Vol. 15(4), pp. 320-328, October-December 2023
DOI: 10.5897/JPHE2023.1477
Article Number: 4517A8A71670
ISSN 2141-2316

http://www.academicjournals.org/JPHE

ACADEMIC JOURNALS
expand your knowledge

Journal of Public Health and Epidemiology

Full Length Research Paper

Association between adiposity indices and hypertension in an urban population of adults in the north west region of Cameroon

Loveline Lum Niba[1]*, Njiawah Austin Chi[2] and Lifoter Kenneth Navti[3,4]

[1]Department of Public Health, The University of Bamenda, P. O. Box 39, Bambili, Bamenda, Cameroon.
[2]Department of Public Health, Natiional Polytechnic University Institute Bamenda, Cameroon.
[3]Department of Biochemistry, University of Bamenda, P. O. Box 39, Bambili, Bamenda, Cameroon.
[4]Nutrition and Health Research Group (NHRG), Bamenda, Cameroon.

Received 9 November, 2023; Accepted 18 December, 2023

The rising prevalence of obesity globally is becoming worrisome as excess weight is associated with hypertension and other adverse cardiovascular outcomes. This study therefore set out to determine the prevalence of hypertension in relation to some measures of adiposity (BMI, WC and WHtR) and to examine the association between blood pressure (BP) and the adiposity indices amongst adults in the North West Region of Cameroon. A community-based cross-sectional study involving 263 adults (mean age 35.6 ± 15.9 years) recruited through a random sampling technique. Anthropometric measurements and BP were measured following standard protocols. Linear regression analysis was used to assess the relationship between BP and measures of adiposity (BMI, WC, WHtR) amongst the study participants. The prevalence of hypertension in the study population was 42.2% (with 18.6 and 23.6% already in stage I and II respectively). A significant (p <0.05) difference in the mean systolic blood pressure (SBP) across the different measures of obesity were observed. A significant positive correlation (p <0.05) was found between BMI, WC and WHtR with systolic and diastolic BP. Linear regression showed a significant positive association (p < 0.05) between WC and systolic BP both in the unadjusted [WC (β = 0.75)] and adjusted analysis [WC (β = 0.56)]. In the contrast, BMI was significantly (p <0.05) associated with diastolic BP both in the adjusted [BMI (β = 0.38)] and unadjusted analysis [BMI (β = 0.39)]. It was found that WC was an independent predictor of hypertension in adults. Interventions should focus on the aspects of behavior (individual level) and culture (population level) which could play a vital role in reducing the prevalence of obesity and hypertension amongst adults in our setting.

Key words: Adiposity indices, hypertension, adults and Bamenda Health District, Cameroon.

INTRODUCTION

Globally, there has been a rise in the prevalence of adult obesity and this is linked to the adult hypertension (HTN) epidemic associated with hypertension and other adverse cardiovascular outcomes (Ali et al., 2022; Amira et al.,

*Corresponding author. E-mail: lumnyanga@gmail.com. Tel: +237)674846150

2012; Landsberg et al., 2012). According to the World Obesity Atlas in 2022, it was estimated that by 2030, more than one (1) billion adults (650 million men and 340 million women) aged 18 years and above will be living with obesity globally. The rise in the number of overweight and obese adults has led to an increase in the prevalence of adult hypertension and the number of adults (30-79 years) living with obesity has doubled from 1990 to 2019 (NCD RisC, 2022). The current rise in the global obesity prevalence in the adult population has been attributed to a decline in physical activity compounded by unhealthy eating habits during the last decades (Mantzoros, 2019; Polyzos and Mantzoros, 2018). Notwithstanding, a report on the trends in obesity have shown that there has been an increase in obesity prevalence in all age groups regardless of socioeconomic status and ethnicity (GBD, 2019).

Evidence from epidemiological studies have demonstrated the association between obesity and blood pressure with abdominal obesity strongly associated with an increased risk of metabolic syndrome, type 2 diabetes, cardiovascular diseases and all-cause mortality in adults (Bigaard et al., 2005; Choi et al., 2018; Janssen et al., 2004; Shrestha et al., 2020; Zhou et al., 2008). Evidence has also shown that the prevalence of hypertension in an overweight person aged 40 to 64 years is 50% higher than that in their normal weight counterparts (Aronow, 2017).

Recent reports have estimated that the prevalence of hypertension ranges from 10.8 to 25.5% in China (Choi et al., 2018; Chua et al., 2017), 36.6% in Cameroon (Defo et al., 2019) and 40.7% in Nepal (Shrestha et al., 2020) with higher prevalence rates reported in urban areas compared to the rural areas (Ali et al., 2022; Chua et al., 2017; Defo et al., 2019). In Cameroon, the prevalence of adult hypertension ranges from 17.1% in the South Region to 36.6% in the West Region of the country with a national prevalence estimated at 30.9% (Defo et al., 2019). A recent survey in Cameroon by Simo et al. (2021) in the Baham health district, an urban area of the Grassfields reported a hypertension prevalence of 40.9%.

Moreover, epidemiological studies have demonstrated the relationship between obesity and hypertension using BMI as a proxy for obesity (Chua et al., 2017; Dua et al., 2014). However, recent studies have shown that other indices of abdominal obesity such as waist circumference (WC) and waist-to-height ratio (WHtR) are also associated with an increased risk of high BP, diabetes, dyslipidemia and other cardiovascular diseases (Choi et al., 2018; Shrestha et al., 2020; Dzudie et al., 2021; Zhang et al., 2019). For example, reports among adults in Nepal (Shrestha et al., 2020), Malaysia (Chua et al., 2017) and China (Li et al., 2019; Zhang et al., 2019) found BMI, WC and WHtR as simple and inexpensive screening tools for identify adults at risk of hypertension. While some studies have found waist circumference to be the best surrogate for abdominal obesity given that it correlates better with visceral fat mass (Lee et al., 2022); others found WHtR as a better tool for predicting HTN in adults. For instance, a study amongst Korean (Choi et al., 2028) and Chinese (Zhang et al., 2019) adults found WHtR as a better predictor for hypertension, while a report amongst Brazilian adults (Gus et al., 2004) found WC as a better predictor for adult hypertension. Nevertheless, another report by Dutra et al. (2018) found that both WC and WHtR are good in predicting hypertension in adults. On the contrary, other studies found BMI and WC better than WHtR in predicting incident HTN (Li et al., 2019; Momin et al., 2020; Rezende et al., 2018; Zhou et al., 2008). However, reports from Nepal (Shrestha et al., 2020) and China (Lee et al., 2022) did not see any superiority between BMI, WC and WHtR in predicting adult HTN.

Notwithstanding, the findings on the best anthropometric index in predicting the risk of HTN amongst adults in sub-Saharan African adults has been controversial. Also, despite well documented evidence of the link between visceral adiposity and cardiometabolic risk (Nazare et al., 2015), there is limited data on the best measure of adiposity in predicting adults at risk of hypertension in our setting. There is therefore a need to investigate the best anthropometric tool that can be used in predicting the risk of hypertension amongst Cameroonian adults. The aim of this study therefore was to determine the prevalence of hypertension in relation to the different adiposity indices (BMI, WC and WHtR) and to examine the association between blood pressure and the adiposity indices amongst adults in the Bamenda Health District of the North West Region of Cameroon.

MATERIALS AND METHODS

Study design and study participants

This was a community based cross-sectional study and data were collected between April 2023 and July, 2023 involving 263 adults (92 males and 171 females) mean age 35.3 ± 6.3 years and residing in the Bamenda health district in the North West Region of Cameroon using a convenient random sampling technique. The study included all adults aged 18 years and above living in the Bamenda Health District, however all adults with cognitive problems were excluded from the study. Using a prevalence of 25.5% for hypertension obtained from a study by Chua et al. (2017) in Malaysia amongst adults aged 18 years and above, a level of significance of (α) of 5% (Z =1.96) a minimum sample size of 291 was calculated using the Cochran`s formula ($N= Z^{2}*p\ (1-p)\ /(d^{2})$. However, the sample size for this study was 263 adult type 2 diabetics.

Ethical considerations

The approval for this study was obtained from the Catholic University of Cameroon (CATUC), Bamenda Institutional Review Board (IRB) (Ref: 001/CATUC-IRB/WFM/LKN/23). Administrative authorization was obtained from the Regional Delegation of Public Health of the North West Region (Ref. No. 139/ATT/NWR/RDPH/BRIGAD of 26th March 2023). In addition, all the participants gave written informed consent before any data

collection procedure was carried out.

Data collection

Anthropometric measurements

Data collection was carried out at home between 9:00 am and 1:00 pm. All anthropometric measurements (weight, height and waist circumference) were taken by well-trained nurses recruited to assist in the data collection process respecting all standard protocols. A stadiometer (Seca 213, Germany) was used to measure the height of the study participants to the nearest 0.1 cm without shoes. Body weight was measured to the nearest 0.1 kg using a digital scale (Omron BF511, Japan). The body mass index (BMI) for participant was calculated by dividing weight (kg) by height (cm) squared (Cole et al., 2000). Waist circumference was measured according to WHO (Silveira et al., 2020; WHO, 2008) to the nearest 0.5 cm using an inelastic ergonomic circumference tape (Seca 201, USA). WC was classified as normal (men <102 cm and women <88 cm), abdominal obesity (men ≥102 cm women ≥88 cm). Waist-to-height ratio was also used to assess central obesity. The WHtR was calculated by dividing the WC (cm) by height (cm) and all the participants were classified as 'low risk' and 'high risk' of developing cardiovascular diseases when the WHtR was < 0.5 and ≥ 0.5 respectively (Ashwell et al., 2012).

Blood pressure

Systolic and diastolic blood pressure of the study participants were measured using an automated blood pressure device (SANITAS SBM21, Hamburg, Germany). Systolic blood pressure (SBP) and diastolic blood pressure (DBP) were measured on the same day, three times within a 3-minute interval with the participant sitting in a relaxed position with the arm resting and the palm facing upwards. The average of the three (3) measurements was recorded. Any adult with an average blood pressure of >140/90 mmHg was considered as hypertensive.

Statistical analysis

Statistical analysis was done using IBM-SPSS for Windows version 23 statistical package. Continuous variables were tested for normality using the Kolmogorov-Smirnov (K-S) test. According to BMI, the study participants were classified as normal weight (BMI, 18.5 – 24.9kg/m^2), overweight (BMI, 25.0 – 29.9kg/m^2) and obese (BMI ≥30kg/m^2). With respect to WC, participants were classified as normal (men <102cm and women <88cm), abdominal obesity (men ≥102cm women ≥88cm) respectively (Silveira *et al.,* 2020; WHO, 2008). In addition, a WHtR of ≥ 0.5 was used to define participants at high cardiometabolic risk ("high risk") (Ashwell *et al*., 2012). The prevalence of hypertension for the different adiposity indices (BMI, WC and WHtR) was then calculated and presented with their corresponding 95% confidence intervals. The association between categorical variables was assessed using Chi square test and proportions presented with their respective 95% confidence intervals. In addition, the means of continuous variables was assessed using an independent student *t*-test and ANOVA as appropriate. Pearson correlation was used to assess the association between the measures of adiposity with blood pressure (SBP and DBP). Finally, linear regression models (unadjusted and adjusted for age and gender) were used to assess the relationship between the adiposity indices (BMI, WC, WHtR) with blood pressure (SBP and DBP). Statistical significance was set at a $p < 0.05$.

RESULTS

Descriptive characteristics of the study population

Table 1 shows the descriptive characteristics of the study participants by gender. On average, males were significantly (p <0.001) taller than females. Also, males had a significantly (p = 0.031) higher mean systolic BP compared to females. In contrast, females had a significantly (p <0.05) higher mean BMI and WHtR compared to males. However, there was no significant difference (p>0.05) in the mean age, mean weight, mean WC and diastolic BP by gender. In addition, we found that the prevalence of general obesity, abdominal obesity (WC) and those with a high cardiometabolic risk (WHtR ≥ 0.5) was 21.3, 19.4 and 35.7%, respectively.

Prevalence of hypertension

The overall prevalence of hypertension in this study population was 42.2% (with 18.6 and 23.6% in stage I and stage II) respectively. With respect to gender, there was a significant difference (X^2 = 8.830, p = 0.012) in the proportion of males with high BP compared to females (50.0% vs 38.0%) respectively. Considering the whole sample, there was a 37.8% increase in the prevalence of hypertension between adults aged ≥51 years compared to those aged 18 to 30 years.

Figure 1 shows the prevalence of hypertension by BMI, WC and WHtR. It was observed that 58.9% of the BMI-obese adults had high blood pressure compared to those who had healthy weight (36.1%) and this difference was significant (X^2 =16.462 p <0.001). Also, it was observed that a higher proportion of adults with abdominal obesity (WC) were hypertensive compared their normal weight (WC) counterparts (64.7% vs 36.8%) respectively and the difference was significant (X^2= 13.326, p = 0.001). In addition, there was a significant difference (X^2= 8.749, p = 0.013) in the proportion of 'high-risk' (WHtR ≥0.5)) adults with hypertension (53.2%) compared to their "low-risk" (WHtR <0.5) counterparts (36.1%).

Mean blood pressure profile of study participants according to weight status

Table 2 shows the mean blood pressure (SBP and DBP) of the study participants by weight status. On average, a 9.7 and 5.5 mmHg difference were observed in the mean systolic and diastolic BP between the BMI-obese adults and those who had healthy weight and this difference was significant (p <0.05). Also, there was a significant difference in the mean systolic BP between the abdominally obese (WC) and "high risk" ((WHtR ≥0.5)) adults compared to their normal (WC) and "low risk" (WHtR < 0.5) counterparts. On the contrary, there was no significant difference (p >0.05) in the mean diastolic BP

Table 1. Characteristics of the study population by gender [mean (± SD)] (N=263).

Variable	Whole sample (N=263)	Male (n=92)	Female (n=171)	*p*-value
	Mean (SD)	Mean (SD)	Mean (SD)	
Age (years)	35.5 (15.8)	35.2 (15.7)	35.6 (15.9)	0.821
Weight (cm)	73.7 (15.9)	73.8 (13.4)	73.6 (17.2)	0.928
Height (cm)	166.9 (9.7)	171.5 (10.3)	164.4 (8.4)	<0.001
BMI (kg/m^2)	26.6 (6.6)	25.5 (7.8)	27.2(5.7)	0.045
WC (cm)	82.2 (13.7)	81.4 (11.6)	82.6 (14.7)	0.504
WHtR	0.49 (0.08)	0.48(0.08)	0.50(0.08)	0.024
SBP (mmHg)	129.4 (19.3)	132.9 (17.6)	127. 5 (19.9)	0.031
DBP (mmHg)	82.6 (11.6)	83.6 (10.1)	82.1(12.3)	0.317

BMI: Body mass index; WC: Waist circumference; WHtR: Waist-to-height ratio; SBP: Systolic blood pressure; DBP: Diastolic blood pressure.

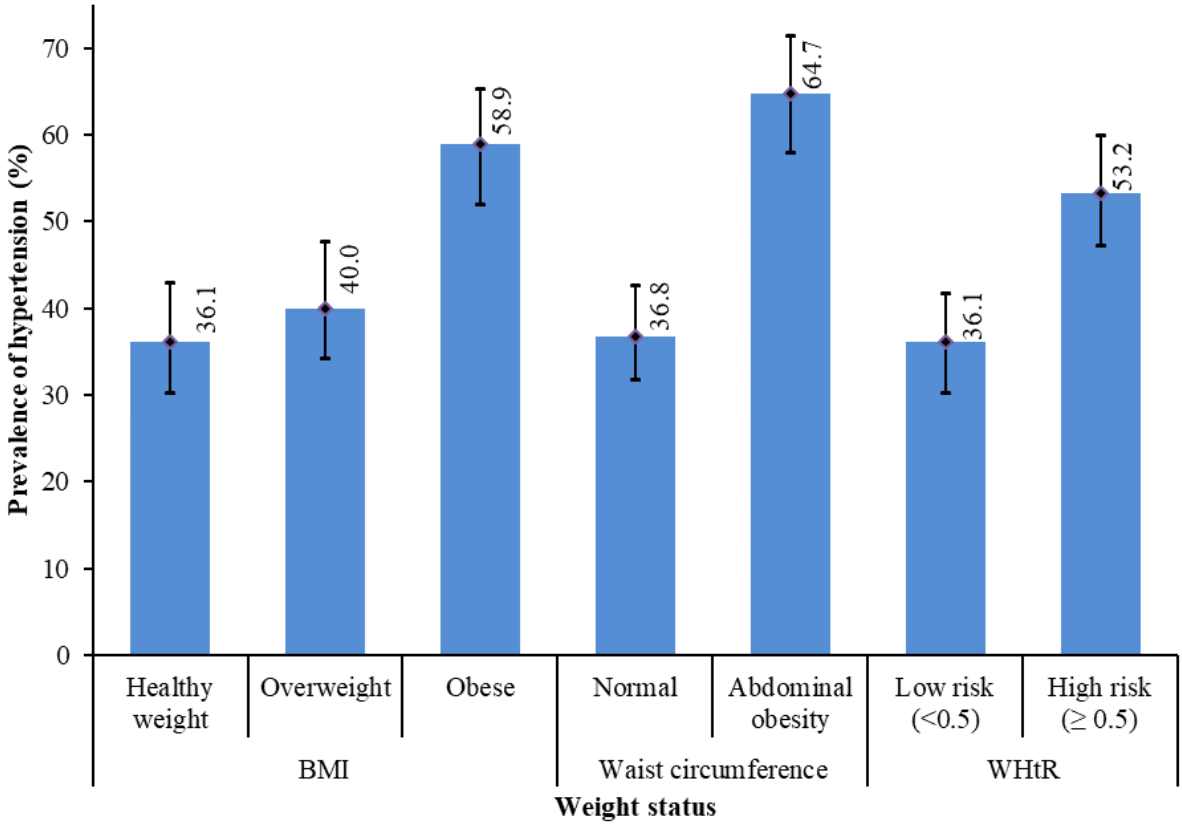

Figure 1. Prevalence of hypertension amongst the study participants by weight status (p <0.05)

between “high risk” (WHtR) and “low risk” (WHtR) adults.

On a gender basis, we observed a 11.0 and 6.0 mmHg significant (p < 0.05) mean differences in SBP and DBP between the BMI-obese females and the BMI-healthy females respectively. On the contrary, no significant difference (p>0.05) was observed in the mean SBP and DBP for males. Additionally, a significant difference (p <0.05) in the mean SBP in the abdominally obese (WC) and “high risk” ((WHtR ≥ 0.5) adults was observed for both gender as opposed to a non-significant difference (p= 0.255) in the mean DBP for the “high risk” ((WHtR ≥ 0.5)) adults for both gender respectively.

Table 3 shows the Pearson correlation coefficients between the different measures of adiposity with blood pressure (SBP and DBP). In this present study, a significant positive weak correlation (p <0.05) was found

Table 2. Mean blood pressure across the different measures of obesity (n=263).

Variable	N	Mean blood pressure					
		SBP (mmHg)			DBP (mmHg)		*p*-value
		Mean	95% CI	*p*-value	Mean	(95% CI)	
BMI (kg/m^2)				0.008*			0.009*
Healthy weight	122	126.4	122.8-129.9		81.3	(79.3–83.2)	
Overweight	85	129.4	125.7- 133.1		81.8	79.0- 84.6	
Obese	56	136.1	130.9- 141.3		86.8	84.2- 89.4	
WHtR				0.001**			0.255**
Low risk (<0.5)	169	126.3	10.8		82.0	8.7	
High risk (≥ 0.5)	94	135.1	15.1		83.7	9.6	
WC (cm)				<0.001**			0.022**
Normal	212	127.1	10.5		81.8	10.7	
Abdominal obesity	51	138.9	12.2		85.9	8.6	
Males							
BMI (kg/m^2)				0.139*			0.151**
Healthy weight	49	129.8	(125.0-134.5)		81.7	(78.7-84.6)	
Overweight	33	135.4	(128.7-142.1)		85.6	(82.0- 89.2)	
Obese	10	140.2	(130.7-149.7)		86.2	(80.3- 92.1)	
WHtR				0.054**			0.457**
Low risk (<0.5)	68	130.5	15.5		83.1	9.8	
High risk (≥ 0.5)	24	139.9	21.3		84.9	10.9	
WC (cm)				0.004**			0.190**
Normal	86	131.5	14.9		83.2	10.1	
Abdominal obesity	6	152.8	15.7		88.8	8.3	
Females							
BMI (kg/m^2)				0.009*			0.005*
Healthy weight	73	124.2	(119.1-129.2)		80.9	(78.3- 83.7)	
Overweight	52	125.6	(121.4-129.7)		79.4	(75.5- 83.3)	
Obese	46	135.2	124.5- 141.2)		86.9	(83.9- 89.9)	
WHtR				0.001**			0.289**
Low risk (<0.5)	101	123.5	19.0		81.3	9.8	
High risk (≥0.5)	70	133.4	19.9		83.3	13.5	
WC (cm)				<0.001*			0.028**
Normal	126	124.1	17.2		80.8	12.5	
Abdominal obesity	45	137.1	16.7		85.5	10.8	

BMI: Body mass index; WC: Waist circumference; WHtR: Waist-to-height ratio.

between WHtR (r = 0.121), BMI (r = 0.161) and WC (r = 0.137) with systolic BP. Similarly, a significant positive weak association ($p < 0.05$) was observed between the BMI (r = 0.298), WC (r = 0.175) and WHtR (r = 0.243) with diastolic BP.

Association between the measures of adiposity and blood pressure (SBP and DBP)

Table 4 shows the linear regression (unadjusted and adjusted for age and gender) for the association between BMI, WC, WHtR and blood pressure amongst the study participants. There was a significant positive association ($p = 0.001$) between waist circumference (β=0.75; 95% CI = 0.31, 1.19) with systolic blood pressure for the unadjusted analysis. After adjusting for age and gender, only waist circumference (β= 0.56; 95% CI = (0.12, 1.00) was still positively associated (p =0.013) with systolic BP. In contrast, there was a significant positive association (p = 0.024) between BMI (β=0.38; 95% CI = 0.05, 0.71) with

Table 3. Pearson correlation between blood pressure and measures of obesity.

Measures of obesity	Pearson's coefficient *(r)*	*p*-value
Diastolic blood pressure		
WHtR	0.121	0.049
BMI (kg/m^2)	0.161	0.009
WC (cm)	0.137	0.026
Systolic blood pressure		
WHtR	0.243	0.001
BMI (kg/m^2)	0.298	0.001
WC (cm)	0.175	0.004

BMI: Body mass index; WC: Waist circumference; WHtR: Waist-to-height ratio.

Table 4. Linear regression analysis (unadjusted and adjusted) for the association between measures of obesity and blood pressure.

Variable	Unadjusted			Adjusted		
	Estimate (β)	(95% CI)	*p*-value	Estimate(β)	(95% CI)	*p**-value
Systolic BP						
BMI (kg/m^2)	0.31	(-0.23, 0.84)	0.258	0.33	(-0.19, 0.84)	0.216
WC (cm)	0.75	(0.31, 1.19)	0.001	0.56	(0.12, 1.00)	0.013
WHtR	-72.08	(-102.66, 11.49)	0.091	-56.71	(-79.91, 26.05)	0.181
Diastolic						
BMI (kg/m^2)	0.38	(0.05, 0.71)	0.024	0.39	(0.07, 0.72)	0.017
WC (cm)	0.25	(-0.02, 0.52)	0.074	0.17	(-0.10, 0.45)	0.217
WHtR	-40.85	(-61.58, 10.87)	0.121	-38.05	(-63.31, 14.22)	0.153

BMI: Body mass index; WC: Waist circumference; WHtR: Waist-to-height ratio; *****adjusted for age and gender.

diastolic blood pressure for the unadjusted analysis. After adjusting for age and gender, BMI (β=0.39; 95% CI 0.07, 0.72) was still observe to have a significant association (*p* =0.017) the with diastolic BP.

DISCUSSION

Measures of adiposity such as WC, BMI and WHtR have been found to have a linear relationship with high BP in adults (Chau et al., 2017; Shrestha et al., 2020; Zhang et al., 2019). Also, evidence has shown that body fat especially in the abdominal region, is a major risk factor for hypertension, type 2 diabetes and other cardiovascular diseases (Chau et al., 2017; Selvaraj et al., 2016). However, very little attention has been focused on the influence of these different anthropometric indices of obesity on blood pressure amongst adults in our setting despite the fact that these adiposity indices increase the risk of high BP in adults. The early diagnosis and effective management of adults with hypertension in our setting will help in preventing adverse cardiovascular outcomes and reduce the burden of the disease on the population and on the fragile health system which is already overburdened with communicable diseases.

This study therefore set out to determine the prevalence of hypertension in relation to the different adiposity indices (BMI, WC and WHtR) and to examine the association between blood pressure and the adiposity indices amongst adults in the Bamenda Health District of the North West Region of Cameroon. This study found that the overall prevalence of hypertension in this study population was high. Also, a high prevalence of hypertension was observed amongst the BMI-obese, abdominally obese (WC) and 'high-risk' ((WHtR ≥ 0.5)) adults. In addition, this study has demonstrated that the measures adiposity (BMI, WC and WHtR) are positively associated with blood pressure with waist circumference being an independent predictor for systolic blood pressure in our setting. This study to the best of the researchers' knowledge is the first study describing the association between three adiposity indices (BMI, WC and WHtR) with blood pressure amongst adults in an urban community in the North West Region of Cameroon.

The study found that the overall prevalence of hypertension was 42.2% (with 18.6 and 23.6% in stage I

and stage II) respectively. The findings of this study are higher than those reported in 2019 by Defo et al. (2019] in a systematic review in Cameroon, where they reported an overall prevalence of 30.9% (ranging from 36.3% in the West region to 17.1% in the South region) of the country. The authors also reported that the prevalence of hypertension varied by gender (34.3% for males and 31.3% for females) respectively. This is similar to the study findings where the prevalence of hypertension was found to be higher amongst men (50.0%) compared to women (38.0%). Also, the findings are higher than the 30.6% reported in Bangladesh (Ali et al., 2022), 10.8% in Korea (Choi et al., 2018), 40.67% in Nepal (Shrestha et al., 2020), 25.5% in Malaysia (Chua et al., 2017) and 73.7% in Sudan (Noor et al., 2023). The differences in the prevalence of hypertension may be due to the differences in the study design and setting given that some of the studies were hospital based and some were carried out both in an urban and rural setting as opposed to this study which was community based and only involving an urban population of adults. In addition, differences in sample size might have contributed to the differences in the prevalence of hypertension reported in these studies.

With respect to the whole sample, the prevalence of hypertension was found to be 58.9% for the BMI-obese, 64.7% for the abdominally obese (WC) and 53.2% for 'high-risk' (WHtR ≥0.05)) adults. The high prevalence of hypertension in this study population from the different adiposity indices might be attributed to the fact that obesity is the most common form of malnutrition both in adults and children in developing nations due to a high level of physical inactivity, urbanization, socio-cultural factors and unhealthy eating habits, all of which increase the risk of hypertension in adults (Assah et al., 2011). This finding highlights the need for early detection and effective management including life style modification particularly weight management of adults at risk of developing hypertension.

Evidence has shown that the prevalence of hypertension is higher in obese adults compared to those with normal weight (Jordan et al., 2012)]. Also, "high risk" (WHtR≥0.5) adults have also been shown to have two-fold odds of developing hypertension compared to those with a low cardiometabolic risk (WHtR < 0.5). It was found that 21.3% of the study participants were BMI-obese, 19.4% were centrally obese (WC) and 35.7% were "high risk" (WHtR ≥ 0.5) and this might contribute to an increase risk of high BP and adverse cardiovascular outcomes. These findings are in line with those reported by Dzudie et al. (2021) amongst adult Cameroonians. Notwithstanding, the findings are higher than those observed in Bangladesh by Ali et al. (2020) in a community-based study involving 1410 participants ≥18 years in both rural and urban settings unlike this study which was conducted only in an urban setting. In addition, similar results have been reported in other studies in Taiwan (Lin et al., 2019), US (Ostchega et al., 2012) and China (Zhang et al., 2022).

In this present study, it was observed that women on average had a significantly higher mean BMI compared to men. This finding is similar to that carried out by Shrestha et al. (2021) in Nepal who also reported that women on average has a significantly higher mean BMI compared to men. However, the Nepalese study included 2256 adults aged 40 to 69 years as opposed to this study which included adults ≥18 years.

This study found that the BMI-obese, centrally obese (WC) and "high risk" (WHtR ≥ 0.5) adults had a significantly higher mean systolic BP compared to their normal weight counterparts. In contrast, only the BMI-Obese and centrally obese (WC) adults has a significantly diastolic BP compared to adults with normal weight. In addition, the BMI-obese, centrally obese (WC) and "high risk" (WHtR ≥ 0.5) females had a significantly higher mean systolic BP to their normal weight or "low risk" counterparts, a finding which was not observed in males. The gender differences in blood pressure can be attributed to sex hormones which have been found to be strongly involved in the developmental differences in blood pressure between females and males with BP in women progressing more rapidly than in men (Ji et al., 2022).

The study revealed that BMI, WHtR and WC which are all measures of adiposity were positively correlated with systolic BP and diastolic BP. These findings are similar to those reported by Shrestha et al. (2020) amongst adults in the Bhaktapur district of Nepal where they also reported a positive correlation between all three anthropometric indices (BMI, WC and WHtR) with blood pressure (SBP and DBP). However, the Nepalese study was carried out in a semi-urban district. Similar findings have been reported in China (Lee et al., 2022), Taiwan (Lin et al., 2019) and in the Manipal region of Nepal (Chaudhary et al., 2019) who also found that BMI, WC and WHtR were positively associated with hypertension in adults.

This present study found WC as an independent predictor for hypertension amongst adults in our setting. This finding is in line with findings in other countries where WC was found to be a reliable predictor for high BP in adults (Dzudie et al., 2021; Lin et al., 2019; Ostchega et al., 2012; Rezende et al., 2018; Shrestha et al., 2020). This finding suggests that in our setting, WC can be used in screening for adults at risk of developing hypertension. Given that obesity and hypertension have become major public health concerns, there is a need for health promotion on health eating, a reduction in sedentary lifestyle and regular checking of blood pressure amongst the adult population in order to reduce the burden of obesity and hypertension amongst them.

One of the limitations of this study included the cross-sectional nature of the study which cannot show elements of causality. In addition, data on feeding habits,

age, physical activity and lipid profiles of the study participants which might influence the development of obesity and hypertension was not collected. Finally, this study was carried out only in one municipality in one region of the country as such the findings might not truly be representative of the blood pressure profile of all adults in the country. Despite the limitations of this study, the study has provided for the first time to the best of the reserachers' knowledge, data on the association between three measures of adiposity (BMI, WC and WHtR) with blood pressure amongst adults in the North West Region of Cameroon.

Conclusion

This study conducted among adults in the Bamenda municipality of the North West Region of Cameroon found that the prevalence of hypertension was high and it has demonstrated that WC is positively associated with high BP. Therefore, WC can be included with BMI in predicting adults at high risk of developing hypertension. Further research needs to be conducted in the other regions of the country to confirm WC as a predictive tool for routine identification of adults at risk of hypertension in our setting in order to reduce the burden of the disease both at the individual and population level. In addition, further research could be carried out on the food habits, age and time dedicated to excessive by adults living with type 2 diabetes as this will help in explaining the correlation between obesity and blood pressure amongst the patients.

CONFLICT OF INTEREST

The authors declare no conflict of interest in this publication.

ACKNOWLEDGEMENTS

The authors are grateful to all the adults in the Bamenda Health District that participated in the study as well as the nurses who assisted in data collection. This study was funded by the authors.

ABBREVIATIONS

BP, Blood pressure; **BMI,** body mass index; **WC,** waist circumference; **WHtR,** waist-to-height ratio; **HTN,** hypertension; CI**,** confidence interval; **SPSS,** Statistical Package for Social Sciences; **OR,** Odds ratio; **ANOVA,** Analysis of variance.

DATA AVAILABILITY

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

REFERENCES

Ali N, Mohanto NC, Nurunnabi SM, Haque T, Islam F (2022). Prevalence and risk factors of general and abdominal obesity and hypertension in rural and urban residents in Bagladesh: a cross-sectional study. BMC Public Health 22(1707):1-14.

Amira CO, Sokunbi DO, Sokunbi A (2012). The prevalence of obesity and its relationship with hypertension in an urban community: Data from world kidney day screening programme. International Journal of Medicine and Biomedical Research 1(2):104-110.

Aronow WS (2017). Association of obesity with hypertension. Annals of Translational Medecine 5(17):350.

Ashwell M, Gunn P, Gibson S (2012). Waist-to-height ratio is a better screening tool than waist circumference and BMI for adult cardiometabolic risk factors: systematic review and meta-analysis. Obesity Reviews 13(3):275-286.

Assah FK, Ekelund U, Brage S, Mbanya JC, Wareham NJ (2011). Urbanization, physical activity and metabolic health in sub-Saharan Africa. Diabetes Care 34(2):491-496.

Bigaard J, Frederiksen K, Tjønneland A, Thomsen BL, Overvad K, Heitmann BL, Sorensen TIA (2005). Waist circumference and body composition in relation to all-cause mortality in middle-aged men and women. International Journal of Obesity 29:778-84.

Chaudhary S, Alam M, Singh S, Deuja S, Karmacharya P, Mnda M (2019). Correlation of blood pressure with body mass index, waist circumference and waist by hip ratio. Journal of Nepal Health Research Council 16(41):410-413.

Choi JR, Koh SB and Choi E (2018). Waist-to-height ratio index for predicting incidences of hypertension: the ARIRANG study. BMC Public Health 18(767):1-6

Chua EY, Zalilah MS, Haemamalar K, Norhasmah S, Geeta A (2017). Obesity indices predict hypertension among indigenous adults in Krau Wildlife Reserve, Peninsular Malaysia. Journal of Health, Population and Nutrition 36 (24):1-7.

Cole TJ, Bellizzi MC, Flegal KM, Dietz WH (2000). Establishing a standard definition for child overweight and obesity worldwide: international survey. British Medical Journal 320(7244):1240-3.

Defo BK, Mbanya JC, Knigue S, Tardif JC, Choukem SP, Perreault S, Fournier P, Ekundayo O, Potvin L, D`Atntono B, Emami E, Cote R, Aubin MJ, Bouchard M, Khairy P, Rey E, Richard L, Zarowsky C, mampuya W, Mbanya D, Sauve S, Ndom P, da Silva RB, Assah F, Roy I, Dubois CA (2019). Blood pressure and burden of hypertension in Cameroon, a microcosm of Africa: a systematic review and meta-analysis of population-based studies. Journal of Hypertension 37(11):2910-2199.

Dua S, Bhuker M, Sharma P, Dhall M, Kapoor S (2014). Body mass index relates to blood pressure among adults. North American Journal of Medical Sciences 6(2):89-95.

Dutra MT, Reis DB, Martins KG, Gadelha AB (2018). Comparative evaluation of adiposity indices as predictors of hypertension among Brazilian adults. International Journal of Hypertension, pp. 1-7.

Dzudie A, Njedock N, Boombhi J, ba H, Amougou SN, Kamdem F, Barche B, Nzali A, Njomou A, Ngwasiri C, Geh MM, Azabji M, Mefire AC, Njamnshi AK, Kingue S, Empana JP, Sobngwi E, Ngoa LSE, Kengne AP (2021). Association between measures of adiposity and blood pressure levels in adult Cameroonians. Health Science Reports 4(2):e259.

Global Burden of Disease Study 2019 (GBD 2019). Covariates 1980-2019, 2019, GHDx.n.d, https://ghdx.healthdata.org/record/global-burden-disease-study-2019-gbd-2019-covariates-1980-2019.(accessed 17.08.2023).

Gus M, Fuchs SC, Moreira LB, Moraes RS, Wiehe M, Silva AF, Albers F, Fuchs FD (2004). Association between different measurements of obesity and the incidence of hypertension. American Journal of Hypertension 17:50-53.

Janssen I, Katzmarzyk PT, Ross R (2004). Waist circumference and not body mass index explains obesity-related health risk. American Journal of Clinical Nutrition 79:379-84.

Ji H, Kim A, Ebinger JE, Niiranen TJ, Claggett BL, Merz CNB, Cheng S (2022). Sex Differences in Blood Pressure Trajectories Over the Life Course. JAMA Cardiology 5(3):255-262.

Jordan J, Yumuk V, Schlaich M, Nilsson PM, Zahorska-Markiewicz B, Grassi G, Schmieder RE, Engeli S, Finer N (2012). Joint statement of the European Association for the Study of obesity and the European Society of Hypertension: obesity and difficult to treat arterial hypertension. Journal of Hypertension 30(6):1047-55.

Landsberg L, Aronne LJ, Beilin LJ, Burke V, Igel LI, Lloyd-Jones D, Sowers J (2012). Obesity-Related Hypertension: Pathogenesis, Cardiovascular Risk, and Treatment. Position statement. Journal of Clinical Hypertension 15(1):S14- S33.

Lee X, Gao Y, Zhang Y, Feng Y, Gao L, Wang A, Jiang Y, Huang H (2022). Comparison of 10 obesity-related indices for predicting hypertension based on ROC analysis in Chinese adults. Frontiers in Public Health 10(1042236):1-13.

Li N, Yang T, Yu WQ, Liu H (2019). Is waist-to-height ratio superior to body mass index and waist circumference in predicting the incidence of hypertension? Annals of Nutrition and Metabolism 74:215-223.

Lin YA, Chen YJ, Tsao YC, Yeh WC, Li WC, Tzeng I-S, Chen JY (2019). Relationship between obesity indices and hypertension among middle aged and elderly populations in Taiwan: a community-based, cross-sectional study. BMJ Open 9:e031660.

Momin M, Fan F, Li J, Zhang L, Zhang Y, Huo Y (2020). Joint effects of body mass index and waist circumference on the incidence of hypertension in a community-based Chinese population. European Journal of Obesity 13:245-255.

Nazare JA, Smith J, Borel AL, Aschner P, Barter P, Van GL, Tan CE, Wittchen HU, Matsuzawa Y, Kadowaki T, Ross R, Brulle-Wohlhueter C, Almeras N, Haffner SM, Balkau B, Despres JP, INSPIRE ME IAA Investigators (2015). Usefulness of measuring both body mass index and waist circumference for the estimation of visceral adiposity and related cardiometabolic risk profile (from the INSPIREME IAA study). American Journal of Cardiology 115(3):307-315.

NCD Risk Factor Collaboration (NCD-RisC) (2022). Worldwide trends in hypertension prevalence and progress in treatment and control from 1990 to 2019: a pooled analysis of 1201 population-representative studies with 104 million participants. Lancet 2021398(10304):957-980.

Noor SK, Fadlelseed MHE, Bushara SO, Badi S, Mohammed M, Elmubarak A, Kheir M, Abubaker NE, Ahmed MH, Ahmed M (2023). Prevalence of obesity related hypertension among overweight or obese adults in River Nile State in Northern Sudan: a community based cross-sectional study. Cardiovascular Diagnosis and Therapy 13(2):384-394

Ostchega Y, Hughes JP, Terry A, Fakhouri THI, Miller I (2010). Abdominal obesity, body mass index and hypertension in US adults: NHANES 2007 – 2010. American Journal of Hypertension 25(12):1271-1278.

Polyzos SA, Mantzoros CS (2019). Obesity: seize the day, fight the fat. Metabolism 92:1-5.

Rezende AC, Souza LG, Jardim TV, Perillo NB, Araujjo YCL, Souza SG, Sousa AL, Moreira HG, Jardim PCBG (2018). Is waist-to-height ratio the best predictive indicator of hypertension incidence? A cohort study. BMC Public Health 18(281):1-11.

Selvaraj S, Martinez EE, Aguilar FG, Kim KY, Peng J, Sha J, Irvin MR, Lewis CE, Hunt SC, Arnett DK, Shah SJ (2016). Association of central adiposity with adverse cardiac mechanics: findings from the hypertension genetic epidemiology network study. Circulation, Cardiovascular Imaging 9(6):e004396.

Shrestha S, Khatri B, Upadhyay MP, Bhattarai JR, Kayastha M, Upadhyay SK (2020). BMI, waist to height ratio and waist circumference as a screening tool for hypertension in hospital out patients: a cross-sectional study. BMJ Open 11:e050096

Silveira EA, Pagotto V, Barbosa LS, Oliveira C, Pena GG, Velasquez-Melendez G (2020). Accuracy of BMI and waist circumference cut-off points to predict obesity in older adults. Ciencia and Saude Coletiva 25(3):1073-1082.

Simo LP, Agbor VN, Temgoua FZ, Fozeu LCF, Bonghaseh DT, Mbonda AGN, Yurika R, Dotse-Gborgbortsi W, Mbanya D (2021). Prevalence and factors associated with overweight and obesity in selected health areas in a rural health district in Cameroon: a cross-sectional analysis, BMC Public Health 21(475):1-12.

Upadhyay J, Farr O, Perakakis N, Ghaly W, Mantzoros C (2018). Obesity as a disease. Medical Clinics North America 102(1):13-33.

World Health Organization (WHO) (2008). Waist circumference and waist-hip ratio: report of a WHO expert consultation, Geneva. https://www.who.int/publications/i/item/9789241501491 (accessed 10.08.2023)

World Obesity Atlas (2022). https://www.worldobesity.org/resources/resource-library/world-obesity-atlas-2022 (accessed 15.08.2023)

Zhang Y, Hou LS, Tang WW, Xu F, Liu X, Liu Y, Liu JX, Yi YJ, Hu TS, Hu R, Wang TD, Huang XB (2019). High prevalence of obesity-related hypertension among adults aged 40 to 79 years in Southwest China. Scientific Reports 9(15838):1-8.

Zhang Y, Zhang WQ, Tang WW, Zhang WY, Liu JX, Xu RH, Wang TD, Huang XB (2022). The prevalence of obesity-related hypertension among middle-aged and older adults in China. Frontiers in Public Health 10(865870):1-13.

Zhou Z, Hu D, and Chen J (2008). Association between obesity indices and blood pressure or hypertension: which index is the best? Public Health Nutrition 12(8):1061-1071.