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Control of Blood Pressure and Complication Presence in Khartoum State, Sudan

Nisreen A. A. Ahmad[1], Maha M. Bilal[2], Ziryab Z. M. Elmahdi[3], Tayseer Abdelmotalib Ahmed Taha[4], Tamadur A. Abdelrahman[3], Rowa Abdelmonem Sidig Hamadto[5], Sahar M. B. Elnour[6*]

[1]Minstery of Health, Kariba Health Center, Wad Madani, Sudan
[2]Family Medicine Department, Najran University, Najran, Saudi Arabia
[3]Emergency Department, Sheikh Khalifa Medical City, Abu Dhabi, United Arab Emirates
[4]Dhaman Health Assurance Hospitals Company, Kuwait City, Kuwait
[5]Diabetes Specialized Centre, Port Sudan, Sudan
[6]Sudan Medical Specialization Board, Khartoum, Sudan
Email: *dr.saharelnour@gmail.com

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Abstract

Background: Hypertension is a common chronic disease and an important public health problem. The prevention of complications depends on hypertension control. **Aim:** To assess blood pressure control, complication presence, and their influencing factors. **Methods:** This cross-sectional study was conducted on patients with hypertension attending a private medical facility, a governmental facility, and a primary health care center in Khartoum, Sudan, between September 2022 and February 2023. Statistical Package for Special Sciences version 25 was used for data analysis; frequency and percentage were used to describe the qualitative variables. A chi-square test was used for correlation analysis; a P-value ≤ 0.05 was considered statistically significant, and the confidence interval was 95%. **Results:** The study included 250 participants; 55.6% were males. Their age was 58.77 ± 6.80 years, and they had hypertension for 10.7 ± 8.51 years. The duration of the disease was 10.7 ± 8.51 years. Systolic blood pressure was 127.1 ± 11.3 mm hg, and diastolic blood pressure was 81.6 ± 7.1 mm hg. Of the participants, 76.4% had controlled hypertension, while 27.6% had complications due to hypertension. Controlled blood pressure was associated with females, age group 40 - 60 years, normal waist circumference, and high adherence level (P ≤ 0.05). The presence of complications was associated with males, participants older than 60 years, and a low adherence level (P ≤ 0.05). **Conclusions:** In Sudan, the level of control is good; nonetheless, not all patients achieve it. Availability and access to treatment facilities and medications should be improved. Proper patient counseling should be offered, as well as continuous care.

Keywords

Hypertension, Blood, Pressure, Control, Complications

1. Introduction

Hypertension (HTN) is a prevalent chronic disease that affects both rural and urban areas worldwide. It requires continuous monitoring and lifelong treatment. HTN poses a significant public health challenge due to its association with cardiovascular diseases, which contribute to a high morbidity and mortality rate. According to the World Health Organization (WHO), complications of hypertension account for approximately 9.4 million deaths annually, making it a major contributor to global mortality. Cardiovascular diseases, including those caused by hypertension, account for approximately one-third of all deaths worldwide and account for around 17 million deaths per year [1].

By implementing lifestyle modifications, patients can have a significant impact on their blood pressure control and overall health [2]. Studies have shown that patients with HTN are least educated about normal blood pressure (BP) values and lifestyle modifications required for treatment [3]. Lifestyle modifications are crucial for preventing and treating HTN. Clinical studies prove that proper lifestyle modifications can have a hypotensive effect that can equate to a single-agent pharmaceutical treatment [4].

Lifestyle changes may be a safe and effective way of preventing or delaying HTN or even evading pharmaceutical treatment in patients with grade 1 HTN and reducing BP in patients who are already treated, which can lead to a decrease in doses of medications [5]. Safe and effective HTN control depends on patients being aware of their medication, lifestyle modifications (diet, weight loss, exercise, mental relaxation, and unhealthy habits such as smoking and alcohol consumption), and the possible complications arising from HTN.

One approach that has shown promise is the use of pill organizers to help patients remember to take their medication as prescribed [6]. This can be especially beneficial for those who report forgetting to take their medication. Additionally, engaging patients in self-monitoring of blood pressure can also improve control. Encouraging patients to regularly check their blood pressure at home can provide valuable information and empower them to take an active role in managing their hypertension.

The aim of this paper is to study the control of blood pressure (BP), complication presence, and their influencing factors in patients with HTN.

2. Martials and Methods

2.1. Design and Population

We conducted a descriptive cross-sectional facility-based study of out-patients attending a specialized hospital, a teaching hospital, and a primary healthcare

center, which are located in Khartoum State, Sudan.

The study was carried out between September 2022 and February 2023.

The study included adult participants who were diagnosed with primary or essential hypertension; patients with secondary hypertension were excluded.

The sample size was determined using the Yamane sample size equation [7], and the participants were selected using a simple random method (provided in the **Appendix**).

A well-structured questionnaire was designed, and to ensure the objectives could be achieved, a sample of 20 questionnaires was filled out and analyzed.

2.2. Data Collection Tools

2.2.1. Questionnaire

The questionnaire consisted of 3 parts (provided in the **Appendix**):

Part 1: Characteristics of study participants included: sex, age, marital status, level of education, and employment.

Part 2: Disease-related data included: duration of disease, presence of complications.

Part 3: Medication Adherence.

Part 4: Measurements of blood pressure, weight, height, and waist circumference.

2.2.2. Measurements Tools

The data collection tools used in the study included an electronic sphygmomanometer to record blood pressure, a weight scale to measure weight, and a tape to measure height and waist circumference. Before data collection, these tools were compared to two other standardized tools to ensure accuracy and minimize errors.

2.2.3. Measurements

Morisky's Medication Adherence Scale (MMAS-8) was employed to assess the study participant's medication adherence. This measure was found to be reliable ($\alpha = 0.83$) and considerably related to blood pressure control ($P < 0.05$) in patients with hypertension.

A scoring scheme of "Yes" = 0 and "No" = 1 for the first seven items except item number five, in which the values of "Yes" and "No" were reversed, and for the last item, a five-point Likert response was used with options "never", "once in a while", "sometimes", "usually", and "always". With a sum of scores equaling 8, 6 to <8, or <6, patients can be categorized as having high, medium, or low adherence to therapy, respectively. These cut-off values were established based on the association between adherence to medication and blood pressure control in patients with hypertension [8].

Hypertension control (average of 3 readings) refers to a systolic blood pressure (SBP) < 140 and a diastolic blood pressure (DBP) < 90 mmHg based on the Joint National Committee (JNC8) [9].

Body mass index (BMI) was calculated by dividing weight (in kilograms) by the square of height (meters) and was defined as follows: underweight (BMI < 18.5), normal weight limits (BMI 18.5 - 24.9), overweight/pre-obese (BMI 25 - 29), class 1 obesity (BMI 30 - 34.9), class 1 obesity (BMI 35 - 39.9), and class 3 obesity (BMI ≥ 40).

Central obesity was defined by a waist circumference of 37.6 inches for males and 32 inches for females from sub-Saharan African countries [10].

2.3. Data Analysis

For data analysis, the Statistical Package for Social Sciences (SPSS) version 25.0 by SPSS Inc. in Chicago, IL was used. The data was presented in the form of tables and figures. Frequency distributions were generated for both independent and dependent variables. The chi-square test was employed to compare proportions between two groups. A P-value of ≤ 0.05 was considered statistically significant, with a confidence level of 95%.

2.4. Ethical Considerations

It was ensured that all participants were provided with a clear explanation of the study protocol, aims, and benefits. Additionally, written voluntary informed consent was obtained from each participant, indicating their consent to participate in the study. Participants with high blood pressure were specifically informed about their condition and directed to follow up with a doctor for further evaluation and management. This step was taken to ensure the well-being and appropriate medical care for participants with high blood pressure.

3. Results

The study included 250 participants, with 55.6% being males. The average age of the participants was 58.77 ± 6.80 years. Among the participants, 82.0 percent were married, and 38.4% had a university-level education. Additionally, 57.6% of the participants were employed (**Table 1**).

In terms of health measurements, 54.0% of participants were classified as overweight or pre-obese, and 54.8% had central obesity. The average duration of hypertension in the participants was 10.7 ± 8.51 years. The systolic blood pressure (SBP) was measured at 127.1 ± 11.3 mmHg, and the diastolic blood pressure (DBP) was measured at 81.6 ± 7.1 mmHg (**Table 2**). Of the participants, (76.4%) had controlled hypertension, while (27.6%) experienced complications due to hypertension (**Table 2**).

Figure 1 showed the adherence to medication, it was high, medium, and low in 163 (65.2%), 65 (26%), and 22 (8.8%), respectively (**Figure 1**).

The controlled blood pressure was higher among females (79.2%) compared to males (74.1%) (P = 0.005). It was also more prevalent in the age group of 40 - 60 years (86.8%) (P = 0.038), among participants with normal waist circumference (not having central obesity) (90.2%) (P = 0.015), and among those who had high adherence to medications (82.8%) (P = 0.003) (**Table 3**).

Table 1. Distribution of characteristics of participants (N = 250).

Variable	N	%
Sex		
Male	139	55.6
Female	111	44.4
Age (years)	20 - 89	58.77 ± 6.80
Marital status		
Single	6	2.4
Married	205	82.0
Divorced	9	3.6
Widowed	30	12.0
Educational level		
Uneducated	44	17.6
Primary school	36	14.4
Secondary school	74	29.6
University	96	38.4
Employment		
Employed	144	57.6
Unemployed	106	42.4
Total	250	100

Table 2. Distribution of disease related data of participants (N = 250).

Variable	N	%
BMI		
Underweight	5	2
Normal weight	63	25.2
Overweight/pre obese	135	54.0
Class 1 obesity	41	16.4
Class 2 obesity	4	1.6
Class 3 obesity	2	0.8
Central obesity		
Normal	113	45.2
Present	137	54.8
Duration of hypertension (years)	2-39	10.7 ± 8.51
Blood pressure reading (mm hg)		
Systolic blood pressure	95 - 162	127.1 ± 11.3
Diastolic blood pressure	68 - 103	81.6 ± 7.1
Blood pressure control		
Yes	191	76.4
No	59	23.6
Presence of complication		
Yes	69	27.6
No	181	72.4
Total	250	100

Table 3. Distribution of risk factors for blood pressure control and hypertension complications.

	Controlled BP		HTN complications	
	Number (%)	P-value	Number (%)	P-value
Sex				
Male	103 (74.1)	0.005*	46 (29.4)	0.030*
Female	88 (79.2)		23 (20.7)	
Age groups (years)				
<40	6 (50)	0.038*	3 (25)	0.043*
40 - 60	99 (86.8)		24 (21.1)	
>60	86 (69.3)		42 (33.8)	
Marital status				
Single	6 (100)	0.238	0	0.405
Married	148 (77.1)		57 (27.8)	
Divorced	3 (33.3)		2 (22.2)	
Widow	22 (73.3)		10 (33.3)	
Educational level				
Uneducated	34 (77.2)	0.368	13 (29.5)	0.432
Primary	29 (80.5)		10 (27.7)	
Secondary	54 (72.9)		23 (31.1)	
	74 (77.1)		23 (23.9)	
Employment				
Yes	113 (78.4)		37 (25.6)	
No	78 (73.5)	0.548	32 (30.1)	0.436
BMI				
Underweight	3 (1.6)		2 (40)	
Normal	33 (16.6)		22 (34.8)	
Overweight	106 (55.9)		31 (22.8)	
Class 1	43 (22.6)		12 (29.4)	
Class 2	4 (2.2)	0.893	0	0.385
Class 3	2 (1.1)		1 (50)	
Central obesity				
Normal	102 (90.2)	0.015*	29 (25.6)	0.691
Present	89 (64.9)		40 (29.2)	
Adherence to medications				
High	135 (82.8)	0.003*	17 (10.4)	0.049*
Medium	46 (70.7)		34 (52.3)	
Low	10 (45.4)		18 (81.8)	
Total	**191 (76.4%)**		**69 (27.6%)**	

*Statistically significant correlation.

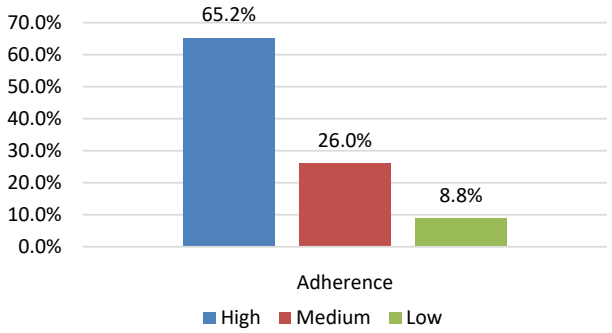

Figure 1. Distribution of adherence to medications (N = 250).

The presence of HTN complications was higher among males (29.4%) compared to females (20.7%) (P = 0.030). It was also more prevalent in participants older than 60 years (33.8%) (P = 0.043) and among those who had low adherence to medications (81.8%) (P = 0.049) (**Table 3**).

4. Discussion

Hypertension has always been present in low- and middle-income countries (LMICs) throughout the world, to varying degrees. Blood pressure levels are currently much higher in LMICs, especially in sub-Saharan Africa [11]. In our study, we explored the control of blood pressure among patients with hypertension as well as the complications due to it.

4.1. Blood Pressure Control and Complications

The study observed a mean systolic blood pressure (SBP) of 127.1 ± 11.3 mmHg and a mean diastolic blood pressure (DBP) of 81.6 ± 7.1 mmHg. These findings were similar to a study by Zhang *et al.* [12] that reported an approximate range of SBP 127.7 ± 18.8 mmHg and DBP 76.8 ± 11.2 mmHg.

The prevalence of controlled hypertension (HTN) in the study was 76.4%. Factors that were found to be statistically significant in relation to blood pressure control were female sex, the 40 - 60 year age group, participants with a normal waist circumference, and those with high medication adherence.

Compared to other studies, in Sweden and China by Santoza *et al.* [13], it was observed that Swedish men and women had better hypertension control than their Chinese counterparts, and women generally showed better control. In Uganda, only 9.4% of hypertensive participants had controlled BP. Similar to the current study, previous research has also shown higher control rates among females compared to males.

Another factor associated with blood pressure control in the study was normal waist circumference, indicating the importance of weight management in hypertension. Weight loss has been shown to have a linear effect on blood pressure reduction, with around a 1 mmHg decrease per kilogram of weight loss [14]. Therefore, non-pharmacological approaches such as lifestyle changes, including caloric restriction and increased physical activity, are recommended for weight re-

duction in obese hypertensive patients.

In patients who are unable to sustain weight loss or achieve recommended blood pressure targets, additional pharmacotherapy may be necessary. However, it is important to note that even though the control level in our study was high, any amount of uncontrolled hypertension is concerning due to its impact on patients' quality of life.

Patient variables and health system problems may contribute to the ineffective management of hypertension. Poor hypertension control can be attributed to various health system-related issues such as medication unavailability, long distances to healthcare facilities, high drug costs, inadequate counseling, and a lack of knowledge, skills, and resources to address hypertension. These factors need to be addressed to improve hypertension management and control [15].

In our study, 27.6% had complications due to hypertension. Factors that were found to be statistically significant in relation to the presence of HTN complications were male sex, older than 60 years of age, and those with low medication adherence.

These observed differences in sex in the prevalence, awareness, treatment, and control of hypertension might reflect the different risks men and women have to develop hypertension when its onset is related to biological mechanisms and physiological [16] [17] [18]. Another influencing factor is adherence to hypertensive medications [19].

Although our study did not find a statistical association with education level and we did not explore health literacy, both were previously found to significantly affect hypertension outcomes and the presence of complications [20] and health-care-seeking outcomes [21].

A key component of patient factors is that hypertension is asymptomatic; a lack of symptoms makes it difficult for people to accept their condition and start appropriate treatment. Further, research shows that even when people accept their conditions, lifelong management, which includes long-term pharmacotherapy and significant lifestyle changes, can be challenging for people living in LMIC [22] [23].

There is suboptimal medication adherence in the LMIC studies [23]; however, in our study, adherence to medication was good and associated with better blood pressure control ($P = 0.003$).

Adherence to medication is essential in controlling BP and decreasing the risk of complications, as discussed. However, the antihypertensive medications' regular availability, along with their price, determines whether patients can access and afford the medication [24], thus affecting the level of adherence. Other suggested interventions for helping improve medication adherence are home visits by community health workers and other community-based health promotion programs [25] [26] [27] [28] [29].

4.2. Benefits of Blood Pressure Control

Evidence has shown that a 10 mmHg reduction in SBP and/or a 5 mmHg reduc-

tion in DBP is associated with substantial reductions in all major cardiovascular events (about 40% in heart failure, 35% in stroke, 15% in coronary heart disease, 20% in cardiovascular mortality, and 10% in all-cause mortality). Most importantly, these relative risk reductions are consistent across baseline levels of blood pressure, absolute disease risk, and comorbidities [30].

There are variables that impact how hypertension is treated. Access to healthcare is influenced by the implementation of universal health coverage, the amount of out-of-pocket spending on treatments and medications, and the quantity and location of medical facilities. The number of healthcare professionals, task sharing between healthcare workers, and clinical guidelines for hypertension management, among other factors, affect the amount of hypertension diagnosis and proper treatment [31] [32].

4.3. Study Limitations

It is worth noting that the study was conducted in an urban area, which was a limitation of this study due to the established difference between rural and urban settings when it comes to hypertension [33]. Another limitation was that we did not explore the type and duration of hypertension complications. Nor the insurance coverage of medications.

5. Conclusion

Duration of HTN was 10.7 ± 8.51 years. SBP was 127.1 ± 11.3 mmHg and DBP was 81.6 ± 7.1 mmHg, 76.4% had controlled hypertension, 27.6% had complications, and the most frequent adherence to medication level was high in 65.2%. Controlled blood pressure was higher among females, age group 40 - 60 years, participants with normal waist circumference, and those who had high medication adherence levels ($P \leq 0.05$). The presence of complications was greater in males, participants older than 60 years, and those with low medication adherence levels ($P \leq 0.05$).

Recommendations

Hypertension remains one of the most prevalent chronic illnesses in the world, In Sudan the level of control is good, nonetheless; not all patients achieve it. Availability and access to treatment facilities and medications should be improved by healthcare policy makers. Proper patient counselling should be offered by doctors and other HCWs to all patients, as well as continuous care.

Furthermore, socioeconomic factors have been shown to play a significant role in the control of hypertension. Low socioeconomic status, financial difficulties, and high medication costs are all barriers that can hinder access to healthcare and adherence to treatment recommendations [34].

To improve hypertension outcomes, it is crucial to address these barriers and promote adherence to self-care practices. Patient education and health literacy programs can play a vital role in improving understanding and treatment adhe-

rence. Additionally, healthcare providers should focus on enhancing social support, and self-efficacy.

Conflicts of Interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Appendix

Questionnaire

Serial number __ __ __

I) Demographic data

1) Sex:

a) Male

b) Female

2) Age _____ years (record to the closest year).

3) Marital status:

a) Single

b) Married

c) Divorced

d) Widowed

4) Educational level

a) Uneducated

b) Primary school

c) Secondary school

d) University

5) Employment:

a) Employed

b) Unemployed

6) Duration of disease _____ (years)

7) Presence of complications

a) Yes

b) No

II) Medication adherence

1) Do you sometimes forget to take you hypertension medicine?

a) Yes

b) No

2) In the past 2 weeks, were there any days you missed taking your hypertension medication for a reason besides forgetting?

a) Yes

b) No

3) Have you ever cut back or stopped taking your medication without informing your doctor, because you felt worst when you took it?

a) Yes

b) No

4) When you travel or leave home, do you sometimes forget to bring along your hypertension medicines?

a) Yes

b) No

5) Did you take your hypertension medicines yesterday?

a) Yes

b) No

6) When you feel like your blood pressure is under control, do you sometimes stop taking you medicine?

a) Yes

b) No

7) Taking medications every day is real inconvenience for some people. Do you ever feel hassled about sticking to your blood pressure treatment plan?

a) Yes

b) No

8) How often do you have difficulties in remembering to take all your medications? (Please circle the correct number)

a) Never/Rarely

b) Once in awhile

c) Sometimes

d) Usually

e) All the time

III) Measurements

Bp Reading 1 ___/___ mmHg

Bp Reading 2 ___/___ mmHg

Bp Reading 3 ___/___ mmHg

Weight: ____Kg

Height: ____m^2

Waist circumference: ____ inch

Sample Size Calculations

N = Population of study

K = Constant (1)

e = Degree of error expected

n = Sample size

$n = N/K + N(e)^2$

$667/1 + 667(0.05)^2$

$667/1 + 667(0.0025000000000000005)$

$667/1 + 1.6675000000000004$

$667/2.6675000000000004$

$n = 250.04686035613867$

Site of data collection	Population frequency in the month prior to data collection	Percentage from total population (%)	Number in Sample size
Private hospital	255	38.3	96
Governmental teaching hospital	241	36.1	90
Primary health care center	171	25.6	64
Total	667	100	250