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The Burden of Undiagnosed Hypertension and Associated Risk Factors among Adults in a Rural Community in Imo Sate, South-East Nigeria

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Abstract

Background: Cardiovascular diseases are the leading cause of death globally and hypertension is a major contributor to this burden. Many people with hypertension have poorly controlled blood pressure and up to half of the adults with hypertension are unaware of their hypertensive status due to factors that bother on poor management and poor screening approaches. The implication is that people who have poor access to healthcare especially those in the rural communities are at increased risk of cardiovascular complications and all-cause mortality. Unfortunately, not much has been done to ascertain the burden of undiagnosed hypertension and associated risk factors in rural communities in Nigeria. **Methods:** We conducted a community-based cross-sectional study in a rural community in Imo State, Nigeria, on burden of undiagnosed hypertension with participants recruited via a multi-stage sampling method. An interviewer-administered questionnaire was used, and standardized instruments were applied to obtain, process and analyze the data. Tests of association between the independent variables and outcome were conducted using logistic regression. *P*-value of < 0.05 was used as the criterion for statistical significance. **Results:** A total of 380 adults participated in the study. The mean age was 44.2 years. The prevalence of undiagnosed hypertension was 35.8%. Logistic regression revealed that age, with the respondents in the age groups 26 - 35 years (OR = 10.647, 1.910 - 59.345, p-value = 0.007), 36 - 45 (OR = 3.680, 1.263 - 10.723, p-value = 0.017), 46 - 55 years (OR = 2.737, 1.114 - 6.727, p-value = 0.039), 56 - 65 years old (OR = 3.384, 1.610 - 7.115, p-value = 0.001); and being married (OR = 3.846, 1.118 - 13.233, p-value = 0.033), were independent risk factors for undiagnosed

hypertension. **Conclusion:** The prevalence of undiagnosed hypertension in the rural population of South-East Nigeria is high. Younger age (26 - 35 years) had the highest odds of risk for occurrence of hypertension. Also being married was identified as a risk factor for undiagnosed hypertension.

Keywords

Hypertension, Undiagnosed Hypertension, Risk Factors, Rural Community

1. Introduction

Cardiovascular co-morbidities are the leading cause of mortality worldwide [1]. Hypertension, is the single most significant contributing factor, causing over 9.4 million deaths globally and accounting for more than 50% of stroke and cardiac disease cases respectively [2] [3]. Despite these health risks, many people the world over have undiagnosed hypertension. Hypertension is a global problem with the prevalence projected to be on the rise due to several factors including lifestyle and environmental changes, about 1.5 billion people are expected to be hypertensive by 2025 worldwide [1] [2]. It is estimated that 1 out of every 3 adult Americans is hypertensive [3] [4] and similar ratios have been reported in different parts of Europe and Asia including UK [5], Indonesia [6], India [7], Malaysia [8], and Poland [9]. In Africa studies from different countries such as Ethiopia, and Ghana have also reported high prevalence rates [10] [11] [12]. Similarly, many reviews from Nigeria indicate that 1 out of every 5 Nigerian is hypertensive [13] [14] [15] [16]. The implication is that more people will die because of complications from hypertension, which is largely a preventable scenario.

Hypertension is defined as systolic blood pressure of 140 mmHg and above and/or diastolic blood pressure of 90 mmHg or above [12] while undiagnosed hypertension is defined as the presence of hypertension in a person who has not been previously diagnosed as hypertensive. In addition to the high prevalence of hypertension globally, many studies have reported a high prevalence of undiagnosed hypertension in various settings and populations. On average, about half the adult population who are hypertensive may not be aware of their hypertensive status at the first time they were told, this is corroborated by studies from Peru [17] and Bangladesh [18] which reported prevalence rates of 67.2% and 56.9% respectively. Another study from Lebanon by Kanji *et al.* [19] reported the prevalence of undiagnosed hypertension as 42.69%. Some other studies from India by Bharati *et al.* [20] and Schuda *et al.* [21] reported significant proportions of undiagnosed hypertension as 27.6% and 26% respectively. In Africa, one systematic review by Ataklte *et al.* [22] in 2015 yielded a pooled prevalence of 15% to 70% for undiagnosed hypertension. Other researchers in Africa such as Dejenie *et al.* [23], Getachew *et al.* [24], and Bushara *et al.* [25] reported prevalence rates between 13% and 38.2%. Studies from different parts of Nigeria reported

the prevalence of undiagnosed hypertension as between 20% and 60% depending on the study population and the setting [26]-[31]. A significant number of these studies were conducted in rural areas with prevalence levels in these communities approximating the lower limits reported in the literature.

Some predictors have been identified as significant risk factors for hypertension. These factors include age, gender, educational status, place of residence, family history of hypertension, smoking, alcohol use disorder, substance use, abnormal lipid profile, obesity, high sodium consumption and sedentary lifestyle [1] [2] [15]-[25]. In Nigeria, rural communities have documented reports of low prevalence rates for hypertension but emerging reports indicate a worrisome trend that undiagnosed hypertension may be on the rise in these communities [32]-[37] with poor access to healthcare, poverty, ignorance, and poor health-seeking behaviour implicated as contributory factors. Additionally, hypertension with complications such as stroke and myocardial infarction remains shrouded in myths and misconceptions in many rural settings [38] [39] [40]. A complex web is the scenario where many rural settlements are caught in a demographic transition occasioned by urbanization and globalization resulting in behavioural changes, such as fewer farming activities, less recreational activities, less exercise, more sedentary lifestyle, and more refined saturated diets; yet with poor access to healthcare, poverty, ignorance, and poor health-seeking behaviour subsisting [38] [39] [40].

Despite a plenitude of literature on hypertension globally [1]-[6] there appears to be a paucity of information on the burden and correlates of undiagnosed hypertension in rural communities of southeastern Nigeria. This is of great concern considering that from observations a significant proportion of adult patients seen at the General Outpatient Clinics of the Federal University Teaching Hospital, Owerri, the foremost tertiary health facility in urban Imo State, on referral, present with at least one of these cardiovascular complications—hypertensive heart disease, heart failure, stroke or ischaemic heart disease, and many of the patients are resident in the rural communities. The majority of them had no prior knowledge of being in a state of persistently elevated blood pressure. Against this background, this study set out to assess the burden of undiagnosed hypertension and its associated risk factors in a rural community with the view to identifying risk factors that may be amenable to early intervention and population-based prevention strategies to minimize cardiovascular morbidity and mortality.

2. Methodology

2.1. Study Area

The research was carried out in Mbieri community of Mbaitoli Local Government Area (LGA) of Imo state. Mbieri is a rural community with a projected population of 43,130 adults (20,487 males and 22,643 females) as at 2017 based on 2006 Nigerian census [41].

2.2. Study Population

Adults aged 18 years and above resident in Mbieri community.

2.3. Study Duration

Collection of data for the study lasted from January 2022 to April 2022.

2.4. Study Design and Variables

This was a community-based cross-sectional analytical study. The dependent variable was undiagnosed hypertension while the independent variables were family history of hypertension, physical activity, diabetes mellitus, obesity, alcohol use and dyslipidaemia. Undiagnosed hypertension is defined as blood pressure (BP) of greater than or equal to 140/90 mm/Hg on at least two different occasions with the individual unaware of his/her blood pressure status. The nature of measurements for the independent variables are described under data collection below.

2.5. Sample Size

The sample size was calculated using the formula:

$$n_0 = Z^2 Pq/d^2 \text{ (with the population size greater than 10,000)}$$

where,

n_0 = the desired sample size (when population is greater than 10,000).

Z = the standard normal deviate usually set at 1.96 which corresponds to 95% confidence interval, it contains the area under the normal curve.

p = the estimated proportion of an attribute present in the population. The prevalence of hypertension used was 44.5%. This was the prevalence value obtained from a community-based study done in Enugu state by Ahaneku *et al*. [42].

d = desired level of precision, this was set at 0.05.

$q = 1 - P$.

Therefore n = $(1.96)^2 \times 0.445 \times (1 - 0.445)/(0.05)^2$

= 0.94877916/0.0025

= 379.5 approximately 380

The minimum sample size was 380 respondents.

2.6. Sampling Method

Multi-stage sampling technique was used to recruit the respondents. This study was carried out in Mbieri community of Mbaitoli Local Government Area of Imo State. In Mbieri community, there are 17 villages. Proportionate sample was recruited from each of the villages into the study as calculated accordingly using

Proportionate samples recruited from each village = [total population of the village/Total population of the community] × [380].

Subsequently, data was consecutively collected from each of the villages starting from the first in the list drawn up for the villages using the multistage sam-

pling. In the first stage, compounds were sampled. This was followed by households in the second stage. The third stage involved sampling of one individual out of every eligible adult in the household. On arrival at each village, a starting point was chosen from the centre of the village which was the "village square". At the "village square", the first compound to be sampled was chosen by spinning a bottle and it was allowed to make at least three rotations before it stopped. The compound in the direction the tip of the bottle points was sampled first. Subsequently, alternate compounds were selected and sampled. In each compound, a list of all the households in that compound was made and alternate households were sampled. One individual out of every eligible adult in the household was recruited into the study using the simple random sampling. Where there was only one household in the compound that household was sampled. The same process was repeated for each selected compound in the village until the estimated number of respondents to be recruited from the village was reached, thereafter, the researcher moved to another village. Structured interviewer administered questionnaire and validated instruments were used to collect demographic and clinical information.

2.7. Inclusion Criteria

Consenting adults' resident in Mbieri community.

2.8. Exclusion Criteria

Individuals previously diagnosed as having hypertension, respondents on anti-hypertensive agents, those who are unable to provide verbal or written consent pregnant women due to possible presence of pregnancy induced hypertension, and individuals too ill to cope with the physical and mental exertion of data collection.

2.9. Data Collection

Data were consecutively collected from each of the villages starting from the first using multistage sampling. In the first stage, compounds were sampled. This was followed by households in the second stage. The third stage involved sampling one individual out of every eligible adult in the household. A pretested interviewer-administered questionnaire, designed by the researcher, and validated instruments were used to collect demographic and clinical information after consent was obtained. The blood pressure was measured using standard procedure. The Alcohol Use Disorders Identification Test (AUDIT) questionnaire [43] was used to assess alcohol use, and International Physical Activity Questionnaire-Short Form (IPAQ-SF) [44] was used for physical activity measurement. The response for AUDIT was categorized as harmful use or not, while physical activity was categorized as category 1-sedentary, category 2-moderate activity, category 3-health enhancing physical activity (HEPA) [45] [46]. Standard aseptic processes were used to collect the blood samples which were sent to the laboratory for analysis of glucose and lipid profile using standard techniques.

Non-fasting lipid levels were used for this study and have been suggested not to be significantly different from fasting lipid levels [47] [48] [49]. Height and weight were also measured using standard validated instruments, and body mass index (BMI) was estimated. Four categories of BMI (<18.5 kg/m^2, 18.5 - 24.9 kg/m^2, 25.0 - 29.9 kg/m^2 and >30.0 kg/m^2) were identified as underweight, normal weight, overweight and obesity respectively. Several studies used this classification method [50]-[55].

2.10. Statistical Analysis

Data were analysed using SPSS version 22. Statistical significance was taken as a *p*-value less than 0.05. The results were represented in frequency tables. Mean and standard deviation were calculated for continuous variables and *Chi-square* was done for categorical proportions. Logistic regression was conducted for variables with significant association to detect independent risk factors for undiagnosed hypertension.

2.11. Ethical Clearance

This was obtained from the Institutional Ethics Committee of the Federal University Teaching Hospital, Owerri (FUTHO), formerly Federal Medical Centre, Owerri.

3. Results

All 380 participants sampled consented and were recruited into the study giving a 100% response rate. The prevalence of undiagnosed hypertension was 35.8% (n = 136).

3.1. Socio-Demographic Distribution of Participants

Majority of the respondents in the study were between the 56 - 65 age group (27.6%, n = 105) and there were more female responders 57.6%, (n = 219) than males. Most were married 51.3%, (n = 195) and predominantly Christians 92.1%, (n = 350). Nearly all of them had at least primary level education with just three of them (0.8%) not having any formal education. Many had family history of hypertension, 42.1%, (n = 160) while 6.3% (n = 24) of the participants were not aware of the presence of hypertension in the family. The most-reported cardiovascular event in the family was stroke, 42.7%; followed by heart failure, 36.6%. In terms of occupation, the responders were predominantly farmers, civil servants in active service or retired, professionals, farmers, and students (**Table 1**).

3.2. Pattern of Blood Pressure Distribution of Participants

The pattern of undiagnosed hypertension among the respondents is represented in the bar chart below (**Figure 1**). About 35.8% of the respondents have undiagnosed hypertension with 15.5% (n = 59) in stage 2; and 20.3% (n = 77) in stage 1.

Table 1. Frequency distribution of respondents according to socio-demographic characteristics.

Socio-demographic characteristics	Frequency (n = 380)	Percentage (%)
Age group		
<26	64	16.9
26 - 35	48	12.6
36 - 45	75	19.7
46 - 55	88	23.2
56 - 65	105	27.6
Gender		
male	161	42.4
female	219	57.6
Level of education		
No formal	3	0.8
primary	110	28.9
secondary	136	35.8
tertiary	131	34.5
Occupation		
Farming	72	18.9
trading	42	11.1
professional	55	14.5
C/S	69	18.2
retired	62	16.3
student/apprentice	59	15.5
Unemployed/others	21	5.5
Marital status		
single	107	28.2
married	195	51.3
widowed	78	20.5
Religion		
Christianity	350	92.1
Islam	3	0.8
Traditional	27	7.1
Family history		
positive	160	42.1
negative	196	51.6
not aware	24	6.3
Complications of hypertension suffered by relative (s)		
heart failure	30	36.6
stroke	35	42.7
kidney failure	14	17.1
Others (eye disorders, death)	3	3.6

A significant number of the respondents had prehypertension 30.5% (n = 116) while about a third (33.7%) were normo-tensive (n = 128).

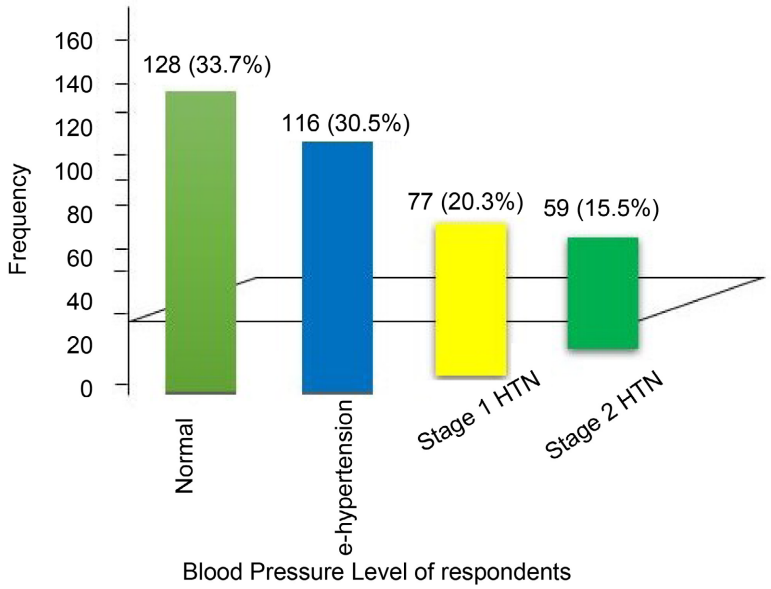

Figure 1. Pattern of blood pressure measurement among respondents.

3.3. Association between Socio-Demographic Characteristics and Undiagnosed Hypertension

The association between socio-demographic characteristics and undiagnosed hypertension is shown in Table 2. Factors such as age ($p \leq 0.001$), occupation ($p \leq 0.001$), level of education ($p = 0.001$), family history (FH) of hypertension ($p = 0.001$), marital status, ($p \leq 0.001$) and religion ($p \leq 0.001$) were found to be significantly associated with the presence of hypertension.

3.4. Association between Lifestyle Indices and Undiagnosed Hypertension

Table 3 below shows the association between lifestyle indices and undiagnosed hypertension. A good number of the participants had central obesity (n = 133), out of whom 59 (43.38%) were hypertensive. Central obesity was found to be significantly associated with undiagnosed hypertension ($p = 0.011$). Also, regarding general obesity, the majority of the participants were either obese (n = 86) or overweight (n = 124), and general obesity was significantly associated with undiagnosed hypertension ($p = 0.001$). The majority of the respondents (n = 343) were not involved in harmful alcohol use and alcohol use was not found to be significantly associated with undiagnosed hypertension ($p = 0.086$). Among the respondents, only a few were involved in high physical activity (n = 26), while the majority were involved on low physical activity. The level of physical activity was significantly associated with undiagnosed hypertension ($p \leq 0.001$).

3.5. Association between Lipid Profile and Diabetes Mellitus, and Undiagnosed Hypertension

The majority of the respondents had dyslipidaemia (n = 195), and this was

Table 2. Association between socio-demographic characteristics and undiagnosed hypertension.

Socio-demographic characteristics	Hypertension status Hypertensive Not hypertensive 136 (100%) 244 (100%)		Total 380	Chi-square	p-value
Age group (years)					
<26	6 (4.4)	58 (23.8)	64	52.166	<0.001*
26 - 35	12 (8.8)	36 (14.8)	48		
36 - 45	22 (16.2)	53 (21.7)	75		
46 - 55	32 (23.5)	56 (22.9)	88		
56 - 65	64 (47.1)	41 (16.8)	105		
Gender					
male	58 (42.6)	103 (42.2)	161	0.007	0.935
female	78 (57.4)	141 (57.8)	219		
Level of education					
No formal	1 (0.7)	2 (0.8)	3	18.058	<0.001*
primary	55 (40.5)	55 (22.5)	110		
secondary	49 (36.0)	87 (35.7)	136		
tertiary	31 (22.8)	100 (41.0)	131		
Occupation					
Farming	28 (20.6)	44 (18.0)	72	26.451	<0.001*
trading	23 (16.9)	19 (7.8)	42		
professional	16 (11.8)	39 (16.0)	55		
C/S	21 (15.4)	48 (19.7)	69		
retired	32 (23.5)	30 (12.3)	62		
student/apprentice	9 (6.6)	50 (20.5)	59		
Unemployed	7 (5.2)	14 (5.7)	21		
Marital status					
single	12 (8.8)	95 (38.9)	107	47.868	<0.001*
married	78 (57.4)	117 (48.0)	195		
widowed	46 (33.8)	32 (13.1)	78		
Religion					
Christianity	122 (89.7)	228 (93.5)	350	4.836	<0.001*
Islam	0	3 (1.2)	3		
Traditional	14 (10.3)	13 (5.3)	27		
FH of Hypertension					
positive	75 (55.2)	85 (34.8)	160	14.803	0.001*
negative	54 (39.7)	142 (58.2)	196		
not aware	7 (5.1)	17 (7.0)	24		

found to be statistically significant (p-value < 0.001). The presence of abnormal levels of low-density lipoprotein ($p \leq 0.01$), high density lipoprotein ($p \leq 0.001$), and total cholesterol ($p \leq 0.01$) were found to be significantly associated with hypertension. Similarly, the presence of diabetes mellitus was found to be

Table 3. Association between life style index and hypertension.

Life style	Hypertension status Hypertensive	Not hypertensive	Total	Chi-square	p-value
Central obesity (WC)					
Yes	59 (43.38)	74 (30.33)	133	6.542	0.011*
No	77 (56.62)	170 (69.67)	247		
General obesity (BMI)					
Underweight	3 (2.2)	13 (5.3)	16		
Normal weight	40 (29.4)	114 (46.7)	154	18.248	<0.001*
Overweight	61 (44.9)	63 (26.0)	124		
Obesity	32 (23.5)	54 (22.0)	86		
Alcohol use					
Harmful use	18 (13.2)	19 (7.8)	37	2.950	0.086
Un harmful use	118 (86.8)	225 (92.2)	343		
Physical activity status					
Low	99 (72.79)	117 (48.0)	216	22.10	<0.001*
Moderate	33 (24.27)	110 (45.0)	143		
High	4 (2.94)	17 (7.0)	21		

*= Statistically significant, X^2 = Chi-square.

significantly associated with hypertension (p = 0.007). These are as shown in Table 4 below.

3.6. Risk Factors for Undiagnosed Hypertension

Logistic regression was conducted for factors with significant association with undiagnosed hypertension and the results are shown Table 5(a) and Table 5(b). Age (p ≤ 0.001), and marital status (being married, p ≤ 0.001), were identified as risk factors for undiagnosed hypertension. As regards age the respondents in the age group 26 - 35 years were about 10 times more likely to have undiagnosed hypertension (OR = 10.647, 1.910 - 59.345, p-value = 0.007) compared to participants aged less than 26 years. Similarly, in comparisons with participants less than 26 years, respondents between the ages of 36 - 45 years were about 4 times likely to have undiagnosed hypertension (OR = 3.680, 1.263 - 10.723, p-value = 0.017) while respondents aged between 46 - 55 years old were about 3 times more likely to develop hypertension. (OR = 2.737, 1.114 - 6.727, p-value = 0.039). Furthermore, respondents aged 56 - 65 years old were about 3 times more likely to develop hypertension. (OR = 3.384, 1.610 - 7.115, p-value = 0.001).

As regards marital status participants who were married were about 4 times more likely to develop hypertension (OR = 3.846, 1.118 - 13.233, p-value = 0.033) compared to those who were single. Furthermore, as shown in Table 5(b) below, the odds for the occurrence of undiagnosed hypertension in individuals

Table 4. Association between dyslipidaemia, diabetes mellitus and hypertension.

Lipid profile	Hypertension status		Total (380)	Chi-square	p-value
	Hypertensive	Not hypertensive			
	136 (100%)	244 (100%)			
Dyslipidaemia					
Yes	89 (65.44)	106 (43.44)	195	16.916	<0.001*
No	47 (35.46)	138 (56.56)	185		
Triglycerides					
High TG	6 (4.41)	2 (0.82)	8	5.467	0.019*
Low TG/normal	130 (95.59)	242 (99.18)	372		
Low density lipoprotein					
High LDL	26 (19.12)	15 (6.15)	41	15.262	<0.001*
Low LDL/normal	110 (80.88)	229 (93.85)	339		
High density Lipoprotein					
Low HDL	79 (58.1)	101 (41.39)	180	26.451	<0.001*
High HDL/normal	57 (41.9)	143 (58.61)	200		
Total cholesterol					
High TC	33 (24.26)	6 (2.46)	39	45.085	<0.001*
Low TC/normal	103 (75.74)	238 (97.54)	341		
Diabètes mellitus					
Diabetic	18 (13.2)	13 (5.33)	31	7.288	0.007*
Non-diabetic	118 (86.8)	231 (94.67)	349		

*= Statistically significant, X^2 = Chi-square.

without dyslipidaemia was twice that of participants with dyslipidaemia R = 0.526, 0.307 - 0.902, p-value = 0.019). Factors such as occupation, level of education, religion, family history, obesity, lipid profile were not found to be independent risk factors.

4. Discussion

This study sought to determine the burden of undiagnosed hypertension in a rural community of Mbieri in Imo State Nigeria and identified a high bur den of hypertension in the study population. We identified such factors as age range 26 - 35, 36 - 45, and 46 - 55; and marital status to be independent risk factors for undiagnosed hypertension. This is the first time such a study is conducted in a rural population in Imo state Nigeria and, thus, serves as a reference point for similar studies in future.

In this study, we were able to determine the prevalence of undiagnosed hypertension as 35.8%. This is strikingly high and worrisome for a rural population, and could be the reason for the common observation at the General

Table 5. (a) Logistic regression analysis showing independent risk factors of hypertension. (b) Logistic Regression analysis showing independent risk factors of hypertension (cont'd).

(a)

Variable	Odds ratio	95% Confidence level (lower - higher)	P-value
Age (years)			
<26	1		
26 - 35	10.647	1.910 - 59.345	0.007*
36 - 45	3.680	1.263 - 10.723	0.017*
46 - 55	2.737	1.114 - 6.727	0.039*
56 - 65	3.384	1.610 - 7.115	0.001*
Level of education			
Tertiary	1		
No formal	2.764	0.191 - 39.942	0.456
Primary	0.675	0.279 - 1.637	0.385
Secondary	0.585	0.282 - 1.213	0.149
Occupation			
Farmers	1		
Professionals	0.668	0.194 - 2.299	0.523
Traders	0.731	0.179 - 2.984	0.662
C/S	1.602	0.438 - 5.858	0.476
Retired	0.737	0.207 - 2.622	0.637
Student/apprentice	1.411	0.372 - 5.353	0.613
Unemployed	0.317	0.054 - 1.855	0.202
Marital status			
Single	1		
Married	3.846	1.118 - 13.233	0.033*
Widowed	1.637	0.728 - 3.681	0.234

(b)

Variable	Odds ratio	95% Confidence level (lower - higher)	P-value
Religion			
Christianity	1		
Islam	1.127	0.379 - 3.348	0.830
Others	0.212	0.461 - 8.623	0.214
Family history			
Negative	1		
Positive	0.429	0.132 - 1.391	0.159
Not aware	1.024	0.319 - 3.285	0.968
Diabetes status			
Non-diabetic	1		
Diabetic	0.988	0.359 - 2.713	0.981

Continued

Dyslipidaemia			
No	1		
Yes	0.526	0.307 - 0.902	0.019*
Central Obesity Status (WC)			
No obesity	1		
Obesity	1.136	0.613 - 2.105	0.685
General Obesity Status (BMI)			
Underweight	1		
Normal weight	3.472	0.664 - 18.143	0.140
Overweight	1.459	0.645 - 3.300	0.364
Obesity	0.562	0.272 - 1.161	0.119
Physical Activity (PA)			
Low	1	0.099 - 1.593	0.192
Moderate	0.397	0.099 - 1.593	0.192
High	0.606	0.153 - 2.408	0.477

Out-Patient Clinics where patients often present with complication(s) of hypertension at their first encounter without any previous diagnosis. This is important for the design and development of a care plan for the rural population that incorporates their natural food and active life of farming as against the trend for unhealthy westernized diets and sedentary lifestyle, respectively. This report is similar to the results reported by Gyang *et al.* [27] in northern part of Nigeria. However, it was different from reports in other parts of Nigeria, Vincent-Onabajo *et al.*, reported 25% [34] which was less while Okubadejo *et al.* reported a much higher figure of 55% [51]. The prevalence in this study was also higher than that reported from other parts of Africa by Gudina *et al.* [10], Birlow *et al.* [11], Basu *et al.* [12], Dejenie *et al.* [23], and Getachew *et al.* [24]. Another study in Poland by Szuba *et al.* [9] and Peru by Guerrero-Diaz *et al.* [17] reported a prevalence of undiagnosed hypertension to be as high as 61.7% and 67.2% respectively among the study population, which is far higher than what we found in our study. The differences could be accounted for by the differences in the study population, the age ranges chosen, and the diagnostic criteria for hypertension.

We identified such factors as certain age groups as being significantly associated with undiagnosed hypertension and were also found to be a significant risk factor. With reference to the age group of less than 26 years, those between 26-and 35 years were 10 times more likely to have undiagnosed hypertension and those between 56 and 65 years were three times more likely to have undiagnosed hypertension. This is in agreement with other studies published by Lim *et al.* [8], Dejenie *et al.* [23], Basu *et al.* [12], Bharati *et al.* [20] in their respective reports. They reported that increasing was significantly associated with hypertension. The changes associated with arterial wall compliance and arteriosclerosis, which occurs with age, in addition to less physical activity in the older, could

be a plausible explanation for this.

This study also identified marital status as being associated with undiagnosed hypertension, with being married an independent risk factor for hypertension. We found out that being married increased the risk of hypertension by four folds compared to being single. This may be due to the fact that married persons are more likely to be older, and are likely to be exposed to more psychosocial stressors. This finding is similar to what has been reported in other studies by Onwuchekwa *et al.* in Nigeria [32] and Dejenie in Ethiopia [23].

The study showed that hypertension was more common in females than males, although this was not found to be a statistically significant independent risk factor. This was similar to the reports made by Bharati *et al.* [20] where more women were found to be more likely to have hypertension, though in contrast to the reports made by Szuba *et al.* [9] and Vincent-Onabajo *et al.* [34], in their respective studies.

In addition, the study identified abnormal lipid profiles in the respondents although not as an independent risk factor for undiagnosed hypertension. The prevalence of abnormal lipid profiles was 51.3%. Similar studies by Akinlua *et al.* [16] and Oguejiofor *et al.* [52] also reported similar high prevalences of dyslipidemia among their respective study populations, and the presence of abnormal lipid profile was associated with hypertension in these studies. This association could be related to the roles abnormal lipids play in the development of atherosclerosis which will result in an increase in total peripheral resistance with attendant hypertension. Similar to abnormal lipids, obesity was common among the participants with undiagnosed hypertension but was not found to be an independent risk factor for occurrence of undiagnosed hypertension. Onwuchekwa *et al.* [32] reported similar result. This was not in tandem with most other studies as reported by Bharati *et al.* [20], Bushara *et al.* [25], Vincent-Onabanjo *et al.* [34], and Iloh *et al.* [53]. Obesity is known to be an independent risk factor for hypertension, and also associated with other risk factors of hypertension such as poor exercise. It is possible that the relatively small sample size of this study may have contributed to the inability to observe an association between abnormal lipid profile and obesity with undiagnosed hypertension in this study. Despite the well documented association between diabetes and physical inactivity with hypertension, there was no association between these factors and undiagnosed hypertension in this study, which may be related to the study site being a rural area as diabetes and physical inactivity are less common in rural areas relative to urban or developed communities.

Limitations of the Study

This study involved the collection of data of individuals in a rural community where expo sure to education and health literacy is expected to be limited. Challenges included access to the residents, and protection of the rights of the participants. Strategies applied were a meticulous informed consent process and

early interphase with the stakeholders in the community to address any concerns that the participants might have had. Secondly, this was a cross-sectional study, and the data cannot be applied in asserting a cause-effect relationship, unlike a longitudinal or experimental study. It is possible that the relatively small sample size may have yielded some false negative outcomes. In addition, random plasma lipid levels were used for analysis rather than the fasting levels which may have affected interpretation of serum triglyceride results and the conclusions therefrom.

5. Conclusion

This study revealed that the prevalence of undiagnosed hypertension in Mbieri, a rural community in Southeastern Nigeria is strikingly high. This result may not be far from what is obtainable in other rural communities in the region. Age between 26 and 36, and being married were found to be independent risk factors for undiagnosed hypertension. This study has given an insight into the burden of hypertension (and associated factors) in a rural population which is quite high. Advocacy should be sustained in the design and development of programs that will help prevent occurrence of hypertension and early detection of the disease in the community through coordinated and regular community-based health out reaches, and strengthening of the capacity of Primary Healthcare Centres which statutorily attend to the health needs of majority of populations in rural communities.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix

Questionnaire

Participants serial number…

Good day Sir/Madam. This is a Questionnaire on the topic The Burden of Undiagnosed Hypertension and associated risk factors among adult dwellers of a Mbieri; a rural community in Mbaitoli LGA of Imo State. Your participation and cooperation is highly needed to carry out the study. Please fill the consent form attached to this questionnaire indicating that you are willing to participate in the study.

Using this questionnaire, the researcher will ask you some questions about your person and the disease being studied. Responses to this questionnaire will be treated confidentially. As part of the study, measurements of your blood pressure, weight, height and waist circumference will be done and your random blood glucose level and non fasting lipid profile will be determined.

Thank you for your cooperation.

SECTION A: Socio-demographic data

1) Age (in years): ☐

2) Gender: Male ☐ Female ☐

3) Level of Education: No formal education ☐ Primary ☐

Secondary ☐ Tertiary ☐

4) Occupation: Unemployed ☐ Farmer Petty trader ☐ Civil Servant ☐ Retired ☐ Student/apprentice ☐ Professional Others (Specify): ☐

5) Marital Status: Single Married ☐ Widowed ☐ Separated Divorced ☐

6) Religion: Christianity ☐ Islam ☐

Traditional Atheist Others ☐ specify ☐

SECTION B: Family history of hypertension

7) Has anyone in your family suffered from hypertension before or is there any one in your family suffering from hypertension now? Yes ☐ No ☐ Not aware ☐

8) If yes, has anyone in your family suffered from these following complications of hypertension before: Heart failure ☐ Stroke ☐ Kidney failure ☐ others (specify) ☐

SECTION C: Screening for alcohol using the AUDIT Questionnaire

1) How often do you have a drink containing alcohol (0) Never (skip to questions 9 - 10) ☐

(1) Monthly or less ☐ (2) 2 to 4 times a month ☐

(3) 2 to 3 times a week ☐ (4) 4 or more times a week ☐

2) How many drinks containing alcohol do you have on a typical day when you are drinking? (0) 1 or 2 ☐ (1) 3 or 4 ☐ (2) 5 or 6 ☐ (3) 7, 8, or 9 ☐ (4) 10 or more ☐

3) How often do you have six or more drinks on one occasion? (0)Never ☐ (1) Less than monthly ☐ (2) Monthly ☐ (3) Weekly ☐ (4) Daily or almost daily ☐

Skip to Questions 9 and 10 if Total Score for Questions 2 and 3 = 0

4) How often during the last year have you found that you were not able to stop drinking once you had started? (0) Never ☐ (1) Less than monthly ☐ (2) Monthly ☐ (3) Weekly ☐ (4) Daily or almost daily ☐

5) How often during the last year have you failed to do what was normally expected from you because of drinking? (0) Never ☐ (1) Less than monthly ☐ (2) monthly ☐ (3) Weekly ☐ (4) Daily or almost daily ☐

6) How often during the last year have you needed a first drink in the morning to get yourself going after a heavy

drinking session?

(0)Never □ (1) Less than monthly □ (2) Monthly

(3) Weekly □ (4) Daily or almost daily □

7) How often during the last year have you had a feeling of guilt or remorse after drinking?

(0) Never □ (1) Less than monthly □ (2) Monthly □ (3) Weekly □ (4) Daily or almost daily □

8) How often during the last year have you been unable to remember what happened the night before because you had been drinking?

(0) Never □ (1) Less than monthly □ (2) Monthly □ (3) Weekly □

(4) Daily or almost daily □

9) Have you or someone else been injured as a result of your drinking?

(0) No □ (2) Yes, but not in the last year □ (4) Yes, during the last year □

10) Has a relative or friend or a doctor or another health worker been concerned about your drinking or suggested you cut down?

(0)No □ (2) Yes, but not in the last year □ (4) Yes, during the last year □

SECTION D: Screening for Physical activity using the IPAQ-SF Questionnaire.

The questions will ask you about the time you spent being physically active in the last 7 days. Please answer each question even if you do not consider yourself to be an active person. Please think about the activities you do at work, as part of your house and yard work, to get from place to place, and in your spare time for recreation, exercise or sport.

Think about all the vigorous activities that you did in the last 7 days. Vigorous physical activities refer to activities that take hard physical effort and make you breathe much harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

1) During the last 7 days, on how many days did you do vigorous physical activities like heavy lifting, digging, aerobics, or fast bicycling?

_____ days per week _____No vigorous physical activities (skip to question 3)

2) How much time (average) did you spend doing vigorous physical activities on one of those days?

_____hours per day _____minutes per day _____Don't know/Not sure

Think about all the moderate activities that you did in the last 7 days. Moderate activities refer to activities that take moderate physical effort and make you breathe somewhat harder than normal. Think only about those physical activities that you did for at least 10 minutes at a time.

3) During the last 7 days, on how many days did you do moderate physical activities like carrying light loads, bicycling at a regular pace, or doubles tennis? Do not include walking.

_____days per week _____No moderate physical activity (skip to question 5)

4) How much time did you usually spend doing moderate physical activities on one of those days? _____hours per day _____minutes per day _____ Don't know/Not sure

Think about the time you spent walking in the last 7 days. This includes at work and at home, walking to travel from place to place, and any other walking that you might do solely for recreation, sport, exercise, or leisure.

5) During the last 7 days, on how many days did you walk for at least 10 minutes at a time? _____days per week _____No walking (skip to question 7)

6) How much time did you usually spend walking on one of those days?

_____hours per day ____minutes per day ____Don't know/Not sure

The last question is about the time you spent sitting on weekdays during the last 7 days. Include time spent at

work, at home, while doing course work and during leisure time. This may include time spent sitting at a desk, visiting friends, reading, or sitting or lying down to watch television.

7) During the last 7 days, how much time did you spend sitting on a week day?

_____hours per day _____minutes per day _____Don't know/Not sure

Section E: Clinical Measurement

Weight ……. (kg)

Height……(m)

BMI…… (kg/m^2)

Waist circumference…….. (cm)

Blood pressure …….. (mm/Hg)

Random Plasma Glucose…… (mg/dl)

Non Fasting Lipid Profile, (mg/dl) TC…… LDL……. HDL …….TG……...

THANK YOU