Assessment of Cardiovascular Risk for Prevention and Control of Cardiovascular Disease in Ghana's Northern Region

A Cross-Sectional Study of 4 Rural Districts Using World Health Organization/International Society of Hypertension (WHO/ISH) Risk Prediction Charts

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Abstract

Ghana is experiencing an increase in cardiovascular (CVD) -related mortality with poor rural communities suffering greater complications and premature deaths. The point of this exploratory research is to evaluate the prevalence of CVD risk factors and to calculate the cardiovascular risk among adults aged > 40 years in Ghana's Northern Region. A cross-sectional study was performed with 536 subjects. A pre-tested questionnaire, anthropometric measurements, and standardized WHO/ISH risk prediction charts assessed for 10-year risk of a fatal or non-fatal major cardiovascular event according to age, sex, blood pressure, smoking status, and diabetes mellitus status. Low, moderate and high CVD prevalence risk in females was 88.4%, 7.1%, and 4.5% while in males the prevalence was 91.3%, 5.8%, and 2.9%, respectively. Hypertension was noted as a clinically significant risk factor with females at 37.3% versus males at 32%. The 10-year risk of a fatal or non-fatal cardiovascular event was statistically significant for females according to age group. A moderate to high CVD risk of a fatal or non-fatal cardiovascular event was found in 10.4% of subjects. Notable CVD risk factors included a high prevalence of hypertension. Decentralizing care to local village healthcare facilities is one way to tackle cardiovascular risk reduction. Task shifting of primary care duties from physicians to nurses in terms of cardiovascular (CV) risk assessment and management of uncomplicated CV risk factors is a potential solution to the acute shortage of trained health staffs for the control and prevention of CVD in Northern Ghana.

Keywords: Cardiovascular Disease (CVD), Hypertension, Diabetes, Ghana, task shifting, total risk

1. Introduction

Non-communicable diseases (NCDs) are the primary cause of death globally, contributing to 71% of deaths each year (WHO, 2018). Cardiovascular diseases (CVDs) account for the majority of NCD deaths and the World Health Organization (WHO) estimates that in 2016, almost 18 million deaths occurred globally due to CVDs. In the past, NCDs such as CVD were predominantly seen in high-income countries (HIC). However, there has been an estimated 50% decline in CVD mortality in many HIC from 1965 to 1990 due to prevention and treatment (Reddy & Yusuf, 1998). Around the time that CVD-related deaths began to decrease in HIC, the prevalence of such deaths in low-and middle-income countries (LMIC) rose (Mercer, 2018). LMIC were once primarily concerned with infectious diseases and malnutrition; then an epidemiological transition facilitated by urbanization and lifestyle changes introduced escalating amounts of CVDs into LMIC (Reddy & Yusuf, 1998). Approximately 82% of the 17 million premature NCD deaths globally occur in LMIC, and 37% of these deaths are caused by CVDs (WHO, 2017). Cerebrovascular accident (stroke) is the leading CVD cause of death and mortality in sub-Saharan Africa (Ofori-Asenso & Garcia, 2016). Compared to HIC, members of these LMIC populations do not have the advantage of integrated primary health care programmes for early screening and management of CVD risk factors.

Ghana, a LMIC in West Africa is one country that is experiencing an increase in CVD-related mortality (World

Bank Data Help Desk, 2017). In 2008, CVDs were the most prevalent contributor to mortality in Ghana among all NCDs (Bosu, 2013). Stroke is ranked as the 3rd leading cause of death in Ghana and was responsible for 3.25% of total disability-adjusted life years (DALYs) in Ghana in 2017, whereas in 1990, it accounted for only 1.75% (Health Profile Ghana, n.d.). Hypertension and diabetes mellitus (DM), both risk factors for CVD, are on the rise in Ghana including a significant undiagnosed hypertension and DM population. For the hypertensive and DM populations that are diagnosed, control remains very low (Awuah et al., 2014). The increase in burden of CVD in Ghana can be detrimental to Ghanaians who may not have any access to screening/monitoring, patient education, follow-up, adherence management and triaging referrals to specialists. There are few interventions being executed in Ghana surrounding CVD awareness and as such Ghanaians may be unaware of the preventable lifestyle factors that put them at risk of CVD (De-Graft Aikins et al., 2012). As a result, many people are detected late in the course of the disease and die younger from CVDs, often in their most productive years. The economic impact is significant because working-age adults account for a high proportion of the CVD burden in Ghana. Poor rural communities living with CVDs suffer greater complications and die prematurely because they lack access – in geographical, economic and cultural terms – to quality healthcare. Many of the risk factors (smoking, hypertension, elevated lipid levels, and elevated blood glucose) for heart disease and stroke can be prevented or completely eliminated. Early identification and control of risk factors, prevention and education programmes, treatment and control of NCDs is essential to decrease this burden of CVDs in Ghana (Nelson et al., 2015).

Urban and rural populations in Ghana are being affected by this epidemiologic transition differently. Ghanaians living in urban cities such as Accra have very different lifestyles than those in rural areas. Rural populations may lack the resources such as health care, transportation, and the funds to treat CVDs. However, they may be less exposed to some of the risk factors of CVDs. Obesity, a known risk factor for CVDs, was recorded in both rural and urban adults in Ghana. Agyemang et al. (2009) determined that the prevalence of obesity in Ghana was 10.3% in rural men, 22% in urban men, 19% in rural women, and 50% in urban women. A separate study of several LMIC including Ghana found that there were lower levels of occupational physical activity in urban areas along with a higher prevalence of diagnosed diabetes (Oyebode et al., 2015). Interestingly, the same study discovered that frequent alcohol consumption levels were higher in rural areas than urban (Oyebode et al., 2015). It is likely that the urbanized lifestyle that some Ghanaians have adopted has exposed them to more risk factors of CVDs than those in rural areas. Sociodemographic differences between urban and rural populations account for some of the differences in prevalence rates of CVDs. Lower education level, illiteracy, lack of awareness or knowledge of CVD and its risk factors, and poverty increased the prevalence rates in rural areas (Nyarko, 2016; Gómez-Olivé et al., 2017).

An important first strategy in the prevention and management of CVDs is the early identification of at-risk individuals. CVD risk assessment tools are widely used in HIC population. The appropriateness of using these assessment tools developed for HIC populations may not be accurate when applied to LMIC populations (Zhao et al., 2015). The WHO and the International Society of Hypertension (IHS) have developed specialized CVD-risk prediction charts for use in countries using the best available mortality and risk factor data specific to each country (WHO, n.d.). These charts are a cost-effective way to identify at-risk individuals in a specific population and determine a ten-year risk of major cardiovascular outcomes. We have implemented the WHO/ISH cardiovascular risk prediction charts in this exploratory study.

The point of this exploratory study is to evaluate the prevalence of CVD risk factors and to calculate the CV risk among adults aged > 40 years in Ghana's Northern Region using WHO/ISH risk prediction charts (WHO, n.d.). The prediction charts were used to estimate each individual's 10-year risk of a major cardiovascular event (myocardial infarction or stroke) by considering age, sex, blood pressure, smoking status, and presence or absence of diabetes mellitus. Data from this study will be used to: (1) Improve the effectiveness of CVD risk prevention and management at the individual level; (2) Direct health service delivery planning for cardiovascular disease and all other chronic NCDs at the population level; and (3) Guide planning for a chronic disease management clinic within the proposed 50---bed general hospital in the town of Carpenter, Northern Ghana.

2. Method

2.1 Participant (Subject) Characteristics

A cross-sectional study was performed from November 14-25, 2016 among a sample representative (N=536) of the Northern Empowerment Association (NEA) / Ghana Rural Integrated Development (GRID) Health Clinic patient population to calculate the prevalence of cardiovascular disease risk factors. Adult participants (age > 40) were selected by systematic random sampling. Standardized WHO/ISH risk prediction charts were used to assess 10-year risk of a fatal or non-fatal major cardiovascular event (myocardial infarction or stroke), according to age,

sex, blood pressure, smoking status, and presence or absence of diabetes mellitus in four rural Northern Ghana districts (Bole, Kintampo South, and Kintampo North Districts).

2.2 Study Area

The Northern Region is located in North Ghana. It is the largest of ten regions covering an area of 70,384 square kilometers or 31% of Ghana's area and is home to 2.5 million individuals (GSS, GHS, ICF International, 2015). Four villages in three separate districts comprise the study sites: Asantekwa (Kintampo North District), Yaara (Kintampo North District), Nyamboi (Kintampo South District), and Carpenter (Bole District). The research study was conducted as an extension of the NEA/GRID community health team visit. The 2016 Ghana Health Team was a team of 64 medical/surgical/dental and ophthalmology health personnel from Canada, United States and the United Kingdom. Local Ghanaian volunteers, including nurses and university students, provided support to the Ghana Health Team. The four health team village sites were pre-determined by NEA/GRID based on health care needs. Since 2009, the NEA/GRID Ghana Health Team has annually visited rural villages in the Northern Region. Health clinic data has identified a growing increase in the number of hypertension, diabetes and stroke cases in this patient population. This non-research data led to the need to properly assess cardiovascular risk in the patient population served by the NEA/GRID Ghana Health Team through the annual community health team visits.

2.3 Study Population

The study sample included consented persons above 40 years of age (N=536) and attendees of one of the NEA/GRID community health team clinic sites during the annual NEA/GRID health team visit to Northern Ghana from November 14-25, 2016. The sample size was calculated using Creative Research Systems (n.d.) quantitative research sample size calculator. In order to obtain a confidence level of 95% with a 4% confidence interval in a population size of 4700, a sample size of N=532 was required. The NEA/GRID health team provided a health clinic from 9:00 – 4:00 in each of the four villages for two consecutive days (8 clinics in total). The representative sample was randomly selected from an estimated total of 4,700 NEA/GRID community health team clinic sites attendees. At each of the four health team clinic sites, a research station comprised of the Principal Investor/Nurse Practitioner and 2 research students surveyed eligible patients after clinic registration. Simple random sampling was used to sample only the population that met the eligibility of age > 40 years, as the WHO/ISH risk score is designed for this population only.

2.4 Study Tool

After providing written informed consent, study participants were interviewed using a questionnaire based on the WHO STEPwise Approach to NCD risk factor surveillance (STEPS) (WHO, n.d.). STEPS surveys are cross-sectional surveys that include interviews and physical examination and use standardized questionnaires and measurement protocols. The questionnaire was tested on a group of 15 individuals before its utilization. The questionnaire was approved by the Ghana Health Services Ethics Review Committee. Sampled participants were interviewed in person to elicit information on selected demographic characteristics, tobacco use, and diagnosis and treatment history for diabetes and hypertension. Data collection according to the following steps was completed: 1) First blood pressure (BP) measurement; 2) Administration of demographic information questionnaire; 3) Second BP measurement; 4) Administration of risk factors questionnaire; and 5) blood glucose measurement. All research students were educated by the PI on how to properly interview potential research participants and complete blood pressure and blood glucose measurements.

2.5 Calculating Total CVD Risk Using WHO/ISH Risk Prediction Charts

The WHO/ISH cardiovascular risk prediction charts for the Africa D sub-region (AFD D) were adopted to calculate the CV risk among study participants. The risk categories for 10-year total risk of a fatal or non-fatal CVD event include <10% classified as "low risk", 10- <20% "moderate risk", 20- <30% as "high risk" and > 30% as "very high risk" (WHO, n.d.). To observe the stratified prevalence of CVD risk, the cut-off for the high risk was taken as a CVD risk above 20%. There are two sets of risk prediction charts for the AFR D sub-region depending on the ability to measure blood cholesterol. Blood cholesterol was not measured in this study. The predictor variables for the risk prediction were age (measured in single years), gender (male/female), current smoking status (yes/no), blood pressure (in mmHg), and diabetes status (yes/no). For total CVD risk calculation, all current smokers and those who quit smoking less than 1 year before the assessment were considered smokers. Blood glucose for data analysis was obtained by fingerstick blood sampling and analyzed using the LifeScan OneTouch Verio Flex ™ (2015). Subjects were diagnosed as diabetic if currently taking insulin and/or oral hypoglycemic drugs and/or with a measured fasting glucose blood sample above 7.0 mmol/L or a postprandial (approximately 2 hours after a main meal) blood glucose level above 11.0 mmol/L (WHO, n.d.). Blood pressure was measured using

a digital blood pressure monitor (Healthcare Wellness & Healthcare Products, n.d.). Blood pressure was measured on the left arm with the patient in the sitting position. The first reading of blood pressure was taken after 5 minutes of rest and the second reading was taken 5 minutes later. The second reading was taken as the final reading for the WHO/ISH cardiovascular risk calculation. Screening for hypertension was based on the following American Society of Hypertension and the International Society of Hypertension criteria (Weber et al., 2014). Blood pressure below 120/80 mm Hg was considered normal. Prehypertension was defined as systolic blood pressure between 120 mm Hg to 139 mm Hg, or diastolic pressures between 80 to 89 mm Hg. Stage 1 hypertension was defined as systolic blood pressure 140 to 159 mm Hg or diastolic blood pressure 90 to 99 mm Hg. Stage 2 hypertension was defined as systolic blood pressure ≥160 mm Hg or diastolic blood pressure ≥100 mm Hg (Weber et al., 2014). For the WHO/ISH cardiovascular risk calculation, subjects were diagnosed to be hypertensive if SBP > 140 mmHg and / or DBP > 90 mmHg or taking antihypertensive medication.

WHO/ISH risk score charts are supplemented by practice notes for researchers to support interpretation and adjustment of study participant's risk. For example, the notes state that those who have persistent blood pressure > 160/100 mm Hg should be considered in the high-risk category regardless of risk calculations using the charts (WHO, n.d.).

2.6 Statistical Analysis

Data collected was entered into Microsoft Excel and then analyzed by the IBM® SPSS® Statistics Version 24 for Mac (2016). Frequency and percent distribution were computed for all variables. The association between various study categorical variables and gender was calculated by using Chi-Square test. All P-values were two tailed and significant when values were less than 0.05.

3. Results

3.1 Characteristics of Study Population

Table 1 explains the association between study variables and the gender of study subjects. A total of 536 adults were examined in this study (289 females and 247 males). The mean age of the subjects was 53.8 (+ 12.0) years with 53.9% subjects being female and 46.1% being male. The majority of study participants, 232 (43.1%) were from the age group 40-49 years, followed by 132 (24.6%) of the 50-59 age group. Diabetes status as present was comparable between females at 30 (13.5%) and males at 23 (13.3%). Current smoking status was statistically significant in males at 43 (17.6%) and in females at 1 (0.3%). Blood pressure above normal was present in 108 (37.6%) females compared to 81 (32.6%) males. Prehypertension classification was higher in males at 103 (41.8%) versus females at 92 (31.7%). Hypertensive medications were prescribed in females at 33 (11.5%) and in males at 26 (10.5%).

Table 1. Characteristics of Study Population including CVD Risk Factors

Study Variables	Total n (%)	Female n (%)	Male n (%)	*P*-value
Total (n)	536	289 (53.9)	247 (46.1)	
Age in years				0.478
40-49	232 (43.1)	116 (40.1)	114 (46.2)	
50-59	132 (24.6)	75 (26.0)	57 (23.1)	
60-69	100 (18.6)	54 (18.7)	46 (18.6)	
>69	74 (13.8)	44 (15.2)	30 (12.1)	
Diabetes1				0.816
Absent	343 (86.6)	193 (86.5)	150 (86.7)	
Present	53 (13.4)	30 (13.5)	23 (13.3)	
Smoking Status2				< 0.001
Yes	45 (8.3)	1 (0.3)	43 (17.6)	
No	491 (91.7)	288 (99.7)	204 (82.4)	
HTN				0.116

Classification3				
Normal	153 (28.5)	89 (30.7)	64 (25.9)	
Prehypertension	195 (36.4)	92 (31.8)	104 (42.1)	
Stage 1	101 (18.9)	59 (20.4)	42 (17.0)	
Stage 2	87 (16.2)	49 (16.9)	37 (14.9)	
HTN Meds4				0.816
Yes	59 (11.0)	33 (11.5)	26 (10.5)	
No	477 (89.0)	256 (88.5)	221 (89.5)	

Note. [1] Present [taking insulin and/or oral hypoglycemic drugs and/or fasting blood sugar > 7.0 mmol/L and/or a postprandial blood sugar > 11.0 mmol/L). Nyamboi (Kintampo South) data not included due to data collection error. (n=396) Female n=223 / Male n=175.

[2] Yes (all current smokers and those who quit smoking less than 1 year before the assessment).

[3] Normal (systolic blood pressure < 140 mmHg and diastolic blood pressure < 90mmHg and not taking antihypertensive medication); Prehypertension (systolic blood pressure between 120 mm Hg to 139 mm Hg, or diastolic pressures between 80 to 89 mm Hg); Stage 1 hypertension (systolic blood pressure 140 to 159 mm Hg or diastolic blood pressure 90 to 99 mm Hg); Stage 2 hypertension (systolic blood pressure ≥160 mm Hg or diastolic blood pressure ≥100 mm Hg).

[4] Yes (Self-reported receipt of medication for hypertension).

3.2 10-Year Risk of a Fatal or Non-Fatal Cardiovascular Event

Table 2 presents the distribution of total CVD risk as per the WHO/ISH risk prediction chart for AFR D and indicates the 10-year risk of a fatal or non-fatal cardiovascular event by gender, age, systolic blood pressure, smoking status and presence or absence of diabetes mellitus. To observe the stratified prevalence of CVD risk by gender, the cut-off for the high risk was taken as a CVD risk above 20%. The CVD risk was greater among females than in males. The prevalence of low, moderate and high CVD risk in females was 88.4%, 7.1%, and 4.5% while in males the prevalence was 91.3%, 5.8%, and 2.9%, respectively.

Table 2. 10-year risk of a fatal or non-fatal cardiovascular event (n=396)

WHO-ISH risk score1	Total n (%)	Gender (%)		*P*-value
		Female n=224	Male n=172	
<10% (Low)	355 (89.6)	198 (88.4)	157 (91.3)	
10-<20% (Moderate)	26 (6.6)	16 (7.1)	10 (5.8)	0.710
> 20% (High)	15 (3.8)	10 (4.5)	5 (2.9)	

Note. [1]10 year risk of combined myocardial infarction and stroke risk - Nyamboi (Kintampo South) data not included due to data collection error.

3.3 Prevalence of NCD Risk Factors in the CVD Risk Groups

Table 3 presents the prevalence of risk factors stratified by CVD risk (mild, moderate, and high). Hypertension was noted as a clinically significant risk factor in all three risk categories (low, moderate and high CVD risk) at 23.7%, 6.6%, and 3.8%, respectively.

Table 3. Prevalence of NCD risk factors in the CVD risk groups (n=396)

| Risk Factors | CVD Risk | | | Total n (%) | *P*-value |
	Mild n (%) (<10%)	Moderate n (%) (10-20%)	High n (%) (>20%)		
Total (n)1				396	
Smoking	32 (8.1)	1 (0.25)	2 (0.5)	35 (8.8)	0.396
Hypertension	94 (23.7)	26 (6.6)	15 (3.8)	135 (34)	< 000.1
Diabetes	43 (10.8)	5 (1.3)	4 (1.0)	52 (13.1)	0.160

Note. 1Nyamboi (Kintampo South) data not included due to data collection error.

3.4 Prevalence of NCD Risk Factors According to Age and Gender

The prevalence of risk factors and CVD risk was stratified by age and gender (Tables 4a/4b). Hypertension was statistically significant for females at 108 (37.3%) versus males at 79 (32%) with the highest female rates in the 40-49 and 60-69 age groups at 29 (28%) and 30 (28%), respectively. The 10-year risk of a fatal or non-fatal cardiovascular event was statistically significant for females according to age group.

Table 4a. Prevalence of NCD risk factors and risk categories according to age and gender (Male)

| Risk Factors | Age n (%) | | | | Total n (%) | *P*-value |
Categories	40-49	50-59	60-69	>69		
HTN	31 (41)	19 (25)	15 (20)	14 (18)	79 (31.98)	.815
DM1 (n=175)	8 (35)	8 (35)	3 (13)	4 17)	23 (13)	.516
Smoking	12 (28)	17 (40)	9 (21)	5 (12)	43 (17)	.089
RISK1 (n=175)						.086
Risk 1	71 (45)	37 (24)	30 (19)	19 (12)	157 (90)	
2	3 (30)	2 (20)	1 (10)	2 (20)	10 (5.7)	
3	0 (0)	2 (.4)	1 (.2)	2 (.4)	5 (2.8)	

Note. 1Nyamboi (Kintampo South) data not included due to data collection error.

Table 4b. Prevalence of NCD risk factors and risk categories according to age and gender (Female)

| Risk Factors | Age n (%) | | | | Total n (%) | *P*-value |
Categories	40-49	50-59	60-69	>69		
HTN	29 (28)	25 (23)	30 (28)	24 (21)	108 (37.3)	< 000.1
DM[1]	12 (41)	7 (24)	4 (14)	6 (21)	29 (13.1)	.797
Smoking	1 (1)	0 (0)	0 (0)	0 (0)	1 (.03)	.356
RISK[1]						< 000.1
Risk 1	83 (42.1)	59 (29.9)	34 (18.8)	21 (10.6)	197 (88.3%)	
2	2 (12.5)	2 (12.5)	2 (12.5)	10 (62.5)	16 (7.2%)	
3	0 (0)	0 (0)	4 (40)	6 (60)	10 (4.5%)	

Note. 1 Nyamboi (Kintampo South) data not included due to data collection error.

4. Discussion

In the present study, moderate to high CVD risk was found to be 10.4% utilizing WHO/ISH risk prediction charts for the Africa D sub-region (AFD D). WHO-ISH risk scores for females in the moderate to high-risk category were

higher than males at 11.6% versus 8.7%. However, these findings were not statistically significant. Of the NCD risk factors studied, hypertension was noted as statistically significant in all three risk categories for both genders. Females were found to have a higher prevalence of hypertension and risk categories according to age. An extensive literature review was completed and no published studies using WHO/ISH risk prediction charts have been completed in Ghana. A cross-sectional study in Nigeria found the prevalence of moderate to high 10-year coronary risk was 12.8% according to WHO/ISH risk prediction charts incorporating blood cholesterol (Edward et al., 2013). A dissertation submitted to the Department of Community Health, School of Medical Sciences, College of Health Sciences, Kwame Nkrumah University of Science and Technology – Kumasi, Ashanti Region, Southern Ghana used the Framingham Risk Score for cardiovascular disease risk assessment and found the prevalence of low, medium and high total CVD risks were 41.5%, 28.1% and 30.4% respectively (Waindim, 2015). More males were at moderate to total CVD high risk compared to females.

Diabetes mellitus (DM) is a major cause of adult disability and death in Ghana (De-Graft Aikins, 2014). In our study, DM status as present was comparable between females at 13.5% and males at 13.3%. The prevalence of DM found in this sample is greater than the estimated average prevalence of 7.7% for adult populations from a rural community (Cook-Huynh et al., 2012). Kweku et al. (2017) examined prevalence, awareness and determinants of DM among urban and rural settlements and discovered a high prevalence of undiagnosed and uncontrolled DM especially in rural areas. The study further investigated participant awareness of DM and found that out of the urban DM cases, 69.2% were not aware they were diabetic whilst out of rural DM cases, 81.3% were not aware that they had DM. In addition, Kweku et al. (2017) identified the level of knowledge of DM to be low in both urban and rural study populations. The current study did not examine awareness or knowledge levels of DM but the higher-than-average prevalence rate could be attributable to a lack of awareness and/or knowledge about DM and its causes, complications and prevention strategies. In addition, access to DM screening in the study area is extremely limited.

Our study found the current smoking status was significantly greater in males at 17.6% versus females at 0.3%. The Ghana Demographic and Health Survey (GDHS) revealed the prevalence of smoking is below 10% and smoking is relatively predominant among males versus females in Ghana (Brathwaite et al., 2017). Another study surveyed tobacco smoking in the Ashanti region of Ghana and found the prevalence of self-reported current smoking was 8.9% for males and 0.3% for females. Specific to the male Ghanaian population, a study by Nketiah-Amponsah et al. (2018) found that men in lower socioeconomic categories have a higher likelihood to smoke. In Northern Ghana, poverty is endemic in rural areas and according to the Ghana Health Service [(GHS), the percentage of population with no education (never been to school or elementary schooling only) in Northern Ghana is 47.4% for males and 65.8% for females (Ghana Health Service, 2018). Hence, the high prevalence of smoking in rural areas may be largely attributed to lower socioeconomic categories.

The overall prevalence of hypertension (35.1%) identified in this study corresponds to the findings of Acheampong et al. (2019) and Solomon et al. (2017), who reported the prevalence of hypertension among adults in Ghana as 33.8% and 39.4% respectively. This is consistent with a systematic review conducted by Bosu (2010) in Ghana which showed the prevalence of hypertension among adults ranged from 25% and 48% in both urban and rural communities. In our study, the prevalence of hypertension was higher among females at 37.3% compared to males at 31.9% (P=.000). The systematic review by Bosu (2010), conducted in rural and urban populations, reported a higher prevalence of hypertension in males than females though differences were small (< 4 percentage points) and not statistically significant. Over the last 3 to 4 decades, several population-based studies conducted in Ghana have examined hypertension, however, only 1 was conducted in Northern Ghana. Kunutsor & Powles (2009) found a high prevalence of hypertension with a higher reported mean systolic blood pressure for females over males. Gomez-Olive et al. (2017) conducted a population-based cross-sectional study at 6 sites in 4 African countries, two of which were in West Africa, specifically, Burkino Faso and rural Northern Ghana. The prevalence of hypertension in the entire cohort was 33.3% and was significantly higher in females than in males. Burkino Faso had the lowest prevalence rate of hypertension among males (19.2%) and females (11.0%), however, the rural Northern Ghana site had significantly higher rates among males (24.1%), and more than double the prevalence among females (24.8%) (Kunutsor & Powles, 2009).

The prevalence of hypertension according to age cohort was studied in this population. For males, the highest rate of hypertension was found in the 40-49 age cohort at 41%, however not statistically significant. For females, the highest rates of hypertension were in the 40-49 and 60-69 age cohorts, both at 28% and statistically significant (<.001). Studies have identified the mean age cohort of hypertensives in sub-Saharan Africa to be in the 30-49 age cohort, thus, burdening those at peak productivity (Nulu et al., 2016). Specifically, a study conducted by Cappuccio & Miller (2016) explain the burden of CVD in sub-Saharan Africa and highlight hypertension as the

commonest underlying risk factor. The high prevalence of hypertension creates an enormous impact on socio-economic development as many of those in the high-risk group are at the peak of their productive and economic activity. Studies of hypertension prevalence and age cohorts in Ghanaian females have identified similar findings to our study. Acheampong et al. (2019) found females aged 45-64 were two to five times as likely as those with age 25-44 years to be hypertensive and Nyarko (2016) found the highest percentage of hypertension history was reported among females aged 40–49. Other studies have demonstrated age as a non-modifiable risk CVD factor in females and suggest an association between increasing age and hypertension in other sub-Saharan countries (Arrey et al., 2016; Kishore et al., 2016; Okyere et al., 2017). In Ghana, hypertension studies rarely focus on rural females. As such, little research is available to explain reasons for increased prevalence of hypertension in Ghanaian rural females. Oyekale et al. (2017) conducted a study to analyze factors on hypertension risk among rural and urban Ghanaian females of reproductive age and discovered that hypertension risk was positively associated with obesity, being overweight, age and consumption of salted meat. Nyarko (2016) conducted a study to determine the prevalence and sociodemographic determinants of hypertension among females in reproductive age in urban and rural Ghana and discovered increasing age, lower education level or literacy, and marital status (married or cohabiting females and widows, divorcees, or separated females) were significantly associated with hypertension. Lastly, Capistrant et al. (2019) found Ghanaian females with more education and income were more likely to be aware of their hypertension, which is consistent with having greater awareness of non-communicable diseases (NCDs) and healthcare access.

Many studies have investigated the associated link between high prevalence rates of hypertension and low levels of awareness in rural Ghana. Gómez-Olivé et al. (2017) examined the levels of awareness of hypertension in rural Northern Ghana and found low levels of awareness at 21.4% for men and 34.6% for women. A study conducted by Kweku et al. (2017) discovered that half of the adult's population in rural communities had hypertension but only one out of three (29.2%) adults were aware of their hypertension status. A similar study by Agyei-Baffour et al. (2018) conducted in rural Ghanaian communities demonstrated an increased prevalence of hypertension, knowledge gaps and misconceptions surrounding hypertension. Other population-based studies on hypertension in Ghana have discovered that detection, treatment and control was generally low. A Ghanaian survey involving a nationally representative sample found 63% of females and 86% of males were found to be hypertensive, however, participants reported to be unaware of their condition and only 17% of the females and 6% of the males were treated and controlled (GSS, GHS, ICF International, 2015). In our current study, a disparity in hypertension and treatment was found in that the prevalence of hypertension was 37.6% among females and 32.6% among males. Hypertensive medications were prescribed in females at 11.5% and in males at 10.5%. One explanation for low levels of awareness is the limited primary health care programmes on CVD in rural communities and the lack of public education around regular blood pressure screening and monitoring.

Individuals with prehypertension may have an increased risk of progressing to hypertension. Prehypertension has been associated with an increased risk of stroke and higher CV morbidity and mortality (Guwatudde et al., 2015). In Ghana, stroke is an increasing cause of morbidity, mortality and disability with hypertension and diabetes as major risk factors of stroke. The severe disability associated with stroke which poses many challenges to patients and their families, healthcare staffs, and the entire country of Ghana (Ofori-Asenso & Garcia, 2016; Olutobi & Agyemang, 2013). Our study found the prevalence of prehypertension classification was higher in males at 41.8% versus females at 31.7%. Agyemang & Owusu-Dabo (2008) assessed prehypertension among Ghanaian adults in rural Ghana and discovered 31% of the study population were normotensive, 40% were prehypertensive and 29% were hypertensive with prehypertension more common in non-hypertensive males than non-hypertensive females. Owiredu et al. (2019) assessed prehypertension prevalence and identified certain demographic and lifestyle characteristics such as lower educational level, sedentary lifestyle, and alcohol consumption, were associated with prehypertension among apparently healthy Ghanaian adults. In our study, sedentary lifestyle is not a risk factor for the working men in the four villages investigated and alcohol consumption was not researched. However, in our population investigated, lower educational level and poor level of awareness are two relevant risk factors.

Cardiovascular risk reduction in Northern Ghana needs to start with population awareness in conjunction with prevention, detection, treatment and control of CVD. Healthcare systems in many parts of Ghana are designed to treat acute communicable diseases, rather than preventable non-communicable diseases. In rural settings, the addition of primary health care programmes will make significant demands on already scarce health resources. Another great challenge in rural settings is the lack of health care providers to serve the population and the distance to centralized facilities ensues transportation costs (BeLue et al., 2009). Human resources for health development and delivery in Ghana is skewed in favour of the more affluent regions, most of which are in the southern half of the country. In 2018, the GHS reported the distribution of health professionals in Northern Ghana to be 216 doctors

with a 1:11,130 doctor-to-population ratio and 6,248 nurses with a 1:479 nurse-to-population ratio (Ghana Health Service, 2018). This maldistribution of health workforce in the Northern region calls for new strategies to cope with the demand to increase awareness, prevent, treat and control for CVD. Task-shifting from physicians to non-physician healthcare providers at the primary care level has been effective in the care of CVD in other LMIC countries (Okyere et al., 2017; Lekoubou et al., 2010; Ogedegbe et al., 2014; Tsolekile et al., 2015). In 2012, the Global Alliance for Chronic Disease (GACD) funded 8 studies focused on task shifting from physician to non-physician health workers (NPHWs) on prevention and management of hypertension. Tasks that were shifted included screening, patient education, follow-up including adherence management and triaging/case management to physicians. The authors concluded that task-shifting to NPHWs is an achievable model for facing the burden of NCDs in LMIC where health human resources are limited. Khan et al. (2018) evaluated a training curriculum for NPHWs to reduce CVD and affirmed that NPHWs can be trained in implementing measures for CVD prevention and control. A study conducted by Kavita et al. (2020) in Northern India found that nurse led interventions were effective in CVD risk detection and improved medication adherence among patients for primary and secondary prevention of CVDs. A study by Ogedegbe et al. (2018) investigated the effectiveness of community health nurses (CHNs) within Ghana's community-based health planning and services (CHPS) programme in utilizing the WHO *Package of Essential Noncommunicable Disease Intervention for Primary Care* (WHO PEN) for hypertension control. The study found that task shifting of CVD primary prevention duties from physicians to CHNs within Ghana's CHPS programme led to a greater decrease in systolic BP when added to the provision of health insurance coverage (Ogedegbe et al., 2018). Gyamfi et al. (2017) studied the training of CHNs in task-shifting the management and control of hypertension in the Ashanti Region of Ghana. Their conclusions indicate that if all nurses receive training hypertension management and control, major public health benefits related to CVDs are likely to be achieved in Ghana (Gyamfi et al., 2017). As such, task shifting CV risk assessment and management of uncomplicated risk factors, such as hypertension and diabetes, from physicians to nurses is a feasible and cost-effective strategy. Implementing a physician to CHN task-shifting strategy, within the CHPS programme, to target uncomplicated CVDs risk assessment and management could serve as a model for Northern Ghana.

Two key limitations were noted in our study. First, this study did not investigate awareness, knowledge gaps and misconceptions with respect to CVD and risk factors. Second, this study did not investigate all modifiable and non-modifiable risk factors relevant to CVD. Other studies conducted in Ghana found the prevalence of hypertension can be attributed to body mass index (BMI), waist circumference and lifestyle factors such as salt (Na) intake, alcohol consumption, obesity and physical inactivity (Bosu, 2010; Kunutsor & Powles, 2009; Dosoo et al., 2019). Salt intake was specifically associated with higher levels of BP and with more marked increases in BP with age. Our study did not include demographic characteristics such as education status, literacy level and occupational status which could be considered relevant contributory factors to CVD risk. Cholesterol/lipid profiles were not measured as testing was not available in the study area. Minimal studies have assessed cholesterol/lipid profiles in West Africa and when explored found generally low-risk profiles, creating the assumption that dyslipidemia is not a health issue. Further studies are required to investigate whether dyslipidemia in this population presents with any adverse cardiovascular disease outcomes (Agongo et al., 2019).

5. Conclusions

In conclusion, a moderate to high CVD risk of a fatal or non-fatal cardiovascular event was found in 10.4% of the population in four rural Northern Ghana districts. Notable CVD risk factors included a high hypertension prevalence along with the presence of DM. Although this study is small, it adds pertinent information to the scarce research available on CVD risk and the prevalence of CVD risk factors in rural Northern Ghana. CVD is preventable and treatable, given adequate healthcare systems and resources. Decentralizing care to local village healthcare facilities, such as CHPS programmes is one way to tackle CVD risk reduction. CHNs within the CHPS programme are available in rural Northern Ghana and in greater numbers compared with physicians. Task shifting of primary care duties from physicians to nurses in terms of CV risk assessment and management of uncomplicated CVD is a feasible solution to the acute shortage of trained health staffs in Northern Ghana. Further studies need to investigate the feasibility of task shifting of CVD risk assessment and management from physicians to nurses in Ghana's Northern Region.

Competing Interests Statement

The authors declare that there are no competing or potential conflicts of interest.

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