Jordan Journal of Applied Science
Natural Science Series

Research Article

Prevalence, awareness, and social determinants of hypertension: A cross-sectional study in Northern State, Sudan

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ARTICLE INFO

Article history:
Received 9 Dec 2020
Accepted 16 Dec 2020
Published 30 Dec 2020

DOI:https://doi.org/10.35192/jjoas-n.v14i2.280

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Keywords:
Hypertension
Prevalence
Awareness
Northern State
Sudan

ABSTRACT

Background: Hypertension remains a significant risk factor for life-threatening conditions globally. This study was intended to determine the prevalence, awareness, and risk factors of hypertension.

Methods: A community-based, cross-sectional study was conducted among 757 participants aged ≥18 years in rural areas of the Northern State of Sudan in 2017. Blood pressure measurements were taken. Besides, data on demographic characteristics and treatment history of hypertension were collected. Pearson's chi-square test and logistic regression were used to identify risk factors associated with hypertension.

Results: Prevalence of hypertension and prehypertension were 40.1% (95%CI: 36.6-43.7) and 41% (95%CI: 36.6-43.3), respectively. The study found older adults ≥60 years were twice (AOR=2.08; 95%CI: 1.31-3.31) more likely to have hypertension compared to younger. Males were 1.5 times (AOR=1.53; 95%CI: 1.03-2.26) more likely to have hypertension compared to females. Illiterates were more than twice (AOR=2.26; 95% CI: 1.16-4.39) more likely to have hypertension compared to educated. Participants with a positive family history of hypertension were almost twice (AOR=1.68; 95%CI: 1.23-2.29) more likely to have hypertension compared to those without a family history. The overall awareness rate of hypertension was 35.5% and significantly reduced among males, younger, not married, educated, and belonged to the Danaglah tribe (p. value <0.05). The majority (78.7%) of hypertensive patients were on treatment. However, the rate of controlled hypertension among them was low (37.7%).

Conclusion: The overall burden of hypertension is increasing with low rate of awareness and controlled hypertension. Therefore, regular screening programs and improving management are essential for reducing the burden.

Introduction

Hypertension (HTN), also known as high or elevated blood pressure, is a major public health problem contributing to increased morbidity and mortality worldwide [1–4]. HTN is the persistently raised pressure generated within blood vessels as blood flows through these vessels [2–5]. This pressure within blood vessels is generated when the heart beats to pump blood out – systolic blood pressure (SBP) – and when the heart rests in between pumping blood out – diastolic blood pressure (DBP) [3–5]. Blood pressure reading comprises both SBP and DBP in the unit of a millimeter of mercury (mm Hg). HTN is the main risk factor for stroke, coronary heart disease, heart failure, vascular disease, chronic kidney disease, and other non-communicable diseases[2–5,7]. It is known as the "silent killer" because it is mostly asymptomatic[2–5]. Globally, HTN solely or in combination with smoking is identified as the leading cause of premature or early mortality and disability in all age groups[4,8].

The worldwide prevalence of HTN among the adult population was 26.4% in 2000 and is expected to rise to 29.2% in 2025 [9]. Globally, the approximate number of adults with HTN was 594 million [4], 972 million [9], 1.39 billion [10], and 1.13 billion [4] in 1975, 2000, 2010, and 2015 respectively. The prevalence of HTN appears to be increasing in developing countries while it has plateaued or is decreasing in developed countries [4,9,10]. Generally, in Africa, the overall prevalence of HTN in adults has been rise from 19.7% (1990) to 27.4% (2000) and 30.8% (2010) [11]. It is anticipated that the total adult population with HTN in Africa will increase by about 4-folds from 54.6 million in 1990 to 216.8 million in 2030[11]. In Arab countries comprising 22 developing countries, including Sudan, the pooled prevalence of HTN was estimated at 29.5% [12]. This prevalence was high compared to that of 27.6% in sub-Saharan African countries and 28% in the United States [12]. However, it was low compared to the prevalence of 44.2% reported for adults in European countries [13]. In Sudan, the prevalence of HTN among the rural population in the Northern State was 16.4% in 2012 and 21.1% in Sinnar State in 2013 [14,15]. While it was at 35.7% among the urban population in River Nile State in 2015 [16].

Awareness of HTN is when individuals can self-report HTN previously diagnosed by healthcare providers [12,17]. Compared to developed countries, awareness of HTN is low in developing countries including Sudan[11,12,15,18]. Awareness of HTN empowers hypertensive individuals, improves shared decision making, participation in and adherence to the management of their condition [15,19].

Risk factors associated with developing HTN are 1) modifiable – unhealthy diets (high salt, saturated/trans-fat, and inadequate vegetables and fruits), sedentary lifestyle, tobacco and alcohol consumption, overweight and obesity; and 2) non-modifiable risk – over 65 years of age, family history of HTN, and comorbidity with diabetes or kidney disease[4,11,20]. Prior studies reported similar risk factors in adults with HTN in Sudan [19].

Studies increasingly examine the prevalence and risk factors associated with HTN in Sudan [14–16,19,21–23]. However, studies of this nature-focused on adding awareness and control of HTN, particularly on the predominantly rural population in the Northern State of Sudan, are nonexistent. Therefore, this study intended to determine the prevalence, awareness, control, and social determinants of hypertension among the rural adult population of the Northern State of Sudan.

Materials and methods

Study design and setting

A community-based, cross-sectional study was carried out in rural areas in the Northern State of Sudan in 2017. Northern State has a total population of 699,065 with about 80% living in rural areas [24]. It consists of seven localities: Halfa, Dalgo, Al-Burgage, Dongola, Al-Golid, Al-Dabba, and Marawi [24,25].

Sample size estimation and sample procedures

The lowest sample size was 735 when calculated by the formula; $\frac{z^2 P(1-P)}{d^2}$ where the expected prevalence is 35.7% [16] with 95% confidence interval and precision of 3.5%. We used a multistage sampling technique; first, we randomly selected two (Dongola and Al-Golid) of the seven localities. Second, three villages (Al-Khannag, Mushu, and Al-Khandag) were randomly selected. Third, households were selected by using a systematic sampling method, and those who were ≥18 years and permanent residents within the selected household were selected to participate in the study.

Data collection

Three consecutive blood pressure measurements using mercury sphygmomanometers with a minimum of one minute apart were taken, and the average blood pressure was estimated. The American Heart Association Guidelines for In-Clinic Blood Pressure Measurement were applied for the participants [26]. While guidelines of the 7th Joint National Committee on Prevention, Detection, Evaluation, and Treatment of hypertension (JNC-7) were used for the categorization of HTN [1]. HTN was defined as blood pressure ≥140/90 mm Hg or being on treatment for HTN[1–4,11,27]. Prre-HTN is SBP from 120 to 139 mm Hg and/or DBP from 80 to 89 mm Hg [1–6].Participants who were not known to have HTN and discovered to have a blood pressure ≥140/90 mmHg were considered to have undiscovered HTN [27].

On the other hand, controlled HTN was considered as the ratio of participants with a blood pressure of <140/90 mmHg to all known hypertensive participants[4,27,28]. The awareness rate was calculated as the proportion of diagnosed HTN (previous diagnosis by a health professional and identified as having HTN to all known hypertensive participants)[17].A questionnaire was used to collect data by trained interviewers, which including demographic characteristics, family history, treatment history of HTN, tobacco use, and physical activity. Participants who reported receiving regular monthly support from Al -Zakat charity or other organizations were considered poor or supported.

Data analysis

Pearson's chi-square test was used to identify factors associated with HTN and pre-HTN participants. Moreover, to identify factors associated with awareness rate among hypertensive participants. Further, the significant factors ($p<0.05$) were included in the logistic regression module to predict factors associated with hypertension (dependent variable) using the block entry of variables method. The results were obtained after adjustment for age, gender, occupation, educational level, and social status. All results were presented by adjusted odds ratio (AOR) with a confidence interval (CI), as well as 2-sided $P<0.05$ was considered significant. IBM SPSS Statistics software (version 24.0 from Armonk, NY: IBM Corp, USA) was used to analyze the data.

Ethical consideration

Ethical approval was obtained from the Research Ethics Committee at the Ministry of Health, Northern State, Sudan. Permission was sought from the village's public council as well as the community leaders of the selected villages. In addition, informed consent was obtained from the study participants. Any participant identified with high blood pressure was referred to Dongola Specialized Hospital for further assessment and treatment.

Results

A total of 757 participants, with mean ages 47.10±6.94, ranged from 18 to 97 years, were analyzed for this study. The prevalence of pre-HTN and HTN were 41% (95%CI: 36.6-43.7) and 40.1% (95%CI: 36.6-43.3), respectively, as shown in Figure 1.

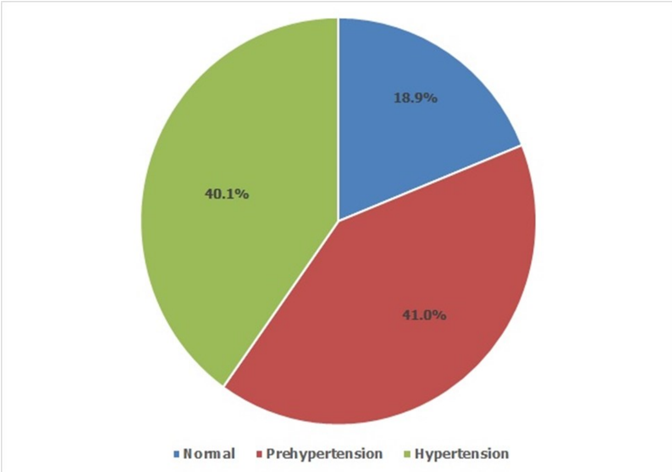

Figure 1. Prevalence of prehypertension and hypertension among the adult rural population of the Northern State, Sudan

This study showed a significant preponderance of HTN in participants 60 years and older, those with a positive family history of HTN, laborers, illiterate participants, and married participants (p- value <0.05). In contrast, the observed prevalence of pre-HTN was the inverse wherein pre-HTN was significantly prominent in study participants less than 40 years old, those with no family history of HTN, employed participants, those with university level and higher educational attainment, and those not married (p-value <0.05). Interestingly, the prevalence of both HTN and pre-HTN was significantly high among the poor or supported participants (p-alue <0.05) as shown in Table 1.

Table 1. Sociodemographic characteristics of study population in Northern State of Sudan

Variables	Total n(%)	Blood Pressure Categories: Normal n(%)	Pre-HTN n(%)	HTN n(%)	p value
Age					
<40 years	342(45.2)	74(21.6)	169 (49.4)	99(28.9)	<0.001
40-<60 years	272(35.9)	50(18.4)	95(34.9)	127 (46.7)	
≥60 years	143(18.9)	19(13.3)	46(32.2)	78(54.5)	
Gender					
Male	334(44.1)	56(16.8)	131 (39.2)	147(44)	0.130
Female	423(55.9)	87(20.6)	179 (42.3)	157 (37.1)	
Family history of HTN					
No	377(49.8)	83(22)	166(44)	128(34)	0.002

Yes	380(50.2)	60(15.8)	144 (37.9)	176 (46.3)	
Villages					
Al-Khandag	199(26.3)	32(16.1)	87(43.7)	80(40.2)	0.086
Mushu	296(39.1)	53(17.9)	133 (44.9)	110 (37.3)	
Al-Khannag	262(34.6)	58(22.1)	90(34.4)	114 (43.5)	
Tribes					
Danaglah	659(87.1)	121 (18.4)	276 (41.9)	262 (39.8)	0.361
Others	98(12.9)	22(22.4)	34(34.7)	42(42.9)	
Occupation					
Labourer	405(53.5)	83(20.5)	144 (35.6)	178(44)	0.009
Employee	116(15.3)	22(19)	60(51.7)	34(29.3)	
House wife	236(31.2)	38(16.1)	106 (44.9)	92(39)	
Education					
Illiterate	212(28)	31(14.6)	71(33.5)	110 (51.9)	<0.001
Pre-university	447(59)	94(21)	183 (40.9)	170 (38.1)	
University & above	98(12.9)	18(18.4)	56(57.1)	24(24.5)	
Marital status					
Not married	166(21.9)	35(21.1)	76(45.8)	55(33.1)	0.037
Married	591(78.1)	108 (18.3)	234 (39.6)	249 (42.1)	
Social status					
Poor or supported	93(12.3)	8(8.6)	45(48.4)	40(43)	0.023
Not poor	664(87.7)	135 (20.3)	265 (39.9)	264 (39.8)	
Smoking					
No	664(87.7)	126(19)	270 (40.7)	268 (40.4)	0.399
Ex-smoker	33(4.4%)	8(24.2)	14(42.4)	11(33.3)	
<10 years	29(3.8)	6(20.7)	15(51.7)	8(27.6)	
≥10 years	31(4.1)	3(9.7)	11(35.5)	17(54.8)	
Snuff					
No	596(78.7)	111 (18.6)	294 (41.8)	236 (39.6)	0.151
Ex-snuffer	26(3.4)	2(7.7)	12(46.2)	12(46.2)	
<10 years	45(5.9)	8(17.8)	12(26.7)	25(55.6)	
≥10 years	90(11.9)	22(24.4)	37(41.1)	31(34.4)	
Exercise					
Yes	433(57.2)	84(19.4)	169(39)	180 (41.6)	0.460
No	324(42.8)	59(18.2)	141 (43.5)	124 (38.3)	

Figure 2-A shows the rate of undiscovered HTN and pre-HTN as 30.2% and 47.8%, respectively, among participants with no history of HTN. In addition, the rate of pre-HTN was significantly high in females (*p*-value <0.05).

The overall rate of uncontrolled HTN was 59.2% while, the rate of uncontrolled HTN among treated participants was 49% among participants with a known history of HTN. Slightly less than a quarter (21.3%) of the known hypertensive participants were not on antihypertensive drugs. The remainder of the known hypertensive participants took either one (71.3%) or more than one (7.4%) antihypertensive drug, respectively, as shown in figure 2-B.

The overall awareness rate of HTN was 35.5%. The awareness rate was significantly decreased among participants that were males, those younger than 40 years, participants not married, educated participants, and those participants belonging to the Danaglah tribe (p-value <0.05) as shown in Table 2.

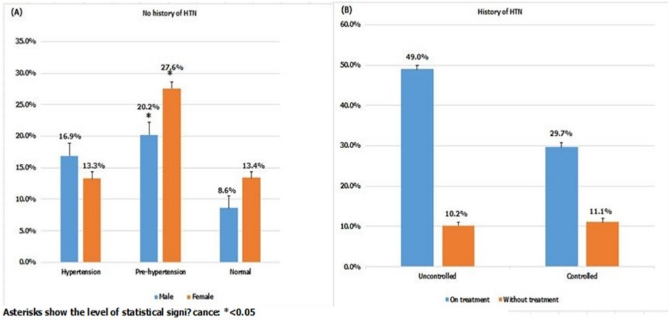

Figure 2. (A) Prevalence of undiscovered HTN and pre-HTN among the unknown-hypertensive participants. (B) Rate of controlled and uncontrolled HTN among the known hypertensive participants

Table 2. Factors associated with awareness rate of hypertension among hypertensive participants

Variables	HTN Awareness Status		p value
	Known	Unknown	
Total	108(35.5)	196(64.5)	
Age			
<40 years	11(11.1)	88(88.9)	<0.001
40-<60 years	49(38.6)	78(61.4)	
≥60 years	48(61.5)	30(38.5)	
Gender			
Male	37(25.2)	110(74.8)	<0.001
Female	71(45.2)	86(54.8)	
Education level			
Illiterate	52(47.3)	58(52.7)	0.004
Pre-university	51(30)	119(70)	
University & above	5(20.8)	19(79.2)	
Tribes			
Danaglah	78(29.8)	184(70.2)	<0.001
Others	30(71.4)	12(28.6)	
Marital status			
Not married	7(12.7)	48(87.3)	<0.001
Married	101(40.6)	148(59.4)	
Family history			
Yes	78(43.3)	102(56.7)	0.001
No	30(24.2)	94(75.8)	

Table 3 shows that the participants 40-<60 years and ≥60 years were 1.75 times (AOR=1.75; 95%CI: 1.23-2.45; p value = 0.002) and twice times (AOR=2.08; 95%CI: 1.31-3.31; p value = 0.002) respectively more likely to have HTN compared to younger participants less than 40 years old. Male participants were 1.5 times (AOR=1.53; 95%CI: 1.03-2.26; p value = 0.035) more likely to have HTN compared to females. The labourers were almost twice times (OR=1.89; 95%CI: 1.21-2.95) more likely to have HTN compared to employees. However, after adjustment this association was not statistically significant. Illiterate participants were twice times (AOR=2.26; 95% CI; 1.16-4.39; p-value =0.016) more likely to have HTN compared to participants with university and higher educational attainment. Participants with a positive family history of HTN were almost twice times (AOR=1.68; 95%CI: 1.23-2.29; p-value = 0.001) more likely to have HTN compared to those with no family history. All results were obtained after adjustment, for age, gender, occupation, educational level, and social status.

Discussion

A recently published meta-analysis revealed significant global variations in the prevalence of HTN between different countries ranging from 4% to 78%[29].

Table 3. Logistic regression analysis to predict factors associated with hypertension among the adult rural population in Northern state, Sudan

Variable	Normal BP n (%)	HTN n (%)	OR (95%CI)	AOR (95%CI)
Age				
<40 years	243(32.1)	99(13.1)	Reference	Reference
40-<60 years	145(19.2)	127(16.8)	2.15(1.54-3.00) ***	1.75(1.23-2.45) **
≥60 years	65(8.6)	78(10.3)	2.94(1.97-4.41)***	2.08(1.31-3.31) **
Gender				
Female	266(35.1)	157(20.7)	Reference	Reference
Male	187(24.7)	147(19.4)	1.33(0.99-1.78)ns	1.53(1.03-2.26) *
Occupation				
Employee	82(10.8)	34(4.5)	Reference	Reference
Laborer	227(30)	178(23.5)	1.89(1.21-2.95)**	1.23(0.73-2.07) ns
House wife	144(19)	92(12.2)	1.54(0.96-2.49)ns	1.23(068-2.22) ns
Education level				
Illiterate	102(13.5)	110(14.5)	3.33(1.95-5.67)***	2.26(1.16-4.39) **
Pre university	277(36.6)	170(22.5)	1.89(1.15-3.11)**	1.59(0.91-2.81) ns
University	74(9.8)	24(3.2)	Reference	Reference
Marital status				
Not married	111(14.7)	55(7.3)	Reference	Reference
Married	342(45.2)	249(32.9)	1.47(1.03-2.11)*	0.86(0.57-1.31) ns
Family history				
No	249(32.9)	128(16.9)	Reference	Reference
Yes	204(26.9)	176(23.2)	1.68(1.25-2.25)***	1.68(1.23-2.29) ***

Asterisks show the level of statistical significance: ns >0.05; *<0.05; **<0.01 *** <0.001. CI: Confidence interval; OR: Odd ratio; AOR: Adjusted odd ratio for covariate.

These differences in prevalence tended to increase in low- and middle-income countries compared to the high-income countries [29]. The overall prevalence of HTN in the rural population of the Northern State in Sudan increased more than twofold from 16.4% in 2012[14] to the current value of 40.1%. The prevalence was higher than several studies conducted among urban populations in the different States of Sudan; River Nile State (35.7%) and Sinnar State (21.1%) [15,16]. This finding, combined with the increasing prevalence of type2 diabetes mellitus in the State [20], might also indicate an increased rate of stroke and atherosclerotic cardiovascular diseases in North Sudan.

The prevalence of HTN (40.1%) in this study was higher than that of many studies performed in middle- and low-income countries (32.3%, 31.5%) [10,30], Arab countries (29,5%) [12], Middle East countries (33%) [31], and sub-Saharan African countries (14-39%) [32].The higher prevalence of HTN in this study could be attributed to increasing urbanization, dietary changes, and increasing life stress.

Moreover, the prevalence of pre-HTN was 41%, which is lower than that reported from Nigeria (58.7%) [33],but similar to that of Ghana (40%) and China (42.7%) [34]. Pre-HTN carries the risk of progression to HTN and is associated with an increased risk of cardiovascular diseases and stroke [35,36]. Lifestyle modifications such as weight reduction, low-salt diet, and regular exercise are important in controlling pre-HTN[1]. These modifications subsequently prevent progression to HTN and reduce the risk of stroke and cardiovascular disease [1]. Participants with pre-HTN and other comorbidities such as diabetes mellitus, chronic kidney disease, and cardiovascular disease need treatment to control their high blood pressure[37].

The prevalence of HTN was significantly higher among older, males, illiterates, and those with family history. This result is consistent with the findings of several studies in the world[27].

More than one third (35.5%) of the hypertensive participants were aware of their disease at the time of the study. This is lower than that reported from low-income countries (40.8%) [28], Kingdom of Saudi Arabia (44.7%) [38], and Jordan (52.5%) [39]. The awareness rate is almost similar to that reported from Egypt (37.5%), and the rural population of India (33.8%) [38,39]. However, it is higher than awareness rates reported by the studies conducted in Uganda (28.2%), and Kenya (19.5%) [40]. In addition, the awareness rate was significantly lower among younger and male participants; this might be explained by the fact that older and females have more desire to medical check [27]. Surprisingly, in our study, educated participants, males, not married, and those from the Danaglah tribe have a significantly lower awareness rate. There is no explanation for these associations. However, we can speculate that the observed association could be due to the nature of the participants from rural areas where access to health services is challenging. Therefore, education and age may not necessarily influence HTN awareness.

Over three quarters (78.7%) of the known hypertensive participants were on antihypertensive treatment, which was slightly better than that reported from Saudi Arabia (71.8%)[38], and higher compared to that of Egypt (23.9%) and India (32.1%)[40]. Despite the higher rate of treatment in our study, the rate of controlled HTN was (37.7%) among them, which is higher than several studies from Jordan (35%)[27], Uganda (33.1%)[41], and pooled cross-section analysis in different countries (32.5%)[28]. Surprisingly, 11.1% of participants with controlled HTN were not under antihypertensive treatment; this might be explained by the fact that most of them had mild HTN (stage 1) at the time of diagnosis and became well controlled by dietary advice only, or they might be taking some herbal remedies that lower BP like hibiscus [42]. Other factors might be responsible yet to be elaborated more by further large-scale studies.

The higher rates of uncontrolled HTN in this study may be explained by poor access to medical services, non-compliance with medication, and lack of awareness about the effects and complications of uncontrolled HTN. This issue needs to be investigated more by further studies because other factors may not yet be discovered, including the lack of efficacy of some drugs in such patients. Controlling blood pressure is known to lower the risk of stroke by 35-40%, myocardial infarction by 20-25%, and heart failure by more than 50% [1].

The following limitations should be considered while understanding the findings of this study. First, a cross-section study design cannot precisely determine the cause-effect association. Second, the study was carried out in rural areas where it is expected that the prevalence of HTN would be higher as well as the awareness and access to medical services are expected to be lower than the urban population. Therefore, we recommend conducting further studies on the urban population. Third, more females were recruited because they were more likely to be at home during the survey compared to males. Third, most of the participants were from the Danaglah tribe because they represent the majority in the State.

Conclusion

There is a high prevalence of hypertension and pre-hypertension among the rural adult population in the Northern State. Besides, lower rates of awareness and controlled hypertension exist in this population. Therefore, improvement of knowledge, awareness, treatment, and control by health care professionals of hypertension is essential to reduce the burden of hypertension in the Northern State of Sudan. Additionally, regular screening for high-risk groups is essential in reducing the morbidity and mortality associated with hypertension in this part of Sudan.

Competing interests

The authors declare no competing interest.

Authors' contributions

Mohamed Osman Abdelaziz, Mohamed Ali Alzain, Mohamed Elshiekh, Collins Otieno Asweto, and Najm Eldinn Elsser, developed the research concept; and designed the data collection process; analysis of the data, and drafted the study reports. Adeniyi Abolaji Adeboye, Rafeek Adeyemi Yusuf, and Fahad Algahtani provided academic guidance and continuous supervision, reviewed the study reports and manuscript. All authors revised and agreed the final manuscript.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

References

1. Chobanian Aram V., Bakris George L., Black Henry R., Cushman William C., Green Lee A., Izzo Joseph L., et al. Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. Hypertension. 2003;42(6):1206–1252.
2. WHO. The world health report 2002: reducing risks, promoting healthy life. 2002. World Health Organization.
3. Organization WH, Group IS of HW. 2003 World Health Organization (WHO)/International Society of Hypertension (ISH) statement on management of hypertension. J Hypertens. 2003;21(11):1983–1992.
4. Organization WH. Global action plan on physical activity 2018-2030: more active people for a healthier world. 2019. World Health Organization.
5. What is High Blood Pressure? www.heart.org. https://www.heart.org/en/health-topics/high-blood-pressure/the-facts-about-high-blood-pressure/what-is-high-blood-pressure. Accessed 16 April 2020.
6. Ondimu DO, Kikuvi GM, Otieno WN. Risk factors for hypertension among young adults (18-35) years attending in Tenwek Mission Hospital, Bomet County, Kenya in 2018. Pan Afr Med J. 2019;33.
7. Organisation mondiale de la santé. Global status report on non-communicable diseases 2010. 2011. Geneva. World Health Organization.
8. GBD_2017_Booklet.pdf. http://www.healthdata.org/sites/default/files/files/policy_report/2019/GBD_2017_Booklet.pdf. Accessed 17 April 2020.
9. Kearney PM, Whelton M, Reynolds K, Muntner P, Whelton PK, He J. Global burden of hypertension: analysis of worldwide data. The lancet. 2005;365(9455):217–223.
10. Mills KT, Bundy JD, Kelly TN, Reed JE, Kearney PM, Reynolds K, et al. Global disparities of hypertension prevalence and control: a systematic analysis of population-based studies from 90 countries. Circulation. 2016;134(6):441–450.
11. Adeloye D, Basquill C. Estimating the prevalence and awareness rates of hypertension in Africa: a systematic analysis. PloS One. 2014;9(8).
12. Tailakh A, Evangelista LS, Mentes JC, Pike NA, Phillips LR, Morisky DE. Hypertension prevalence, awareness, and control in A rab countries: A systematic review. Nurs Health Sci. 2014;16(1):126–130.
13. Wolf-Maier K, Cooper RS, Banegas JR, Giampaoli S, Hense H-W, Joffres M, et al. Hypertension prevalence and blood pressure levels in 6 European countries, Canada, and the United States. Jama. 2003;289(18):2363–2369.
14. Balla SA, Abdalla AA, Elmukashfi TA, Ahmed HA. Hypertension among rural population in four states: Sudan 2012. Glob J Health Sci. 2014;6(3):206.
15. Elfaki BAAM, Elnimeiri MKM. Prevalence of Hypertension among Sudanese Rural Population, Sinnar State-Sudan. 2017.
16. Bushara SO, Noor SK, Ibraheem AAH, Elmadhoun WM, Ahmed MH. Prevalence of and risk factors for hypertension among urban communities of North Sudan: Detecting a silent killer. J Fam Med Prim Care. 2016;5(3):605.
17. Sengul S, Akpolat T, Erdem Y, Derici U, Arici M, Sindel S, et al. Changes in hypertension prevalence, awareness, treatment, and control rates in Turkey from 2003 to 2012. J Hypertens. 2016;34(6):1208.
18. Kearney PM, Whelton M, Reynolds K, Whelton PK, He J. Worldwide prevalence of hypertension: a systematic review. J Hypertens. 2004;22(1):11–19.
19. Abdalla AA, Alagib MEA, Balla SA. Socio-demographic Characteristics, Risk Factors and Awareness of Adults Hypertensive Population in Khartoum Locality, 2014. J Adv Med Med Res. 2019;1–9.
20. Eltom MA, Mohamed AHB, Elrayah-Eliadarous H, Yassin K, Noor SK, Elmadhoun WM, et al. Increasing prevalence of type 2 diabetes mellitus and impact of ethnicity in north Sudan. Diabetes Res Clin Pract. 2018;136:93–99.
21. Ali I, Behairy H, Abugroun A, Beaney T, Kobeissi E, Abdalla A, et al. May Measurement Month 2017: an analysis of blood pressure screening in Sudan—Northern Africa and Middle East. Eur Heart J Suppl. 2019;21(Supplement_D):D111–D114.
22. Awadalla H, Elmak NE, El-Sayed EF, Almobarak AO, Elmadhoun WM, Osman M, et al. Hypertension in Sudanese individuals and associated risk factors: the critical intersection between salt and sugar intake. Cardiovasc Diagn Ther. 2018;8(4):432–438.
23. Full article: Undiagnosed hypertension in a rural community in Sudan and association with some features of the metabolic syndrome: how serious is the situation? https://www.tandfonline.com/doi/full/10.3109/0886022X.2015.1052951. Accessed 17 April 2020.
24. Population Census Council. 5th Sudan population and housing census – 2008, priority results: Northern State. Central Bureau of Statistics, the Republic of Sudan. December 2009. Available at: https://www.ilo.org/surveydata/index.php/catalog/136025.Sudan. OCHA. 2018. https://www.unocha.org/sudan. Accessed 17 December 2019.
25. Pickering Thomas G., Hall John E., Appel Lawrence J., Falkner Bonita E., Graves John, Hill Martha N., et al. Recommendations for Blood Pressure Measurement in Humans and Experimental Animals. Hypertension. 2005;45(1):142–161.
26. Khader Y, Batieha A, Jaddou H, Rawashdeh SI, El-Khateeb M, Hyassat D, et al. Hypertension in Jordan: Prevalence, Awareness, Control, and Its Associated Factors. Int J Hypertens. 2019;2019:1–8.
27. Chow CK, Teo KK, Rangarajan S, Islam S, Gupta R, Avezum A, et al. Prevalence, Awareness, Treatment, and Control of Hypertension in Rural and Urban Communities in High-, Middle-, and Low-Income Countries. JAMA. 2013;310(9):959–968.
28. Salem H, Hasan DM, Eameash A, El-Mageed HA, Hasan S, Ali R. Worldwide Prevalence of Hypertension: A Pooled Meta-Analysis of 1670 Studies in 71 Countries with 29.5 Million Participants. J Am Coll Cardiol. 2019;71(11 Supplement):A1819.
29. Sarki AM, Nduka CU, Stranges S, Kandala N-B, Uthman OA. Prevalence of Hypertension in Low- and Middle-Income Countries. Medicine (Baltimore). 2015;94(50).
30. Yusufali AM, Khatib R, Islam S, Alhabib KF, Bahonar A, Swidan HM, et al. Prevalence, awareness, treatment and control of hypertension in four Middle East countries. J Hypertens. 2017;35(7):1457–1464.
31. Addo Juliet, Smeeth Liam, Leon David A. Hypertension In Sub-Saharan Africa. Hypertension. 2007;50(6):1012–1018.
32. Isezuo SA, Sabir AA, Ohwovorilole AE, Fasanmade OA. Prevalence, associated factors and relationship between prehypertension and hypertension: a study of two ethnic African populations in Northern Nigeria. J Hum Hypertens. 2011;25(4):224–230.
33. Guo X, Zhang X, Hu J, Sun Y, Zheng L, Zou L, et al. The prevalence and heterogeneity of prehypertension: a meta-analysis and meta-regression of published literature worldwide. Cardiovasc J Afr. 2012;23(1):44–50.
34. Ferguson TS, Younger N, Tulloch-Reid MK, Lawrence-Wright MB, Forrester TE, Cooper RS, et al. Progression from prehypertension to hypertension in a jamaican cohort: incident hypertension and its predictors. West Indian Med J. 2010;59(5):486–493.
35. Huang Y, Wang S, Cai X, Mai W, Hu Y, Tang H, et al. Prehypertension and incidence of cardiovascular disease: a meta-analysis. BMC Med. 2013;11(1):177.
36. Gupta P, Nagaraju SP, Gupta A, Chikkalingaiah KBM. Prehypertension - Time to Act. Saudi J Kidney Dis Transplant. 2012;23(2):223.
37. Saeed AA, Al-Hamdan NA, Bahnassy AA, Abdalla AM, Abbas MAF, Abuzaid LZ. Prevalence, Awareness, Treatment, and Control of Hypertension among Saudi Adult Population: A National Survey. Int J Hypertens. 2011;2011:1–8.
38. Jaddou HY, Bateiha AM, Al-Khateeb MS, Ajlouni KM. Epidemiology and management of hypertension among Bedouins in Northern Jordan. 6.
39. Ibrahim M. Mohsen, Rizk Hussein, Appel Lawrence J., Aroussy Wafaa El, Helmy Sherif, Sharaf Yasser, et al. Hypertension Prevalence, Awareness, Treatment, and Control in Egypt. Hypertension. 1995;26(6):886–890.
40. Musinguzi G, Nuwaha F. Prevalence, Awareness and Control of Hypertension in Uganda. PLoS ONE. 2013;8(4).

41. Jalalyazdi M, Ramezani J, Izadi-Moud A, Madani-Sani F, Shahlaei S, & Ghiasi S S. Effect of hibiscus sabdariffa on blood pressure in patients with stage 1 hypertension. Journal of Advanced Pharmaceutical Technology & Research, 2019;10(3), 107.