Original Article

Prevalence of obesity related hypertension among overweight or obese adults in River Nile State in Northern Sudan: a community based cross-sectional study

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Background: Reducing excess body weight is important for control and management of high blood pressure (BP) in adults. Previous studies showed high prevalence of hypertension in River Nile State—north of Sudan, hence this study to establish whether obesity can be among the main risk factors and to study the prevalence of obesity related hypertension among Sudanese adults in River Nile State.

Methods: This was a cross sectional community-based study conducted in River Nile State, Northern Sudan from January to June 2021. Obese and overweight, aged 18 years and above and accepted to participate in the study were included in the study. Convenience sampling method was used to select the participants. Data was collected through structured questionnaire filled by the patients after taking informed consent. Anthropometric measurements were taken. Two measurements of BP were obtained. Data was analyzed using SPSS version 23.0 (IBM, Chicago, USA). Chi-square test was used to determine the associations between categorical variables while logistic regression test was used to predict the presence of hypertension among studied population.

Results: A total of 1,295 participants were enrolled in this study. Obesity was reported in 1,118 (86.3%) of the participants. The prevalence of hypertension among the participants was 1,027 (79.3%). Central obesity was reported in 951 (92.6%) among hypertensive patients (P<0.001). Moreover, among hypertensive patients 470 (45.8%) were obese class I, 334 (32.5%) overweight, 139 (13.5%) obese class II and 84 (8.2%) obese class III (P<0.001). Obesity, BMI are risk factor of hypertension (P<0.001). Other risk factors were age above 40 years (P<0.001), unemployment (P<0.001), low education level (P<0.001) and being married (P<0.001). Logistic regression analysis showed that increasing age [P<0.001; odds ratio (OR) =1.055; 95% confidence interval (CI): 1.041–1.068], central obesity (P<0.001; OR =5.16; 95% CI: 3.4–7.8) and high body mass index (BMI) (P<0.001; OR =3.7; 95% CI: 1.7–7.9) were associated with uncontrolled hypertension.

Conclusions: The study showed that the prevalence of obesity related hypertension was high. Common risk factors were age above 40 years, unemployment, and marriage. Importantly, central obesity, gross obesity and increasing age can be associated with uncontrolled BP management.

Keywords: Obesity; hypertension; age; River Nile; Sudan

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Introduction

Background

Hypertension is a major public health issue (1). It is estimated that nearly one quarter of the adults in the world have hypertension. The high prevalence of hypertension worldwide is due to different demographic and epidemiological factors particularly in the developing countries (2). Hypertension is the leading risk factor for disability and death (3). The risk factors for hypertension in Sudan and globally are age, obesity, alcohol consumption, smoking, behavioral, metabolic and genetic factors (4-6). The prevalence of hypertension is about 30% in in Sub-Saharan Africa and it increases over time (7,8). The prevalence and risk factors of hypertension were extensively studied in African countries (9-11). For instance, obesity is a well-recognized risk factor for development of hypertension (12) and hypertension is frequently associated with obesity (13,14). Furthermore, obesity increases the risk of death from type 2 diabetes mellitus (T2DM), cardiovascular disease, cancer, and chronic kidney disease (13). The existing relationship between hypertension and obesity is well studied in in both sexes (15). It has been suggested that high body mass index (BMI) and the increase of waist circumference are the strongest risk factors for developing hypertension and obese women have higher incidence of hypertension (16). Interestingly, maintaining a weight reduction of 4.5 kilograms for thirty months reduces the risk of developing hypertension by more than 60% (17) and elimination of obesity and high blood glucose could decrease the prevalence of hypertension (18). Treatment of hypertension in Obese patients is difficult because obese hypertensive patients need more antihypertensive medications (19). The prevalence of hypertension in Sudan was found to be 35.7 % (5,20) and the prevalence of obesity is also high in Sudan and this found to be 21.2% (21). Obesity is socially acceptable in Sudan and is considered a sign of wealth (21). Previous studies conducted in Khartoum, the capital of Sudan and Eastern Sudan showed the association of hypertension with obesity in Sudanese patients (21,22). For instance, in Eastern Sudan obesity in association with hypertension was found to be 32.7%, while in Khartoum, the capital of Sudan, the prevalence was 40.2%.

Highlight box

Key findings
- Prevalence of obesity related hypertension is high in River Nile State.

What is known and what is new?
- High prevalence of hypertension in River Nile State.
- There is a significant association between hypertension and obesity in River Nile State. Risk factors are age group above 40 years, unemployment, low education level, excessive coffee drinking, and marriage

What is the implication, and what should change now?
- Driving initiatives to mitigate the complications of hypertension.
- Primary care physicians may also need to pay more attention in obese individuals with hypertension to compliance with antihypertensive medications and improve awareness of patients about hypertension complications and to educate the public on prevention of hypertension and obesity and reducing salt intake.
- Study whether hypertension and obesity can be the driver behind the high prevalence of diabetes in River Nile state.

Rationale and knowledge gap

River Nile state is unique as large numbers of tribes of Sudan lives in the region, it is large agricultural hub for food and fruits with many workers travelling to and from the region. The study will be continuation of the series of previous studies conducted in the region about hypertension in urban, rural and different ethnic groups in River Nile state (4,5,20).

Objective

The aim of the present study is to determine the prevalence of hypertension in overweight and obese adults in the River Nile State and the associated other risk factors. This is first large study to assess the link between obesity and hypertension in River Nile State. We present the

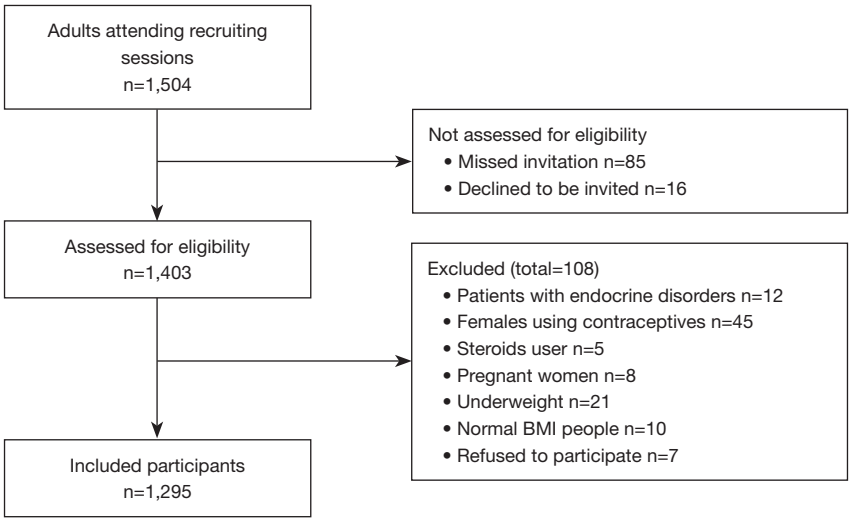

Figure 1 Flow chart to report numbers of participants at each stage of study, including the selection of potential eligible ones, the final included ones, and with reasons for inclusion and exclusion. BMI, body mass index.

following article in accordance with the STROBE reporting checklist (available at https://cdt.amegroups.com/article/view/10.21037/cdt-22-473/rc).

Methods

Study setting

This was a cross sectional community-based study conducted in in Shendi and Atbara cities at River Nile State, Sudan from January to June 2021. The study population was obese and overweight people living in Shendi and Atbara cities during the study period.

Inclusion criteria

Obese and overweight, aged 18 years and above and accepted to participate in the study were included in the study.

Exclusion criteria

Individuals with diabetes and patients with other endocrine disorders, females using contraceptives, steroids user, pregnant women, underweight and normal BMI people and those who refused to participate in the study were excluded from this study to exclude the presence of confounders and any type of including selection bias (*Figure 1*).

Sample size and sampling technique

Convenience sample by which available number (in clubs, market, khalwa) of obese and overweight individuals living in River Nile State during the study period and fulfilled the inclusion criteria of the study were selected. To obtain suitable and representative sample, 2% from each of the two cities out of the total population (obtained from the local authorities of the two cities) was selected. The total population of Atbara was 111,399 persons and we selected 2% of them (824 persons) while the total population of Shendi city was 89,947 and we selected 2% of them (471) persons, so the total sample size was 1,295 participants (23,24).

Method of recruitment of study participants

Study participant were recruited by self-selection through advertisements in markets and clubs in the study area.

Data collection

Data was collected from participant after taking written consent and questionnaire was filled by the researchers. The questionnaire was validated questionnaire including information about the patients' socio-demographic characteristics, clinical history and examination and possible risk factors for developing hypertension (25). Standardized pretest questionnaire was used to record medical history

social and life style (21).

Anthropometric measurements

Weight and height were measured using calibrated equipment and standardized technique. Body weight was measured to the nearest 0.1 kg using a digital scale, and height was recorded to the nearest 0.1 cm using a wall-mounted stadiometer. Measurements were taken for each participant with light clothing and without shoes, and BMI was calculated by the following formula: weight in kilograms divided by height in meters squared (26). According to WHO, normal weight is defined as BMI =18.5–24.9 kg/m^2; overweight as BMI =25–29.9 kg/m^2; and obesity as BMI ≥30 kg/m^2 (27), while obesity was classified into: obese class I (30–34.9 kg/m^2), obese class II (35–40 kg/m^2), obese class III (>40 kg/m^2). Hypertension is correlated with high BMI and elevated waist-hip ratio. Growing evidence showed that the use of waist-hip ratio is more sensitive in identifying health risk than using the BMI and is also associated with obesity control (28). Waist circumference of the study participants was measured at the iliac crest highest point during minimal respiration. Hip circumference was measured at the maximum posterior protuberance of the buttocks. Waist hip ratio is calculated as the ratio of Waist circumference (cm) to hip circumference (cm) (29). Central obesity is defined as a waist circumference of >94 cm in males and >80 cm in females, or a waist to hip ratio of >0.90 in males and >0.85 in females (30,31).

Measurement of blood pressure (BP)

Two readings of BP were obtained using a mercury sphygmomanometer in the sitting position following rest for 15 minutes, and the second reading was used to confirm the diagnosis of hypertension (32). The diagnosis of hypertension is established in those with BP of ≥140/90 mmHg (32).

Statistical analysis

Data was analyzed using Statistical Packages for Social Sciences (SPSS) version 23.0 (IBM, Chicago, USA). Frequencies and Chi squire test was used when appropriate. The P value was considered significant if <0.05. Logistic regression test was performed to predict the presence of hypertension (BP more than or equal to 140/90 mmHg at the second time); which was the primary outcome variable of interest, among studied obese populations. The independent variables were age of the participants, occupation, associated disorders, waist/hip ratio and BMI. The reference category for weight classification in the logistic regression analysis was those who were overweight, while the reference category for waist/hip ratio in the logistic regression analysis were those who have normal values, while age was assessed as a continuous variable.

Ethical considerations

Ethical clearance was obtained from the ethics committee of Sudan Medical Specialization Board-Khartoum. Written informed consent from patients was obtained before participation. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

Results

Socio-demographic characteristics of the participants

The participants aged 40–59 years were 608 (46.9%). Males were 717 (55.4%) and secondary level of education was reported in 395 (30.5%) of the participants while university/post-graduate was reported in 338 (26.1%). Unemployed participants were 577 (44.6%), workers were 395 (30.5%). The participants from rural areas were 773 (59.7%). The majority of the participants 1,093 (84.4%) were married. High waist to hip ratio (central obesity) was reported in 1,118 (86.3%) of the participants obesity class I was reported in 556 (42.9%) of the participants and 507 (39.2%) were overweight (*Table 1*).

Comorbidities and lifestyle habits

The reported symptoms of hypertension were headache with dizziness 499 (38.5%) and 353 (27.3%) of the participants did not show any symptom of hypertension. The majority of the participants were healthy, 926 (71.5%). Apart from asthma 128 (9.9%), renal diseases 124 (9.6%), cardiac diseases 76 (5.9%). The first measurement of BP revealed high BP in 844 (65.2%) of the participants. After 15 minutes, the reading indicated hypertension in 1,027 (79.3%) of the participants and 268 (20.7%) of the participants were normotensive. While 287 (22.2%) were smokers, 100 (7.7%) were alcohol drinkers, 627 (48.4%) excessive coffee drinkers and the physically inactive participants were 635 (49.0%) (*Table 2*).

Chi-square test revealed that the socio-demographic

Table 1 Socio-demographic characteristics of the participants (n=1,295)

Basic information	N	%
Age group		
<20 years	18	1.4
20–39 years	350	27.0
40–59 years	608	46.9
60 years and above	319	24.6
Gender		
Male	717	55.4
Female	578	44.6
Educational level		
Not educated	199	15.4
Primary	363	28.0
Secondary	395	30.5
University/above	338	26.1
Employment history		
Unemployed	577	44.6
Employed	718	55.4
Residence		
Urban	522	40.3
Rural	773	59.7
Marital status		
Married	1093	84.4
Not married	202	15.6
Waist/hip ratio		
Normal	177	13.7
High	1118	86.3
Weight status		
Overweight (25–29.9)	507	39.2
Obese class I (30–34.9)	556	42.9
Obese class II (35–40)	139	10.7
Obese class III (>40)	93	7.2
Symptoms		
None	353	27.3
Headache	385	29.7
Dizziness	58	4.5
Headache + dizziness	499	38.5
Comorbidities		
None	926	71.5
Asthma	128	9.9
Cardiac diseases	76	5.9
Renal diseases	124	9.6
Asthma + renal disease	10	0.8
Cardiac disease + renal disease	22	1.7
Asthma, cardiac and renal	9	0.7
Previous history of HTN		
Yes	767	59.2
No	528	40.8
First BP reading		
Normal	451	34.8
High	844	65.2
Second BP reading		
Normal	268	20.7
High	1027	79.3
Smoking		
Yes	287	22.2
No	1008	77.8
Alcoholic		
Yes	100	7.7
No	1195	92.3
Excessive coffee intake		
Yes	627	48.4
No	668	51.6
Physically inactive		
Yes	635	49.0
No	660	51.0

HTN, hypertension; BP, blood pressure.

characteristics of the participants that significantly associated with hypertension were aged group above 40 years, unemployment, rural residence and married participants (P<0.001). Among the participants with high readings of BP (n=1,027), central obesity (elevated waist to hip ratio) was reported in 951 (92.6%) (P<0.001) indicates

Table 2 Association of blood pressure readings with socio-demographic characteristics, medical history and social habits (n=1,295)

Socio-demographics	Second reading of BP				P value
	Normal (n=268)		High (n=1,027)		
	n	%	n	%	
Age groups					
<20 years	3	1.1	15	1.5	<0.001*
20–39 years	117	43.7	233	22.7	
40–59 years	115	42.9	493	48.0	
60 years and above	33	12.3	286	27.8	
Gender					
Male	156	58.2	561	54.6	0.16
Female	112	41.8	466	45.4	
Educational level					
Not educated	29	10.8	170	16.6	<0.001*
Primary	80	29.9	283	27.6	
Secondary	64	23.9	331	32.2	
University/above	95	35.4	243	23.7	
Occupation					
Unemployed	107	39.9	470	45.8	0.05
Employee	161	60.1	557	54.2	
Residence					
Urban	115	42.9	407	39.6	0.18
Rural	153	57.1	620	60.4	
Marital status					
Married	208	77.6	885	86.2	<0.001*
Not married	60	22.4	142	13.8	
Waist/hip ratio					
Normal	101	37.7	76	7.4	<0.001*
High (central obesity)	167	62.3	951	92.6	
Weight status					
Overweight (25–29.9)	173	64.6	334	32.5	<0.001*
Obese class I (30–34.9)	86	32.1	470	45.8	
Obese class II (35–40)	0	0.0	139	13.5	
Obese class III (>40)	9	3.4	84	8.2	

Table 2 (*continued*)

Table 2 (*continued*)

Socio-demographics	Second reading of BP				P value
	Normal (n=268)		High (n=1,027)		
	n	%	n	%	
Associated diseases					
None	231	86.2	695	67.7	<0.001*
Asthma	19	7.1	109	10.6	
Cardiac diseases	4	1.5	72	7.0	
Renal diseases	10	3.7	114	11.1	
Asthma + renal	0	0	10	1.0	
Cardiac + renal	4	1.5	18	1.8	
Asthma, cardiac and renal	0	0	9	0.9	
Symptoms					
None	124	46.3	229	22.3	<0.001*
Headache	81	30.2	304	29.6	
Dizziness	5	1.9	53	5.2	
Dizziness + headache	58	21.6	441	42.9	
Life style habits					
Physically inactive	121	45.1	514	50.0	0.87
Smoking habits	52	19.4	235	22.9	0.12
Excessive coffee	173	64.6	454	44.2	<0.001*
Alcoholic	15	5.6	85	8.3	0.08

*, P values <0.05 are considered significant. BP, blood pressure.

significant association between central obesity and elevated BP. Among patients with high BP, 470 (45.8%) were in class I obesity, 334 (32.5%) overweight (P<0.001) indicates significant association between obesity and overweight and hypertension. The number of the participants with normal BP who had no comorbidities was more than the participants with high BP readings (P<0.001). Furthermore, the number of normotensive participants and had no any symptoms were more than those who had high BP (P<0.001) (*Table 2*).

When logistic regression test was performed, we found that obese patient with class III category were more likely to have uncontrolled BP readings 3.7 times more than overweight ones [P<0.001, odds ratio (OR) =3.7; 95% confidence interval (CI): 1.7–7.9]. Moreover, those who have high waist/hip ratio were more likely to have uncontrolled BP by 5.16 times than those who have normal range (P<0.001; OR =5.16; 95% CI: 3.4–7.8). Those who had cardiac disease and obese or overweight were more likely to have uncontrolled BP 4.4 times more than those who didn't (P=0.008; OR =4.4; 95% CI: 1.4–13.2). So we can conclude that age of the participants, associated disorders, waist/hip ratio, BMI were the predictors of the presence of hypertension (*Table 3*).

Discussion

Key findings

The prevalence of hypertension among the study participants was 79.3%. Obesity was present in 92.6% in hypertensive patients. Higher prevalence of hypertension was observed in age group above 40. Other risk factor for developing hypertension in our study are unemployment,

Table 3 Logistic regression analysis of factors associated with hypertension in obesity (n=1,295)

Variables	P value	OR	95% CI	
			Lower	Upper
Age	<0.001*	1.055	1.041	1.068
Gender (males)	0.92	1.019	0.678	1.532
Educational level				
Uneducated (reference category)	0.15	–	–	–
Primary level	0.88	1.0	0.597	1.8
Secondary level	0.12	1.5	0.884	2.7
University level and above	0.92	1.0	0.563	1.8
Employment (un-employed)	0.33	1.2	0.806	1.8
Waist/hip ratio (high)	<0.001*	5.16	3.4	7.8
Weight status				
Overweight (reference category)	<0.001*	–	–	–
Obese class II	<0.001*	2.0	1.4	2.9
Obese class III	<0.001*	3.7	1.7	7.9
Associated disorder				
None (reference category)	0.049*	–	–	–
Asthma	0.05	1.7	0.9	3.2
Cardiac disease	0.008*	4.4	1.4	13.2
Renal disease	0.03*	2.1	1.0	4.3

*, P values <0.05 are considered significant. OR, odds ratio.

low education level. Marriage increases the risk of developing hypertension. Excessive coffee drinking was associated with high prevalence of hypertension.

Strengths and limitations

The major strength of this study is the large sample size because the larger the sample size, the more accurate the average values. Larger sample sizes identify outliers in data and provide smaller margins of error. However, this study has some limitations. The cross-sectional design of the study does not allow establishment of conclusive relationship between risk factors and the hypertension. The study participants were recruited from Northern Sudan; therefore, conclusions of this study cannot represent the situation in other regions of Sudan.

Comparison with similar studies

The current study recruited slightly higher number of male (55.4%) than females (44.6%). Similar to studies in Turkey (33) and Ethiopia (9). The prevalence of hypertension was higher in males compared to females. Similar observations were noted in previous studies (9,34-36).

Explanation of findings

The prevalence of hypertension among the study participants was 79.3%. Obesity was present in 92.6% in hypertensive patients. Our data endorsed the previous observations by Bushara *et al.*, Omar *et al.* and Noor *et al.* that obesity is an important risk for developing hypertension in Sudan (5,20,22). We showed that higher prevalence of hypertension was

observed in age group above 40. This likely the common trend in countries surrounding Sudan. For instance, Mufunda *et al.* in Eriteria showed that hypertension is also common among those over 40 years old (34). While in China, higher prevalence of hypertension is noted in those aged 50–59 age group (36). The other risk factors for developing hypertension in our study are unemployment, low education level. Unemployment can cause stress and overfeeding which can cause obesity. The combination of obesity and stress can lead to hypertension. Previous studies reported an inverse relationship between obesity and level of education (37,38) and low prevalence of high BP is associated with higher education level (39,40). Noor *et al.* showed that low education level in Sudan is associated with high prevalence of hypertension (20). Similarly, in this study, we showed that low education level is associated with high prevalence of hypertension.

One interesting finding of our study is that marriage increases the risk of developing hypertension. This might be explained by the stress due to poor quality of life in the developing countries (41). It worth mentioning, part of the Sudanese culture is that newly married couples tend to be invited by extended families to different social events and meals within the first and second year of their marriage. Therefore, it is not surprising that marriage in some individuals can be associated with an increase in weight and obesity.

Coffee drinking can increase the BP (42) while other researchers showed that coffee can have protective effect against high BP (43). In our study excessive coffee drinking was associated with high prevalence of hypertension. Excessive coffee drinking could reduce the production of nitric oxide from the vascular endothelium leading to hypertension (44).

Implications and actions needed

Our study will alert the ministry of health in Sudan to design strategies and conduct more research on how to decrease the prevalence of hypertension and complications. We have previously shown in the River Nile state the admission to Atbara Teaching Hospital with non-communicable disease is more than the hospital admission with communicable disease (45). Therefore, this study is expected to have huge implications among health professional and individuals living in the region, in driving initiatives to mitigate the complications associated with hypertension like stroke and renal failure. Perhaps primary care physicians may also need to pay more attention in obese individuals with hypertension. It is imperative to check compliance with antihypertensive medications, improve awareness of patients about hypertension complications and to educate the public on prevention of hypertension and obesity and reducing salt intake. This study will also open the horizons to study whether hypertension and obesity can be the driver behind the high prevalence of diabetes in the River Nile State and whether it is important to educate public and health professional about management of diabetes and hypertension in Ramadan (46).

Conclusions

The study showed that there is a significant association between hypertension and obesity among the Sudanese population in Atbara and Shendi cities. Prevalence of hypertension among the study participants was 79.3%, while hypertension was present in 92.6% among those with central obesity. In order to control the high BP in obese patients, BP of these patients should be measured regularly. The most common risk factors associated with obesity related hypertension among adults were age group above 40 years, unemployment, low education level, excessive coffee drinking, and marriage.

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Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://cdt.amegroups.com/article/view/10.21037/cdt-22-473/rc

Data Sharing Statement: Available at https://cdt.amegroups.com/article/view/10.21037/cdt-22-473/dss

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://cdt.amegroups.com/article/view/10.21037/cdt-22-473/coif). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are

appropriately investigated and resolved. This study was approved by the Sudanese Medical Specialization Board. Written informed consent from patients was obtained before participation. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013).

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