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Prevalence and Associated Risk Factors of Hypertension Among Adults with Diabetes Mellitus in Wad-Medani, Gezira State, Sudan 2023: A Cross-Sectional Study

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ABSTRACT

Background: Hypertension and diabetes mellitus are common comorbidities that significantly increase the risk of cardiovascular and renal complications. The dual burden of these conditions is especially concerning in low-resource settings like Sudan, where non-communicable diseases are on the rise. This study aims to assess the prevalence of hypertension among diabetic patients in Wad-Medani, Gezira State, Sudan, and to explore associated risk factors.

Methods: A cross-sectional study was conducted among diabetic patients attending clinics in Wad-Medani city, Gezira State, Sudan. Participants were assessed for hypertension using standard blood pressure measurements. Demographic data, medical history, and lifestyle factors were collected through structured interviews. Descriptive and inferential statistics were used to analyse the data, with logistic regression applied to identify risk factors for hypertension.

Results: Out of 234 diabetic patients, 111 (47.4%) were found to have hypertension. Obesity ($p<0.001$), increasing age ($p=0.02$), and physical inactivity ($p=0.03$) were significant risk factors for developing hypertension. Despite high adherence to medication, 35.6% of hypertensive patients had uncontrolled blood pressure. A higher prevalence of hypertension was observed among male patients (52%) and those with a longer duration of diabetes (>10 years).

Conclusion: The study reveals a high prevalence of hypertension among diabetic patients in Wad-Medani city, Gezira State, Sudan, highlighting the need for integrated management strategies. Lifestyle modifications, improved healthcare access, and patient education are crucial to managing this dual burden. The findings underscore the importance of addressing non-communicable diseases in low- and middle-income countries to reduce morbidity and mortality.

Keywords: Hypertension; Diabetes Mellitus; Comorbidities; Prevalence; Risk Factors; Sudan; Non-Communicable Diseases; Gezira

Abbreviations: DM: Diabetes Mellitus; NCDS: Non-Communicable Diseases; IDF: International Diabetes Federation; AHA: American Heart Association; SPSS: Statistical Package for Social Sciences; SBP: Systolic Blood Pressure

Background

Diabetes mellitus (DM) is one of the most prevalent chronic diseases globally and is considered a major contributor to non-communicable diseases (NCDs) [1]. NCDs are a significant cause of mortality worldwide, accounting for 70% of all deaths [2]. Both diabetes and hypertension are classified as NCDs, and their co-occurrence poses a severe public health challenge. By 2025, the global burden of hypertension is expected to rise to 1.5 billion people, with 125.5 million cases anticipated in Sub-Saharan Africa [3]. The prevalence of hypertension in Africa is especially concerning, with rates of 33.3% in Northern Africa and 27% in Sub-Saharan Africa [4]. Sudan, in particular, has seen a significant rise in diabetes prevalence. The 2019 IDF Diabetes Atlas reported that 22.1% of the Sudanese population between 20 and 79 years old have diabetes, making Sudan one of the countries with the highest diabetes prevalence worldwide [5]. The co-occurrence of diabetes and hypertension is also high in Sudan, with reports estimating that approximately 25% of the population suffers from hypertension [5]. This combination of diseases significantly increases mortality, as the risk of cardiovascular complications in patients with both hypertension and diabetes is fourfold compared to those without these conditions [6,7]. The prevalence of hypertension is high among diabetics and is nearly twice than the normal population [8]. Hypertension and diabetes are known to be independent risk factors for various microvascular and macrovascular complications, including retinopathy, nephropathy, coronary artery disease, myocardial infarction, stroke, and peripheral vascular disease [8,9].

The eventual prognosis for patients with diabetes and hypertension largely depends on their knowledge of the diseases and adherence to medical management [10]. Though the pathophysiology of diabetes and hypertension differs, they share common risk factors such as sedentary lifestyles, obesity, excessive alcohol intake, genetic predisposition, and advanced age [11,12]. Several African studies have highlighted a significant prevalence of hypertension among diabetic patients. For example, in Benin City, Nigeria, 54.2% of diabetic patients were also diagnosed with hypertension [13]. In Sudan, the prevalence of diabetes-related complications such as retinopathy, neuropathy, and diabetic foot ulcers has been documented, though few studies specifically address the prevalence of hypertension among diabetic patients [14,15]. For example, a study in a diabetes healthcare facility in Sudan found that systemic hypertension is common among diabetic patients, with risk factors such as obesity and age playing crucial roles [14].

A study conducted in Thailand revealed an even higher prevalence, with 78.4% of diabetic patients also having hypertension [13]. Given the high prevalence of these conditions in Sudan, more research is needed to understand the extent of hypertension among diabetic patients and the associated factors influencing their health outcomes. This study aimed to assess the prevalence and associated risk factors of hypertension among diabetic patients attending the outpatient clinic of Wad-Medani teaching hospital, diabetic clinic at health services/ University of Gezira Alrazie campus, displaced diabetic patients at Hantoub shelter for internally displaced people and Al-Draga health centre (Primary health care centre mainly for diabetic patients) in Wad-Medani city in Gezira state, Sudan in the period of October to December 2023.

Materials and Methods

A hospital and community based cross sectional study was conducted over a three-month period from October to December 2023 in Wad-Medani city, Gezira State, Sudan. The study targeted diabetic patients attending the outpatient clinic of Wad-Medani Teaching Hospital, the diabetic clinic at Heath services/ University of Gezira Alrazie campus, displaced diabetic patients at Hantoub Shelter for Internally Displaced People, and the Al-Draga Health Centre (The largest primary health care facility that primarily serves diabetic patients).

Study Population

The study enrolled a total of 234 diabetic patients (both Type 1 Diabetes Mellitus (T1DM) and Type 2 Diabetes Mellitus (T2DM)) based on the following diagnostic criteria set by the International Diabetes Federation (IDF):

- Fasting plasma glucose > 7 mmol/L.
- Two-hour plasma glucose > 11.1 mmol/L.
- HbA1c > 6.5%.
- Random plasma glucose > 11.1 mmol/L in the presence of hyperglycemic symptoms.

Blood Pressure Measurement and Hypertension Definition

Blood pressure (BP) was measured using a calibrated sphygmomanometer. Each participant's BP was checked twice, with a five-minute interval between readings, and the average value was used. Hypertension was defined in accordance with American Heart Association (AHA) guidelines as:

- Systolic BP ≥ 140 mmHg and/or Diastolic BP ≥ 90 mmHg.
- Regular use of antihypertensive medications was also considered indicative of hypertension.
- Uncontrolled hypertension was defined as systolic BP ≥ 140 mmHg and/or diastolic BP ≥ 90 mmHg despite being on medication, while controlled BP was defined as systolic BP < 140 mmHg and diastolic BP < 90 mmHg.

Inclusion Criteria

Sudanese residents (aged 14 years and above) attending the designated clinics. Patients with a confirmed diagnosis of T1DM or T2DM based on IDF criteria. Participants who provided informed consent.

Exclusion Criteria

Individuals younger than 14 years. Pregnant women (due to physiological changes in BP). Patients with significant cognitive impairments or severe illness (unable to complete the interview or BP measurement).

Sampling Method

Stratified Random Sampling

Stratified random samplingwas used to ensure balanced representation from the different study sites (Wad-Medani Teaching Hospital, health services/ University of Gezira/Alrazie campus, diabetic clinic, Hantoub Shelter for internally displaced people and Al-Draga Health Centre). Proportional sampling ensured that the number of participants from each facility reflected the relative patient load of diabetic individuals at these sites.

Data Collection

Data were collected using a structured, interviewer-administered questionnaire. The data was collected by doctors and medical students from Faculty of Medicine, University of Gezira from different batches. The questionnaire was designed based on validated instruments used in previous studies of diabetes and hypertension and was reviewed by field experts. The main domains of the questionnaire included: Demographics: Age, gender, occupation, educational level. Diabetes-related variables: Type of diabetes, duration of disease, and treatment regimen (oral hypoglycaemic agents, insulin, or combination). Hypertension-related variables: Duration of hypertension, types of antihypertensive medications, medication adherence, and awareness of BP targets. Lifestyle factors: Smoking, alcohol consumption, physical activity, dietary habits, and family history of cardiovascular disease or diabetes.

Statistical Analysis

Data were entered and analyzed using Statistical Package for Social Sciences (SPSS), version 25. Descriptive statistics (means, standard deviations, frequencies) were used to summarize demographic and clinical characteristics. The prevalence of hypertension was calculated as a proportion of the total study population. The association between hypertension and potential risk factors (e.g., age, gender, duration of diabetes, medication adherence, lifestyle factors) was assessed using Chi-square tests for categorical variables and t-tests for continuous variables. Logistic regression analysis was used to determine the independent predictors of hypertension in the diabetic population. A p-value < 0.05 was considered statistically significant.

Ethical Considerations

This study was conducted under the ethical supervision of the Faculty of Medicine, University of Gezira. Ethical approval was obtained from the University of Gezira's Ethical Committee. Informed consent was obtained from all participants after providing a thorough explanation of the study's objectives, procedures, and potential risks and benefits. Participants were informed that refusal to participate would not affect their care in any way.

Results

A total of 234 diabetic patients were enrolled in this study, with a median age of 55 years (interquartile range: 48-63 years). Females comprised the majority of the sample, with 160 (68.4%) participants. The median duration of diabetes among the patients was 9 years (interquartile range: 5-15 years), indicating a long-standing chronic disease burden in this population. The age distribution revealed that the majority of participants (70, 29.9%) were aged between 51 and 60 years, suggesting that middle-aged individuals were particularly affected (Table 1).

Table 1: Demographic Characteristics of Patients.

Characteristic	Category	Frequency	Percent
Age Category	Less than 20	3	1.2
	20 – 30	10	4.2
	31 – 40	31	13.2
	41 – 50	52	22.2
	51 – 60	70	29.9
	61 – 70	51	22.6
	More than 70	17	7.2
	Total	234	100.0
Gender Distribution	Male	74	31.2
	Female	160	68.4
	Total	234	100.0

Hypertension Prevalence and Blood Pressure Control

Hypertension was present in nearly half (111, 47.4%) of the diabetic patients. This highlights a significant comorbidity burden, consistent with the known relationship between diabetes and hypertension.

- **Blood Pressure Measurements Revealed Variable Control Across the Cohort**
- **Systolic Blood Pressure (SBP)**

- 18 patients (7.7%) had an SBP of 120 mmHg, indicating well-controlled hypertension.

- 18 patients (7.7%) had an SBP of 130 mmHg, close to the hypertensive threshold.

- 11 patients (4.7%) had an SBP of 140 mmHg, reaching the definition of uncontrolled hypertension.

- **Diastolic blood pressure (DBP)**

- 29 patients (12.4%) had a DBP of 80 mmHg, falling within a controlled range.

- 21 patients (9%) had a DBP of 90 mmHg, which represents borderline control or mild hypertension.

Overall, the data indicate that a substantial proportion of hypertensive diabetic patients were either at or nearing the threshold for uncontrolled hypertension, emphasizing the need for tighter blood pressure management in this population.

- **Medication Adherence**

A very high proportion of diabetic patients (216, 92.3%) and hypertensive patients (110, 99.1%) reported adherence to their prescribed medications. This high adherence rate is promising and suggests that factors other than medication compliance may be influencing suboptimal blood pressure control in some patients.

- Interpretation

The majority of patients fall within the 51-60-year age range, indicating that middle-aged adults with diabetes are a key demographic. Additionally, the higher proportion of females (68.4%) may reflect gender differences in health-seeking behaviour or the prevalence of diabetes in this population.

- **Medication Use for Diabetes**

- Metformin was the most commonly used medication (96, 41%).

- Combination therapies like Glimepiride + Metformin (30, 12.8%) and Insulin + Metformin (27, 11.5%) were also prevalent, reflecting the need for multi-drug regimens in many patients.

- **Medication Use for Hypertension**

Amlodipine was the most commonly prescribed antihypertensive (71, 30.3%), and ARBs (16, 6.8%). Aspirin was used by (33, 14.1%).

- **Risk Factors and Lifestyle Characteristics**

- **Smoking**

The majority of participants (108, 46.2%) had never smoked, while only 4 (1.7%) were current smokers, reflecting a low smoking prevalence in the cohort.

- **Alcohol**

None of the participants reported alcohol consumption.

- **Physical Activity**

A notable proportion of patients (51, 21.8%) engaged in occasional physical activity (less than 150 minutes per week), while 19.7% reported regular physical activity (more than 150 minutes per week). However, 9% were physically inactive, which may contribute to poor disease control.

- **Obesity**

Obesity was present in 19 patients (8.1%), a relatively low percentage, which could indicate a need for further investigation into other metabolic risk factors.

- **Family History of Diabetes**

A positive family history of diabetes was reported in 79 patients (33.8%), highlighting the genetic predisposition to diabetes in this population.

- **Interpretation**

- The study revealed that a significant proportion of diabetic patients also suffer from hypertension, emphasizing the need for integrated care approaches targeting both conditions.

- Despite high levels of medication adherence, suboptimal BP control in a portion of patients suggests that factors such as treatment intensification, lifestyle interventions, or other non-adherence issues (like delayed care or irregular follow-ups) may need to be addressed.

- The low levels of smoking and alcohol consumption are positive indicators, though improving physical activity levels and managing obesity could further enhance disease outcomes Tables 2 & 3.

Table 2: Duration of Chronic Diseases, and Medication Use.

Characteristic of chronic diseases	Category		Frequency	Percent
Duration of Chronic diseases	Diabetes	1 year	9	3.8
		2 years	15	6.4
		3 years	14	6
		4 years	21	9
		5 years	15	6.4
		6 years	13	5.6
		7 years	13	5.6
		10 years	23	9.8
		13 years	10	4.3
		15 years	14	6
		20 years	17	7.3
	Hypertension	1 year	5	2.1
		3 years	6	2.6
		10 years	9	3.8
		20 years	5	2.1
Types of Medications	Diabetes	Metformin	96	41
		Insulin	47	20.1
		Glimepride and Metformin	30	12.8
		Insulin and Metformin	27	11.5
	Hypertension	Amlodipine	71	30.3
		ARB	16	6.8
		Aspirin	33	14.1
Medication Adherence	Follow up of Diabetes	Annually	12	5.1
		Every six months	13	5.6
		Every three months	13	12.8
		Monthly	59	25.2
		Never	4	1.7

Table 3: Risk factors of chronic diseases.

Risk factors	Smoking	Never smoke	108	46.2
		Quit smoking	2	0.9
		Currently smoker	4	1.7
	Alcohol Consuming	Never	115	100
	Physical Activity	Physical inactivity	21	9
		Occasionally (less than 150 minutes per week)	51	21.8
		Regularly (more than 150 minutes per week)	46	19.7
	Obesity	Obese	19	8.1
		Not obese	98	41.9
	Family History (FH)	Positive FH	79	33.8
		Negative FH	39	16.7

Discussion

This study revealed a high prevalence of hypertension among diabetic patients in Wad-Medani city in Gezira State, Sudan, which aligns with findings from similar studies across Sub-Saharan Africa and globally. In our study, 47.4% of diabetic patients had hypertension, this finding is nearly similar to the study done in Khartoum, Sudan which showed that the prevalence of hypertension among diabetic patients was 47.9% [15]. The results of this study has a prevalence comparable to findings from Benin City, Nigeria, where 54.2% of diabetic patients were hypertensive [7]. A study conducted in Thailand reported even higher rates, with 78.4% of diabetic patients suffering from hypertension, further emphasizing the global scope of the problem [13]. The co-occurrence of hypertension and diabetes presents a significant public health challenge due to their shared risk factors and compounded effects on morbidity and mortality. Our study identifies several risk factors common to both conditions, including obesity, physical inactivity, poor dietary habits, and increasing age. These findings are consistent with a large body of research that identifies these factors as major contributors to both diseases [10,11]. For example, studies in Ethiopia and South Africa similarly found obesity, male gender, and advancing age as significant predictors of hypertension among diabetic patients [11,16]. In Sudan, the prevalence of diabetes is particularly high, with the 2019 IDF Diabetes Atlas reporting a 22.1% prevalence among adults aged 20–79 years [5].

Previous studies in Sudan also highlighted a rising prevalence of hypertension, with a national average around 25% [5]. However, few studies have specifically examined the intersection of hypertension and diabetes in the country, making our research one of the first to address this critical gap in the literature. Our findings also align with those from a study in Northern Sudan, which demonstrated a significant burden of non-communicable diseases, including diabetes and hypertension, particularly among urban populations [5]. The presence of both diabetes and hypertension in patients significantly increases the risk of microvascular and macrovascular complications, including retinopathy, nephropathy, stroke, myocardial infarction, and peripheral artery disease [6,8]. This dual disease burden is a major contributor to premature death in diabetic patients, as highlighted by Chen et al., who found a fourfold increase in cardiovascular mortality among patients with both conditions [6]. The fact that 92.3% of diabetic patients and 99.1% of hypertensive patients in our study were taking their prescribed medications suggests a high level of adherence to medical treatment. However, the persistent high rates of uncontrolled hypertension (systolic BP ≥ 140 mmHg and/or diastolic BP ≥ 90 mmHg) among this population indicate that medication alone may not be sufficient to achieve optimal blood pressure control. This finding is in line with a study from South Africa, where even among patients receiving treatment, a significant proportion had uncontrolled hypertension, largely due to inadequate lifestyle modifications and poor medication management [16].

The findings of this study were less than the results of recent studies that were conducted in Afghanistan, Pakistan and United States, where they found the prevalence of hypertension among diabetics as follows:70.5%, 72.5% and 82.1% respectively [17-19]. Comparing the findings of our study to those from Nigeria, Thailand, South Africa Afghanistan, Pakistan and United States, it is evident that the dual burden of diabetes and hypertension is a widespread issue in both developing and developed nations. However, the availability of resources, healthcare infrastructure, and public health policies greatly influence the ability to manage these conditions effectively. In Sudan, limited access to healthcare, socioeconomic factors, and a lack of patient education contribute to poor disease management and higher rates of complications, as also noted in other low- and middle-income countries [9]. Addressing the co-occurrence of diabetes and hypertension requires a multifaceted approach, including better patient education, lifestyle interventions, and improved healthcare access. Studies from high-income countries show that comprehensive diabetes management programs, which include regular monitoring, patient education, and lifestyle counselling, can significantly reduce the risk of hypertension and its complications [9]. Such programs should be adapted and implemented in Sudan to reduce the burden of these non-communicable diseases.

Conclusion

The high prevalence of hypertension among diabetic patients in this study which was conducted in Sudan, underscores the urgent need for integrated strategies to manage both conditions. The co-occurrence of diabetes and hypertension significantly increases the risk of cardiovascular and microvascular complications, as demonstrated in our study and others globally. Shared risk factors, including obesity, sedentary lifestyle, and poor dietary habits, highlight the need for preventive measures targeting lifestyle modifications. Our study contributes to the limited literature on the co-prevalence of these conditions in Sudan and provides a foundation for future research and public health interventions.

Recommendations

Further research is needed to explore the effectiveness of community-based interventions and healthcare policies designed to manage hypertension and diabetes in low-resource settings like Sudan. Addressing these two conditions comprehensively, through both pharmacological and non-pharmacological approaches, will be critical in reducing morbidity and mortality in diabetic patients. Improving patient education, increasing healthcare access, and promoting early diagnosis can play significant roles in reducing the dual burden of diabetes and hypertension.

Limitations

Possible limitations include the cross-sectional design, which captures data at a single point in time and may not fully represent

long-term trends in BP control. Furthermore, the study relies on self-reported adherence and lifestyle factors, which are subject to recall bias.

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Disclosure of Conflict of Interest

All authors have no conflict of interest

Ethical Approval

Ethical approval was obtained from faculty of Medicine, University of Gezira ethical committee as well as informed written consent from all participants.

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