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Knowledge, Attitude, and Practice of Residents of Khartoum State about Hypertension: A Community-Based Cross-Sectional Study

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Research Article

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Abstract

Background: Hypertension is one of the most important risk factors for cardiovascular disease, cerebrovascular accidents, and renal diseases, contributing to substantial morbidity, mortality, and socioeconomic burden worldwide [1]. In Sudan, the prevalence in urban communities rose from 7.5% in 1990 to 27.6% by 2018 [5]. Adequate population-level knowledge, attitudes, and practices (KAP) are essential for effective prevention and control. This study assessed hypertension-related KAP among adult residents of Khartoum State and identified independent predictors of hypertension history, knowledge, blood-pressure monitoring, and physical activity.

Methods: A descriptive cross-sectional community-based study was conducted in Khartoum State, Sudan (n = 240). Data were collected via a researcher-developed, self-administered online questionnaire not previously validated or standardised; a full English-language version is provided as Supplementary File 1. A composite knowledge score (0-4) was derived; scores >=3 were classified as 'high knowledge.' Chi-square tests and Firth's penalised logistic regression provided adjusted odds ratios (AOR) with 95% confidence intervals (CI).

Results: The sample was predominantly male (57.1%) and young (73.8% aged 18-25 years). Self-reported hypertension prevalence was 7.9% (n=19). Only 15.8% correctly identified the normal blood-pressure range. Salt restriction awareness was high (85.0%), as was recognition of the importance of regular blood-pressure measurement (82.5%). Despite this, only 20.4% practised a low-salt diet and fewer than 24% exercised regularly. Older age (>=36 years) strongly predicted hypertension (AOR 30.73, 95% CI 4.84-195.26; p<0.001), while university-level education was protective (AOR 0.26, 95% CI 0.07-0.95; p=0.041) and predicted high knowledge (AOR 2.93, 95% CI 1.14-7.52; p=0.026). Hypertension history dominated blood-pressure monitoring (AOR 22.29, 95% CI 5.63-88.34; p<0.001) and male sex predicted regular exercise (AOR 2.53, 95% CI 1.31-4.87; p=0.006).

Conclusions: A critical knowledge-practice gap exists. While attitudes toward prevention are positive and theoretical knowledge is moderate, preventive behaviours remain poor. These findings should be interpreted in the context of a researcher-developed, non-validated questionnaire. Education-focused and behaviour-change interventions are urgently needed, targeting younger, less-educated, and asymptomatic individuals.

Background

Hypertension is a progressive cardiovascular syndrome caused by a complex interaction of genetic and environmental factors [8]. Based on 2017 ACC/AHA guidelines, blood pressure is classified as normal (<120/80 mmHg), elevated (120-129/<80 mmHg), Stage 1 (130-139/80-89 mmHg), and Stage 2 (>=140/90 mmHg) [10]. Out-of-office ambulatory blood pressure monitoring is often more reliable than office measurements due to the white-coat effect [9]. Essential hypertension accounts for approximately 95% of cases and involves over-activation of the sympathetic nervous system and the renin-angiotensin-

aldosterone system (RAAS), compounded by obesity, physical inactivity, high salt intake, alcohol use, smoking, and psychological stress [1].

Lifestyle modification is a cornerstone of both prevention and treatment: weight reduction can lower systolic blood pressure (SBP) by 5-20 mmHg per 10 kg lost; a DASH-type diet by 8-14 mmHg; sodium restriction by 2-8 mmHg; and regular aerobic exercise by 4-9 mmHg [1]. Sodium reduction from 9-12 to 5-6 g/day produces clinically significant blood-pressure reductions [11].

Globally, an estimated 1.39 billion adults had hypertension in 2010, with higher prevalence in low- and middle-income countries (31.5%) than in high-income countries (28.5%) [12]. In Sub-Saharan Africa (SSA), the overall prevalence is estimated at 30%, rising from 16% at age 30 to 44% at age 60, with approximately 74.7 million individuals affected - a figure projected to reach 125.5 million by 2025 [2, 3].

In Sudan specifically, hypertension prevalence in urban communities increased from 7.5% in 1990 to 18.2% in 2002 [4]. A 2018 study found a prevalence of 27.6%, significantly associated with male sex, increasing age, obesity, and high salt and sugar intake [5]. SHHS and STEPS survey data reported hypertension prevalence of 20.1% and 20.4%, respectively [13]. Blood pressure was controlled in only 19.4% of patients in Eastern Sudan, with the most common reason for non-compliance being inability to purchase medications [6].

KAP surveys are a validated tool for identifying community-level gaps and guiding health education programme design. Previous KAP studies have reported that knowledge does not automatically translate into preventive behaviour [16, 15], and that sociodemographic variables such as education, age, and sex modulate both knowledge and practice. Despite growing interest in hypertension in the region, there is a paucity of studies from Khartoum State applying multivariable methods to disentangle independent sociodemographic predictors. This study therefore aimed to: (1) describe sociodemographic characteristics and hypertension-related KAP; (2) assess knowledge of normal blood-pressure values, causes, symptoms, and preventive strategies; (3) examine bivariate associations between sociodemographic variables and KAP outcomes; and (4) identify independent predictors of hypertension history, high knowledge, regular blood-pressure monitoring, and regular physical exercise.

Methods

Study design and setting

This was a descriptive cross-sectional community-based study conducted in Khartoum State, one of the eighteen states of Sudan (area: 22,142 km2), comprising three cities: Khartoum (the national capital), Omdurman, and Bahri (North Khartoum).

Study population and eligibility

The target population comprised residents of Khartoum State aged 18 years or above. Participants were excluded if they did not complete the questionnaire fully.

Sample size

The sample size was calculated using the formula n = z2pq/d2 (z=1.96, p=0.50, q=0.50, d=0.05), yielding a target of 384. Due to time constraints, 240 participants were enrolled.

Data collection instrument

Data were collected via a self-administered, close-ended online questionnaire distributed through Google Forms in both English and Arabic. Participation was voluntary and anonymous.

The questionnaire was researcher-developed and was not a previously validated or standardised instrument. It was designed specifically for this study, reviewed for content relevance and face validity by the research team and the supervising academic, but was not subjected to formal psychometric evaluation (e.g., Cronbach's alpha, test-retest reliability, or criterion validity). It has not been published elsewhere. A full English-language version is provided as Supplementary File 1. Readers should consider this limitation when interpreting findings and comparing results with studies using validated tools (see Limitations).

Questionnaire structure

The questionnaire comprised four domains. Background variables: age group, sex, marital status, employment status, educational level, and self-reported hypertension history. Knowledge variables: family history of hypertension; normal blood-pressure range (open-ended, coded as correct if <120/80 mmHg); causes and symptoms of hypertension (multiple-select); benefit of salt restriction; benefit of fruit and vegetable consumption; and importance of regular blood-pressure measurement for asymptomatic individuals. Attitude variables: positive attitudes toward preventive behaviour including salt reduction, balanced diet, weight management, and regular blood-pressure monitoring. Practice variables: frequency of blood-pressure measurement; physician visits; current use of antihypertensive medication; low-salt diet adoption; and regular exercise.

Variable coding for multivariable analysis

Binary variables were created as follows: sex (male=1, female=0); marital status (married=1, single=0); age (>=36 years=1, younger=0); education (university or postgraduate=1, below university=0); hypertension history (yes=1, no=0); family history (yes=1, no=0); regular BP monitoring (monthly or more=1, other=0); low-salt diet (yes=1, no=0); regular exercise (yes=1, no=0). A composite knowledge

score (0-4) was derived from four items. Participants scoring >=3 were classified as having 'high knowledge.'

Statistical analysis

Descriptive statistics were expressed as frequencies and percentages. Bivariate associations were assessed using Pearson chi-square tests (or Fisher's exact test where expected cell count was <5). Four multivariable logistic regression models were fitted: (1) hypertension history; (2) high knowledge; (3) regular BP monitoring; (4) regular exercise. Firth's penalised likelihood logistic regression was used for Models 1 and 3 due to small event counts (n=19 and n=27, respectively) [17]. Data were analysed using SPSS v22.0 and Python 3 (NumPy/SciPy).

Results

Sociodemographic characteristics

A total of 240 adult residents of Khartoum State were enrolled. The sample was predominantly male (n=137, 57.1%), young (18-25 years: n=177, 73.8%), single (n=188, 78.3%), and university-educated (n=153, 63.8%). Self-reported hypertension prevalence was 7.9% (n=19), and 85.8% (n=206) reported at least one close relative with hypertension. Full details are presented in Table 1.

Table 1: Sociodemographic characteristics of study participants (N = 240)

Variable	Category	n	%
Sex	Male	137	57.1
	Female	103	42.9
Age group (years)	18-25	177	73.8
	26-35	29	12.1
	36-45	13	5.4
	>45	21	8.8
Marital status	Single	188	78.3
	Married	52	21.7
Educational level	Primary school	1	0.4
	High school	22	9.2
	University	153	63.8
	Postgraduate	10	4.2
Hypertension history	Yes	19	7.9
	No	221	92.1
Family hypertension history	Yes - one of the parents	112	46.7
	Yes - sibling	16	6.7
	Yes - other relative	79	32.9
	No	33	13.8

Knowledge assessment

Only 15.8% of participants correctly identified the normal blood-pressure range (<120/80 mmHg); 67.5% gave an incorrect value and 16.7% did not know. Regarding causes, participants most commonly identified hereditary reasons (18%), followed by high salt intake (17%), psychological stress (16%), increased weight (14%), physical inactivity (12%), smoking (11%), and kidney diseases (11%). For symptoms, headache was most frequent (38%), followed by palpitations (33%), chest pain (15%), and dyspnoea (14%). Awareness of preventive strategies was higher: 85.0% knew that salt reduction prevents hypertension, 73.3% endorsed fruit and vegetable consumption, and 82.5% agreed regular blood-pressure measurement is important for asymptomatic individuals. Overall, 179 participants (74.6%) achieved a high knowledge score (>=3/4 items correct). Results are summarised in Table 2.

Table 2: Knowledge of hypertension among study participants (N = 240)

Knowledge item	n	%
Correct identification of normal BP range (<120/80 mmHg)	38	15.8
Salt restriction prevents hypertension (Yes)	204	85.0
Fruit/vegetable consumption prevents hypertension (Yes)	176	73.3
Regular BP monitoring important for asymptomatic individuals (Yes)	198	82.5
High knowledge score (>=3/4 items correct)	**179**	**74.6**

Practice assessment

Blood-pressure monitoring was largely irregular: 201 participants (83.8%) did not measure blood pressure on a schedule, while only 27 (11.2%) reported monthly or more frequent monitoring and 12 (5.0%) checked yearly. Among the 19 hypertensive participants, 16 (83%) reported currently taking antihypertensive medication. Only 49 participants (20.4%) adopted a low-salt diet and 57 (23.8%) exercised regularly. Practice results are shown in Table 3.

Table 3: Self-reported preventive practices (N = 240)

Practice item	n	%
Blood-pressure monitoring frequency (whole sample)		
Monthly or more frequently	27	11.2
Yearly	12	5.0
No regular schedule	201	83.8
Doctor visits for BP management (hypertensive patients, n=19)		
Weekly	1	5.3
Monthly	3	15.8
Yearly	1	5.3
When symptoms occur	14	73.7
Currently on antihypertensive medication (Yes) a	16	83.2
Low-salt diet adopted (Yes)	49	20.4
Regular exercise (Yes)	57	23.8

a Percentage of known hypertensive participants (n=19).

Bivariate associations (chi-square)

Education level was significantly associated with knowledge level (chi2=7.90, df=1, p=0.005). Older age (>=36 years) was significantly associated with hypertension history (chi2=45.22, p<0.001) and marital status was also associated (chi2=18.36, p<0.001). Hypertension history was strongly associated with regular blood-pressure monitoring (chi2=50.18, p<0.001). Male sex was significantly associated with regular exercise (chi2=5.96, p=0.015). Critically, there was no significant association between composite knowledge level and practice level (p=0.867), confirming a knowledge-practice gap. Full results are shown in Table 4.

Table 4: Chi-square bivariate associations between key sociodemographic variables and KAP outcomes (N = 240)

Outcome	Predictor	chi2	df	p-value
Hypertension history	Age >=36 vs <36	45.22	1	<0.001
	Married vs single	18.36	1	<0.001
	Male sex	0.10	1	0.752
	University education	7.01	1	0.008
	Family HTN history	0.00	1	1.000
High knowledge score	University education	7.90	1	0.005
	Family HTN history	0.13	1	0.715
	Male sex	0.25	1	0.615
	Age >=36	0.00	1	1.000
Knowledge vs Practice	High knowledge	---	---	0.867 a
Regular BP monitoring	Hypertension history	50.18	1	<0.001
	Age >=36	50.18	1	<0.001
Regular exercise	Male sex	5.96	1	0.015
	University education	1.70	1	0.192

a Result from original SPSS analysis confirming the knowledge-practice gap.

Multivariable analysis (Firth's penalised logistic regression)

Model 1 - Hypertension history (n=19 events): Older age (>=36 years) was the strongest independent predictor (AOR 30.73, 95% CI 4.84-195.26; p<0.001). University education was independently protective (AOR 0.26, 95% CI 0.07-0.95; p=0.041). Sex, marital status, and family history were not significant.

Model 2 - High knowledge score (n=179 events): University education independently predicted high knowledge (AOR 2.93, 95% CI 1.14-7.52; p=0.026). Being married was inversely associated (AOR 0.34, 95% CI 0.13-0.88; p=0.026). Other variables were not significant.

Model 3 - Regular BP monitoring (n=27 events): Hypertension history was the dominant predictor (AOR 22.29, 95% CI 5.63-88.34; p<0.001). No other variable was independently significant, confirming that monitoring is reactive rather than proactive.

Model 4 - Regular exercise (n=57 events): Male sex was independently associated with greater odds of regular exercise (AOR 2.53, 95% CI 1.31-4.87; p=0.006). Age, marital status, education, and hypertension history were not independently significant.

Table 5: Firth's penalised logistic regression: adjusted odds ratios for four outcomes (N = 240)

Outcome	Predictor	AOR	95% CI	p-value
Hypertension history (n=19)	Age >=36 (vs <36)	30.73	4.84-195.26	<0.001
	University education (vs other)	0.26	0.07-0.95	0.041
	Male sex (vs female)	1.27	0.41-3.96	0.676
	Married (vs single)	0.59	0.09-3.73	0.575
	Family HTN history (vs none)	0.53	0.12-2.28	0.393
High knowledge (n=179)	University education (vs other)	2.93	1.14-7.52	0.026
	Married (vs single)	0.34	0.13-0.88	0.026
	Hypertension history (vs no)	3.05	0.72-12.96	0.130
	Family HTN history (vs none)	1.35	0.58-3.13	0.488
	Age >=36 (vs <36)	1.73	0.52-5.77	0.375
	Male sex (vs female)	0.92	0.49-1.72	0.789
Regular BP monitoring (n=27)	Hypertension history (vs no)	22.29	5.63-88.34	<0.001
	Married (vs single)	3.61	0.91-14.30	0.068
	University education (vs other)	2.99	0.58-15.55	0.193
	Male sex (vs female)	0.53	0.20-1.37	0.188
	Age >=36 (vs <36)	0.91	0.19-4.25	0.900
Regular exercise (n=57)	Male sex (vs female)	2.53	1.31-4.87	0.006
	Married (vs single)	2.45	0.85-	0.099

Outcome	Predictor	AOR	95% CI	p-value
			7.09	
	University education (vs other)	3.63	0.96-13.75	0.058
	Age >=36 (vs <36)	0.32	0.08-1.28	0.106
	Hypertension history (vs no)	0.48	0.10-2.34	0.367

AOR = adjusted odds ratio; CI = confidence interval. Bold = p<0.05. Firth's penalised logistic regression used throughout.

Discussion

Hypertension prevalence and sociodemographic predictors

The self-reported hypertension prevalence of 7.9% is lower than the 27.6% from a 2018 Sudanese population study [5] and the 20.1-20.4% from SHHS/STEPS data [13], reflecting the predominantly young, university-educated, convenience-sampled nature of this cohort. Older age (>=36 years) was the strongest predictor of hypertension (AOR 30.73), consistent with the established epidemiology of age-related blood-pressure elevation [1, 10]. University education was independently protective (AOR 0.26), aligning with evidence that educational attainment confers health literacy [5].

Knowledge of hypertension

Only 15.8% correctly identified the normal blood-pressure range, comparable to the 12% among non-hypertensive adults in the Seychelles [14]. By contrast, awareness of preventive strategies was higher: 85.0% knew that salt reduction prevents hypertension (vs 66% in an Indian study [16]) and 73.3% endorsed fruit and vegetable consumption [15]. University education was the sole independent predictor of high composite knowledge (AOR 2.93) [16]. Married participants had lower odds of high knowledge (AOR 0.34), possibly reflecting age-related confounding. Neither personal nor family hypertension history independently predicted knowledge, suggesting disease exposure alone does not ensure adequate understanding [6].

The knowledge-practice gap

The absence of a significant association between knowledge level and practice level (p=0.867) confirms a critical knowledge-practice gap. Only 20.4% adopted a low-salt diet (vs 35% in Kabul [15]) and fewer than 24% exercised regularly (vs over 60% in Kabul [15]). This points to barriers beyond knowledge deficit, including economic constraints, lack of facilities, social norms, and motivational factors [16, 15].

Hypertension history was the dominant predictor of regular blood-pressure monitoring (AOR 22.29), confirming that monitoring is almost entirely reactive. Non-hypertensive individuals - over 90% of the sample - are largely not engaging in preventive monitoring despite hypertension frequently being asymptomatic [1, 9]. Male sex was the only significant predictor of regular exercise (AOR 2.53), reflecting well-documented sex disparities in physical activity in conservative-cultural contexts [5, 15].

Comparison with prior literature

Headache (38%) and palpitations (33%) as the most common perceived symptoms are consistent with the Kabul study (36.6% and 25%, respectively) [15] and a Kassala Hospital study (38.8% symptom knowledge) [6]. The leading perceived causes - heredity (18%) and high salt intake (17%) - align with findings from Kabul and Indian studies [16, 15], suggesting a pan-regional pattern in lay hypertension beliefs.

Strengths and limitations

This study contributes novel multivariable evidence on predictors of KAP dimensions in Khartoum State through Firth's penalised logistic regression, a methodologically rigorous approach appropriate for the small event counts [17]. The bilingual (English/Arabic) questionnaire ensured accessibility.

However, several limitations must be explicitly acknowledged. Most importantly, the questionnaire was researcher-developed and had not been previously validated or standardised. No pilot study was conducted to assess internal consistency (Cronbach's alpha), no test-retest reliability was established, and no criterion validity was examined against an established KAP instrument. Consequently: (a) the knowledge score may not capture the full construct with precision; (b) the questionnaire's reliability is unknown; and (c) direct numerical comparisons with scores from validated-tool studies must be made with caution. Future research should use validated instruments such as the HELM questionnaire or WHO STEPS instruments for cross-population comparisons.

Additional limitations include: the cross-sectional design (precludes causal inference); convenience sampling via an online platform (over-represents younger, urban, university-educated individuals; limits generalisability); reliance on self-report (recall and social desirability bias); absence of objective clinical measurements; and a final sample of 240 (below the target of 384, reducing statistical power - particularly with only 19 hypertensive events).

Conclusions

Residents of Khartoum State demonstrate a critical knowledge-practice gap regarding hypertension: attitudes toward prevention are generally positive and awareness of preventive strategies is moderate-to-high, yet preventive behaviours remain markedly poor. Only 15.8% correctly identified the normal blood-pressure range - a fundamental deficit. Older age is the strongest risk factor for hypertension, while university education independently drives knowledge and protection against hypertension. Blood-pressure monitoring is largely reactive. Male sex is a significant determinant of exercise behaviour, highlighting gender disparities requiring targeted intervention.

These findings should be interpreted in light of the study's primary limitation: the use of a researcher-developed, non-validated questionnaire. The knowledge and practice scores generated here cannot be directly compared with those from studies using standardised tools. Replication using psychometrically validated KAP instruments is strongly recommended.

Future prevention programmes must move beyond information dissemination toward structured behaviour-change strategies, targeting asymptomatic young adults, women, and less-educated community members. Population-wide screening campaigns and mass health education, with attention to dietary and physical activity modifications, are strongly recommended.

Abbreviations

ACC/AHA: American College of Cardiology/American Heart Association; ABPM: Ambulatory blood-pressure monitoring; AOR: Adjusted odds ratio; BMI: Body mass index; BP: Blood pressure; CI: Confidence interval; CVD: Cardiovascular disease; DASH: Dietary Approaches to Stop Hypertension; DBP: Diastolic blood pressure; HTN: Hypertension; KAP: Knowledge, attitude, and practice; RAAS: Renin-angiotensin-aldosterone system; SBP: Systolic blood pressure; SHHS: Sudan Household Health Survey; SSA: Sub-Saharan Africa.

Declarations

Ethics approval and consent to participate

This study was conducted in full accordance with the principles of the World Medical Association Declaration of Helsinki (2013 revision). Ethical approval was obtained from the Research Ethics Committee of the Department of Community Medicine, Faculty of Medicine, Al Neelain University, Khartoum, Sudan. All participants provided informed consent prior to completing the questionnaire, and full confidentiality of their data was assured throughout the study.

Consent for publication

Not applicable.

Availability of data and materials

The datasets generated and analysed during the current study are not publicly available due to the anonymity assurances given to participants, but are available from the corresponding author on reasonable request.

Competing interests

The author declares no competing interests.

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Authors' contributions

MMA conceived the study, designed the questionnaire, collected data, performed the analysis, and wrote the manuscript.

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Supplementary Files

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- SUPPLEMENTARYFILE1TheQuestionnaire.pdf