0	26.29	0.000
Legumes	78	78.0	13	13.0	9	9.0	20.76	0.000
Milk	74	74.0	23	23.0	3	3.0	24.89	0.000
Yoghurts	36	36.0	57	57.0	7	7.0	28.92	0.000
Cheese	24	24.0	34	34.0	42	42.0	27.38	0.000

As presented in **Table 6**, bread was the most frequently consumed item, with 85% of participants reporting daily intake, followed by legumes (78%), milk (74%), and vegetables (72%). Fruits were always consumed by 47%, while natural juices were always consumed by 39%. Foods with high sugar content such as sweets (34%) and juices (34%) were less commonly consumed daily, and the majority reported only occasional intake of pasta (61%), cakes (47%), and noodles (30%). High-fat animal products such as full-fat meats (72% never) and full-fat livestock (62% never) were largely avoided, with a preference for fat-removed meats and livestock products. Ice cream and soft drinks were rarely consumed daily (4% each), with most participants reporting no or occasional intake. All differences in consumption patterns were statistically significant ($p < 0.001$).

Table 7 : Distribution of BMI Categories Among Participants

BMI Category	Frequency	Percent (%)
Normal	28	28.0
Overweight	23	23.0
Obesity I	24	24.0
Obesity II	10	10.0
Obesity III	15	15.0
Total	**100**	**100.0**

As shown in **Table 7**, 28% of participants had a normal BMI, while the remainder were overweight (23%) or obese, with obesity class I being most common (24%), followed by class III (15%) and class II (10%).

Table 8 : Lipid Profile Comparison Between Type I and Type II Diabetes Mellitus

VARIABLE	TYPE OF DIABETES MELLITUS	N	MEAN	STD. DEVIATION	P-VALUE
LDL	Type I	20	102.80	22.06	0.03*
	Type II	80	93.13	31.86	0.184
HDL	Type I	20	37.55	7.86	0.340
	Type II	80	37.64	14.83	0.340
Triglyceride	Type I	20	132.25	77.38	0.447
	Type II	80	132.89	63.95	0.441
Cholesterol	Type I	20	157.45	39.61	0.724
	Type II	80	161.33	44.75	0.706

* P. Value significant at < 0.05

As presented in **Table 8**, mean LDL levels were higher in type I diabetes (102.80 ± 22.06 mg/dL) compared to type II (93.13 ± 31.86 mg/dL), with a statistically significant difference ($p = 0.03$). No significant differences were observed between diabetes types for HDL, triglycerides, or total cholesterol levels ($p > 0.05$).

Table 9 : Knowledge of Diabetes Mellitus: Correct Responses on Symptoms and Supplement Use

CORRECT ANSWERS	FREQUENCY	PERCENT (%)
Signs and symptoms of DM hypoglycemia	93	31.0
Signs and symptoms of DM hyperglycemia	86	28.7
Food supplements or Vitamins with DM treatments	53	17.6
Total	232/300	77.3

* Scoring ranges (0-49 poor), 50-69 moderate , and 70-100 good

As shown in **Table 9**, correct answers related to diabetes management totaled 77.3% of responses. Signs and symptoms of hypoglycemia were correctly identified by 31.0% of participants, signs and symptoms of hyperglycemia by 28.7%, and 17.6% reported use of food supplements or vitamins alongside diabetes treatment.

Table 10 : Biochemical Test Results Among Study Participants

Test	Category	N	Percent (%)
FBG (mg/dl)	Low < 70	2	2.0
	Normal 70–110	13	13.0
	High > 110	85	85.0
HbA1C	Normal < 7%	82	82.0
	Abnormal > 7%	18	18.0
LDL (mg/dl)	Normal < 100	57	57.0
	Abnormal > 100	43	43.0
HDL (mg/dl)	Normal > 45	99	99.0
	Abnormal < 45	1	1.0
Triglyceride (mg/dl)	Normal < 150	73	73.0
	Abnormal > 150	27	27.0
Cholesterol (mg/dl)	Normal < 200	81	81.0
	Abnormal > 200	19	19.0

As shown in **Table 10**, the majority of participants (85%) had high fasting blood glucose (FBG >110 mg/dL), while 82% had normal HbA1c levels (<7%). Lipid profile results indicated that 43% had abnormal LDL (>100 mg/dL), but 99% had normal HDL (>45 mg/dL). Triglycerides were normal in 73% of participants, and total cholesterol was normal (<200 mg/dL) in 81%.

Table 11 : **Diabetes Management Practices by Duration of Disease Onset**

Category	0–5 years	6–10 years	11–15 years	> 15 years	Total
Regular DM Check					
Yes	18	34	20	21	93
No	2	2	3	0	7
Status of BG Control					
Good	8	8	6	12	34
Moderate	9	23	12	8	52
Bad	3	5	5	1	14
Frequency of Doctor Visits per Year					
Once	1	6	5	4	16
Twice	8	6	2	6	22
More than 2	10	24	14	10	58
Never	1	0	2	1	4

As shown in **Table 11**, most participants (93%) regularly monitored their diabetes across all duration groups, with the highest regular check rates in the 6–10 years category (34 participants). Blood glucose control was mostly moderate (52%), followed by good control (34%), regardless of diabetes duration. Regarding doctor visits, the majority (58%) attended more than twice per year, especially those with 6–10 years of diabetes, while only a small number (4%) never visited a doctor.

Discussion

The present study provides a comprehensive overview of the sociodemographic, clinical, nutritional, and management characteristics of diabetes mellitus (DM) patients in Sudan. The predominance of female participants (56%) reflects a common trend observed in many clinical studies where women more frequently engage with healthcare services or exhibit higher health-seeking behaviors compared to men (Smith, Brown, & Davis, 2021). The age distribution, with most patients aged between 41 and 55 years (44%) and 56 to 70 years (30%), aligns with the natural history of Type II diabetes, which typically manifests in middle to older adulthood (International Diabetes Federation [IDF], 2022). The high proportion of Type II diabetes (80%) in this cohort is consistent with global data indicating that Type II diabetes constitutes the vast majority of cases worldwide, particularly in low- and middle-income countries undergoing rapid urbanization and lifestyle transitions (Chen, Magliano, & Zimmet, 2020).

The presence of a strong family history of diabetes in 70% of participants emphasizes the genetic predisposition and shared environmental risk factors in diabetes pathogenesis (Zhang, Jiang, & Wei, 2021). This suggests a pressing need for targeted family screening and early preventive interventions, as supported by Campbell and Deane (2020), who highlighted family-centered approaches as effective in curbing diabetes progression.

Despite a high rate of regular diabetes check-ups (93%) and medication adherence (91%), only 34% of patients demonstrated good glycemic control. This disparity underscores the multifactorial challenges in effective diabetes management beyond medication adherence alone. Factors such as suboptimal medication regimens, patient health literacy, psychosocial barriers, and comorbidities may compromise metabolic control (Alwhaibi et al., 2021; Garcia-Perez et al., 2020; Moller & Johansen, 2023). Similar patterns have been reported in other developing country contexts where resource constraints limit comprehensive diabetes care (Feleke & Wondimagegne, 2020; Ojo & Brooke, 2022).

The role of lifestyle modification is evident in this population, with 84% of patients participating in nutritional programs, primarily delivered by nutritionists. However, only 63.6% reported making qualitative and quantitative dietary changes, suggesting persistent barriers such as cultural food preferences, economic limitations, and insufficient education about nutrition (Lee & Chen, 2020; Khan et al., 2023; de Souza & Morais, 2021; Park & Lee, 2021). Knowledge gaps regarding fat types and their health effects further highlight the need for enhanced, culturally appropriate nutrition education focusing on cardiovascular risk reduction through diet.

Physical activity engagement, recorded at 64% mainly through walking, is encouraging but still suboptimal relative to global physical activity guidelines (World Health Organization ,2021; Chen, Wu, & Zhang, 2022; Khatri & Khatri, 2020; Qureshi & Zafar, 2022). Barriers such as lack of time (58.3%) and inadequate facilities reflect broader socio-environmental constraints faced by patients in resource-limited settings (Gupta & Singh, 2020; Nguyen & Tran, 2020; Rao & Balaji, 2021). Increasing access to safe and convenient physical activity opportunities through community infrastructure improvements and policy support could significantly impact diabetes outcomes (Wang & Hu, 2020).

The lipid profile results reveal that 43% of patients had abnormal LDL cholesterol levels, with only 65% receiving lipid-lowering treatment. This is concerning given the elevated cardiovascular disease (CVD) risk among diabetic patients (Jones et al., 2022; Peterson & Burke, 2022). Integrating aggressive lipid management strategies into routine diabetes care is critical to reduce morbidity and mortality. Moreover, only 20% reported using local drinks for lipid control, reflecting a reliance on pharmacotherapy but also an openness to traditional remedies like Tabaldi and Gum Arabic (Liu et al., 2022; Williams & Patel, 2020; Farhat & Karam, 2023). Further research is warranted to validate and potentially integrate such traditional treatments with modern care protocols.

Biochemical markers indicate that 82% of patients had HbA1c within normal ranges (<7%), which contrasts somewhat with self-reported glycemic control status, hinting at possible variability in disease monitoring or laboratory accuracy. Regular and accurate biochemical monitoring remains vital for personalized treatment adjustments and early detection of complications (Alwhaibi et al., 2021).

The study also sheds light on the high prevalence of comorbidities such as hypertension (94.5% post-diabetes onset), neuropathy (91.7%), and retinopathy (87.5%), highlighting the severe burden of micro- and macrovascular complications in this population (Farooq & Hussain, 2020). These complications necessitate integrated care models combining diabetes, cardiovascular, renal, and eye health services to optimize patient outcomes.

Despite the study's strengths, including a large sample size and detailed multi-dimensional data, certain limitations should be acknowledged. The cross-sectional design restricts causal inference, and reliance on self-reported data may introduce recall and social desirability biases. Additionally, biochemical and clinical data were limited to available routine testing, potentially missing nuances in disease progression. Future longitudinal studies incorporating continuous glucose monitoring, detailed dietary assessments, and psychosocial evaluations would enhance understanding of diabetes management dynamics.

Conclusion

This study highlights important sociodemographic, clinical, nutritional, and management characteristics of diabetic patients in Sudan. Despite good medication adherence and healthcare engagement, glycemic control and lifestyle modifications remain suboptimal. The high prevalence of complications underscores the need for integrated, patient-centered care approaches. Enhancing nutritional education, physical activity promotion, and lipid management within culturally appropriate frameworks is essential. Future research should explore longitudinal outcomes and tailored intervention effectiveness to improve diabetes management in Sudan and comparable contexts.

Ethical Considerations

Ethical approval for the study was obtained verbally from the relevant institutional authorities. Verbal informed consent was also obtained from all participants prior to data collection.

Conflict of interests: No conflict of interest to be declared.

Authors Contributions: I hereby verify that all authors mentioned on the title page have made substantial contributions to the conception and design of the study, have thoroughly reviewed the manuscript, confirm the accuracy and authenticity of the data and its interpretation, and consent to its submission.

Availability of Data and Materials: All datasets analysed and described during the present study are available from the corresponding author upon reasonable request.

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