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Original Article

Selected Cardiometabolic Risk-factor Clusters of Urban Hypertensive Adults in Response to 72-hour ABU Radio Frequency Modulated (F.M.) Call for Free-medical Screening

Obiageli Uzoamaka Onyemelukwe[1,2*], Bilkisu Bello Maiha[2], Lydia Ojonemile Ayanwuyi[2], Tukur Dahiru[3], Nana Hawwa Madugu[4], Mohammed Aliyu[4], Idayat Folashade Mudashir[2,4], Rahman Khaleequr[4], Chetachi Chukwuka Chukwumerije[4], Usman Abubakar Adamu[4], Lilian Okwubenata Okonkwo[1], Innocent Onoja Okpe[1], Adamu Girei Bakari[1]

[1]*Department of Medicine, Ahmadu Bello University Teaching Hospital, Zaria, NIGERIA.*
[2]*Department of Pharmacology and Therapeutics, Faculty of Pharmaceutical Sciences, Ahmadu Bello University, Zaria, NIGERIA.*
[3]*Department of Community Medicine, Faculty of Medicine, Ahmadu Bello University, Zaria, NIGERIA.*
[4]*Ahmadu Bello University Medical Centre, Zaria, NIGERIA.*

ABSTRACT

Objective: It sought to determine the prevalence of Cardiometabolic risk factor clusters (CMRFCs) and their association with uncontrolled hypertension among urban hypertensive subjects who responded to a free health screening radio announcement. **Methods:** This cross-sectional epidemiologic study randomly selected 200 previously diagnosed hypertensive subjects aged ≥ 30 years. CMRFCs included hypertension in addition to obesity, prediabetes/diabetes, smoking and alcohol intake. Independent Student's *t*-test determined the difference in numerical variables between sexes. Cardiometabolic risk associations were determined via Binary Logistic Regression analysis. **Results:** Of the 180 who met inclusion, 72.2% were females with mean age of 50.4±9.3 years. About 1 in every 4 subjects (22.2%) had diabetes of which 62.5% were undiagnosed. Almost 2 of every 5 subjects (38.9%) had prediabetes. Almost half (42.2%) had BMI ≥30 kg/m^2 with central obesity identified in 78.3%. The mean SBP was 145.7±18.4 mmHg with DBP of 91.8±12.1 mmHg. Uncontrolled hypertension was found in 90.6% and 73.3% for systolic and diastolic respectively. Most (71.7%) had >1 CMRFC associated with uncontrolled systolic hypertension while almost half (42.2%) had same associated with uncontrolled diastolic hypertension. The overall mean prevalence of CMRFC was 49.6%. Significant association was found between male sex (p=0.01) and systolic/diastolic hypertension; prediabetes/diabetes (p=0.01), overweight/obesity (p=0.04) with diastolic hypertension and alcohol intake (p=0.02) with systolic hypertension. **Conclusion:** This study shows that there is a high prevalence of cardiometabolic risk factor clusters amongst hypertensive urban-dwellers in Northern-Nigeria. Combined overweight/obesity, prediabetes/diabetes, male sex and alcohol were significantly associated with uncontrolled hypertension.

Key words: Cardiometabolic risk-factor clusters, Hypertensive, Urban dwellers, Free medical screening, Northern-Nigeria..

Correspondence
Dr. Obiageli Uzoamaka Onyemelukwe
Department of Medicine, Ahmadu Bello University Teaching Hospital, Shika, Zaria, NIGERIA.
Ph.no: +234 8129930000
E-mail address: obiageliuo629@gmail.com

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INTRODUCTION

Cardiometabolic risk is a recent entity that transcends metabolic syndrome/syndrome-X/Raeven's syndrome to encompass established traditional modifiable and emerging risk factors associated with a propensity towards cardiovascular diseases (CVD) like stroke, myocardial infarction, peripheral vascular disease as well as metabolic diseases like type-2 diabetes mellitus.[1] These risk factors includes elevated blood pressure, abdominal adiposity, dyslipidaemia {elevated triglycerides (TG), low density lipoprotein cholesterol (LDL-C) and decreased high density lipoprotein cholesterol (HDL-C)}, smoking, inflammatory markers and insulin resistance.[2] Cardiometabolic risk is not restricted to multiple risk factors but extends to involve multiple physiologic systems of which the endocrine system is pivotal to the cardiometabolic risk model.[3] Abdominal obesity which contains adipose tissues previously thought to be inert storage depots is regarded as an endocrine organ as it secretes signalling molecules like tumour necrosis factor-alpha (TNF-á), C-reactive protein (CRP), interleukin-6 (IL-6), myriads of anti-insulinic hormones and adipokines associated with insulin resistance and cardiovascular events.[3]

Globally, there is a rising trend in cardiometabolic risk associated with increasing morbidity and mortality, more so in low-middle income countries like in the sub-Saharan Africa: Nigeria being the giant of Africa.[4] This is attributable to "Globalization and rapid urbanization" as the search for greener pastures and more enticing socio-economic opportunities rises as well as "Westernization" inclusive of poor dietary habits, excessive smoking, alcoholism, sedentary lifestyle/lack of physical activity and psychosocial stress.[4,5] Additionally, there is demographic transition associated with progressively ageing population in countries like Nigeria as well as epidemiologic transition as the battle against communicable diseases is competing with the rising burden of non-communicable diseases like diabetes, hypertension and CVD's.[6,7] Consequently, the emergence of these cardiometabolic risk factors and its attendant increased morbidity and mortality is a cause for alarm as it poses significant health-care burden in Nigeria.[6] More so, hypertensive population are particularly vulnerable to cardiometabolic risk hence optimal reduction of such risk is imminent.[8]

Hypertension is a major risk factor for arteriosclerotic cardiovascular diseases affecting one billion people globally as at the year 2000 with projection of 1.56 billion by 2025.[9,10] With the recent re-definition of hypertension to blood pressure of 130/80 mmHg, the prevalence of hypertension in the United States has risen to 46% as against 32% with the previous definition.[11] It was barely existent in African societies in the first half of the twentieth century however in the recent past, it has been shown that in some African settings; more than 40% of adults have hypertension.[10] Furthermore, there is evidence showing that hypertensive related complications, particularly stroke and heart failure, are becoming more rampant in the sub-Saharan Africa.[10] In Nigeria, the prevalence of hypertension was rated 11% by the Nation-wide non-

communicable disease (NCD) survey as far back as the nineties with partition limits of hypertension in that survey being BP>160/90 mmHg.[11] Adeloye *et al.* reported a review and meta-analysis of pooled prevalence of hypertension in Nigeria in the range of 22.5%-28% with higher urban prevalence of 30.6% and rural prevalence of 26.4%.[12] This rising trend may be attributed to poor detection, treatment and control rates in addition to lifestyle changes of Africans inclusive of an increase in tobacco use, excessive alcohol consumption, obesity, lack of exercise and adoption of "Western" lifestyle and diets that are high in salt, refined sugar, unhealthy fats and oils and low fibre.[10,13-14] Furthermore, regardless of the varied non-pharmacological and pharmacological approaches to hypertension therapy, blood pressure control rates fail to meet expected targets globally.[15] Asides several factors mentioned earlier, the association of hypertension with metabolic disorders like obesity, diabetes and dyslipidaemia may be contributory to greater difficulty in blood pressure control coupled with the fact that these metabolic disorders are individually associated with adverse cardiovascular outcomes.[16]

Opportunistic screening and awareness campaigns have been recommended by the World Heart Federation as the first line key steps in improving management and prevention of cardiovascular diseases.[14,17] The 2013-2020 World Health Organisation (WHO) global action plan targeted at the prevention and control of non-communicable diseases highlighted the importance of monitoring cardiometabolic risk profile of the population.[14,18] Systematic studies incorporating random risk profile screening programs in health care facilities in both rural and urban Nigerian communities were initiated to encourage healthier lifestyle of which the Africa and Middle East Cardiovascular Epidemiological Study (ACE) is one of such.[6] Furthermore, there are few studies emanating from Northern part of the country on cardiometabolic risk profile assessment in hypertensive subjects[19,20] with previous reports from the Southern part of the country[21-23] as well as meta-analysis and reports cutting across the geopolitical zones of Nigeria.[6,24] This study was therefore aimed at determining the prevalence of selected cardiometabolic risk among hypertensive adults who responded to a 72 hr radio FM call for free medical attention and cardiovascular screening at Zaria, Nigeria and to evaluate its association with hypertension.

MATERIALS AND METHODS

Research Design

It was a community-based cross-sectional epidemiologic study carried out on the 29th December 2015 among 200 randomly selected hypertensive adults presenting at the venue of the study which was the large conference Hall of the Ahmadu Bello University (ABU) Medical Centre, Zaria. Permission was obtained from the Medical Director of ABU Medical Centre and Ethical Clearance from the HREC, Ministry of Health, Kaduna. The study was carried out in accordance with the Helsinki's declaration and all participants gave written informed consent.

Inclusion and Exclusion Criteria

Inclusion criteria were adult hypertensive subjects above 30 years with willingness to participate, prior physician diagnosis of hypertension (BP≥140/90 mmHg), current use of antihypertensive medications and fasting state within 8-12 hrs of the previous day. Exclusion criteria included patients with historical and clinical evidence of renal failure; historical and clinical evidence of heart failure, liver failure or stroke, pregnancy as well as subjects with incomplete data. Subjects with known endocrine disorders like historical and clinical evidence of Cushing's syndrome, polycystic ovarian syndrome or thyroid disorders were also excluded.[25]

Screening and Data Collection

Consecutively, a total of 200 randomly selected adult hypertensive subjects were prospectively screened at the large conference Hall of the ABU Medical Centre on the 29th of December 2015 in response to an Ahmadu Bello University (ABU) FM radio announcement done by the author on the 26th of December 2015 and re-echoed by the radio station from 26th to the early morning hours of 29th December, 2015. The content of the radio announcement was a 30 mins brief talk on hypertension: definition, burden of the disease, causes/risk factors, complications, lifestyle measures in its prevention and control and most importantly need for regular screening, treatment and follow-up. An invitation was also made to all adult hypertensive subjects living in Zaria for free medical screening inclusive of anthropometry {weight, height, body mass index (BMI), waist circumference (WC)}; free blood pressure check; free blood glucose screening; free health education talk; free medical therapy as well as free drug delivery. Emphasis was also made on the need to come in a fasted state by 7 a.m. on the 29th of December at the venue being the ABU Medical Centre Hall ensuring their last meal did not exceed 10 p.m. Posters were also another means of communication which was placed at strategic positions within ABU main campus, the primary health care facility in Samaru, Graceland, Zango and Hanwa.

By 7 a.m. on the designated day, there was a large crowd of people about 250 waiting to be screened. Of these, 200 hypertensive subjects were randomly selected. Most of the subjects attested to have received the information via radio announcement. The subjects were given code numbers once they met eligibility criteria. They were also divided into 2 batches of 100 subjects each taking into cognisance those that had fasted. The first batch was screened on "Day 1" while the second batch was asked to return on "Day 2" within the subsequent week in 2016 for their screening in a fasted state. Their phone numbers and residential addresses were obtained and they were followed up with phone calls and text messages as reminders. Some subjects were also gotten from the medical out-patient department (MOPD) of ABUTH, Zaria. Free anti-hypertensive drugs contributed by free will donation of MicroNova Pharmaceuticals Industries Nigerian Ltd. were given to the subjects who could not afford medications as well as free health talks. Those who did not meet eligibility criteria were excluded but attended to medically and given referrals to the tertiary hospital in town.

A standard well-structured questionnaire was interviewer-administered to each eligible study participant by 5 trained senior medical doctors inclusive of the author. This included record of the subjects' bio-data (address, age, sex, tribe, highest educational level, marital status and religion); prior physician diagnosis of hypertension, duration of hypertension, drug treatment of hypertension and drug compliance; prior physician diagnosis of diabetes and duration of diabetes; family history of hypertension, diabetes, dyslipidaemia, sudden cardiac death or stroke; history of alcohol and cigarette smoking and 24 hr dietary recall.

Anthropometric measurements {waist circumference (WC), weight, height and body mass index} as well as blood pressures were determined in accordance with the standard protocol approved by World Health Organisation (WHO).[26-27] This was carried out by a team of trained health professionals inclusive of 8 nursing officers, 5 senior medical doctors and 2 community health extension workers. The WC was measured at the end of several consecutive natural breaths following end of normal expiration, at a level parallel to the floor, midpoint between the top of the iliac crest and the lower margin of the last palpable rib in the mid axillary line.[26] This was done with a non-stretch one cm wide measuring tape that was wrapped snugly around the subject without constricting effect, with the tape level and parallel to the floor at the measurement point.[26] The subjects were standing upright during the measurement, with their arms relaxed at their side, feet spread evenly

apart and body weight evenly distributed. The partition limits for WC in determining central obesity were >80 cm for females and >94 cm for males as recommended by the International Diabetes Federation[28] which is also the threshold for sub-Saharan ethnicity recommended by the Joint Scientific Statement on Harmonizing the Metabolic Syndrome.[29]

The weight was measured in Kilogram (kg) with the subjects standing motionless on the calibrated weighing scale placed on a firm flat ground while wearing light clothing and without foot wear. Measurements were approximated to the nearest 0.5 kg having ensured the weighing scale was always at 'zero' mark. The height was measured in meters approximated to the nearest 0.5 cm with the subject in erect posture against a vertical scale stadiometer without foot wear or cap and with feet together on a horizontal flat surface; with occiput and heels in contact with the stadiometer.[27] The Body mass index (BMI) was determined as weight (kg)/height^2 in kg/m^2.[30] BMI was classified into underweight (BMI <18 kg/m^2); normal (BMI 18-24.9 kg/m^2); overweight (BMI 25-29.9 kg/m^2); class I obesity (BMI 30-34.9 kg/m^2); class II obesity (BMI 35-39.9 kg/m^2) and class III obesity (BMI >40.0 kg/m^2).

Blood pressures were measured by standard protocol using Accoson Mercury Sphygmomanometer, taken initially in both arms and the arm with the higher pressure used. Subsequently, this was taken twice from comfortably seated subjects previously rested for 5 mins, with feet on the floor, arm at the level of the heart and free from any tight clothing. The mean of the two readings was used.[27] Hypertension was defined from self-reported history, SBP ≥ 140 mmHg or DBP ≥ 90 mmHg or current use of anti-hypertensive therapy.[27] For the purpose of this study, uncontrolled BP was defined as systolic blood pressure SBP ≥ 130 mmHg or diastolic blood pressure DBP ≥85 mmHg as recommended by the IDF for diagnosis of metabolic syndrome.[28]

Preliminary fasting blood glucose were also assessed for all subjects using accu-check glucometer which had been previously standardized with the Chenray 120 automated clinical chemistry auto-analyser in the Chemical pathology laboratory of Ahmadu Bello University Teaching Hospital (ABUTH), Zaria.

Blood Sample Collection

Blood samplings for fasting blood glucose (FBG) were obtained from the ante-cubital vein of either arm using aseptic procedures following an overnight fast. Five millilitres (5 ml) of venous blood was collected in fluoride oxalate bottles and the test tubes were taken to the Chemical pathology laboratory of the ABUTH, Zaria within 4 hrs of collection and centrifuged at 1800 RPM for 20 mins. The serum was separated and placed in cryovials for storage at -70°C till analysis by the glucose oxidase method. The partition limits for dysglycaemia were 100-125 mg/dL or 5.55-6.94 mmol/L (Impaired fasting glucose/pre-diabetes) and ≥126 mg/dL or 6.99 mmol/L (diabetes). Subjects with self-reported history of diabetes or use of anti-hyperglycaemic agents or fasting glucose ≥126 mg/dL or 6.99 mmol/L were considered to have diabetes, while subjects with FBG of 100-125 mg/dL or 5.55-6.94 mmol/L were considered to have impaired fasting glucose or pre-diabetes.

Selected Cardiometabolic Risk Assessed

For the purpose of this study, six modifiable risk factors were assessed in the hypertensive subjects inclusive of uncontrolled hypertension, diabetes/pre-diabetes, BMI, abdominal obesity, smoking and alcohol intake.

The metabolic syndrome was defined with respect to the International Diabetes Federation (IDF) consensus criteria:[28] Central obesity plus any two of the following viz-a-viz: raised BP ≥130/85 mmHg or treatment of previously diagnosed hypertension; raised fasting plasma glucose (FPG) ≥100 mg/dL or 5.55 mmol/L or previously diagnosed type 2 diabetes; raised triglyceride levels ≥150 mg/dL (1.7 mmol/L) or specific treatment of the lipid abnormality; reduced High Density Lipoprotein-Cholesterol (HDL-C) <40 mg/dL (1.03 mmol/L) in men and <50 mg/dL (1.29 mmol/L) in women or specific treatment of this lipid abnormality.

Data Analysis

Data was validated on excel and analysed by the Statistical Package for Social Sciences, SPSS version-16 software (SPSS Inc., Chicago, IL, USA). Incomplete/missing data were excluded. Numerical data was checked for normality of data distribution by Shapiro-Wilks test and was found to be normally distributed. Categorical variables such as educational level, tribe, resident area, anti-hypertensive drug, smoking and alcohol history were presented as frequencies and percentages with difference between male and female determined by Chi square (X^2). Descriptive statistics was done to estimate the prevalence of cardiometabolic risks such as prediabetes, diabetes, smoking, alcohol, abdominal obesity, uncontrolled hypertension and BMI amongst the hypertensive subjects. The numerical variables such as age, SBP, DBP, Fasting blood glucose FBG, WC, weight, height, Body mass index BMI were presented as mean ± SD and the difference between male and female subjects was determined by Independent Student's *t*-test. Systolic blood pressure was recoded into a different variable viz-a-viz: 0 if <130 mmHg and 1 if >130 mmHg; diastolic blood pressure was grouped as 0 if <85 mmHg and 1 if >85 mmHg based on the IDF criteria.[28] BMI was recoded as 1 if normal (<25kg/m^2) and 2 if overweight (>25 kg/m^2) as well as 1 if not obese (<30 kg/m^2) and 2 if obese(>30 kg/m^2); age was recoded as 1 if <45 years and 2 if >45 years; alcohol, smoking, history of hypertension and diabetes as well as family history of same were recoded as 1 if response was "Yes" and 2 if "No"; FBG was recoded as 1 if <5.55 mmol/L (normal) and 2 if ≥ 5.55 mmol/L (combined prediabetes/diabetes) as well as 1 if <6.99 mmol/L (combined normal/prediabetes) and 2 if >6.99 mmol/L (diabetes); WC was recoded for female as 1 if >80cm and 2 if <80 cm and for male as 1 if >94 cm and 2 if <94 cm. The association between cardiovascular risks (age, sex, alcohol, smoking, recoded BMI, recoded WC, history of hypertension, history of diabetes, family history of hypertension, family history of diabetes, pre-diabetes and diabetes via recoded FBG) and SBP/DBP was determined using the multiple Binary Logistic Regression analysis. The level of significance was assumed to be $p \leq 0.05$ at 95% confidence interval.

RESULTS

Subject Participation

Out of a total of 250 subjects that presented at the ABU Medical Centre conference hall and MOPD of ABUTH, Zaria, 200 hypertensive subjects were randomly selected and underwent screening. Of these, 180 met the inclusion criteria, were enrolled, given code numbers and had complete data which was analysed. Twenty subjects were excluded: 4 on account of previous history of hypertensive stroke with residual deficit; 2 on account of heart failure; 2 on account of early pregnancy; 6 on account of being newly diagnosed within 2 weeks not on any anti-hypertensive therapy and 6 due to incomplete data (Figure 1).

General Socio-demographic Characteristics and Overall Profile of the Study Population

Table 1 depicts the socio-demographic characteristics of the study population. A total of 180 hypertensive subjects were studied consisting of 27.8% (50) males and 72.2% (130) females. Overall mean age was 50.4 ± 9.3 years with greater proportion being middle aged, among whom 57.8% (104) were from Hayin Dogo, Samaru and ABU main campus; 16.7% (30) came from Graceland, Zango, Basawa, Kwangila and Hanwa; 11.1% (20) came from Shika; 8.9% (16) from Sabon-Gari and 5.6% (10) from Wusasa resident areas of Zaria (Figure 2). All (100%)

Table 1: Socio-demographic Characteristics and Overall Profile of the Study Population

Variables	Males (*n*=50)	Females (*n*=130)	Total (*n*=180)	*P*-value
Sex	50(27.8%)	130(72.2%)	180(100%)	
Age	53.2 ± 9.5	49.3 ± 9.0	50.4 ± 9.3	0.02*
Young (30-45 years)	10(5.6%)	38 (21.1%)	48(26.7%)	0.04*
Middle Age (45-65years)	34(18.9%)	88(48.9%)	122(67.8%)	
Elderly(> 65 years)	6(3.3%)	4(2.2%)	10(5.6 %)	
Tribe				
Hausa	22(12.2%)	70(38.9%)	92(51.1%)	0.07
Yoruba	9(5%)	12(6.7%)	21(11.7%)	
Igbo	1(0.6%)	13(7.2%)	14(7.8%)	
Others	18(10%)	35(19.4%)	53(29.4%)	
Level of Education				
Primary	10(5.6%)	32(17.8%)	42(23.3%)	0.002**
Secondary	5(2.8%)	23(12.8%)	28(15.6%)	
Tertiary	17(9.4%)	20(11.1%)	37(20.6%)	
Post-Graduate	6(3.3%)	8(4.4%)	14(7.8%)	
No Formal Education	10(5.6%)	49(27.2%)	59(32.8%)	
Duration of Hypertension				
<5 years	27(15.1%)	78(43.6%)	105(58.7%)	0.77
5-10 years	13(7.3%)	28(15.6%)	41(22.9%)	
>10 years	9(5%)	24(13.4%)	33(18.4%)	
Family History of Hypertension				
No	22(12.2%)	64(35.6%)	86(47.8%)	0.53
Yes	28(15.6%)	66(36.7%)	94(52.2%)	
History/Duration of Diabetes				
No	45(25.0%)	120(66.7%)	165(91.6%)	0.31
Yes	5(2.8%)	10(5.6%)	15(8.3%)	
<5 years	3(1.7%)	7(3.9%)	10(5.6%)	
5-10 years	2(1.1%)	3(1.7%)	5(2.8%)	
>10 years	0(0.0%)	0(0.0%)	0(0.0%)	
Family History of Diabetes				
No	41(22.8%)	107(59.4%)	148(82.2%)	<0.001***
Yes	9(5%)	23(12.8%)	32(17.8%)	
Alcohol History				
No	42(23.3%)	125(69.4%)	167(92.8%)	0.005**
Yes	8(4.4%)	5(2.8%)	13(7.2%)	
Smoking History				
No	45(25.0%)	127(70.6%)	172(95.0%)	0.025*
Yes	5(2.8%)	3(1.7%)	8(4.4%)	

Difference determined by X^2.*$p<0.05$ is the level of significance. **$p<0.01$ is significant.***$p<0.001$ is significant.

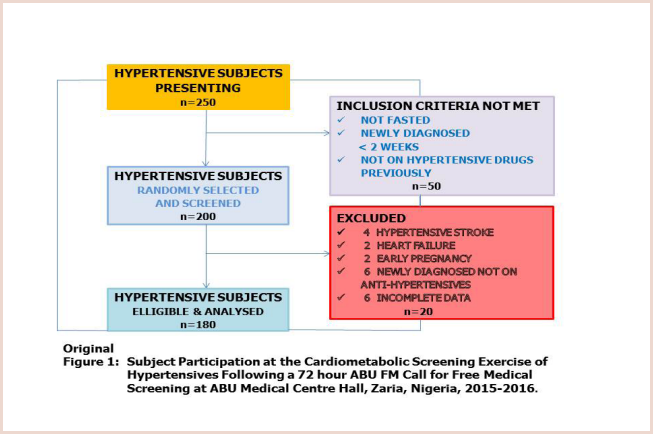

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Figure 1: Subject Participation at the Cardiometabolic Screening Exercise of Hypertensives Following a 72 hour ABU FM Call for Free Medical Screening at ABU Medical Centre Hall, Zaria, Nigeria, 2015-2016.

Figure 1: Subject Participation at the Cardiometabolic Screening Exercise of Hypertensives Following a 72 hr ABU FM Call for Free Medical Attention/Screening at ABU Medical Centre Hall, Zaria, 2015-2016.

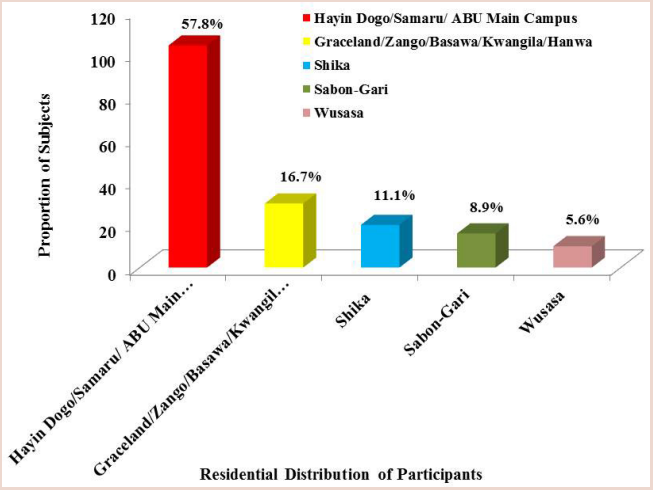

Figure 2: Distribution of Subjects according to Residential Areas in Zaria.

of the study population were urban dwellers. There were more literate and semi-literate subjects, 67.2% (121) than those who had no formal education, 32.8% (59). There were more females, 27.2% (49) having no formal education than males, 5.6% (10), p=0.002 (Table 1). Of the literate/semi-literate subjects, 22.8% (41) had primary school education, 20.6% (37) had tertiary education and 16.1% (29) had secondary education while 7.8% (14) were post-graduates. There were predominantly Hausa and Hausa-Fulani tribe consisting of 51.1% (92) followed by other minority tribes, 29.4% (53) inclusive of Tiv, Idoma, Ebera, Urhobo, Nupe, Ninzo, Jaba, Miango, Birom, Jukun, Adara, Dankaka, Kagoma, Zuru, Barbara, Guchi, Kataf and Southern Kaduna. There were 11.7% (21) Yoruba's and 7.8% (14) Igbos (Table 1).

There were 52.2% (94) with a family history of hypertension and 47.8% (86) with no such family history. A larger proportion, 58.3% (105) had hypertension for a duration of <5 years, while 23.3% (42) had hypertension for a duration of 5-10 years and 18.3% (33) had it for >10 years. There were 91.6% (165) of the hypertensive subjects without a history of diabetes mellitus while 8.3% (15) had a positive history viz: 5.6% (10) for < 5 years and 2.8% (5) for 5-10 years. Regarding family history of diabetes, there were 82.2% (148) with no such family history and 17.8% (32) with a family history (Table 1).

Most of the hypertensive subjects, 58.3% (105) were on two or more blood pressure medications while 41.7% (75) were on single anti-hypertensive therapy (*Data not shown*). Majority, 52.8% (95) were on Calcium channel blocker (CCB) combination therapy with either an Angiotensin converting enzyme inhibitor (ACE I)/Angiotensin receptor blocker (ARB), diuretic, β-blocker or a centrally acting agent (Table 2). The diuretics were frequently used, 48.3% (87) followed by the ACE I/ARB's, 34.4% (62) as combination therapy. The most commonly used single anti-hypertensive agent was the diuretics, followed by the CCB's then ARB's (Table 2). There were 11.7% (21) who were not sure of their medication history (Table 2).

Despite the major proportion on two or more anti-hypertensives, 90.6% (163) still had their systolic blood pressures uncontrolled above 130 mmHg and in the range of >130 to 200 mmHg with mean SBP of 145.7 ± 18.4 mmHg (Table 2). When the partition limit for systolic hypertension was applied at 140 mmHg, there were still 72.8% (131) of the hypertensive subjects who had their SBP above 140 mmHg. Similarly, 73.3% (132) hypertensive subjects had their DBP above 85 mmHg and in the range of >85 to 130 mmHg with mean DBP of 91.8 ± 12.1 mmHg. Further application of partition limit for diastolic hypertension at 90 mmHg showed that 71.7% (129) still had their DBP above 90 mmHg.

Amongst the hypertensive subjects, 41.1% (74) had impaired fasting blood glucose while 17.8% (32) had diabetes. The mean FBG was 6.0 ± 1.5 mmol/L. There were 8.3% (15) of the hypertensive subjects who attested to having a history of previously diagnosed diabetes. Of these, 46.7% (7) had their blood glucose uncontrolled beyond 6.99 mmol/L; 26.7% (4) had their blood glucose within the impaired fasting blood glucose (5.55-6.94 mmol/L) as well as normal ranges (<5.55 mmol/L) respectively. The total number of diabetes subjects was therefore 22.2% (40). There were 62.5% (25) of the diabetes subjects who were undiagnosed diabetes (*Data not shown*). The actual number of prediabetes/impaired fasting glucose subjects was therefore 38.9% (70).

The mean BMI was 29.1 ± 5.3 kg/m^2 with significantly (p<0.001) higher levels in females compared to males. There were 33.3% (60) overweight subjects and 42.2% (76) obese subjects. The totality of combined overweight/obese subjects via BMI was 75.5% (136) (Table 2). With regards to central obesity, 52% (26) of males had their WC above 94 cm while 88.5% (115) of females had their WC above 80 cm with a total of 78.3% (141) of both males and females with abnormal waist circumference or central obesity (Table 2).

Figure 3 shows the distribution of cardiometabolic risk factors amongst hypertensive subjects with uncontrolled blood pressure >130/85 mmHg. Out of the 90.6% (163) hypertensives with uncontrolled systolic blood pressure (SBP), there were 71.7% (129) who had central obesity; 33.9% (61) with impaired fasting glucose (FBG > 5.55 mmol/L); 16.7% (30) with diabetes (FBG > 6.99 mmol/L); 70% (126) who were overweight and obese (BMI > 25 kg/m^2); 39.4% (71) with overall obesity (BMI > 30 kg/m^2); 6.7% (12) who took alcoholic beverage and 3.9% (6) who smoked (Figure 3). Likewise, out of the 73.3% (132) hypertensive subjects with uncontrolled diastolic blood pressure (DBP), there were 42.2% (76) who had central obesity; 28.9% (52) with impaired fasting glucose; 11.1% (20) with diabetes; 58.3% (105) who were overweight and obese; 32.2 % (58) with overall obesity and 3.3% (6) with history of alcohol intake and smoking respectively (Figure 3).

Based on the IDF criteria for diagnosis of metabolic syndrome which is a cardiometabolic risk, this study showed that there were more than half

Table 2: Clinical and Laboratory Parameters of the Hypertensive Study Population

Variables	Males (*n*=50)	Females (*n*=130)	Total (*n*=180)	*P*-value
Systolic Blood Pressure (mmHg)	**142.9 ± 20.9**	**146.7 ± 17.4**	**145.7 ± 18.4**	0.25
<130 mmHg	9(5.0%)	8(4.5%)	17(9.5%)	0.02*
>130 mmHg	41(22.8%)	122(67.8%)	163(90.6%)	
Diastolic Blood Pressure (mmHg)	**90.1 ± 14.6**	**92.4 ± 12.1**	**91.8 ± 12.9**	0.32
<85 mmHg	19(10.6%)	29(16.1%)	48(26.7%)	0.03*
>85 mmHg	31(17.2%)	101(56.1%)	132(73.3%)	
Fasting Blood Glucose (mmol/L)	**6.1 ± 1.4**	**6.0± 1.6**	**6.0± 1.5**	0.71
Normal (<5.5 mmol/L)	19(10.6%)	55(30.6%)	74(41.1%)	0.20
IFG (5.55-6.94 mmol/L)	18(10.0%)	56(31.1%)	74(41.1%)	
Diabetes (>6.99 mmol/L)	13(7.2%)	19(10.6%)	32(17.8%)	
Weight (kg/m^2)	**74.6 ± 13.2**	**75.7 ± 15.3**	**75.6 ±14.7**	0.65
Height (m)	**1.7 ± 0.9**	**1.6± 0.1**	**1.6 ± 0.1**	<0.001**
Body Mass Index (kg/m2)	**26.9 ± 4.1**	**30.0 ± 5.5**	**29.1 ± 5.3**	<0.001**
Normal (<25 kg/m^2)	17(9.4%)	27(15.0%)	44(24.4%)	0.014*
Overweight (25-29.9 kg/m^2)	22(12.2%)	38(21.1%)	60(33.3%)	
Obese (>30 kg/m^2)	11(6.1%)	65(36.1%)	76(42.2%)	
Class I obesity (30-34.9 kg/m^2)	9(5.0%)	44(24.4%)	53(29.4%)	
Class II obesity (35-39.9 Kg/m^2)	2(1.1%)	16(8.9%)	18(10.0%)	
Class III obesity (>40 Kg/m^2)	0(0.0%)	5(2.8%)	5(2.8%)	
ᵀ**Waist Circumference (WC)(cm)**	**94.2 ± 13.5**	**92.6 ± 11.5**	**93.0 ± 12.1**	0.48
WC > 94 cm	26(52%)		ᵀ141(78.3%)	
WC < 94 cm	24(48%)			
WC > 80 cm	0(0.0%)	115(88.5%)		
WC < 80 cm	0(0.0%)	15(11.5%)		
Packed Cell Volume (%)	**42.3 ± 4.9**		**39.4 ± 4.9 40.2 ± 4.6**	<0.001**
Anti-hypertensive Drug History				
Diuretics Combination Therapy (ACE I/CCB/β-blockers)	27(15%)	60(33.3%)	87(48.3%)	0.55
Diuretics Only Therapy	7(3.9%)	21(11.7%)	28(15.6%)	
CCB Combination Therapy (ACE I/ diuretics/β-blockers/Centrally Ag)	21(11.7%)	74(41.1%)	95(52.8%)	
CCB Only Therapy	4(2.2%)	10(5.6%)	14(7.8%)	
ACE I/ARB'sCombination Therapy	17(9.4%)	45(25.0%)	62(34.4%)	
ACE I/ARB Only Therapy	1(0.6%)	3(1.6%)	4(2.2%)	
Centrally Ag Combination Therapy	1(0.6%)	9(5.0%)	10(5.6%)	
Centrally acting Only	1(0.6%)	6(3.3%)	7(3.9%)	
β-Blockers Combination Therapy	5 (2.8%)	5(2.8%)	10(5.6%)	
β-Blocker Only	0(0.0%)	1(0.6%)	1(0.6%)	
Cannot Recall Drug	9(4.4%)	13(7.2%)	21(11.7%)	

Difference between the two groups by Chi-square analysis. Independent student's *t*-test for numerical variables.*Significant at $p < 0.05$. **Level of significance at $p \leq 0.01$.ᵀ WC for both sexes. CCB: Calcium channel blockers; ACE I/ARB's: Angiotensin converting enzyme inhibitor/Angiotensin receptor blockers; Ag: Acting; β: Beta; Kg/m^2: kilogram/meter squared; Class I Obesity: Mild; Class II Obesity: Moderate; Class III: Severe/Morbid Obesity.

(53.9%) of the subjects who had metabolic syndrome with 3 risk factors viz: central obesity with impaired fasting glucose/diabetes and uncontrolled SBP >130 mmHg and half (45.6%) with 3 risk factors inclusive of DBP >85 mmHg (Figure 4). The overall mean prevalence of metabolic syndrome from the selected CMRF was 49.6%.

Table 3 shows the association of cardiometabolic risk factors with uncontrolled hypertension (BP >130/85 mmHg) using the Binary logistic regression analysis. Findings are a significant association of male sex (p=0.02) with systolic blood pressure with Odd ratio of 2.11 (95% CI, 1.25-3.54) as well as diastolic blood pressure (p=0.02) with Odd ratio of 1.78 (95% CI, 1.12-2. 83). Combined prediabetes/diabetes showed a significant (p=0.01) association with systolic blood pressure with an Odd ratio of 1.58 (95% CI, 1.27-1.97). Likewise, combined overweight/obesity by BMI showed a significant (p=0.04) association with diastolic blood pressure with an Odd ratio of 0.82 (95% CI, 0.65-1.02). Alcohol use was also significantly (p=0.02) associated with diastolic blood pressure OR 6.07 (95% CI, 1.28-28.89) (Table 3).

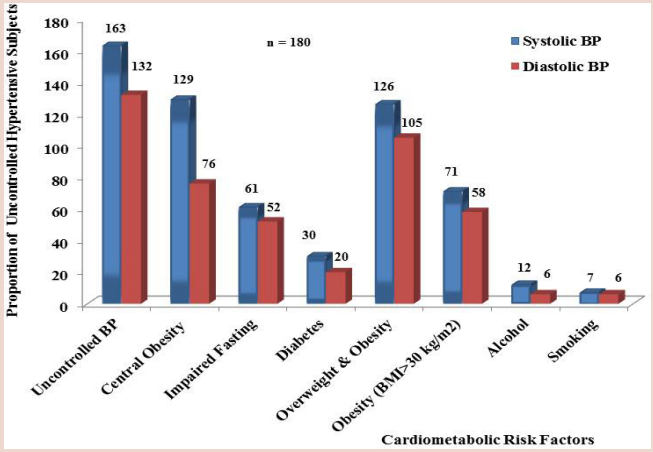

Figure 3: Distribution of Cardiometabolic Risk Factors amongst Uncontrolled Hypertensive Subjects (BP >130/85 mmHg).
n: Total sample size; BP: Blood Pressure; BMI: Body Mass Index.

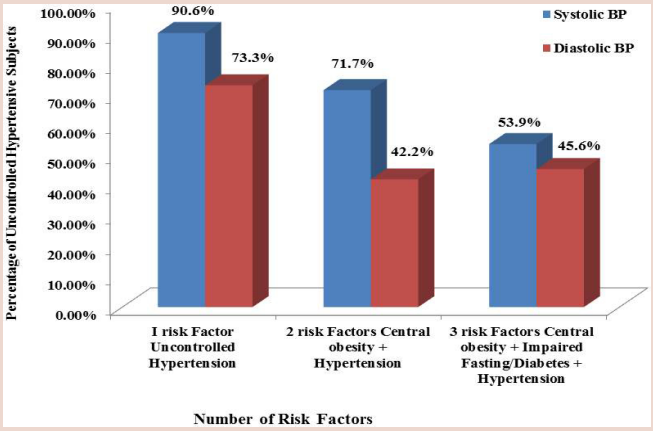

Figure 4: Proportion of Hypertensive subjects with one or more Selected Cardiometabolic Risk Factor Clusters fulfilling IDF criteria for Metabolic Syndrome.

DISCUSSION

A high prevalence of the various CMRFC assessed were documented in this unique study targeted at hypertensive urban dwellers who sought for free health-care delivery in response to radio announcement. Approximately 3 of every 4 (71.7%) subjects in this study had 1 cardiometabolic risk factor in addition to uncontrolled systolic hypertension and more than half (53.6%) had 3 cardiometabolic risk factors associated with uncontrolled systolic hypertension. Similarly, almost half to half (42.2%-45.6%) had 2 to 3 cardiometabolic risk factor clustering with uncontrolled diastolic hypertension respectively. The overall mean prevalence of Cardiometabolic risk factor cluster (CMRFC) via selected risk factors in this study was 49.6%. This high prevalence of cardiometabolic risk clusters is similar to previous reports from the REACH registry[31]as well as the Framingham study[32] done in the United States which documented a cluster of ≥2 additional cardiovascular risk factors in about half of hypertensive persons with <20% of hypertensive cases said to occur without one or more concomitant cardiovascular risk. A similar report was shown from some other study among 6,527 hypertensive patients from 28 United States physician practices in which 82% of the subjects had ≥1 cardiometabolic risk factor in addition to hypertension.[33]

Furthermore, a study done across four sub-Saharan African countries documented similar high overall prevalence rate of 39.4% with a range of 66.1% documented in Nigeria to 27.7% in Madagascar.[14] A systematic review of hospital-based cross-sectional studies in Nigeria over a 12 year period (2002-2013) showed similar prevalence of CMS of 40.8% based on the IDF criteria.[24] Among type-2 diabetes patients, documented prevalence of metabolic syndrome was higher ranging between 59.1%-87.1%[34-38] with a range between 24.7%-40.7% amongst hypertensive patients,[19-24] however with different diagnostic criteria utilized.[39] Likewise, a recent community-based study done in the urban city of Sokoto, North-West Nigeria reported a similar high prevalence of metabolic syndrome of 35.1%,[20] consistent with previous reports by Akintunde *et al.* amongst hypertensive Nigerians in the South-West Nigeria[21] as well as 31.2% overall prevalence documented in South-East Nigeria increased to 40.4% with 2 risk factor clusters.[23] Some other study on CMRFC in 11 semi-urban communities in Ekiti and Osun States of South-Western Nigeria documented a prevalence of 32.9% and 8% of two and at least three cardiovascular risk factors respectively.[40] Even among apparently healthy Nigerians, a rural community-based study in the North-Western part of the country also reported a high prevalence of 25.8%.[34]

The high prevalence of CMRFC in the present study however doubly exceeds report by the African and Middle East Cardiovascular and Epidemiological study done in several general outpatient clinics across Nigeria.[6] The reason for this disparity may be the targeted cohort of hypertensive subjects aged above 30 years presenting from urban areas in this study as against the subject selection of patients with varied disease conditions and age groups recruited from primary health care facilities of both rural and urban areas in the latter study. It also contrasts previous reports of low prevalence of metabolic syndrome in sub-Saharan Africa.[41-42] Likewise, a 3 year population-based survey done in Egbada rural community in South-West Nigeria showed a lower prevalence of 12.9% with one cardiometabolic risk factor and lower trend with more clusters,[43] while a semi-urban study done in Dakace settlement near Zaria showed 33% having only one risk factor as well as 19% and 15% with two and three risk factor clusters respectively.[44] This further goes to show the high prevalence of CMRFC even among apparently healthy population as documented in the latter two studies done over one half to one decade ago, the burden not surprisingly higher in this hypertensive cohort.

Table 3: Association of Cardiometabolic Risk Factors with Uncontrolled Hypertension

Dependent Variable {SBP (*n*=163)/DBP (*n*=132)}	*P*-Value	OR Odd Ratio	95% ConfidenceInterval (CI)	
Age (> 45 years)				
SBP	0.60	1.40	0.40	4.97
DBP	0.61	0.81	0.36	1.81
Sex				
SBP ǂ Male	0.02*	2.11	1.25	3.54
ǂ Female		0.63	0.38	1.05
DBP ǂ Male	0.02*	1.78	1.12	2.83
ǂ Female		0.77	0.60	0.97
Alcohol (Yes)				
SBP	0.82	0.70	0.04	13.82
DBP	0.02*	6.07	1.28	28.89
ǂ Cigarette Use (Yes)				
SBP	0.76	1.37	0.18	10.48
DBP	0.89	0.89	0.17	4.6
Duration of Hypertension (>10 years)				
SBP	0.65	1.32	0.41	4.25
DBP	0.74	1.13	0.54	2.37
Family History Hypertension (Yes)				
SBP	0.18	0.47	0.16	1.41
DBP	0.84	0.94	0.49	1.81
History of Diabetes (Yes)				
SBP	0.70	0.67	0.08	5.40
DBP	0.58	1.38	0.45	4.25
Family History of Diabetes (Yes)				
SBP	0.87	0.88	0.18	4.29
DBP	0.51	0.68	0.21	2.61
Prediabetes/Diabetes (FBG >5.55 mmol/L)				
ǂ SBP	0.01*	1.58	1.27	1.97
ǂ DBP	0.08	0.34	0.27	1.08
Frank Diabetes (FBG > 6.99 mmol/L)				
ǂ SBP	0.50	0.64	0.17	2.45
ǂ DBP	0.15	1.60	0.85	3.03
Central Obesity				
ǂ SBP (WC > 94 cm: Male)	0.62	0.83	0.38	1.81
(WC > 80 cm: Female)	0.29	1.14	1.07	1.22
ǂ DBP (WC > 94 cm: Male)	0.42	0.79	0.45	1.41
(WC > 80 cm: Female)	0.08	0.87	0.72	1.06
Body Mass Index (BMI)				
Overweight &Obesity (BMI > 25 kg/m^2)				
ǂ SBP	0.25	0.84	0.58	1.20
ǂ DBP	0.04*	0.82	0.65	1.02
Obesity (BMI> 30 kg/m^2)				
ǂ SBP	0.26	0.66	0.32	1.45
ǂ DBP	0.36	0.83	0.55	1.26

Binary Logistic Regression Analysis. ǂ Two by two contingency table with Pearson's chi-square analysis. Level of significance at $p \leq 0.05$. SBP: Systolic Blood Pressure; DBP: Diastolic Blood Pressure; WC: Waist Circumference; BMI: Body Mass Index; n: total number of hypertensive subjects with BP >130/85 mmHg

The reason for the high prevalence in this study may be attributed to the urban residents studied as most of the subjects were from Samaru/Ahmadu Bello University main campus/Graceland areas of Zaria, as well as the hypertensive cohort and older age group studied. Urbanization has been linked with sedentary lifestyle and physical inactivity associated with advancement in technology, consequently leading to central obesity, insulin resistance, diabetes and or hypertension.[4-6,20,24,42] It has also been associated with nutritional transition to poor low fibre, refined sugary, high salt/cholesterol and energy-rich diets devoid of fruits and vegetables, consequently resulting in increased adiposity and thus cardiometabolic risks.[4-7,10,20] The findings here is of importance for public health intervention policies as it suggests that people of urban incline in the Northern region of the country have multiple risk factors for cardiometabolic disease and adverse cardiovascular outcome as against the previous thinking.[20,24,45] More so, hypertensive subjects are more vulnerable to clusters of cardiometabolic risks such as obesity, diabetes and dyslipidaemia when compared to the general population which may contribute to poor blood pressure control, as observed in this study.[16] Likewise, with demographic transition associated with ageing populations in countries like Nigeria,[6] there will be more clustering of these CMRF especially as the subjects studied were mostly middle aged with overall mean age in the 5th decade.

Almost half, (42.2%) of the study population were obese (BMI > 30 kg/m^2) similar to the National Health and Nutrition Examination Survey (NHANES) 1999-2002 study[46] and somewhat similar though slightly lower than the 48.7% prevalence of obesity reported in hypertensives among 28 physician practices in the US.[16] Majority of the hypertensive subjects were either overweight or obese (BMI >25 kg/m^2). Overall obesity via BMI was preponderant in females compared to males (*p=0.014*) similar to previous studies.[6,20,25,32,37] Central obesity identified a larger proportion (78.3%) of the subjects with obesity equivalent to approximately twice the risk of identifying obesity by BMI, higher in females than males, even though there was a female preponderance in the study; perhaps due to the health-seeking nature of women. This was consistent with findings from the ACE study in Nigeria where central obesity (63.7%) identified obesity more than overall BMI (24.4%);[6] albeit with much higher prevalence in the present study. The higher prevalence of obesity in this study when compared to the ACE study may be attributed to the selection bias of the free health care seeking status of the study population with emphasis on hypertensive subjects. Similarly, a hospital-based study done in Nnewi, South-East Nigeria on newly diagnosed hypertensive cohorts identified more than half of the subjects with central obesity however using the National Cholesterol Education Program's Adult Treatment Panel III (NCEP-ATP III) criteria with higher cut-offs for central obesity.[23] Furthermore, there was a significant association of combined overweight and obesity via BMI with diastolic hypertension (*p=0.04*) though with a lower than significant Odd ratio value for adverse risk. Documented evidence from the Framingham study[31] showed that obesity and overweight are the most important determinants of high blood pressure development as well as predictor of other cardiovascular risk factors that will cluster with hypertension.[16,33]

The reason for the high prevalence of central obesity may be attributed to lack of exercise culture especially in women who are known to gain weight following series of pregnancies and deliveries after which they fail to get rid of the accumulated abdominal fat after each delivery;[47]coupled with poor nutrition/unhealthy diets, sedentary lifestyle, high socio-economic status as well as high literacy level in both sexes.[4-7,47] Large population based studies have documented WC as a strong correlate of clinical outcome especially diabetes independent of BMI and remains a strong predictor of diabetes, coronary heart disease and increased mortality even following adjustment for BMI and other cardiometabolic risks.[48]

Three mechanisms have been proposed to explain the relation of central obesity to cardiometabolic syndrome viz-a-viz: i) Insulin resistance associated with the hyperlipolytic state of omental adipose tissues with consequent high free fatty acid levels which is lipotoxic to the liver resulting in impaired hepatic metabolism and reduced insulin clearance. Hyperinsulinaemia, increased gluconeogenesis, impaired glucose tolerance as well as hypertriglyceridaemia consequently occur;[48] ii) Adipocytes act as endocrine organs, secreting adipokines (Adiponectin, cytokines like IL-6 and TNF-alpha, ghrelin, resistin amongst myriads of others)[48-49] which are anti-insulinic hormones, thereby contributing to insulin resistance, pro-inflamatory, pro-thrombotic and pro-hypertensive state of visceral obesity.[48] This consequently leads to dysglycaemia, type-2 diabetes and hypertension;[37,47-49] iii) Accumulation of excess fat at undesired sites such as the liver, heart, pancreas and skeletal muscles on account of the inability of subcutaneous tissue to serve as a protective depot due to its inability to expand (lipodystrophy) or it being in a hypertrophied, dysfunctional and insulin resistant state.[48] These mechanisms underlie endothelial dysfunction, resulting in atherosclerosis and consequently cardiometabolic disease clusters.[47-49]

Consistent with prior studies, there were approximately 1 in 4 subjects (22.2%) who had diabetes both historically (prior diagnosis) and via fasting blood glucose estimation.[6,50-51] This high prevalence of diabetes mellitus similar to a recent report of 23.3% in an urban community in Kaduna, North-West Nigeria[50] as well as the 26.3% reported among oil company workers in Port Harcourt[51] far exceeds the global prevalence rate of 8.8%[52] as well as the 5.7% prevalence rate in Nigeria following recent meta-analysis by Uloko *et al*.[53] The recent ACE study across several geopolitical zones in Nigeria also documented a high prevalence of diabetes (18.7%) amongst urban communities with a surprisingly higher rate of 28.6% amongst rural communities as against the previous lower trend.[6] Likewise, data from centres across four Sub-Saharan African countries (Camaroon, Nigeria, DRC and Madagascar) showed similar high prevalence rate of 17% albeit higher levels in the present study.[14] Previous reports over the past two decades on diabetes prevalence across several geopolitical zones in Nigeria were on the lower range.[24,53-54] This rapid shift in trend can be attributed still to urbanization, demographic transition and westernization of Nigerian-Africans.[4-7,24,53-54] The hypertensive cohorts studied here may be an additional risk factor, as studies globally have shown that hypertension is linked with type-2 diabetes as 80% of diabetes patients have hypertension while 50% of hypertensive patients have hyperinsulinaemia or glucose intolerance.[49,55] Higher socio-economic status of the study population[54]even though not objectively assessed may have contributed as most of the subjects were literate/semiliterate with only 32.8% who had no formal education; a lot of high profile academics coming from urban residential areas of Zaria as well as ABU main campus were also seen. The percentage of undiagnosed diabetes was quite high similar to previous reports locally and internationally[52,53-54] and may be attributed to ignorance, lack of proper and regular health screening, lack of affordable health services and the clustering of cardiometabolic risk in the hypertensive cohort studied.

Prediabetes/impaired fasting glucose as a CMRF was found in 38.9% of the hypertensive subjects similar to the 39.1% rate reported in Calabar, Nigeria;[56] slightly higher than the 33.1% reported amongst hypertensive Nigerians at a primary care clinic in Owerri, Eastern Nigeria[57] and the 25% documented amongst hypertensives in Enugu.[58] The European Study of hypertension and diabetes reported prevalence range of 25% to 47% of which that of this study falls into.[57,59] Contrary reports of lower prevalence rates were reported previously.[24,54] The differences in study setting (population/community versus hospital-based studies), sample size variation, glucose assay method, racial/environmental/geographical differences (including access to early morning sunshine and vitamin D),

lifestyle differences, varied degrees of urbanization and sociocultural disparity may account for the marked differences in different studies.[60] The use of diuretics especially the thiazides which was found in more than half of the study population (48.3% in combination therapy and 15.6% as a single agent) may have contributed to the higher prevalence of prediabetes and diabetes as diuretics have been shown to affect glucose homeostasis.[33,61] The finding of this high prevalence of prediabetes as a cardiometabolic risk factor amongst hypertensives residents in the Northern part of the country portends their rapidly growing risk for type-2 diabetes.[57] This is therefore of public health importance and must be tackled aggressively via education of the public on the urgent need for lifestyle modification, early screening, home self-blood glucose and blood pressure monitoring as well as regular health checks in a bid to prevent diabetes and other CMRF clusters in hypertensive subjects who are more vulnerable.

Most of the hypertensive subjects (90.6% and 73.3%) had their systolic and diastolic blood pressures respectively at uncontrolled levels despite ≥2 anti-hypertensive therapy. Overweight/obesity was a strong risk factor via its association with uncontrolled hypertension in this study confirming the link between obesity, prediabetes/diabetes and hypertension from previous reports.[33,48,55] The cluster of central obesity and overall combined overweight/obesity by BMI were more associated (p=0.02) with uncontrolled hypertension in this study. Furthermore, the significant (p=0.01) association of combined prediabetes and diabetes with uncontrolled hypertension which showed an Odd ratio of 1.58 (95% CI 1.27-1.97), implies that the hypertensive subjects with impaired fasting blood glucose had an approximately two times risk of having uncontrolled blood pressure targets (BP ≥130/85 mmHg). Other risk factor predicting poor BP control among the hypertensives was male sex (*p=0.02*) with an approximately 2 times odd of having high systolic blood pressure and 1.8 time odd of having high diastolic blood pressure levels with 95% CI of 1.25-3.54 and 1.12-2.83 respectively. Alcohol was also significantly (*p=0.02*) associated with high diastolic hypertension with a 6 times odd of having poor diastolic blood pressure control with 95% CI of 1.28-28.89. It is noteworthy that the prevalence of alcohol and smoking in this cohort of hypertensive subjects was very low perhaps because of the sociocultural and religious lifestyle of the geographical region studied.

CONCLUSION

This study shows that there is a high prevalence of cardiometabolic risk factor clusters amongst hypertensive urban dwellers in Northern-Nigeria. Combined overweight/obesity, prediabetes/diabetes, male sex and alcohol were significantly associated with uncontrolled hypertension.

RECOMMENDATION

It is therefore imperative that the Nigerian government at all levels viz: primary, secondary and tertiary should make concerted efforts at combating or reversing this rising scourge primarily via health education as knowledge is key; organisation of regular free screening exercises; encouragement of lifestyle modification inclusive of healthy high fibre, high vegetable and fruit diet with low salt-low cholesterol, non-refined sugar content as well as exercise via creation of supportive social environment and buildings for physical activity.[62] They should work in collaboration with the public-private partnership schemes to improve health infrastructure and enhance the health system response to non-communicable diseases (NCD's). To cap it up, collective efforts by people in the community, health-care providers, hypertensive and diabetes subjects, non-governmental organizations, food manufacturers, medical and technological suppliers as well as the government should be made to act in line with the objectives of the WHO NCD Global Action Plan 2013-2020 to reduce the impact of hypertension as well as diabetes and by extension other cardiovascular risk factor clusters.[62]

LIMITATIONS

The lipid profile of the subjects were not assessed in this study so as to cut down costs hence the prevalence of metabolic syndrome by the other diagnostic criteria could not be assessed however the IDF criteria takes into cognisance central obesity with 2 other risk factors of which elevated blood pressure (BP>130/85 mmHg) and impaired fasting glucose/diabetes are inclusive. Perhaps the actual prevalence may have been affected if this was assessed. Other cardiometabolic risk factors like insulin resistance and CRP were also not assessed due to costs. Larger community or population based studies involving lipid profile, insulin resistance and CRP should be carried out across the Northern part of the country and by extension other geo-political zones to determine the impact of the CMRFC on a larger scale as this study may be limited by this even though similar studies with such numbers or smaller numbers made valid conclusions.[21,22,25,39,44,50]

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

ABBREVIATIONS

CMRFC: Cardiometabolic Risk Factor Cluster; **CVD:** Cardiovascular Disease; **SBP:** Systolic Blood Pressure; **DBP:** Diastolic Blood Pressure; **DM:** Diabetes Mellitus; **BMI:** Body Mass Index; **WC:** Waist Circumference; **TG:** Triglycerides; **LDL-C:** Low Density Lipoprotein Cholesterol; **HDL-C:** High Density Lipoprotein Cholesterol; **IDF:** International Diabetes Federation; **TNF-á:** Tumour Necrosis Factor-Alpha; **CRP:** C-Reactive Protein; **IL-6:** Interleukin-6; **ABU:** Ahmadu Bello University; **ACE:** Africa and Middle East Cardiovascular Epidemiological Study; **WHO:** World Health organization.

SUMMARY

Africa and infact the entire developing world, Nigeria inclusive is currently facing the triple burden of increasing incidence of non-communicable diseases (NCD's), infectious diseases and a weak and overburdened health system. With this increasing menace of NCD's as observed in this study, there is a worrisome trend of sub-optimal hypertension control even among those on medication, thereby driving and sustaining poor cardiovascular outcomes like stroke, heart failure, kidney failure and peripheral vascular disease with its attendant consequences. Oppourtunistic screening and awareness campaigns as recommended by the World Heart Federation are therefore encouraged as the first line key steps in addressing these problems.

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