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Research Article

Prehypertension, Hypertension and Associated Risk Factors among Adults Living in the Port City of Boma in the Democratic Republic of the Congo. A Population-Based Cross-Sectional Survey

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Abstract

Background: The risk for CVD starts to increase at BP levels above 115/75 mmHg. Therefore, early detection of individuals with mild to moderate BP increase could help reducing hypertension-associated CV risk. The present survey was aimed to assess the prevalence of prehypertension and hypertension in adults living in a port City.

Methods: In the present cross-sectional survey, a sample of households was systematically selected from the port City of Boma ant its rural suburb. A total of 3510 adult subjects (2265 men and 1245 women) were included in the study. Demographic, socioeconomic, clinical and biological data were collected using WHO Stepwise questionnaire. Systolic and diastolic BP were as well as heart rate measured for all subjects. Blood examination included only fasting capillary blood glucose taken between 8 - 10 hours a.m. following 12 hours of fasting. Prehypertension and hypertension were defined according to JNC7 guidelines. Logistic regression analysis was used to assess risk factors associated with both conditions. P values < 0.05 defined the level of statistical significance.

Results: The crude prevalence of prehypertension and hypertension was 11.4% and 35.5%, respectively. Increased age, overweight and obesity emerged as the main factors associated with both conditions whereas family history of hypertension and smoking were only associated with hypertension.

Conclusion: Prehypertension and hypertension were a common finding in the present survey and associated with lifestyle factors. A strategy based on therapeutic lifestyle changes and pharmacologic therapy (if needed) is awaited.

Keywords: Prehypertension; Hypertension; Prevalence; Risk Factors; Black Africans

Introduction

High blood (HBP) is a major public health challenge and is identified as the foundation of the epidemics of cardiovascular disease (CVD), chronic kidney disease (CKD) and associated morbi-mortality in sub-Saharan Africa (SSA) [1,2]. HBP accounts for one quarter of the global preventable premature death annually [3,4]. There is an estimated increase in the prevalence of HBP by 17% worldwide in the next decade, with the greatest increase in the African region, if effective preventive measures as well as an early detection and management-based strategy are not implemented [5]. The first step in implementing such a strategy implies the assessment of the disease's burden and the identification of associated risk factors in high risk settings for HBP like port cities [5]. With reference to the disease's burden, the risk of developing HBP-related complications has been reported to depend on the level of BP and starts in all age groups from BP as low as systolic BP (SBP) 115 mmHg and diastolic BP (DBP) 75 mmHg [6]. Indeed, suboptimal SBP > 115 mmHg was reported to be responsible for 62% of CVD and 42% of ischemic heart disease (IHD), with little variation by sex [6]. Furthermore, data from observational studies involving more than one million individuals have indicated that death from both IHD and stroke increase progressively and linearly from levels as low as SBP 115 mmHg and DBP 75 mmHg upward, especially in individuals ranging from 40 to 89 years [6]. These above-mentioned observations prompted the need for new BP classification and Joint National Committee 7 (JNC 7) report on the prevention, detection, evaluation, and treatment of HBP introduced a new BP classification that includes the term "prehypertension" for individuals with BP ranging from 120 to 139 mmHg SBP and 80 to 89 mmHg DBP [7]. This new designation was intended to identify those individuals in whom early intervention by adoption of healthy lifestyles could re-

duce BP, decrease rate of progression of BP to hypertensive levels with age or prevent hypertension entirely [7]. Therefore, reliable population-based data on prehypertension are needed to inform policy decision, especially in SSA, a world region confronted to limited health resources and a less operational health system [8]. Unfortunately, most epidemiological studies still focus on the detection of hypertension with less attention to prehypertension.

Considered as rare even inexistent in the early sixties, hypertension prevalence has attained prevalence rates around 30 - 40% in both sex and in urban as well as rural areas of the Democratic Republic of the Congo (DRC) [10-13]. This ever growing hypertension prevalence is contrastingly associated with low awareness and proportion of treated and BP controlled individuals [11,12]. As a consequence, hypertension-related morbidity and mortality has been reported to be very high [14,15] highlighting thus the need for early detection and management of HBP prior to the development HBP-related complications. In this regard, few epidemiological studies have been unfortunately devoted to prehypertension [16].

Aim of the Study

Therefore, the aim of the present study was to assess the prevalence of both prehypertension and hypertension and to identify associated risk factors among adults living in a port city.

Methods

Study setting

The study was conducted in Boma, a port city with a population of 459. 361 inhabitants, located in the province of Kongo Central at about ... Km southwest of Kinshasa, the Capital City. It has mixed urban and rural communities and comprised of three administrative districts and one rural district.

The study used a cross-sectional design. The minimum desired sample size was 384 participants using the Fischer formulae [17]. A multistage sampling strategy was used. The city of Boma includes 3 urban districts and 1 rural district. In all these districts, the lists of existing streets were obtained and 2 streets were selected in each district using simple random sampling strategy. On the streets drawn all the inhabited plots were listed in order to constitute the sampling frame. All the parcels listed with the odd numbers have been selected. In the selected plots, all residents aged 18 or over were invited to participate in the study. A total of 3,510 people were included in the study with a respondent rate of 91,4%.

Data collection

A local language and pretested version of the World Health Organization (WHO)-STEP surveillance (STEPS) questionnaire (version 3-1) was used with minor adaptation [18]. During the first step, sociodemographic and behavioral information on tobacco and alcohol use, diet, physical activity, history of chronic illnesses were collected. In step 2, physical measurements including weight, height, blood pressure (BP) and waist circumference (WC) were collected using standard procedures measurements and WHO recommended instruments that were regularly calibrated. In step 3, fasting capillary blood glucose was the only biochemical test performed in the present study.

Measures

The anthropometric measurements such as body weight, waist circumference, height, blood pressure, and pulse rate were collected by well-trained Medical students? Blood pressure was measured using digital blood pressure measurement devices (OMRON MIT5 Connect, Kyoto, Japan) and recorded during household visits following the STEPS methods at the left arm at heart level after a period of 5 minutes of rest). The average of the two measurements were used in the analysis.

Height was measured, while the participants were in an upright position without shoes, by using a flexible tape meter (Hemostyl, Sulzbach, Germany). Body weight was also measured with individuals wearing light clothing or standing without shoes using a digital weighing scale (Deluxe GBS-721; Seca Deutschland, Hamburg, Germany). Body mass index (BMI) was computed as weight in kilograms divided by height in meters squared (Kg/m^2). A flexible tape meter was used to measure the waist at the level directly above the iliac crest.

During the household visits, questionnaires on tobacco smoking and chewing, intake of fruit and vegetable and patterns of physical activities were administered. Participants were asked about their fruits and vegetables consumption in a typical week, number of days and the number of servings on those days was collected. Fruits and vegetable consumption was analyzed as number of times per week. The Global Physical Activity Questionnaire Version 2 was used to collect the information on physical activities [19].

Operational definitions

Prehypertension was defined as having either an SBP of 120 to 139 mmHg and/or DBP of 80 to 89 mmHg - according to JNC7, in individuals who were not on antihypertensive medication [7]. Hypertension was defined as presence of SBP ≥ 140 mmHg and/or DBP ≥ 90 mmHg or self-report of previous diagnosis of hypertension by a healthcare provider or a history of treatment with antihypertensive agents [7]. Overweight and obesity were defined as having a BMI ≥ 25 Kg/m^2 and ≥ 30 Kg/m^2, respectively [20]. Waist circumference (WC) was used as surrogate for abdominal obesity, defined as a WC value > 94 cm in men and > 80 cm in women [21]. Diabetes was defined as fasting capillary blood glucose ≥ 110 mg/dl or history of antidiabetic treatment [22]. Physical inactivity with reference to global physical activity questionnaire was defined as a total value < 18 [19]. Hazardous alcohol consumption was defined as a daily consumption of at least 20g of alcohol or > 2 glasses?? for at least one year [23]. Smoking was defined as current use of smoked or smokeless tobacco [24]. According to 2013 - 2014 DRC-Demographic and Health Survey (DHS), low, middle and high socioeconomic status (SES) scores were defined as 0 - 3, 4 - 8 and > 9 respectively [25].

Data analysis

The data collected was cleaned and entered into a PC to be examined by using SPSS version 24.0 for Windows. Categorical variables were expressed as absolute (n) and relative (in percent) frequency (n) whereas continuous variables with normal and skewed distribution were expressed as mean ± standard deviation and median (Interquartile range), respectively. A chi-square test was used to examine the association between different categorical variables

whereas t-test or ANOVA were used for normally distributed continuous variables and Mann U Whitney and Kruskall Wallis tests for continuous variables with skewed distribution. Multivariate logistic regression analysis were performed to assess independent risk factors associated with prehypertension and hypertension. P-values of < 0.05 were considered statistically significant.

Ethical approval

The study was conducted according to the principles expressed in the Declaration of Helsinki and the protocol for the Non Communicable Disease (NCD) risk factor survey using the World Health Organization STEPwise approach to Surveillance (WHO STEPS) [23] was approved by the Ethical Committee of the Ministry of Health (N°104/CNES/BN/PMMF/2018) and the Scientific Board of the Department of Internal Medicine, University of Kinshasa Hospital, Kinshasa School of Medicine. Written informed consent was obtained from the study participants and they had the right to withdraw themselves from the study at any time. The identity of the participants as well as their personal information was kept confidential. Participants incidentally reporting with life-threatening conditions during the period of this survey were immediately referred to the hospitals, and those individuals with new incidence of hypertension were also directed to begin a follow-up treatment at the nearby health facility or a hospital.

Results

General characteristics of the study population

General characteristics of the study population as a whole and by BP categories are depicted in table 1. Of the 3510 participants, 1396 (40%) were males while 2114 (60%) were females. Their mean age was 36,3 ± 15,9 years with 43,4%, 23%, 13,4%, 9,6% and 10,5% participants aged 18 - 29 years, 30 - 39 years, 40 - 49 years, 50 - 59 years and ≥ 60 years, respectively. Most participants (74.2%) were recruited from the rural suburb; the proportion of unemployed, married, single, secondary education level and low SES participants was 22.6%, 43%, 46.6%, 58.9% and 63.5%, respectively. Average levels of SBP, DBP, HR, BMI, WC and capillary blood glucose were 122.2 ± 21.9 mmHg, 80.7 ± 14.9 mmHg, 80.8 ± 12.1 bpm, 23.1 ± 5.7 Kg/m^2, 81,7 ± 11,9 cm and 118,1 ± 31,1 mg/dl, respectively.

Variables	All n = 3510	Normotension n	Prehypertention n = 399	Hypertension n	p
Age, years	36,3 ± 15,9	31.0 ± 12.4	35.0 ± 14.0	44.7 ± 17.6	< 0.001
Age categories, n (%)					< 0.001
18 - 29 years	1524 (43.4)	1063 (57.0)	176 (44.1)	285 (22.9)	
30 - 39 years	809 (23.0)	428 (22.9)	102 (25.6)	279 (22.4)	
40 - 49 years	469 (13.4)	204 (10.9)	54 (13.5)	211 (16.9)	
50 - 59 years	338 (9.6)	94 (5.0)	39 (9.8)	205 (16.5)	
≥ 60 years	370 (10.5)	77 (4.1)			0.001
Gender, n (%) M	1396 (40)	755 (40.5)	186 (46.6)	455 (36.5)	
F	2114 (60)	1111 (59.5)	213 (53.4)	790 (63.5)	0.323
Setting, n (%) Urban	904 (25,8)	463 (24.8)	112 (28.1)	329 (26.4)	
Rural	2606 (74,2)	1403 (75.2)	287 (71.9)	916 (73.6)	
Occupation, n (%)					< 0.001
Senior Staff	923 (26,3)	584 (31.30)	104 (26.10)	235 (18.90)	
Businessmen	1187 (33,8)	626 (33.50)	155 (38.80)	406 (32.60)	
Public Servants	513 (14,6)	276 (14.80)	62 (15.50)	175 (14.10)	
Unemployed	93 (2,6)	15 (0.80)	9 (2.30)	69 (5.50)	
Marital status, n (%)					< 0.001
Married	1509 (43,0)	696 (37.3)	184 (46.1)	629 (50.5)	
Divorced	94 (2,7)	39 (2.1)	7 (1.8)	48 (3.9)	
Widow	271 (7,7)	63 (3.4)	17 (4.3)	191 (15.3)	
Single	1636 (46,6)	1068 (57.2)	191 (47.9)	377 (30.3)	
Education level, n (%)					< 0.001
Primary/no	699 (19,9)	306 (16.4)	65 (16.3)	328 (26.3)	
Secondary	2069 (58,9)	1158 (62.1)	249 (62.4)	662 (53.2)	
University/Superior	742 (21,1)	402 (21.5)	85 (21.3)	255 (20.5)	
SES, n (%)					0.051
Low	2229 (63,5)	1206 (64.6)	269 (67.4)	754 (60.6)	
Middle	988 (28,1)	517 (27.7)	99 (24.8)	372 (29.9)	
High	293 (8,3)	143 (7.7)	31 (7.8)	119 (9.6))	
BMI, Kg/m^2	23,1 ± 5,7	22.3 ± 5.3	23.5 ± 5.7	24.1 ± 5.9	< 0.001
WC, cm	81,7 ± 11,9	79.2 ± 10.5	81.8 ± 11.6	85.4 ± 13.2	< 0.001
SBP, mmHg	122,2 ± 21,9	110.1 ± 10.1	126.6 ± 8.3	149.1 ± 25.8	< 0.001
DBP, mmHg	80,7 ± 14,9	71.8 ± 7.7	83.1 ± 6.5	93.1 ± 15.7	< 0.001
MAP, mmHg	94,5 ± 16,2	84.6 ± 7.5	97.6 ± 3.9	108.4 ± 17.4	< 0.001
PP, mmHg	41,6 ± 14,3	38.3 ± 9.0	43.5 ± 12.7	45.9 ± 19.3	< 0.001
HR, bpm	80,8 ± 12,1	80.0 ± 11.9	81.6 ± 12.2	81.6 ± 12.2	0.581
Blood glucose, mg/dl	118,1 ± 31,1	118.4 ± 32.5	117.5 ± 28.7	117.9 ± 29.7	0.982

Table 1: General characteristics of the study population as a whole and by blood pressure categories according to JNC 7.

Data are expressed as mean ± standard deviation, absolute (n) and relative (in percent) frequency. Abbreviations: M: Male; F: Female; SES: Socioeconomic Status; BMI: Body Mass Index; WC: Waist Circumference; SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; MAP: Mean Arterial Blood Pressure; PP: Pulse Pressure; HR: Heart Rate; bpm: Beat Per Minute.

Table 2 summarizes cardiovascular risk factor profile of the study population as a whole and by BP categories. In the study population as a whole, physical inactivity (57.5%), alcohol intake (45.3%), FH-HT (43.6%), central obesity (38.1%) and DM (33.9%) were cardiovascular risk factors most frequently reported by the participants.

Prevalence and clinical profile of prehypertension and hypertension

Prehypertension and hypertension were observed in 399 (11.9%) and 1245 (35.5%) participants, respectively (Figure 1). Age was in average significantly increased in prehypertensive (35.0 ± 14.0 vs 31.0 ± 12.4 years; p < 0.001) and hypertensive (44.7 ± 17.0 vs 31.0 ± 12.4 years; p < 0.001) participants compared to normotensive ones (Table 1). The same picture was observed for the prevalence of prehypertension and hypertension by age categories (Table 1). Prehypertension was more significantly more frequent in men (46.6 vs 40.5%; p < 0.001) whereas hypertension was more frequently encountered in females (63.5 vs 59.5%; p < 0.001) compared to male and females normotensive participants, respectively. The proportion of unemployed participants was significantly higher among prehypertensive (2.3 vs 0.8%; p < 0.001) and hypertensive (5.5 vs 0.8%; p < 0.001) participants compared to their normotensive counterparts. Similarly, the proportion of married (46.1 vs 37.1%; p < 0.001 for prehypertension; 50.5 vs 37.1%; p < 0.001 for hypertension) and widow (4.3 vs 3.4%; p < 0.001 for prehypertension; 15.3 vs 3.4%; p < 0.001 for hypertension) participants compared to normotensive ones. BMI (23.5 ± 5.7 vs 22.3 ± 5.3 Kg/m^2; p < 0.001 for prehypertension; 24.1 ± 5.9 vs 22.3 ± 5.3 Kg/m^2; p < 0.001 for hypertension) were in average significantly increased in prehypertensive and hypertensive participants compared to normotensive ones (Table 1).

Variables	All n = 3510	Normotension n	Prehypertention n = 399	Hypertension n	p
Age,yrs > 55 M/45 F, n (%)	760 (21.7)	760 (21.7)	274 (12.1)	486 (39.0)	< 0.001
FH-HT, n (%)	153 (43.6)	1530 (43.6)	945 (41.7)	585 (47.0)	0.003
FH-DM, n (%)	392 (11.2)	392 (11.2)	260 (11.5)	132 (10.6)	0.232
FH-CVD, n (%)	222 (6.3)	222 (6.3)	138 (6.1)	84 (6.7)	0.244
Smoking, n (%)	515 (14.7)	515 (14.7)	281 (12.4)	234 (18.8)	< 0.001
Alcohol intake, n (%)	1590 (45.3)	1590 (45.3)	1010 (44.6)	580 (46.6)	0.136
Menopause, n (%)	557 (15.9)	148 (7.9)	47 (11.8)	362 (29.1)	< 0.001
Overweight, n (%)	563 (16.0)	563 (16.0)	277 (12.2)	286 (23.0)	< 0.001
Obesity, n (%)	282 (8.0)	282 (8.0)	135 (6.0)	147 (11.8)	< 0.001
Central obesity, n (%)	1337 (38.1)	1337 (38.1)	720 (31.8)	617 (49.6)	< 0.001
PH-DM, n (%)	158 (33.9)	158 (33.9)	95 (25.1)	63 (37.1)	0.162
Physical inactivity, n (%)	2020 (57.5)	2020 (57.5)	1245 (55.0)	775 (62.2)	< 0.001
Consommation graisse, n (%)					< 0.001
Amélioré Chol	43 (1.2)	24 (1.3)	4 (1.0)	15 (1.2)	
No-optimal Chol	1268 (36.1)	764 (40.9)	147 (36.8)	357 (28.7)	
Grave Chol	2199 (62.6)	1078 (57.8)	248 (62.2)	873 (70.1)	
Consommation fruit and légume, n (%)					< 0.001
Pauvre	2497 (71.1)	1389 (74.4)	258 (71.4)	823 (66.1)	
Riche	1013 (28.9)	477 (25.6)	114 (28.6)	422 (33.9)	

Table 2: Cardiovascular risk factor profile of the study population as a whole and by blood pressure categories according to JNC 7. Data are expressed as absolute (n) and relative (in percent) frequency. Abbreviations: yrs: Year; M: Male; F: Female; FH: Family History; HT: Hypertension; DM: Diabetes Mellitus; CVD: Cardiovascular Disease; PH: Personal History.

Figure 1: Distribution of study population by blood pressure categories according to JNC7. Abbreviations: BP: Blood Pressure; PreHT: Prehypertension; HT: Hypertension.

Cardiovascular risk factor profile of participants with prehypertension and hypertension

With reference to cardiovascular risk profile by BP categories (Table 2), the proportion of participants with increased age was significantly higher in hypertensive (39.0 vs 12.1%; p < 0.001) and lower (12.1 vs 21%; p < 0.001) in prehypertensive participants compared to normotensive ones. Hypertensive participants had also a significantly higher proportion of subjects with overweight (23.0 vs 16.0%; p < 0.001), obesity (11.8 vs 8.0%; p < 0.001), central obesity (49.6 vs 38.1%; p < 0.001) and physically inactivity (62.2 vs 55.0%; p < 0.001) as well as those who reported FH-HT (47.0 - 41.7%; p = 0.002) and smoking (18.8 - 14.7%; p < 0.001) compared to normotensive ones. The proportion of menopausal women was significantly higher in prehypertensive (11.8 vs 7.9%; p < 0.001) and hypertensive (29.1 vs 7.9%; p < 0.001) (Table 2).

Cardiovascular risk factors associated with prehypertension and hypertension

In univariate analysis (Table 3), cardiovascular risk factors significantly associated with prehypertension were increased age (p =

0.025), menopause (p = 0.013), overweight (p = 0.041) and obesity (p = 0.0001). In addition to cardiovascular risk factors associated with prehypertension, FH-HT (p = 0.003), smoking (p = 0.0001), personal history (PH) of hyperuricemia (p = 0.011) and central obesity (0.012) emerged as the main cardiovascular risk factors significantly associated with hypertension. In multivariate analysis (Table 4), the strength of the associations observed in univariate analysis with prehypertension persisted for all the cardiovascular risk factors except for menopause. Indeed, the likelihood of being associated with prehypertension was increased around two-fold in the presence of increased age (aOR 1,86; 95%CI 1.10 - 3.14; p = 0.025)], overweight (aOR 1,54; 95%CI 1.03 - 2.04; p = 0.032) and obesity (aOR 2.24; 95%CI 1.46 - 3.43; p = 0.0001), respectively. Except for personal history of hyperuricemia, menopause and central obesity, the strength of the associations observed in univariate analysis with hypertension persisted for all other cardiovascular risk factors. Thus, the likelihood of being associated with hypertension was increased nearly three-fold in the presence of increased age (aOR 2,88; 95%CI 2.08 - 3.99; p = 0.0001), smoking (aOR 2,51; 95%CI 1.21 - 3.87; p = 0.0001) and nearly two-fold for FH-HT ((aOR 1,69; 95%CI 1.21 - 2.64; p = 0.021), overweight (aOR 1.67; 95%CI 1.34 - 3.08; p = 0.0001), and obesity (aOR 1.82; 95%CI 1.03 - 2.85; p = 0.030), respectively.

Variables	PreHT		HT	
	p	OR (95%CI)	p	OR (95%CI)
Age, yrs ≥55 M/≥45 F				
No		1		1
Yes	0,025	1,66 (1,04 - 1,79)	0,000	4,65 (3,93 - 5,52)
FH-HT				
No				1
Yes	-	-	0,003	1,95 (1,08 - 3,42)
Smoking				
No				1
Yesi	-	-	0,000	1,63 (1,35 - 1,98)
PH-Hyperuricemia				
No				1
Yes	-	-	0,011	2,13 (1,67 - 2,72)
Menopause				
No		1		1
Yes	0,013	1,55 (1,10 - 2,19)	0,000	4,35 (3,59 - 5,27)
Overweight				
No		1		1
Yes	0,041	1,79 (1,01 - 2,88)	0,000	2,14 (1,78 - 2,57)
Obesity				
No		1		1
Yes	0,000	2,33 (1,59 - 3,40)	0,000	2,11 (1,65 - 2,70)
Central obesity				
No				1
Yes	-	-	0,012	2,11 (1,83 - 2,43)

Table 3: Cardiovascular risk factors associated with prehypertension and hypertension in univariate analysis.

Abbreviations : PreHT: Prehypertension; HT: Hypertension; yrs: Years; M: Male; F: Female; OR: Odds Ratio; CI: Confidence Interval; FH: Family History; PH: Personal History.

Discussion

The main findings of the present survey are as follows. First, nearly 1 patient out of 10 and 4 patients out of 10 presented with prehypertension and hypertension, respectively. Second, prehypertension and hypertension were more frequent in women than men. Third, increased age, overweight and obesity emerged as common independent cardiovascular risk factors significantly associated with both prehypertension and hypertension whereas family history of hypertension and smoking were specifically associated with hypertension.

One patient out of 10 in the present survey presented with BP values defining prehypertension. The prevalence of prehypertension found in the present survey is lower that of 30.3% reported by Bayauli., *et al.* [16] in urban adults aged ≥ 20 years from Kinshasa, the capital City of the Democratic Republic of the Congo. It is also lower that of 29.8%, 30%, 31.0%, 37.6%, 49.0% and 58.7% and 66.1% reported in a study conducted in four sub-Saharan African countries (Nigeria, South Africa, Tanzania, Uganda) [26], Yaounde/Cameroon [27], Uganda [28], Kenya [29], Ghana [30], Nigeria [31] and in a study conducted in the Republic of the Congo and Central

Variables	PreHT		HT	
	p	aOR (95%CI)	p	aOR (95%CI)
Age, yrs ≥ 55 M/≥ 45 F				
No		1		1
Yes	0.021	1.86 (1.10 - 3.14)	0.000	2.88 (2.08 - 3.99)
FH-HT				
No				1
Yes	-	-	0.021	1.69 (1.21 - 2.64)
Smoking				
No				1
Yes	-	-	0.000	2.51 (1.21 - 3.87)
PH-Hypeuricemia				
No				1
Yes	-	-	0.095	1.27 (0.96 - 1.69)
Menopause				
No		1		1
Yes	0.382	1.32 (0.71 - 2.45)	0.864	1.03 (0.72 - 1.49)
Overweight				
No		1		1
Yes	0.032	1.54 (1.03 - 2.04)	0.000	1.67 (1.34 - 2.08)
Obesity				
No		1		1
Yes	0.000	2.24 (1.46 - 3.43)	0.030	1.82 (1.03 - 2.85)
Central obesity				
No				1
Yes	-	-	0.236	1.15 (0.91 - 1.46)

Table 4: Cardiovascular risk factors associated with prehypertension and hypertension in multivariate analysis.

Abbreviations: PreHT: Prehypertension; HT: Hypertension; aOR: Adjusted Odds Ratio; CI: Confidence Interval; yrs: Years; M: Male; F: Female; FH: Family History; PH: Personal History.

African Republic [32], respectively. Hypertension was observed in nearly 4 out of 10 participants in the present survey. This prevalence was lower that of 40.8% reported in the neighbor port City of Matadi [12] and higher than that of 30.9% [16] and 18 - 19% found in Kinshasa, the capital City and Bukavu, a southwestern DRC City [11]. With reference to sub-Saharan African studies, the observed prevalence of hypertension was nearly similar to that of 36.9% reported by Guwatudde., *et al*. [26] in a cross-sectional study conducted in four sub-Saharan African countries. However, it was lower that of 55.3%, 53.6% and 49% found in South Africa [29], Kenya [29] and Ghana [30] respectively and lower that of 28.5%, 18.0% and 2.8% reported in Uganda [28], Angola [33] and Cameroon [27], respectively. The disparity in prevalence of prehypertension and hypertension between studies could be explained by differences in population studied, sample size and methodology used as well as geographical distribution of cardiovascular risk factors. This could also be explained by differences in the level and the speed of the epidemiological transition to which are confronted sub-Saharan African countries [34].

Increased age, overweight and obesity emerged as common independent cardiovascular risk factors significantly associated with both prehypertension and hypertension. Our finding of an association of increased aged and overweight/obesity with high BP agrees with previous reports from DRC [10,11] and other sub-Saharan African countries [26,28,31]. Bayauli., *et al*. [16] reported that the probability of both prehypertension and hypertension was increased in participants with overweight/obesity (OR 1.666; 95%CI 1.146 - 2.422 for prehypertension; OR 2.263; 95%CI 4.561 - 10.706 for hypertension; increased age (≥ 55 years) was associated only with hypertension (OR 6.988; 95%CI 4.561 - 10.706). Similarly, to Bayauli., *et al*, Katchunga., *et al*. [11] found in Bukavu, a southwestern City of DRC that the potential risk of hypertension was increased by age > 40 years (OR 5.5) and overweight/obesity (OR 1.2). BMI and age were also associated with hypertension in a cross-sectional study conducted in four sub-Saharan African countries (Nigeria, South Africa, Tanzania, Uganda) [26]. In a study from Nigeria, Ononamadu., *et al*. [35] reported that anthropometric indices studied increased from normotension, through prehypertension. In addition, anthropometric indices studied were significantly correlated with systolic and diastolic BP and BMI (cut-off 24.49 Kg/m^2, AUC = 0.698 for prehypertension; cut-off 23.62 Kg/m^2, AUC = 0.659 for hypertension) as well as WC (cut-off 91.44 cm, AUC = 0.692 for prehypertension; cut-off 82.55 cm, AUC = 0.645 for hypertension) showed the highest potential to predict prehypertension and hypertension. Increased age is one of the strongest

risk factors for the development and progression of hypertension [36,37]. Indeed, the ageing process can increase BP through several mechanisms including insulin resistance/hyperinsulinemia and subsequent activation of the sympathetic nervous system and renin angiotensin aldosterone system, clustering of multiple risk cardiovascular risk factors, oxidative stress and subsequent inflammation and endothelial dysfunction, increased renal proximal tubular sodium and water reabsorption mediated by the activation of sodium-proton exchanger [36,37]. Like aging, overweight and obesity also can increase BP through insulin resistance/hyperinsulinemia and their subsequent hemodynamic, metabolic and renal consequences [38].

Family history of hypertension and smoking were specifically associated with hypertension. Family history of hypertension as a surrogate marker of genetic cardiovascular risk factor does translate the contribution of genetic predisposition to the increased prevalence of hypertension observed in the present survey. Indeed, it has been reported that traditional risk factors do not fully explained the ever growing prevalence of hypertension in low and middle income countries including sub-Saharan African countries [39]; thus, other factors of environmental or genetic origin can contribute to this increased prevalence. Among genetic factors, Apolipoprotein L1 (Apol1) gene variants G1 and G2, in homozygous (G1/G1, G2/G2) or heterozygous (G1/G2) compounds, has been reported to increase the risk of hypertension and hypertension-related nephropathy in Afro-Americans as well as in sub-Saharan Africans [39]. In DRC, a recent study by Sumaili., *et al*. [40] reported an association between G1/G2 variants and BP. The mechanisms underlying the effects ApoL1 variants on BP remain not fully elucidated; however, APOL1 protein expression being observed in vascular media of preglomerular resistance vessels in diseased kidneys, but not in normal kidneys, it will be interesting to see whether vascular smooth muscle expression of APOL1 is associated with BP levels [41]. Smoking was also associated with hypertension in the present study. The association of smoking with increased is a well-known phenomenon and rely upon the generation of oxidative stress and subsequent inflammation and endothelial dysfunction as well as the activation of the sympathetic nervous system and renin angiotensin aldosterone system [42].

The interpretation of the results of the present survey should take into account of some limitations. First, the cross-sectional design of the survey precludes the establishment of any temporal relationship between the outcome and the variables of interest. Second, the unique measurement of the variables of interest could have under- or overestimated their true values and the prevalence of prehypertension and hypertension. Third, other factors usually associated with hypertension such as blood lipids were not measured.

Conclusion

The present survey in the port City of Boma showed that nearly one participant out of ten and four participants out of ten had prehypertension and hypertension, respectively with increased age, overweight and obesity as common cardiovascular risk factors associated with the two conditions. A strategy based on therapeutic lifestyle changes (TLC) for prehypertension and TLC and pharmacological treatment for hypertensives with increased global cardiovascular risk is needed.

Conflict of Interest

None.

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Author's Contribution

BMN participated in survey conception and data collection and management; drafted the manuscript.

FLB participated in survey conception and data analysis; revised the manuscript.

AN conducted data analysis and revised the manuscript.

WI revised the manuscript.

PKK participated in survey conception and revised the manuscript.

EKV revised the manuscript.

JRM participated in survey conception and revised the manuscript.

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