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Hypertension prevalence, associated factors, treatment, and control in rural Cameroon: a cross-sectional study

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Abstract

Introduction: Sub-Saharan Africa is experiencing a surge in the burden of hypertension, and rural communities seem to be increasingly affected by the epidemic.

Objectives: We aimed to determine the prevalence of hypertension, its associated factors, as well as its awareness, treatment, and control rates in rural communities of the Baham Health District (BHD), Cameroon.

Design: A community-based cross-sectional study.

Setting: Participants from five health areas in the BHD were recruited from August to October 2018.

Participants: Consenting participants aged 18 years or older were included.

Results: We included 526 participants in this study. The median age of the participants was 53.0 (IQR = 35 – 65) years and 67.1% were female. The prevalence of hypertension was 40.9% (95% confidence interval [CI] = 36.7 – 45.1) were hypertensive with no gender disparity. The overall age-standardised prevalence of hypertension was 23.9% (95% CI = 20.3 – 27.5). Five-year increase in age (adjusted odd's ratio [AOR] = 1.34; 95% CI = 1.23 – 1.44), family history of hypertension (AOR = 2.22; 95% CI = 1.37 – 3.60), and obesity were associated with higher odds of hypertension (AOR = 2.57; 95% CI = 1.40 – 4.69).

The rates of awareness, treatment, and control of hypertension were 37.2% (95% CI = 31.0 – 43.9), 20.9% (95% CI = 16.0 – 26.9), and 22.2% (95% CI = 15.2 – 46.5), respectively.

Conclusion: The high hypertension prevalence in this rural community is associated with contrastingly low awareness, treatment, and control rates. Age, family history of hypertension, and obesity are the major drivers of hypertension in this community. Veracious policies are needed to improve awareness, prevention, diagnosis, treatment, and control of hypertension in this rural community.

Keywords: Hypertension, public health, epidemiology, associated factors, determinants, awareness, treatment, control, Cameroon.

Study strengths and limitations

1. With a non-probabilistic sampling method and a high proportion of the elderly, the findings herein might over-estimate the true prevalence of hypertension in this rural community.
2. There is potential for residual confounding from measured and unmeasured confounders.
3. This study investigates the contribution of non-traditional factors like wood smoke and consumption of fruits and vegetables to the prevalence of hypertension in rural Cameroon.

1. Background

Hypertension is a major modifiable risk factor for cardiovascular diseases globally [1, 2] which is associated with increased cost on health systems, high morbidity and premature mortality. Globally, it is estimated that one billion adults live with hypertension; a figure which is projected to hit 1.5 billion by the year in 2025 [2, 3]. Furthermore, hypertension-related complications are responsible for over 50% of the 17.4 million deaths due to cardiovascular diseases every year worldwide [2]. At least 45% of deaths due to heart disease and 51% of deaths due to stroke are related to hypertension [2].

Cardiovascular diseases are the second commonest cause of premature disability and death in sub-Sahara Africa (SSA) [4–6]. A greater bulk of the burden of heart disease, kidney failure, stroke and premature death in this region is accounted for by hypertension [7–10]. The prevalence of hypertension in SSA is estimated at about 30% with disproportionately low awareness, treatment and control rates [7]. About 29.7% of the general Cameroonian population are affected by hypertension [8] while a significant number of cases of hypertension still remain undiagnosed and untreated, and even those on treatment hardly achieve a controlled blood pressure [9–12].

With the increasing prevalence of hypertension globally, including the rural areas, a continuous evaluation of the burden of hypertension in these areas is needed to plan prevention and control strategies. A limited number of community-based studies have assessed epidemiology of hypertension in rural areas in Cameroon with significant disparities across regions. Cognizant to this, we sought to assess the prevalence and factors associated with hypertension among adults in selected health areas in a rural health district in the West Region of Cameroon. In addition, we evaluated the rates of awareness, treatment, and control of hypertension in the same population.

2. Methods

2.1 Study design, setting and duration

This was a community-based, cross-sectional study conducted between August and October 2018 in the Baham Health District (BHD), as part of the University of Bamenda Medical Students Association (UBaMSA) annual community health campaign. The study was conducted in 5 of the 9 health areas of the BHD including the Hiala Cheffou, Bapa, Baham and Ngouogoua health areas. Baham is a rural community located in the West Region of Cameroon. The Baham Health District had an estimated population of 51500 in 2001 [13] whose major activity is farming. It is made up of 9 health areas with a district hospital.

2.2 Study population and sampling

The five health areas in which our study was conducted were selected based on ease of accessibility. Consenting participants aged 18 years and older were consecutively recruited into the study. Participants with documented or reported diagnosis of chronic kidney disease, those who had taken cardiostimulants such as alcohol, "kola nut" (a caffeine containing fruit of the Kola tree; a genus of trees that are native to the tropical rainforests of Africa) and caffeine at least 30 minutes prior to the study, and pregnant women were excluded from the study.

The sample size was estimated using the following formula:

$$n = \frac{Z^2 P(1 - P)}{d^2}$$

where n is the sample size (number of adult participants), P is the expected prevalence of HTN in an adult population (P= 0.378) [12], and d is the precision (if 5%, d= 0.05). Z statistics (Z): For the level of confidence of 95%, which is conventional, Z value is 1.96 for a 95% confidence interval (CI). A minimum of 361 adult participants was required for this study.

2.3 Study procedure and data collection

One month prior to the UBaMSA health campaign, members of the community were informed by mass communication (through the local radio stations), and interpersonal communication on the dates retained for activities of the campaign. The data collection process was guided by the World Health Organization (WHO) STEPwise approach to Surveillance (STEPS). Data was collected by trained medical students and medical doctors. Information on the participants' socioeconomic status (like age, sex, and education), lifestyle (fruits and vegetable consumption, smoking status, and physical activity), and medical history (family history of hypertension). In cases where participants did not understand English or French, a translator was used.

Blood pressure was measured using a reference protocol in which participants were seated, and measurements were taken after at least 10 minutes of rest. This was done using the auscultatory method with a calibrated sphygmomanometer placed at least 0.5cm above the elbow joint, covering at least 80% of the arm, and a stethoscope was used to detect the sounds. The analysis was done for the average of two measures performed at least five minutes apart.

Height was measured using a calibrated stadiometer to the nearest 0.1 cm. Weights were measured to the nearest 0.5kg with the use of a scale, and the participants mounted the scale only with light clothes on. Abdominal circumference was measured to the nearest 0.5cm with a measuring tape placed all around the bare abdomen at the level of the umbilicus.

Definitions

1. Respondents were considered as hypertensive if they had an average SBP of 140 mm Hg or higher, or DBP of 90 mmHg or greater, or reported current use of anti-hypertensive medication [14].
2. Hypertension awareness rate was defined as the proportion of individuals who responded by a "yes" to have either been diagnosed with hypertension by a healthcare professional and/or "yes" to taking medication for hypertension.
3. The rate of hypertension treatment included the proportion of participants who were diagnosed with hypertension and reported being on treatment for hypertension.

4. Hypertension control was defined as the proportion of individuals on either pharmacotherapy or lifestyle modification or both for hypertension and who had an average SBP < 140 mmHg and DBP < 90 mmHg.
5. Occupational level was classified into "low" (no technical know-how or expert training required, e.g. manual workers), "medium" (requiring a degree of technical know-how but no expert training, like salesmen, and bike and taxi drivers) and "high" (major professionals requiring advanced training like teachers, health personnel, and accountants).
6. We defined an ex-smoker as someone who has smoked at least 100 cigarettes in their lifetime but had stopped smoking at least 28 days before the interview. A smoker was defined as someone who has smoked at least 100 cigarettes in their lifetime and are still regular smokers at the time of the interview. Those who had never smoked or smoked less 100 cigarettes in their lifetime were classified as non-smokers.
7. Alcohol units per week = (number of bottles of beer consumed per week) x 5% x 650ml/1000 [15]. The routine beer bottle in Cameroon occupies 650ml of beer with a concentration of alcohol of 5%.
8. The intensity of physical activity was classified as "moderate" (e.g. brisk walking, moderate farm work like weeding and harvesting, haunting, lifting masses < 20kg, housework and domestic chores, and general building tasks such as roofing and painting) and "vigorous" (running, briskly ascending and descending hills, intense farm work such as manual tilling of the soil, digging ditches and carrying masses ≥ 20kg) [16]. Sedentary lifestyles at work and home were classified as "No physical activity".
9. The body mass index (BMI) was calculated as the ratio of the weight in kilograms and the square of the height in metres. BMI based body habitus (in Kg/m^2) was classified as underweight (BMI < 18.5), normal weight (BMI = 18.5-24.9), overweight (BMI = 25.0-29.9), and obese (BMI ≥30) [17].

10. Abdominal obesity was defined as an abdominal circumference ≥ 102 cm in men or ≥ 88 cm in women [18].

2.4 Data analysis

Data was analysed with Stata v.16 (StataCorp 2019, College Station, TX: StataCorp LLC). Qualitative variables were reported using counts and percentages. Quantitative variables were summarised as means and medians with their corresponding standard deviation (SD) and interquartile range (IQR), respectively. We computed direct age-standardised prevalence of hypertension using the 2011 population structure of Cameroon [19]. For univariate analyses, the Pearson χ^2 test was used to compare categorical variables while the Wilcoxon rank sum test was used to compare medians across independent groups. Independent factors associated with hypertension were determined using unconditional maximum likelihood multivariable logistic regression models. Variables with a p-value ≤ 0.1 on univariate analysis qualified for inclusion in the multivariable model. We sequentially adjusted for socioeconomic factors (like age, gender, occupation, and education), lifestyle factors (smoking status, alcohol consumption, fruit consumption, and physical activity) and clinical characteristics (family history of hypertension and BMI). The maximum likelihood ratio test was used to evaluate model fit and select variables for the final multivariable model. Gender, alcohol consumption, and smoking status were retained in the final model as they have been reported as factors associated with hypertension in literature. Body mass index was retained in the final model over abdominal obesity to facilitate comparison of our findings with previously published studies and to prevention multicollinearity. Ordinal variables were assessed for linear trend using the χ^2 test for linear trend. The χ^2 test for heterogeneity was used to evaluate departures from linearity. Measures of association are reported as odds ratio (OR) with corresponding 95% confidence interval (CI). Missing data was handled using simple mean, median and mode imputation where appropriate. Two-tailed p-values below 0.05 were considered statistically significant.

Patient and Public Involvement: Patients and/or the public were not directly involved in this study.

3. Results

In total, 526 participants with a median age of 53.0 (IQR = 35 – 65) years were included in this study. The ages of the participants ranged from 18 – 99 years. About 67% of the participants were females and 76.6% were married, Table 1. A little over half of the participants were Catholic Christians and about three-quarters of them had at least a primary education. The average BMI was 27.2 (SD=5.2), and about 44% of the participants had android obesity.

3.1 Prevalence of hypertension

Of the 526 participants, 215 were classified as hypertensive giving an overall crude prevalence of 40.9% (95% CI = 36.7 – 45.1). Figure 1 shows the gender-specific prevalence of hypertension (with their 95% CI) across different age groups. There was a linear increase in the prevalence of hypertension among older participants, with no gender disparity. The overall age-standardised prevalence of hypertension was 23.9% (95% CI = 20.3 – 27.5).

3.2 Factors associated with hypertension

On univariate analysis, participants with hypertension were significantly older (median age in years = 64.0 versus 42.0 years) and consumed fruits less regularly (median daily fruit consumption per week = 2.0 versus 4.0) compared to those without hypertension, Table 2. There was strong evidence against the null hypothesis of no difference in marital status, occupation, level of education, family history of hypertension, and intensity of physical activity between participants with and without hypertension. There was weak evidence against the null hypothesis of no difference in exposure to wood smoke between participants with and without hypertension. There was a moderate positive correlation between BMI and abdominal circumference ($r = 0.60$, $p<0.001$).

Figure 2 displays the final multivariable logistic regression model (without abdominal obesity). There was strong evidence of a 34% increase in the odds of hypertension for every five-year increase in age (adjusted odd's ratio [AOR] = 1.34; 95% CI = 1.23 – 1.44; p<0.001). Family history of hypertension associated with 2.22 times higher odds of hypertension (AOR = 2.22; 95% CI = 1.37 – 3.60; p<0.001). Obesity was associated with 2.57 times higher odds of hypertension (AOR = 2.57; 95% CI = 1.40 – 4.69; P_{trend} <0.001).

3.3 Awareness, treatment, and control of hypertension

Table 3 depicts the percentage of hypertension awareness, treatment, and control among our study participants. Of the 215 participants diagnosed with hypertension, 37.2% (95% CI = 31.0 – 43.9) were aware of their hypertensive status, while 20.9% (95% CI = 16.0 – 26.9) reported being on any form of treatment for hypertension. Of the 45 participants who were on treatment for hypertension, 22.2% (95% CI = 12.2 – 37.0) had a controlled BP.

4. Discussion

We report a prevalence of hypertension of 40.9% (age-standardised prevalence = 23.9%) with associated with low awareness, treatment, and control rates in the BHD. Increasing age, family history of hypertension and obesity were drivers of hypertension in this population.

4.1 Prevalence of hypertension and associated factors

The crude prevalence of hypertension in our study is higher than the crude prevalence of 33.9% and 31.1% in rural areas of the Far North Region [12] and South West Region of Cameroon [20], respectively. This higher prevalence of hypertension in our study can attributed to the older age of our study population compared with those of previous studies. Indeed, the median age of our study participants was 53 years compared to a mean age of 39 year reported by Lemogoum *et al* [12]. In addition, over 65% of the participants in the study by Arrey *et al* were between 20-29 years old [20].

Older age is a strong determinant of hypertension. We noted a strong positive linear trend between older age and hypertension as has been observed in other studies in Cameroon [8, 12, 20, 21] and elsewhere [26]. Age-standardisation with Cameroon's population of 2011 permitted comparison of our results with those of Lemogoum *et al* [12]. The age-standardised prevalence of hypertension in our study was half of the crude prevalence, indicating the contribution of age in the overall crude prevalence in this study. The age-standardised prevalence in our study was lower than that reported by Lemogoum *et al* [12].

Differences in ethnicity, socioeconomic, and lifestyle factors could account for the variation in the prevalence of hypertension in our study compared to previous studies [8, 12, 20, 21]. Our study recruited participants from the Bamileke ethnic group. In a recent publication by Defo *et al*, participants recruited from this ethnic group had the highest prevalence of hypertension in Cameroon [22]. Our study suggests that genetic predisposition to hypertension is a significant determinant of hypertension in our study population. History of hypertension was associated with over two-times increase in the odds of hypertension. In the addition, difference in BMI could explain, in part, the variation in the prevalence of hypertension in this study compared to other studies reporting on the prevalence of hypertension in rural Cameroon [12, 20, 21]. Over 60% of our study participants had a BMI over the normal range, and there was a strong positive linear relationship between hypertension and BMI. Adiposity is a strong risk factor for hypertension and an important driver of the prevalence of hypertension in our study [23].

In Cameroon, there has been a roll up in the prevalence of hypertension in the general population from 16.4% in 1998 [24] to 29.7% in 2015 [8], with recent projections estimating an increase by 40% in 2025 and 95% in 2035 [25]. The prevalence of hypertension in this study is approximates the overall prevalence of 47.5% reported in four urban areas in Cameroon a few years back [11] and a rural community in South Africa [26]. Such high prevalence of hypertension, especially among the elderly, in this rural communities warrants further investigation to ascertain the burden of the disease and plan effective prevention and management strategies.

We found no independent association between hypertension sex, education, marital status, and physical activity reported in previous studies [22] nor with the male sex as reported by Lemougoum *et al* in Far North Cameroon [16].

4.2 Awareness, treatment, and control of hypertension

We report a low awareness rate and even lower treatment and control rates. This is in line with findings reported in rural areas of the Far North and South West Regions of Cameroon [12, 20], and a systematic review by Ataklte *et al* [23]. In the Mafia Island of Tanzania, a low control rate of 20.5% was recorded despite the very high treatment rate [27]. This is in contrast to the relatively higher control rates (44.7%) reported in a rural community in Ghana [28].

The low awareness, treatment and control rates reported in this study could be explained by inadequate patient information on the disease, its risk factors, and consequences in the long run. Low awareness is a major barrier to effective management which will result in the development of hypertension-related complications. A paucity of health care professionals at the primary health care level and the absence of a hypertension clinic at the district hospital in this setting for limits awareness, treatment, and control of hypertension in this population. Implementing policies to improve population education on hypertension, and the importance of regular follow up by a trained nurse or physician to prevent long-term complications would go a long way to improve awareness, treatment and control of hypertension in our setting [29]. Other cost-effectiveness measurements like the use home BP monitoring could go a long way to improve adherence and control of hypertension in Cameroon [30].

5 Conclusion

About two in five participants in our study population had hypertension. The high prevalence of hypertension in this study was contrasted by low awareness, treatment, and control rates. In a bit to curb the burden of hypertension in Cameroon, national policies need to adopt measures to address obesity and its risk factors. Measures to improve awareness of hypertension like regulation community education, diagnosis, treatments, and control could go a long way to reduce the burden of hypertension in this rural community.

Abbreviations

AOR: Adjusted odds ratio; BHD: Baham Health District; BMI: Body mass index; BP: Blood pressure; SD: Standard deviation; OR: odds ratio; UBaMSA: University of Bamenda Medical Students Association.

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Availability of data and materials

All data presented in the manuscript results are in possession of the corresponding author and will be made available on reasonable demand.

Authors' contributions

Study design and conception: LPS, VNA and JJN; data collection: LPS, OPN, PNS, AAF, JNM, NFB, HTG; data analysis and interpretation: VNA and LPS; manuscript drafting: LPS and VNA; Revision of the manuscript: LPS, OPN, PNS, AAF, JNN, JNM, NFB, HTG. Critical revision: VNA, JJN and DM. All authors read and approved the final manuscript.

Ethics approval and consent to participate: Ethical approval was obtained from the Faculty of Health Sciences Institutional Review Board, the University of Bamenda (Project ID: 2018/0045H/UBa/IRB) and all participants provided written informed consent prior to recruitment to the study.

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Competing interests

The authors declare that they have no competing interests.

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Table 1. Sociodemographic characteristics of the study population

Participants' characteristics	Total (N=526)
Age (in years)[$]	53 (35 – 65)
Age group (in years)	
18-39	157 (29.8%)
40-59	170 (32.3%)
60 and over	199 (37.8%)
Gender (Female)	353 (67.1%)
Marital Status	
Married	403 (76.6%)
Single	123 (23.4%)
Occupation	
High	22 (4.2%)
Medium	113 (21.5%)
Low	391 (74.3%)
Religion	
Baptist	13 (2.5%)
Catholic	275 (52.3%)
Muslim	14 (2.7%)
Others	119 (22.6%)
None	19 (3.6%)
Presbyterian	86 (16.3%)
Level of education	
No formal education	131 (24.9%)
Primary	155 (29.5%)
Secondary	183 (34.8%)
Tertiary	57 (10.8%)
Family history of hypertension (Yes)	141 (26.8%)
Smoking status	
Non-smoker	435 (82.7%)
Ex-smoker	49 (9.3%)
Current smoker	42 (8.0%)
Alcohol units per week	
Non-drinker	163 (31.0%)
(0.01, 6.49]	205 (39.0%)
(6.49, 117]	158 (30.0%)
Body mass index (in kg/m^2)*	27.2 (5.2)
Abdominal obesity (Yes)	233 (44.3%)
Systolic blood pressure (in mmHg)*	134.1 (24.5)
Diastolic blood pressure (in mmHg)*	83.0 (14.5)

[$] Summarised as median and interquartile range; * Data summarised as mean (standard deviation); N = frequency

Table 2: Factors associated with hypertension in the Baham Health District on univariate analysis

Participants' characteristics	No hypertension N=311	Hypertension N=215	Total N=526	p-value
Age group (in years)	42.0 (28.0-58.0)	64.0 (53.0-73.0)	53.0 (35.0-65.0)	<0.001[a,*]
Gender				0.370[b]
Female	204 (65.6%)	149 (69.3%)	353 (67.1%)	
Male	107 (34.4%)	66 (30.7%)	173 (32.9%)	
Marital Status				<0.001[b,*]
Married	212 (68.2%)	191 (88.8%)	403 (76.6%)	
Single	99 (31.8%)	24 (11.2%)	123 (23.4%)	
Occupation				0.017[b,*]
Low/unemployed	218 (70.1%)	173 (80.5%)	391 (74.3%)	
Medium	80 (25.7%)	33 (15.3%)	113 (21.5%)	
High	13 (4.2%)	9 (4.2%)	22 (4.2%)	
Religion				0.180[b]
Baptist	11 (3.5%)	2 (0.9%)	13 (2.5%)	
Catholic	154 (49.5%)	121 (56.3%)	275 (52.3%)	
Muslim	11 (3.5%)	3 (1.4%)	14 (2.7%)	
Others	74 (23.8%)	45 (20.9%)	119 (22.6%)	
None	12 (3.9%)	7 (3.3%)	19 (3.6%)	
Presbyterian	49 (15.8%)	37 (17.2%)	86 (16.3%)	
Level of education				<0.001[b,*]
None	55 (17.7%)	76 (35.3%)	131 (24.9%)	
Primary	81 (26.0%)	74 (34.4%)	155 (29.5%)	
Secondary	130 (41.8%)	53 (24.7%)	183 (34.8%)	
Tertiary	45 (14.5%)	12 (5.6%)	57 (10.8%)	
Family history of hypertension				0.002[b,*]
No	243 (78.1%)	142 (66.0%)	385 (73.2%)	
Yes	68 (21.9%)	73 (34.0%)	141 (26.8%)	
Smoking status				0.760[b]
Non-smoker	256 (82.3%)	179 (83.3%)	435 (82.7%)	
Ex-smoker	28 (9.0%)	21 (9.8%)	49 (9.3%)	
Current smoker	27 (8.7%)	15 (7.0%)	42 (8.0%)	
Exposure to wood smoke				0.048[b,*]
$\geq$ 4 days/week	200 (64.3%)	160 (74.4%)	360 (68.4%)	
< 4 days/week	75 (24.1%)	36 (16.7%)	111 (21.1%)	
Never	36 (11.6%)	19 (8.8%)	55 (10.5%)	
Alcohol units per week				0.510[b]

Non-drinker	92 (29.6%)	71 (33.0%)	163 (31.0%)	
(0.01, 6.49]	120 (38.6%)	85 (39.5%)	205 (39.0%)	
(6.49, 117]	99 (31.8%)	59 (27.4%)	158 (30.0%)	
Daily consumption of vegetable per week	1.0 (1.0-2.0)	1.0 (1.0-2.0)	1.0 (1.0-2.0)	0.230[a]
Daily consumption of fruit per week	4.0 (2.0-6.0)	2.0 (2.0-4.0)	2.0 (2.0-6.0)	<0.001[a,*]
Intensity of daily physical activity				<0.001 [b,*]
Low	134 (43.1%)	134 (62.3%)	268 (51.0%)	
Moderate	123 (39.5%)	72 (33.5%)	195 (37.1%)	
Vigorous	54 (17.4%)	9 (4.2%)	63 (12.0%)	
Body mass index categories				0.053 [b]
Normal	119 (38.3%)	70 (32.6%)	189 (35.9%)	
Overweight	134 (43.1%)	86 (40.0%)	220 (41.8%)	
Obese	58 (18.6%)	59 (27.4%)	117 (22.2%)	
Abdominal obesity				<0.001[b, *]
Yes	115 (37.0%)	118 (54.9%)	233 (44.3%)	
No	196 (63.0%)	97 (45.1%)	293 (55.7%)	

[a]P-value from Wilcoxon rank sum test, [b] P-value from Chi-square test.

Table 3. Awareness, treatment and control of hypertension, Baham Health District, 2018

	Frequency	Percentage (95% CI)
Hypertension awareness (N=215)	80	37.2 (31.0 – 43.9)
Hypertension treatment (N=215)	45	20.9 (16.0 – 26.9)
Treated and controlled (N=45)	10	22.2 (12.2 – 37.0)

N = Frequency, CI = confidence interval

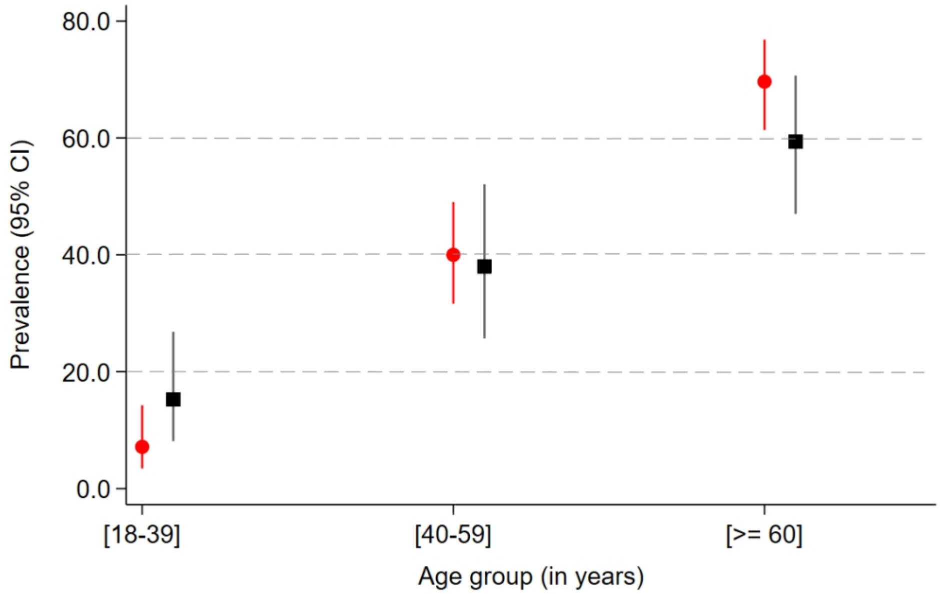

Figure 1: Prevalence (and 95% confidence interval [CI]) of hypertension stratified by age and gender. The red circle and black square represent the point estimate of the prevalence for females and males, respectively. The spikes represent the limits of the 95% CI.

424x309mm (72 x 72 DPI)

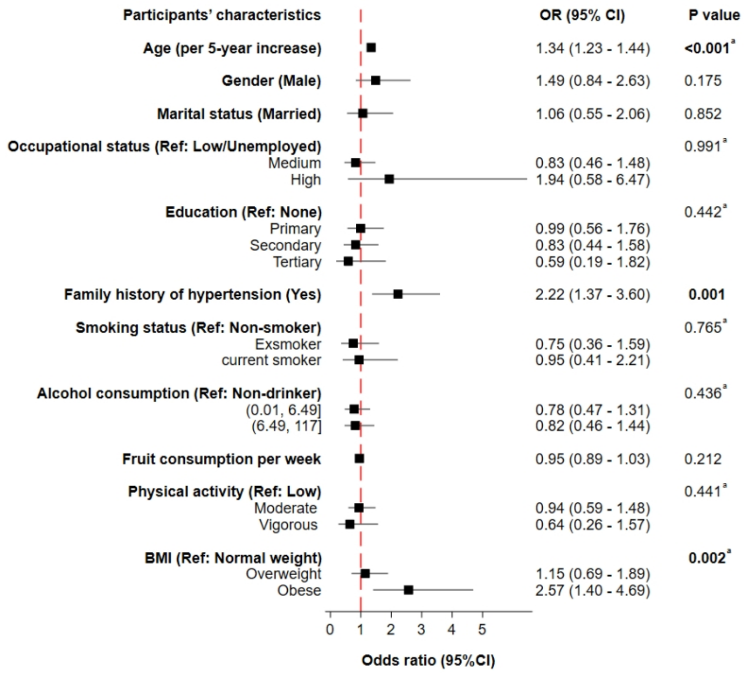

Figure 2: Factors associated with Hypertension in the Baham Health District multivariable logistic regression analysis. Measures of associations are displayed as odds ratio (OR), black squares, with the 95% confidence interval (CI), horizontal spikes. Significant p-values are shown in bold. The red dashed line refers to the null value of 1.0. a= p-value for trend.

424x309mm (72 x 72 DPI)

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract **[Page 1-2]**	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale **[Page 4]**	2	Explain the scientific background and rationale for the investigation being reported
Objectives **[Page 4]**	3	State specific objectives, including any prespecified hypotheses
Methods		
Study design **[Page 5]**	4	Present key elements of study design early in the paper
Setting **[Page 5-7]**	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants **[Page 5]**	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables **[Page 6-8]**	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement **[Page 6-8]**	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias **[Page 4]**	9	Describe any efforts to address potential sources of bias
Study size **[Page 5]**	10	Explain how the study size was arrived at
Quantitative variables **[Page 7]**	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods **[Page 8]**	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(b) Describe any methods used to examine subgroups and interactions
		(c) Explain how missing data were addressed
		(d) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy

		(e) Describe any sensitivity analyses
Results		
Participants [Page 9]	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data [Page 9-10]	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data [Page 9-10]	15*	*Cohort study*—Report numbers of outcome events or summary measures over time *Case-control study*—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results [Page 9-10]	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses [NA]	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results [Page 10]	18	Summarise key results with reference to study objectives
Limitations [Page 3]	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation [Page 10-12]	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability [Page 10-12]	21	Discuss the generalisability (external validity) of the study results
Other information		
Funding [Page 13]	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

Hypertension prevalence, associated factors, treatment, and control in rural Cameroon: a cross-sectional study

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Hypertension prevalence, associated factors, treatment, and control in rural Cameroon: a cross-sectional study

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Word counts: Abstract = 269; Main text = 2845.

Number of tables = 3, **Number of figures** = 2

Abstract

Introduction: Sub-Saharan Africa is experiencing a surge in the burden of hypertension, and rural communities are increasingly affected by the epidemic.

Objectives: We aimed to determine the prevalence of hypertension, and its associated factors, in rural communities of the Baham Health District (BHD), Cameroon. We sought to assess treatment and control rates implemented, whilst additionally identifying awareness of hypertension among community members.

Design: A community-based cross-sectional study.

Setting: Participants from five health areas in the BHD were recruited from August to October 2018.

Participants: Consenting participants aged 18 years and above were included.

Results: We included 526 participants in this study. The median age of the participants was 53.0 (IQR = 35 – 65) years and 67.1% were female. The prevalence of hypertension was 40.9% (95% confidence interval [CI] = 36.7 – 45.1) with no gender disparity. The age-standardised prevalence of hypertension was 23.9% (95% CI = 20.3 – 27.5). Five-year increase in age (adjusted odds ratio [AOR] = 1.34; 95% CI = 1.23 – 1.44), family history of hypertension (AOR = 2.22; 95% CI = 1.37 – 3.60), and obesity (AOR = 2.57; 95% CI = 1.40 – 4.69) were associated with higher odds of hypertension. The rates of awareness, treatment, and control of hypertension were 37.2% (95% CI = 31.0 – 43.9), 20.9% (95% CI = 16.0 – 26.9), and 22.2% (95% CI = 15.2 – 46.5), respectively.

Conclusion: The high prevalence of hypertension in these rural communities is associated with contrastingly low awareness, treatment, and control rates. Age, family history of hypertension, and obesity are the major drivers of hypertension in this community. Veracious policies are needed to improve awareness, prevention, diagnosis, treatment, and control of hypertension in these rural communities

Keywords: Hypertension, public health, epidemiology, associated factors, determinants, awareness, treatment, control, Cameroon.

Study strengths and limitations

1. Due to the non-probabilistic sampling method used, and the high proportion of elderly people in our study, this report may over-estimate the prevalence of hypertension in these rural communities.
2. Random error in and non-differential classification of hypertension in our study due to the use of a one-time blood pressure measure is likely to have reduced the power of our regression analyses.
3. There is potential for residual confounding from measured and unmeasured confounders.
4. Our study did not explore the determinants of controlled hypertension, including medication adherence.
5. This study investigated the contribution of non-traditional factors like wood smoke and consumption of fruits and vegetables to the prevalence of hypertension in these rural communities.

1. Background

Hypertension is a major modifiable risk factor for cardiovascular diseases globally [1, 2] which is associated with increased costs on health systems, high morbidity and premature mortality. Globally, it is estimated that one billion adults live with hypertension; a figure which is projected to hit 1.5 billion by the year in 2025 [2, 3]. Furthermore, hypertension-related complications are responsible for over 50% of the 17.4 million annual deaths caused by cardiovascular diseases globally [2]. At least 45% of deaths due to heart disease and 51% of deaths due to stroke are related to hypertension [2].

Cardiovascular diseases are the second most common cause of premature disability and death in sub-Saharan Africa (SSA) [4–6]. A large proportion of the burden of heart disease, kidney failure, strokes, and premature deaths in this region are caused by hypertension. [7–10]. The prevalence of hypertension in SSA is estimated at about 30% with disproportionately low awareness, treatment and control rates [7]. About 29.7% of the general Cameroonian population are affected by hypertension [8]. A significant number of cases of hypertension still remain undiagnosed and untreated, and even patients that receive treatment rarely achieve a controlled blood pressure [9–12].

With the increasing prevalence of hypertension globally, including the rural areas, a continuous evaluation of the burden of hypertension in these rural communities is needed to plan prevention and control strategies. A limited number of community-based studies have assessed the epidemiology of hypertension in rural areas in Cameroon with significant disparities across regions. Cognizant to this, we sought to assess the prevalence and factors associated with hypertension among adults in selected health areas in a rural health district in the West Region of Cameroon. In addition, we evaluated the rates of awareness, treatment, and control of hypertension in the same population.

2. Methods

2.1 Study design, setting and duration

This was a community-based cross-sectional study conducted between August and October 2018 in the Baham Health District (BHD), as part of the University of Bamenda Medical Students Association (UBaMSA) annual community health campaign. The study was conducted in 5 of the 9 health areas of the BHD including the Hiala Cheffou, Bapa, Baham and Ngouogoua health areas. Baham is a rural community located in the West Region of Cameroon. The Baham Health District had an estimated population of 51500 in 2001 [13] whose major activity is farming. It is made up of nine health areas with a district hospital.

2.2 Study population and sampling

The five health areas in which our study was conducted were selected based on ease of accessibility. Consenting participants aged 18 years and above were consecutively recruited for the study. Participants with documented or reported diagnosis of chronic kidney disease, those who had taken cardiostimulants such as alcohol, “kola nut” (a caffeine containing fruit of the Kola tree; a genus of trees that are native to the tropical rainforests of Africa) and caffeine at least 30 minutes prior to the study, and pregnant women were excluded from the study.

The sample size was estimated using the following formula:

$$n = \frac{Z^2 P(1 - P)}{d^2}$$

where n is the sample size (number of adult participants), P is the expected prevalence of HTN in an adult population (P= 0.378) [12], and d is the precision (if 5%, d= 0.05). Z statistics (Z): For the level of confidence of 95%, which is conventional, Z value is 1.96 for a 95% confidence interval (CI). A minimum of 361 adult participants was required for this study.

2.3 Study procedure and data collection

One month prior to the UBaMSA health campaign, members of the community were informed by mass communication (through the local radio stations), and interpersonal communication on the dates retained for activities of the campaign. The data collection process was guided by the World Health Organization (WHO) STEPwise approach to Surveillance (STEPS). Data was collected by trained medical students and medical doctors. Information on the participants' demographics (like age, sex, and education), lifestyle (fruits and vegetable consumption, smoking status, and physical activity), and medical history (family history of hypertension). In cases where participants did not understand English or French, a translator was used.

Blood pressure was measured using a reference protocol in which participants were seated, and measurements were taken after at least 10 minutes of rest. This was done using the auscultatory method with a calibrated sphygmomanometer placed at least 0.5cm above the elbow joint, covering at least 80% of the arm, and a stethoscope was used to detect the sounds. The analysis was done for the average of two measures performed at least five minutes apart.

Height was measured using a calibrated stadiometer to the nearest 0.1 cm. Weight was measured to the nearest 0.5kg with the use of a scale, and the participants mounted the scale only wearing light clothing Abdominal circumference was measured to the nearest 0.5cm with a measuring tape placed all around the bare abdomen at the level of the umbilicus.

2.4 Definitions

1. Respondents were considered as hypertensive if they had an average SBP of 140 mm Hg or higher, or DBP of 90 mmHg or greater, or reported current use of anti-hypertensive medication [14].
2. Hypertension awareness rate was defined as the proportion of individuals who responded "yes" to being diagnosed with hypertension by a healthcare professional and/or "yes" to taking medication for hypertension.
3. The rate of hypertension treatment included the proportion of participants who were diagnosed with hypertension and reported being on treatment for hypertension.

4. Hypertension control was defined as the proportion of individuals on either pharmacotherapy or implementing lifestyle modification methods or both for hypertension and who had an average SBP < 140 mmHg and DBP < 90 mmHg.
5. Occupational level was classified into “low” (no technical know-how or expert training required, e.g. manual workers), “medium” (requiring a degree of technical know-how but no expert training, like salesmen, and bike and taxi drivers) and “high” (major professionals requiring advanced training like teachers, health personnel, and accountants).
6. We defined an ex-smoker as someone who has smoked at least 100 cigarettes in their lifetime but had stopped smoking at least 28 days before the interview. A smoker was defined as someone who has smoked at least 100 cigarettes in their lifetime and are still regular smokers at the time of the interview. Those who had never smoked or smoked less 100 cigarettes in their lifetime were classified as non-smokers.
7. Alcohol units per week = (number of bottles of beer consumed per week) x 5% x 650ml/1000 [15]. The routine beer bottle in Cameroon occupies 650ml of beer with a concentration of alcohol of 5%.
8. The intensity of physical activity was classified as “moderate” (e.g. brisk walking, moderate farm work like weeding and harvesting, haunting, lifting masses < 20kg, housework and domestic chores, and general building tasks such as roofing and painting) and “vigorous” (running, briskly ascending and descending hills, intense farm work such as manual tilling of the soil, digging ditches and carrying masses ≥ 20kg) [16]. Sedentary lifestyles at work and home were classified as “No physical activity”.
9. The body mass index (BMI) was calculated as the ratio of the weight in kilograms and the square of the height in metres. BMI based body habitus (in Kg/m^2) was classified as underweight (BMI < 18.5), normal weight (BMI = 18.5-24.9), overweight (BMI = 25.0-29.9), and obese (BMI ≥30) [17].

10. Abdominal obesity was defined as an abdominal circumference ≥ 102 cm in men or ≥ 88 cm in women [18].

2.5 Data analysis

Data was analysed with Stata v.16 (StataCorp 2019, College Station, TX: StataCorp LLC). Qualitative variables were reported using counts and percentages. Quantitative variables were summarised as means and medians with their corresponding standard deviation (SD) and interquartile range (IQR), respectively. We computed direct age-standardised prevalence of hypertension using the 2011 population structure of Cameroon [19]. For univariate analyses, the Pearson χ^2 test was used to compare categorical variables while the Wilcoxon rank sum test was used to compare medians across independent groups. Independent factors associated with hypertension were determined using unconditional maximum likelihood multivariable logistic regression models. Variables with a p-value ≤ 0.1 on univariate analysis qualified for inclusion in the multivariable model. We sequentially adjusted for demographic factors (like age, gender, occupation, and education), lifestyle factors (smoking status, alcohol consumption, fruit consumption, and physical activity) and clinical characteristics (family history of hypertension and BMI). The maximum likelihood ratio test was used to evaluate model fit and select variables for the final multivariable model. Gender, alcohol consumption, and smoking status were retained in the final model as they have been reported as factors associated with hypertension in literature. Body mass index was retained in the final model over abdominal obesity to facilitate comparison of our findings with previously published studies and to prevent multicollinearity. Ordinal variables were assessed for linear trend using the χ^2 test for linear trend. The χ^2 test for heterogeneity was used to evaluate departures from linearity. Measures of association are reported as odds ratio (OR) with corresponding 95% confidence interval (CI). Missing data was handled using simple mean, median or mode imputation where appropriate. Two-tailed p-values below 0.05 were considered statistically significant.

Patient and Public Involvement: Patients and/or the public were not directly involved in this study.

3. Results

In total, 526 participants with a median age of 53.0 (IQR = 35 – 65) years were included in this study. The ages of the participants ranged from 18 – 99 years. About 67% of the participants were females and 76.6% were married, Table 1. A little over half of the participants were Catholic Christians and about three-quarters of them had at least a primary education. The average BMI was 27.2 (SD=5.2), and about 44% of the participants had android obesity.

3.1 Prevalence of hypertension

Of the 526 participants, 215 were classified as hypertensive giving an overall crude prevalence of 40.9% (95% CI = 36.7 – 45.1). Figure 1 shows the gender-specific prevalence of hypertension (with their 95% CI) across different age groups. There was a linear increase in the prevalence of hypertension among older participants, with no gender disparity. The overall age-standardised prevalence of hypertension was 23.9% (95% CI = 20.3 – 27.5).

3.2 Factors associated with hypertension

On univariate analysis, participants with hypertension were significantly older (median age in years = 64.0 versus 42.0 years) and consumed fruits less regularly (median daily fruit consumption per week = 2.0 versus 4.0) compared to those without hypertension, Table 2. There was strong evidence against the null hypothesis of no difference in marital status, occupation, level of education, family history of hypertension, and intensity of physical activity between participants with and without hypertension. There was weak evidence against the null hypothesis of no difference in exposure to wood smoke between participants with and without hypertension. There was a moderate positive correlation between BMI and abdominal circumference ($r = 0.60$, $p<0.001$).

Figure 2 displays the final multivariable logistic regression model (without abdominal obesity). There was strong evidence of a 34% increase in the odds of hypertension for every five-year increase in age (adjusted odd's ratio [AOR] = 1.34; 95% CI = 1.23 – 1.44; p<0.001). Family history of hypertension was associated with 2.22 times higher odds of hypertension (AOR = 2.22; 95% CI = 1.37 – 3.60; p<0.001). Obesity was associated with 2.57 times higher odds of hypertension (AOR = 2.57; 95% CI = 1.40 – 4.69; P_{trend} <0.001).

3.3 Awareness, treatment, and control of hypertension

Table 3 depicts the percentage of hypertension awareness, treatment, and control among our study participants. Of the 215 participants diagnosed with hypertension, 37.2% (95% CI = 31.0 – 43.9) were aware of their hypertensive status, while 20.9% (95% CI = 16.0 – 26.9) reported being on treatment for hypertension. Of the 45 participants who were on treatment for hypertension, 22.2% (95% CI = 12.2 – 37.0) had a controlled BP.

4. Discussion

We report a prevalence of hypertension of 40.9% (age-standardised prevalence = 23.9%) with associated low awareness, treatment, and control rates in the BHD. Older age, family history of hypertension and obesity were drivers of hypertension in this population.

4.1 Prevalence of hypertension and associated factors

The crude prevalence of hypertension in our study is higher than the crude prevalence of 33.9% and 31.1% in rural areas of the Far North Region [12] and South West Region of Cameroon [20], respectively. This higher prevalence of hypertension in our study can be attributed to the older age of our study population compared with those of previous studies. Indeed, the median age of our study participants was 53 years compared to a mean age of 39 year reported by Lemogoum *et al* [12]. In addition, over 65% of the participants in the study by Arrey *et al* were between 20-29 years old [20].

Older age is a strong determinant of hypertension. We noted a strong positive linear trend between older age and hypertension as has been observed in other studies in Cameroon [8, 12, 20, 21] and elsewhere [22]. Age-standardisation with Cameroon's population of 2011 permitted comparison of our results with those of Lemogoum *et al* [12]. The age-standardised prevalence of hypertension in our study was half of the crude prevalence, indicating the contribution of age in the overall crude prevalence in this study. The age-standardised prevalence in our study was lower than that reported by Lemogoum *et al* [12].

Differences in ethnicity, socioeconomic, and lifestyle factors could account for the variation in the prevalence of hypertension in our study compared to previous studies [8, 12, 20, 21]. Our study recruited participants from the Bamileke ethnic group. In a recent publication by Defo *et al*, participants recruited from this ethnic group had the highest prevalence of hypertension in Cameroon [23]. Our study suggests that genetic predisposition to hypertension is a significant determinant of hypertension in our study population as history of hypertension was associated with over two-times increase in the odds of hypertension. Differences in BMI can explain, in part, the variation in the prevalence of hypertension in this study compared to other studies reporting on the prevalence of hypertension in rural Cameroon [12, 20, 21]. Over 60% of our study participants had a BMI over the normal range, and there was a strong positive linear relationship between hypertension and BMI. Adiposity is a strong risk factor for hypertension and an important driver of the prevalence of hypertension [24].

In Cameroon, there has been a roll up in the prevalence of hypertension in the general population from 16.4% in 1998 [25] to 29.7% in 2015 [8], with recent projections estimating an increase of 40% by 2025 and 95% by 2035 [26]. The prevalence of hypertension in this study approximates prevalence of 47.5% and 41% reported in four urban areas in Cameroon in 2012 [11], and a rural community in South Africa [27], respectively. Such high prevalence of hypertension, especially among the elderly, in these rural communities warrants the need for further investigations to ascertain the burden of the disease and plan effective prevention and management strategies.

We found no independent association between hypertension and sex, education, marital status, and physical activity as has been reported in previous studies [12, 20].

4.2 Awareness, treatment, and control of hypertension

We report a low awareness rate and even lower treatment and control rates among patients with hypertension in these communities. This is in line with findings reported in rural areas of the Far North and South West regions of Cameroon [12, 20], and a meta-analysis by Ataklte *et al* [28]. In the Mafia Island of Tanzania, a low control rate of 20.5% was recorded despite the very high treatment rate [29]. This is in contrast to the relatively higher control rates (44.7%) reported in a rural community in Ghana [30].

The low awareness, treatment and control rates reported in this study could be explained by inadequate patient information of the disease, its risk factors, and consequences in the long run. Low awareness is a major barrier to effective management which can lead to the development of hypertension-related complications. A paucity of health care professionals at the primary health care level and the absence of a hypertension clinic at the district hospital in our study setting limits awareness, treatment, and control of hypertension in this population. Implementing policies to improve population education on hypertension and the importance of regular follow up by a trained nurse or physician to prevent long-term complications would vastly improve awareness, treatment and control of hypertension in this setting [31]. Other cost-effectiveness measures including the use of home BP monitoring could go a long way to improve adherence and control of hypertension in Cameroon [32].

5 Conclusion

About two in five participants in our study population had hypertension. The high prevalence of hypertension in this study was contrasted by low awareness, treatment, and control rates. In a bit to curb the burden of hypertension in Cameroon, national policies need to adopt measures to address obesity and its risk factors. Measures to improve awareness of hypertension like regular community education, diagnosis, treatments, and control could go a long way to reduce the burden of hypertension in this rural community.

Abbreviations

AOR: Adjusted odds ratio; BHD: Baham Health District; BMI: Body mass index; BP: Blood pressure; SD: Standard deviation; OR: odds ratio; UBaMSA: University of Bamenda Medical Students Association.

Acknowledgements

The authors are grateful for the invaluable contributions of all those who participated in the University of Bamenda Medical Student (UBaMSA) health campaign during the September 2018 edition. Also, we thank Miss Grace Heaton, a DPhil candidate in History at the University of Oxford, for proofreading our manuscript. Dr Agbor and Dr Noubiap are grateful to the University of Oxford and the University of Adelaide, respectively for supporting them with postgraduate scholarships.

Availability of data and materials

All data presented in the manuscript results are in possession of the corresponding author and will be made available on reasonable demand.

Authors' contributions

Study design and conception: LPS, VNA and JJN; data collection: LPS, OPN, PNS, AAF, JNM, NFB, HTG; data analysis and interpretation: VNA and LPS; manuscript drafting: LPS and VNA;

Revision of the manuscript: LPS, OPN, PNS, AAF, JNN, JNM, NFB, HTG. Critical revision: VNA, JJN and DM. All authors read and approved the final manuscript.

Ethics approval and consent to participate: Ethical approval was obtained from the Faculty of Health Sciences Institutional Review Board, the University of Bamenda (Project ID: 2018/0045H/UBa/IRB) and all participants provided written informed consent prior to recruitment to the study.

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Competing interests: The authors declare that they have no competing interests.

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Table 1. Sociodemographic characteristics of the study population

Participants' characteristics	Female N=353	Male N=173	Total N=526
Age (in years)[$]	54.0 (36.0-65.0)	50.0 (33.0-66.0)	53.0 (35.0-65.0)
age groups (in years)			
18-39	98 (27.8%)	59 (34.1%)	157 (29.8%)
40-59	120 (34.0%)	50 (28.9%)	170 (32.3%)
60 and over	135 (38.2%)	64 (37.0%)	199 (37.8%)
Marital Status (Married)	282 (79.9%)	121 (69.9%)	403 (76.6%)
Occupation			
High	11 (3.1%)	11 (6.4%)	22 (4.2%)
Medium	40 (11.3%)	73 (42.2%)	113 (21.5%)
Low	302 (85.6%)	89 (51.4%)	391 (74.3%)
Religion			
Baptist	9 (2.5%)	4 (2.3%)	13 (2.5%)
Catholic	190 (53.8%)	85 (49.1%)	275 (52.3%)
Muslim	4 (1.1%)	10 (5.8%)	14 (2.7%)
Others	76 (21.5%)	43 (24.9%)	119 (22.6%)
Pegan	5 (1.4%)	14 (8.1%)	19 (3.6%)
Presbyterian	69 (19.5%)	17 (9.8%)	86 (16.3%)
Level of education			
No formal education	100 (28.3%)	31 (17.9%)	131 (24.9%)
Primary	114 (32.3%)	41 (23.7%)	155 (29.5%)
Secondary	109 (30.9%)	74 (42.8%)	183 (34.8%)
Tertiary	30 (8.5%)	27 (15.6%)	57 (10.8%)
Family history of hypertension (Yes)	110 (31.2%)	31 (17.9%)	141 (26.8%)
Smoking status			
Non-smoker	334 (94.6%)	101 (58.4%)	435 (82.7%)
Ex-smoker	12 (3.4%)	37 (21.4%)	49 (9.3%)
Current smoker	7 (2.0%)	35 (20.2%)	42 (8.0%)
Alcohol units per week			
Non-drinker	122 (34.6%)	41 (23.7%)	163 (31.0%)
(0.01, 6.49]	164 (46.5%)	41 (23.7%)	205 (39.0%)
(6.49, 117]	67 (19.0%)	91 (52.6%)	158 (30.0%)
Body mass index (in kg/m^2)*	28.1 (5.4)	25.5 (4.4)	27.2 (5.2)
Body mass index categories			
Normal	100 (28.3%)	89 (51.4%)	189 (35.9%)
Overweight	157 (44.5%)	63 (36.4%)	220 (41.8%)
Obese	96 (27.2%)	21 (12.1%)	117 (22.2%)
Abdominal obesity (Yes)	215 (60.9%)	18 (10.4%)	233 (44.3%)
Systolic blood pressure (in mmHg)*	134.5 (25.9)	133.2 (21.3)	134.1 (24.5)
Diastolic blood pressure (in mmHg)*	83.0 (14.8)	83.1 (14.0)	83.0 (14.5)

[$] Summarised as median and interquartile range; * Data summarised as mean (standard deviation); N = frequency

Table 2: Factors associated with hypertension in the Baham Health District on univariate analysis

Participants' characteristics	No hypertension N=311	Hypertension N=215	Total N=526	p-value
Age group (in years)	42.0 (28.0-58.0)	64.0 (53.0-73.0)	53.0 (35.0-65.0)	<0.001[a,*]
Gender				0.370[b]
Female	204 (65.6%)	149 (69.3%)	353 (67.1%)	
Male	107 (34.4%)	66 (30.7%)	173 (32.9%)	
Marital Status				<0.001 [b,*]
Married	212 (68.2%)	191 (88.8%)	403 (76.6%)	
Single	99 (31.8%)	24 (11.2%)	123 (23.4%)	
Occupation				0.017 [b, *]
Low/unemployed	218 (70.1%)	173 (80.5%)	391 (74.3%)	
Medium	80 (25.7%)	33 (15.3%)	113 (21.5%)	
High	13 (4.2%)	9 (4.2%)	22 (4.2%)	
Religion				0.180 [b]
Baptist	11 (3.5%)	2 (0.9%)	13 (2.5%)	
Catholic	154 (49.5%)	121 (56.3%)	275 (52.3%)	
Muslim	11 (3.5%)	3 (1.4%)	14 (2.7%)	
Others	74 (23.8%)	45 (20.9%)	119 (22.6%)	
None	12 (3.9%)	7 (3.3%)	19 (3.6%)	
Presbyterian	49 (15.8%)	37 (17.2%)	86 (16.3%)	
Level of education				<0.001 [b,*]
None	55 (17.7%)	76 (35.3%)	131 (24.9%)	
Primary	81 (26.0%)	74 (34.4%)	155 (29.5%)	
Secondary	130 (41.8%)	53 (24.7%)	183 (34.8%)	
Tertiary	45 (14.5%)	12 (5.6%)	57 (10.8%)	
Family history of hypertension				0.002[b,*]
No	243 (78.1%)	142 (66.0%)	385 (73.2%)	
Yes	68 (21.9%)	73 (34.0%)	141 (26.8%)	
Smoking status				0.760[b]
Non-smoker	256 (82.3%)	179 (83.3%)	435 (82.7%)	
Ex-smoker	28 (9.0%)	21 (9.8%)	49 (9.3%)	
Current smoker	27 (8.7%)	15 (7.0%)	42 (8.0%)	
Exposure to wood smoke				0.048 [b,*]
≥ 4 days/week	200 (64.3%)	160 (74.4%)	360 (68.4%)	
< 4 days/week	75 (24.1%)	36 (16.7%)	111 (21.1%)	
Never	36 (11.6%)	19 (8.8%)	55 (10.5%)	
Alcohol units per week				0.510 [b]

Non-drinker	92 (29.6%)	71 (33.0%)	163 (31.0%)	
(0.01, 6.49]	120 (38.6%)	85 (39.5%)	205 (39.0%)	
(6.49, 117]	99 (31.8%)	59 (27.4%)	158 (30.0%)	
Daily consumption of vegetable per week	1.0 (1.0-2.0)	1.0 (1.0-2.0)	1.0 (1.0-2.0)	0.230[a]
Daily consumption of fruit per week	4.0 (2.0-6.0)	2.0 (2.0-4.0)	2.0 (2.0-6.0)	<0.001[a,*]
Intensity of daily physical activity				<0.001 [b,*]
Low	134 (43.1%)	134 (62.3%)	268 (51.0%)	
Moderate	123 (39.5%)	72 (33.5%)	195 (37.1%)	
Vigorous	54 (17.4%)	9 (4.2%)	63 (12.0%)	
Body mass index categories				0.053 [b]
Normal	119 (38.3%)	70 (32.6%)	189 (35.9%)	
Overweight	134 (43.1%)	86 (40.0%)	220 (41.8%)	
Obese	58 (18.6%)	59 (27.4%)	117 (22.2%)	
Abdominal obesity				<0.001[b, *]
Yes	115 (37.0%)	118 (54.9%)	233 (44.3%)	
No	196 (63.0%)	97 (45.1%)	293 (55.7%)	

[a]P-value from Wilcoxon rank sum test, [b] P-value from Chi-square test.

Table 3. Awareness, treatment and control of hypertension, Baham Health District, 2018

	Frequency	Percentage (95% CI)
Hypertension awareness (N=215)	80	37.2 (31.0 – 43.9)
Hypertension treatment (N=215)	45	20.9 (16.0 – 26.9)
Treated and controlled (N=45)	10	22.2 (12.2 – 37.0)

N = Frequency, CI = confidence interval

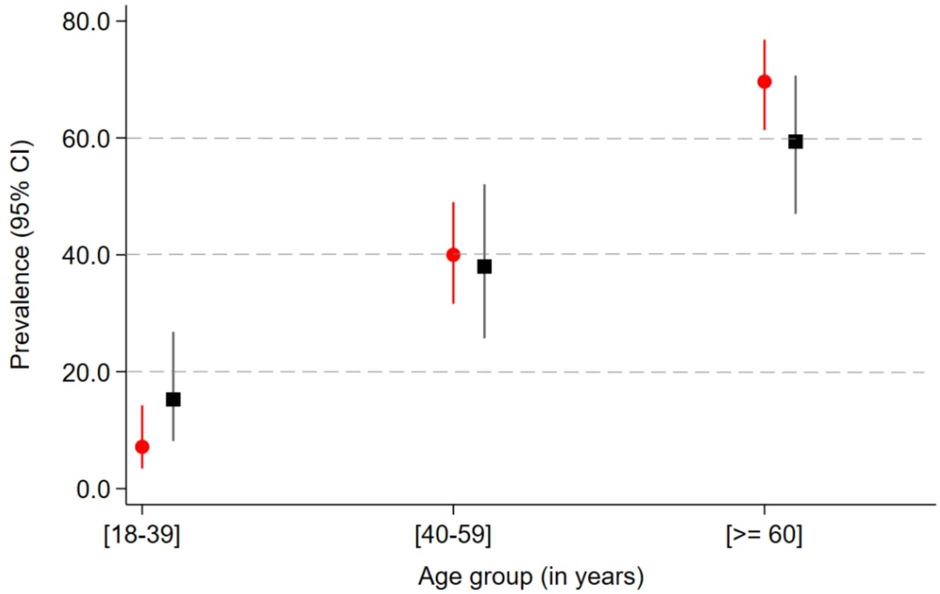

Figure 1: Prevalence (and 95% confidence interval [CI]) of hypertension stratified by age and gender. The red circle and black square represent the point estimate of the prevalence for females and males, respectively. The spikes represent the limits of the 95% CI.

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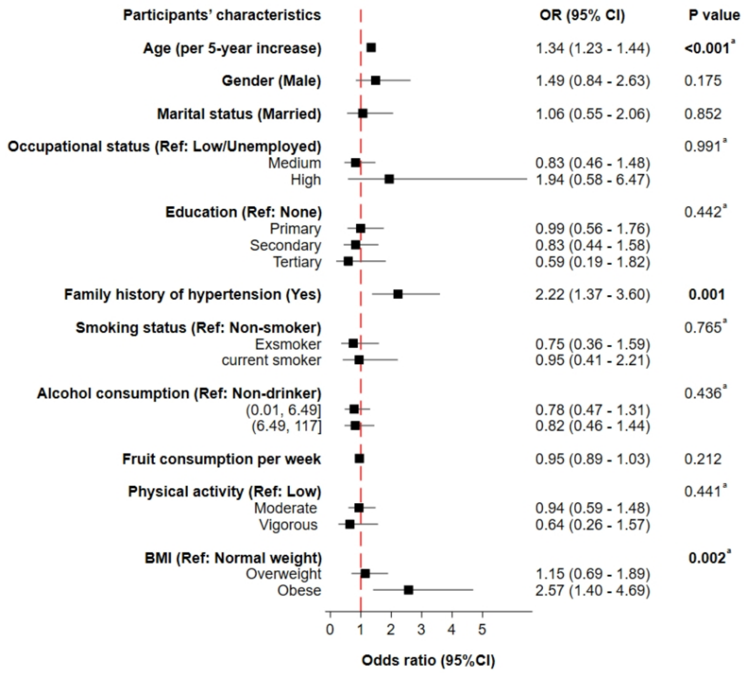

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STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No	Recommendation
Title and abstract **[Page 1-2]**	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale **[Page 4]**	2	Explain the scientific background and rationale for the investigation being reported
Objectives **[Page 4]**	3	State specific objectives, including any prespecified hypotheses
Methods		
Study design **[Page 5]**	4	Present key elements of study design early in the paper
Setting **[Page 5-7]**	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants **[Page 5]**	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case
Variables **[Page 6-8]**	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement **[Page 6-8]**	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group
Bias **[Page 4]**	9	Describe any efforts to address potential sources of bias
Study size **[Page 5]**	10	Explain how the study size was arrived at
Quantitative variables **[Page 7]**	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods **[Page 8]**	12	(*a*) Describe all statistical methods, including those used to control for confounding
		(b) Describe any methods used to examine subgroups and interactions
		(c) Explain how missing data were addressed
		(d) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy

(e) Describe any sensitivity analyses

Results

Participants [Page 9]	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed
		(b) Give reasons for non-participation at each stage
		(c) Consider use of a flow diagram
Descriptive data [Page 9-10]	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) Indicate number of participants with missing data for each variable of interest
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data [Page 9-10]	15*	*Cohort study*—Report numbers of outcome events or summary measures over time *Case-control study*—Report numbers in each exposure category, or summary measures of exposure
		Cross-sectional study—Report numbers of outcome events or summary measures
Main results [Page 9-10]	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included
		(*b*) Report category boundaries when continuous variables were categorized
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period
Other analyses [NA]	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses

Discussion

Key results [Page 10]	18	Summarise key results with reference to study objectives
Limitations [Page 3]	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation [Page 10-12]	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability [Page 10-12]	21	Discuss the generalisability (external validity) of the study results

Other information

Funding [Page 13]	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.