Research Article

Prevalence, Awareness, Treatment, and Control of Hypertension among Young and Middle-Aged Adults: Results from a Community-Based Survey in Rural Tanzania

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Background. Hypertension, which is the single most important risk factor for CVDs, is increasing at an alarming rate in most developing countries. This study estimated the prevalence, awareness, treatment, and control of hypertension among young and middle-aged adults in rural Morogoro, Tanzania. Furthermore, it explored factors associated with both prevalence and awareness of hypertension. *Methods.* A cross-sectional survey was conducted as part of the cluster randomized controlled study of community health workers (CHWs) interventions for reduction of blood pressure in a randomly selected sample of young and middle-aged population in rural Morogoro. Sociodemographics, lifestyle-related factors, history of diagnosis, and treatment for hypertension were collected using a questionnaire adopted from the STEPS survey tool. Blood pressure, height, and weight were measured at home following standard procedures. Descriptive statistics were used to estimate prevalence, awareness, treatment, and control of hypertension. Multiple logistic regression models were used to assess determinants of hypertension and awareness. *Result.* The prevalence of hypertension was 29.3% (95% CI: 27.7–31.0). Among individuals with hypertension, only 34.3% were aware of their hypertension status. Only around one-third (35.4%) of those who were aware of their hypertension status were currently on antihypertensive medication. Hypertension control was attained in only 29.9% among those on medications. Older age ($p < 0.001$), use of raw table salt ($p < 0.001$), and being overweight/obese ($p < 0.001$) were associated with hypertension. Predictors of awareness of hypertension status were older age, being a female, higher socioeconomic status, use of raw table salt, a history of diabetes, and overweight/obesity (all $p < 0.001$). Alcohol drinking was associated with low awareness for hypertension status ($p < 0.001$). *Conclusion.* There is high prevalence of hypertension with low rates of awareness, treatment, and control among young and middle-aged adults in rural Tanzania. Community-level health promotion and screening campaigns for hypertension and other CVD risk factors should be intensified.

1. Introduction

Cardiovascular diseases (CVDs) are the leading cause of mortality globally [1]. Hypertension, which is defined as systolic blood pressure (SBP) ≥ 140 mmHg and/or diastolic blood pressure (DBP) ≥ 90 mmHg or regular use of anti-hypertensive medications [2], is the single most important risk factor for CVDs [3, 4], accounting for 45% of deaths caused by ischemic heart diseases and 51% of deaths caused by cerebrovascular disease [5]. In 2010, the number of people with hypertension was estimated to be 1.4 billion, and with current trend, it is projected to exceed 1.6 billion by 2025 [6].

In 2013, the WHO set a global target for the control of noncommunicable diseases (NCDs), which included a 25% relative reduction in the prevalence of high blood pressure by 2025 [7]. While the prevalence of hypertension declined by 2.6% between 2000 and 2010 in high-income countries (HICs), it increased by 7.7% in low- and middle-income countries (LMICs) during the same period [6]. Similarly, awareness and control for hypertension increased substantially in HICs compared to LMICs [6]. Sub-Saharan Africa (SSA) has the highest rates of hypertension in the world. A study conducted in Soweto, South Africa, reported a prevalence of up to 54.1% [8]. Finding from a systematic review and meta-analysis of studies conducted in SSA reported a pooled prevalence of hypertension of 30%, awareness of 27% among hypertensive individuals, and treatment rates of 18% with only 7% being controlled [9]. In Kenya, findings from a national survey indicated a prevalence of hypertension of 24.5%, awareness of 15.6% among individual with hypertension, 26.9% of those aware were on treatment, and 51.5% were controlled [10].

In Tanzania, available data indicate that CVD risk factors were very low in 1990s [11] but have continued to rise especially among young and middle-aged adults [12, 13]. Data from a national representative STEPS survey indicated the prevalence of hypertension to be 25.9% [14]. A study in Mafia Island in Tanzania reported a high prevalence of 49.5% [15]. Despite the increasing prevalence of hypertension and other CVD risk factors in Tanzania, studies examining awareness, treatment, and control of hypertension are scarce. Both, awareness and treatment for hypertension have been reported to be low in Tanzania. A study in northwestern parts of the country reported awareness and treatment rates of 9.4% and 7.1%, respectively [16]. In contrast, a study in Mafia Island reported higher rates of both awareness (71.2%) and treatment (79.4%) for hypertension [15]. Building on the little existing data, this study assessed the prevalence, awareness, treatment, and control of hypertension and explored their predictors in a random sample of young and middle-aged adults in rural Morogoro.

2. Materials and Methods

2.1. Study Design and Setting. Data analyzed for this study were collected as a baseline survey for cluster randomized controlled trial of community health workers (CHWs) interventions for reduction of blood pressure. The study was conducted in Kilombero and Ulanga districts in Morogoro region, approximately 450 kilometers southwest of Tanzania's commercial capital of Dar es Salaam. The two districts were selected purposely because of high CVD deaths previously reported in the study area [17].

2.2. Study Participants and Eligibility Criteria. Participants were adults aged 25–64 years, residents of the study districts who provided a written informed consent. A resident was defined as an individual who had stayed in the study area for at least 4 months continuously regardless of whether she/he had slept in that household a night before the interview [18]. Household was defined as group of people who served food from the same pot. Self-reported pregnant women and bed-ridden and/or mentally ill health individuals were excluded.

2.3. Sample Size Estimation and Sampling Procedures. The sample size for the baseline cross-sectional survey was estimated according to the WHO stepwise approach to chronic disease risk factors surveillance (STEPS) [19]. The sample size was calculated for 95% CI ($z = 1.96$) on the basis of a 5% margin of error, an estimated prior national prevalence of hypertension of 25.9% [14], a design effect of 1.25, and an anticipated nonresponse rate of 10%. Participants were adults aged 25–64 years and categorized into four age-sex groups, resulting into 8 strata. The resulting minimum sample size 3,145.

We used a multistage cluster sampling technique where villages were considered as clusters. A random sample of 12 villages was drawn from a list of 38 villages with active CHWs stratified by district. For each study, village random sample of households was drawn, and at each household, one eligible respondent was selected by a simple random procedure using the next birthday rule. If the selected individual for interview was not available after two home visit attempts, the next eligible member was interviewed.

2.4. Data Collection. Data collection was conducted by a team of trained research assistants with experience in conducting health and demographic surveys. A modified WHO STEPS questionnaire for noncommunicable diseases surveillance was used to gather sociodemographic and economic information and behavioral CVD risk factors. Sociodemographic information including age, gender, marital status, education level, and occupation were collected. Age was collected as a continuous variable, while education was measured as the highest level of formal education attained. Marital status was grouped into never married, married or living together, divorced or separated, and widow. Occupation was assessed as a categorical variable as none or housewife, formal employment (public/private), peasant/pastoralist, petty business, and others.

We collected data on household ownership of items such as radio, television, telephone, sofa, refrigerator, bicycle, and

car; having working electricity, house ownership, and house construction materials (floor, wall, and roof); source of fuel for cooking and lighting; source of water for drinking and for home use; sanitation facility; and ownership of livestock. A household wealth index in quintiles was then generated following descriptions in the Demographic Health Survey (DHS) toolkit [20] and was used as a proxy for household socioeconomic status.

Behavioral CVD risk factors assessed included smoking, alcohol drinking, and dietary habits. For smoking, questions probed current and past smoking, while for alcohol, they probed current and past alcohol drinking. Dietary assessment included intakes of fruits, vegetables, and use of raw table salt.

2.5. Measurements. Blood pressure was measured using a digital blood pressure machine (OMRON HEM-712C, Omron Healthcare, Inc.). Trained research assistants measured blood pressure on the left arm with participant in a seated position. The first reading was taken after at least 5 minutes of resting. The second and third readings were taken halfway and at the end of interview, respectively. An average of three readings was used during analysis. Participants who had elevated blood pressure had a repeat measurement performed on the following day to confirm their elevated blood pressure. Anthropometric measurements included weight and height. Body weight was measured to the nearest 0.1 kg using a SECA 803 digital scale placed on flat ground with participant wearing light clothing and with no shoes. Height was measured to the nearest 0.1 cm with participant in a standing position with heels perpendicular to the portable stadiometer.

2.6. Definition of Key Terms. Hypertension was defined as average systolic blood pressure (SBP) ≥ 140 mmHg and/or diastolic blood pressure (DBP) ≥ 90 mmHg or currently taking blood pressure lowering medications in accordance with the Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation and Treatment of High Blood Pressure [2]. Awareness of hypertension was defined as self-report of diagnosis of hypertension among participants who had their blood pressure checked before and responded "YES" to the question "Have you ever been told by the doctor or other health worker that you have hypertension?" Treatment for hypertension was defined as taking blood pressure lowering medications at the time of the survey among those aware of their hypertension status. Control of hypertension was considered for individuals on blood pressure lowering medications if they had systolic blood pressure (SBP) < 140 mmHg and diastolic blood pressure (DBP) < 90 mmHg.

2.7. Data Analysis. Data were entered and analysed using IBM-Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, USA) version 20 software for Windows. Data were presented in a frequency distribution with relative frequencies (%) for categorical variables and a measure of central tendency (mean) and of variability (SD) for symmetrically distributed continuous variables. For asymmetrically distributed continuous variables, median with interquartile range (IQR) was used to describe the data. Comparisons between groups were performed using the chi-squared test and independent samples t-test (or ANOVA) for categorical and continuous variables, respectively.

Binary logistic regression was performed to examine the relationship of each independent variable with hypertension and awareness of hypertension status. Predictor variables were age, sex, wealth status, marital status, education level, place of residence, occupation, smoking status, alcohol drinking status, use of raw table salt, fruits and vegetable consumption, and body mass index. Variables with $p < 0.2$ in bivariate logistic regression analysis were retained in the multiple logistic regression analysis. Selection of the best predicting model was performed conducting forward, backward, and stepwise model selection procedures. Overall fitness of the model was assessed using the Pearson chi-squared test and Hosmer–Lemeshow goodness-of-fit test. We first assessed the correlation and strength of correlation between variables in the regression model, using variance inflation factor (VIF) with a cutoff value of ≤ 5 to avoid problem with multicollinearity. Adjusted odds ratio (AOR) and their corresponding 95% confidence intervals (95% CI) are presented as measures of association. Statistical significance was considered based on a two-sided p value ≤ 0.05.

3. Results

3.1. Characteristics of Study Participants. Among 3145 individuals who were approached for participation, 3000 (95.4%) had complete data. Characteristics of the study participants are summarized in Table 1. The median (interquartile range (IQR)) age of the participants was 39 [21–38] years and was significantly higher among men. Higher proportion of the participants (35.7%) was of younger age (25–34 years), while 13.7% was of older age (55–64 years). Majority of the participants were women (74.1%), were married (71.5%), and had primary education (80.4%). Peasant/pastoralist was the predominant occupation (92.5%). Significant sex differences were also observed for marital status, education level, and occupation.

Only 5.9% of the participants was current smokers, and 19.7% was current alcohol drinkers. Both smoking and alcohol drinking were significantly higher in men (all $p < 0.001$). Majority of the participants (85.2%) reported to have ever used raw table salt, with 6.8% reporting to do so always. Men reported to use raw table salt more frequently than women ($p = 0.026$). The proportion of participants who consumed vegetables and fruits 5–7 days/week was 63.9% and 7.9%, respectively. Women consumed vegetables more frequent than men ($p < 0.001$). The proportion of participants who were overweight and obese was 28.5% and 16.3%, respectively, and both were significantly higher in women ($p < 0.001$).

TABLE 1: Characteristics of the study participants.

Variable	All participants $N = 3,000$ n (%)	Males $N = 778$ n (%)	Females $N = 2,222$ n (%)	p value
Age (years) (median (IQR))	39 (31.0–48.0)	41 (32.0–51.0)	38 (30.8–47.0)	<0.001
Age (years)				
25–34	1072 (35.7)	238 (30.6)	834 (37.5)	
35–44	888 (29.6)	208 (26.7)	680 (30.6)	<0.001
45–54	628 (20.9)	182 (23.4)	446 (20.1)	
55–64	412 (13.7)	150 (19.3)	262 (11.8)	
Wealth status				
Poorest	694 (23.1)	190 (24.4)	504 (22.7)	
Poor	497 (16.6)	137 (17.6)	360 (16.2)	
Middle	579 (19.3)	150 (19.3)	429 (19.3)	0.046
Rich	630 (21.0)	134 (17.2)	496 (22.3)	
Richest	600 (20.0)	167 (21.5)	433 (19.5)	
District				
Kilombero	1500 (50.0)	344 (44.2)	1156 (52.0)	<0.001
Ulanga	1500 (50.0)	434 (55.8)	1066 (48.0)	
Marital status				
Never married	383 (12.8)	97 (12.5)	286 (12.9)	
Married	2144 (71.5)	613 (78.8)	1531 (68.9)	<0.001
Separated/divorced/widowed	473 (15.8)	68 (8.7)	405 (18.2)	
Education level				
No formal education	297 (9.9)	32 (4.1)	265 (11.9)	
Primary education	2411 (80.4)	628 (80.7)	1783 (80.2)	<0.001
Secondary education	255 (8.5)	99 (12.7)	156 (7.0)	
College/university education	37 (1.2)	19 (2.4)	18 (0.8)	
Occupation				
Farmer	2775 (92.5)	730 (93.8)	2052 (92.3)	
House wife	79 (2.6)	0 (0.0)	72 (3.2)	
Employed	27 (0.9)	14 (1.8)	13 (0.6)	<0.001
Business	80 (2.7)	25 (3.2)	55 (2.5)	
Others	39 (1.3)	9 (1.2)	30 (1.4)	
Current smoking status				
No	2824 (94.1)	634 (81.5)	2190 (98.6)	<0.001
Yes	176 (5.9)	144 (18.5)	32 (1.4)	
Current alcohol drinking status				
No	2409 (80.3)	547 (70.3)	1862 (80.3)	<0.001
Yes	591 (19.7)	231 (29.7)	360 (19.7)	
Use of raw table salt				
Never	446 (14.9)	95 (12.2)	351 (15.8)	
Sometimes	2351 (78.4)	636 (81.7)	1715 (77.2)	0.026
Always	203 (6.8)	47 (6.0)	156 (7.0)	
Fruits consumption/week				
5–7 days	238 (7.9)	63 (8.1)	175 (7.9)	
1–4 days	2168 (72.3)	567 (72.9)	1601 (72.1)	0.814
Never	594 (19.8)	148 (19.0)	446 (20.1)	
Consumption of vegetables/week				
5–7 days	1916 (63.9)	433 (55.7)	1483 (66.7)	
1–4 days	1043 (34.8)	333 (42.8)	710 (32.0)	<0.001
Never	41 (1.4)	12 (1.5)	29 (1.3)	
History of diabetes mellitus				
No	2971 (99.0)	770 (99.0)	2201 (99.1)	0.838
Yes	29 (1.0)	8 (1.0)	21 (0.9)	
Body mass index (BMI (kg/m^2))				
Underweight	93 (3.1)	30 (3.9)	63 (2.8)	
Normal	1563 (52.1)	531 (68.3)	1032 (46.4)	<0.001
Overweight	855 (28.5)	170 (21.9)	685 (30.8)	
Obese	489 (16.3)	47 (6.0)	442 (19.9)	

TABLE 1: Continued.

Variable	All participants $N = 3,000$ n (%)	Males $N = 778$ n (%)	Females $N = 2,222$ n (%)	p value
Blood pressure (mmHg)				
Mean SBP (SD)	127.2 (20.8)	131.1 (17.9)	125.9 (20.8)	<0.001
Mean DBP (SD)	83.5 (12.6)	83.9 (11.9)	83.3 (12.8)	0.298
Blood pressure profile				
Normal BP	954 (31.8)	163 (21.0)	791 (35.6)	
Prehypertension	1198 (39.9)	374 (48.1)	824 (37.1)	<0.001
High BP (stage 1)	500 (16.7)	157 (20.2)	343 (15.4)	
High BP (stage 2)	348 (11.6)	84 (10.8)	264 (11.9)	

3.2. Blood Pressure Profile. Distribution of blood pressures of study participants is summarized in Table 1. The mean systolic blood pressure (SBP) was 127.2 ± 20.8 mmHg and that of diastolic blood pressure (DBP) was 83.5 ± 12.6 mmHg. Mean SBP was significantly higher among men compared to women ($p < 0.001$). However, no differences were observed for mean DBP. Both SBP and DBP were higher among older compared to young participants. There was a linear increase in SBP and DBP with age in both men and women, although DBP seemed to plateau at 45 years of age (Figure 1). About one-third (31.8%) had normal blood pressure, 39.9% had blood pressure in the pre-hypertension range, 16.7% had stage 1 hypertension, and 11.6% had stage 2 hypertension (Figure 2). The proportion of participants with prehypertension and stage 1 hypertension was higher in men compared to women ($p < 0.001$).

3.3. Prevalence, Awareness, Treatment, and Control for Hypertension. The prevalence of hypertension was 29.3% (Table 2) and increased sharply with age from 12.5% among 25–34 years old age group to 53.2% among 55–64 years groups, respectively ($p < 0.001$). Hypertension was higher among separated/divorced/widowed ($p < 0.001$), among smokers ($p = 0.052$), among current alcohol drinkers ($p = 0.022$), and among overweight and obese participants ($p < 0.001$). Participants who always used raw table salt had significantly higher rates of hypertension compared to those who never used ($p < 0.001$).

Among 880 participants with hypertension, 302 (34.3%) were aware of their hypertension status, while the remaining 578 (65.7%) were newly diagnosed. Of the 302 participants aware of their hypertension status, only 107 (35.4%) were on blood pressure lowering medication, of whom 32 (29.9%) had controlled blood pressure (Figure 3).

Awareness of hypertension was significantly higher among older compared to young participants ($p = 0.016$), women compared to men ($p < 0.001$), those with high socioeconomic status ($p < 0.01$), and those with a history of diabetes mellitus ($p < 0.01$). Awareness was low among alcohol drinkers and participants with normal BMI (both $p < 0.01$). Treatment for hypertension was again higher among older compared to younger participants ($p < 0.001$), individuals who used raw table salt, those who consumed fruits more frequently (all $p < 0.01$), and those with a history of diabetes mellitus ($p < 0.05$). Blood pressure control was

higher for women, individuals with low socioeconomic status, and those who never used raw table salt. However, none of the factors associated with hypertension control attained a statistical significance level.

3.4. Predictors of Prevalence and Awareness of Hypertension. Significant predictors of hypertension in multivariate analysis were older age, use of raw table salt, and higher BMI (Table 3). Compared to young, older participants were 8 times more likely to be hypertensive (AOR = 8.45, 95% CI: 6.33–11.30, $p < 0.001$). Participants who reported using raw table salt had more than twice the odds of being hypertensive (AOR = 2.27, 95% CI: 1.73–2.99, $p < 0.001$). Overweight participants had 53% increased risk (AOR = 1.53, 95% CI: 1.26–1.88, $p < 0.001$), while obese participants had more than double the risk for hypertension (AOR = 2.58, 95% 2.04–3.28, $p < 0.001$).

As for awareness of hypertension (Table 4), predicting factors included older age and being female. Older participants were more than 2 times likely to be aware of their hypertension compared to younger participants (AOR = 2.05, 95% CI: 1.24–3.39, $p < 0.001$). Similarly, women had more than twice the odds of being aware of hypertension compared to men (AOR = 2.47, 95% CI: 1.67–3.66, $p < 0.001$). Other significant predictors of awareness of hypertension were higher socioeconomic status, alcohol drinking, use of raw table salt, history of diabetes mellitus, and higher BMI. Overweight and obese participants were more than 2 times more likely to be aware of their hypertension compared to normal weight participants. Alcohol drinking was associated with 51% decreased odds of being aware of hypertension status (AOR = 0.49, 95% CI: 0.32–0.74, $p = 0.001$).

4. Discussion

This study provides information on prevalence, awareness, treatment, and control of hypertension and their correlates among young and middle-aged adults in rural Tanzania. Key findings were high prevalence of hypertension, low levels of awareness and treatment rates, and poor control among those on treatment. High prevalence of hypertension was driven by older age, use of raw table salt, and higher BMI. Significant predictors of awareness of hypertension were older age, being female, wealth status, drinking alcohol, use of raw table salt, a history of diabetes mellitus, and higher BMI.
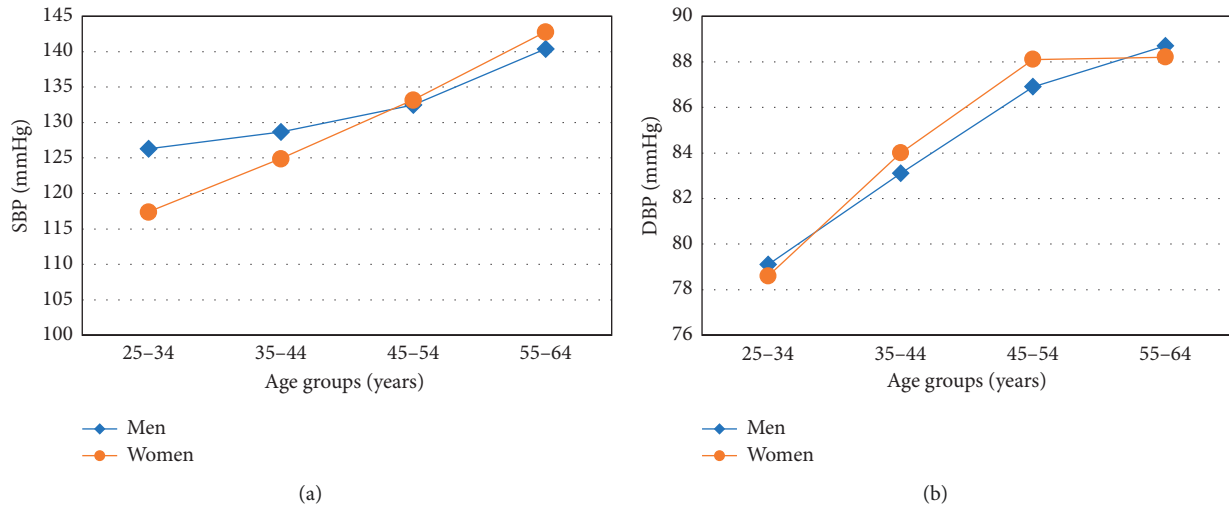
(a)

(b)

FIGURE 1: Trend of systolic and diastolic blood pressure by age and sex.
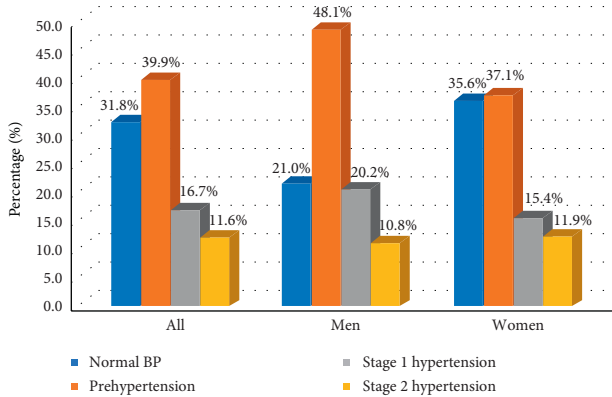

FIGURE 2: Distribution of blood pressure by sex.

4.1. Prevalence and Determinants of Hypertension.

The prevalence of hypertension of 29.3% found in our study was comparable to previous report from a community-based survey in Northern Tanzania [39], which found a prevalence of 28.0%. However, it was higher compared to another community-based study in rural Mwanza [16], which reported a prevalence of 8% and that of 25.9% reported in the national representative STEPS survey conducted in 2012 [14]. Low prevalence of hypertension reported in rural Mwanza may be attributable to inclusion of younger participants as more than one-third (38.9%) were aged 15–24 years. Although reports from rural Mafia and Hai districts in Tanzania [15, 40] found higher prevalence of hypertension than observed in our study, the study in Hai district comprised of participants aged 70 years and above in whom hypertension is not uncommon. Overall, two-fifths (39.9%) of participants had prehypertension. While primary prevention strategies should target the general population, more importantly should focus at prehypertensive individuals who are at increased risk of developing hypertension.

In our study, hypertension increased with age ranging from 12.5% among 25–34 years old to 53.2% among those aged 55–64 years. After controlling for other factors, participants aged 55–64 years were eight times more likely to be hypertensive compared to their counterparts aged 25–34 years. Other studies have reported a similar trend [10, 41, 42]. Changes in arteriolar stiffness and elasticity and decreased ability to respond to abrupt hemodynamic changes [43, 44] that occur with advancing age have been implicated for the rise in blood pressure in elderly. Furthermore, hypertension was higher among separated/divorced, and/or widowed, which is consistent with reports from other studies [45, 46]. Marriage has been shown to be protective against CVDs [47]. Marital disruption on the other hand is associated with increased risk for CVDs and mortality in middle-aged women [21, 22], probably due to psychosocial stress [23]. We found lowest prevalence of hypertension among never married, which may be attributable to their young age.

In our study, 44.8% of the participants was either overweight or obese. There is need to increase awareness on the importance of optimal body weight, physical activity, and healthy dietary habits given that the main staple food in the area is white rice. Consistent with findings from other studies [10, 24, 25], we found positive association between overweight and obesity with hypertension. Similarly, a study conducted among Kenyan women was also reported. These findings suggest the need for healthcare providers to prioritize screening for hypertension to overweight and obese clients that come in contact with the healthcare system. Our findings of association between alcohol drinking and smoking with hypertension were also consistent with report from other studies [10, 26].

Use of raw table salt was associated with more than twice increased odds of being hypertensive. High-salt diet leads to the increase in plasma volume and consequently an increase in blood pressure [27]. There is still debate regarding the exact mechanism through which salt intake leads to hypertension [28, 29]. One hypothesis is that increase in plasma volume and cardiac output results from dysfunctional handling of sodium by kidney [28]. Another is through systemic and renal vasodysfunction that salt-sensitive individuals are unable to

TABLE 2: Prevalence, awareness, treatment, and control of hypertension among study participants by selected population characteristics.

Variable	Hypertension among study participants (N = 3000)		Awareness among hypertensive participants (N = 880)		Treatment among aware participants (N = 302)		Control among participants on treatment (N = 107)	
	Hypertensive %	p value	Aware %	p value	Treated %	p value	Controlled %	p value
Overall	29.3	—	34.3	—	35.4	—	29.9	—
Age (years)								
25–34	12.5		29.1		20.5		25.0	
34–44	29.2	<0.001	28.6	0.016	24.3	0.001	38.9	0.705
45–54	42.7		37.3		37.0		32.4	
55–64	53.2		40.6		49.4		25.0	
Gender								
Male	31.4	0.149	21.3	<0.001	38.5	0.615	15.0	0.106
Female	28.6		39.3		34.8		33.3	
Wealth status								
Poorest	28.5		33.8		28.4		52.6	
Poor	28.4		24.1		35.3		33.3	
Middle	28.2	0.701	28.8	0.001	31.9	0.446	20.0	0.143
Rich	30.2		36.3		36.5		20.0	
Richest	31.3		45.2		36.5		29.0	
Marital status								
Never married	24.0		29.3		33.3		11.1	
Married	28.9	0.001	34.1	0.374	32.2	0.097	29.4	0.336
Separated/divorced/widowed	35.7		37.9		46.9		36.7	
Education level								
No formal education	34.0		31.7		40.6		38.5	
Primary education	29.7		35.0		35.2		29.5	
Secondary education	20.0	0.002	37.3	0.193	26.3	0.457	20.0	0.772
College/university	35.1		7.7		100.0		0.0	
Place of residence								
Kilombero district	47.6	0.092	38.4	0.014	31.1	0.089	28.0	0.687
Ulanga district	52.4		30.6		40.4		31.6	
Occupation								
Farmer	29.5		34.5		35.3		30.0	
House wife	21.5		35.3		16.7		100.0	
Employed	29.6	0.588	37.5	0.492	66.7	0.566	0.0	0.457
Business	27.5		18.2		25.0		0.0	
Others	33.3		46.2		50.0		33.3	
Current smoking status								
No	28.9	0.052	35.0	0.122	35.3	0.859	29.7	0.850
Yes	35.8		25.4		37.5		33.3	
Current alcohol drinking status								
No	28.4	0.022	37.6	<0.001	37.0	0.183	27.4	0.107
Yes	33.2		23.0		26.6		50.0	
Use of raw table salt								
No	17.7	<0.001	17.7	0.001	21.4	0.262	66.7	0.158
Yes	31.4		36.0		36.1		28.8	
Fruits consumption/week								
5–7 days	26.5		31.7		70.0		28.6	
1–4 days	29.8	0.598	34.9	0.825	32.6	0.004	32.9	0.534
Never	29.5		33.1		34.5		20.0	
Consumption of vegetables/week								
5–7 days	30.5		33.4		35.9		31.4	
1–4 days	25.3	0.077	37.4	0.116	34.3	0.876	25.0	0.242
Never	36.6		13.3		50.0		100.0	
History of diabetes mellitus								
No	29.1	0.008	33.4	<0.001	34.3	0.044	30.3	0.753
Yes	51.7		86.7		61.5		25.0	

TABLE 2: Continued.

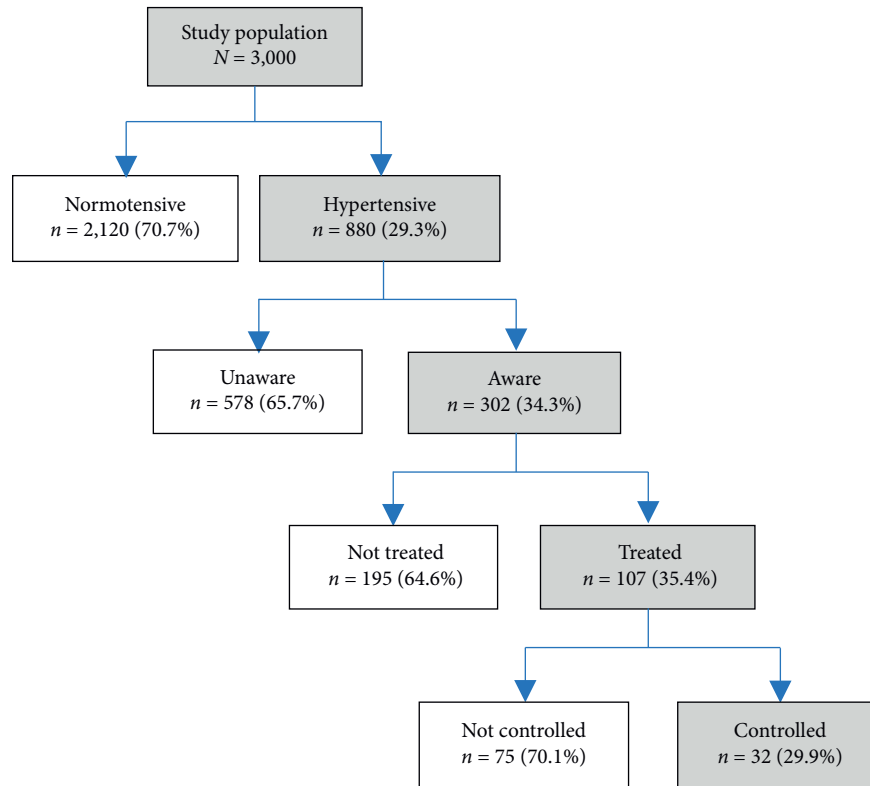| Variable	Hypertension among study participants (N = 3000)		Awareness among hypertensive participants (N = 880)		Treatment among aware participants (N = 302)		Control among participants on treatment (N = 107)	
	Hypertensive %	p value	Aware %	p value	Treated %	p value	Controlled %	p value
Body mass index (BMI (kg/m^2))								
Underweight	12.9		33.3		50.0		50.0	
Normal	25.0	<0.001	27.2	<0.001	37.7	0.770	30.0	0.937
Overweight	31.9		35.9		35.7		28.6	
Obese	41.9		45.9		31.9		30.0	

FIGURE 3: Prevalence, awareness, treatment, and control of hypertension among young and middle-aged population in Morogoro, Tanzania.

appropriately decrease systemic vascular resistance in response to increased sodium intake [29]. A higher proportion of Tanzanian has already been shown to be salt-sensitive (46.2%) compared to Brazilians (36.4%) and Japanese (16.7%) and reported tight positive relation of salt with hypertension among Tanzanians [30].

4.2. Awareness, Treatment, and Control of Hypertension.
Only one-third (34.3%) of hypertensive participants were aware of their hypertension, while the remaining two-thirds (65.7%) were undiagnosed. Despite being low, the rate of awareness in our study is higher than 9.4% reported in rural Mwanza [16] and pooled awareness level of 27% in SSA [9]. High proportion of undiagnosed hypertension can be attributable to unpreparedness of the healthcare system especially lower facilities in rural areas [31]. As a result, most

individuals miss opportunity to be screened for hypertension despite their frequent contact with health facilities.

Awareness of hypertension was higher among older participants, women, individuals of higher socioeconomic status, overweight and obese participants, and individuals with a history of diabetes mellitus. Other studies in SSA have also reported higher rates of awareness of hypertension among older individuals and women [10, 32, 33]. Their higher awareness is proposed to be due to their higher contact with the healthcare system. Women privileged in that antenatal care services provide an opportunity for their health check including blood pressure [34]. Similarly, individuals of higher socioeconomic status have higher access to health care services compared to poor. Individuals who reported to drink alcohol had lower levels of awareness of their hypertension. These findings are consistent with reports from other studies [10, 35].

TABLE 3: Crude and multivariate adjusted logistic regression models for determinants of hypertension in the study population ($N = 3000$).

Variable	Crude odds ratio, COR (95% CI)	p	Adjusted odds ratio, AOR (95% CI)	p
Age (years)				
25–34	Ref		Ref	
35–44	2.88 (2.29–3.63)		2.92 (2.29–3.73)	
45–54	5.21 (4.10–6.63)	<0.001	5.45 (4.20–7.07)	<0.001
55–64	7.94 (6.09–10.3)		8.45 (6.33–11.30)	
Gender				
Male	Ref		Ref	
Female	0.88 (0.74–1.05)	0.149	0.89 (0.72–1.10)	0.286
Wealth status				
Poorest	Ref			
Poor	0.99 (0.77–1.28)			
Middle	0.98 (0.77–1.25)	0.701	—	—
Rich	1.08 (0.85–1.37)			
Richest	1.14 (0.90–1.45)			
Marital status				
Never married	Ref		Ref	
Married	1.28 (0.99–1.65)	0.001	0.87 (0.66–1.15)	0.620
Separated/divorced/widowed	1.76 (1.30–2.37)		0.88 (0.63–1.22)	
Education level				
No formal education	Ref		Ref	
Primary education	0.82 (0.63–1.06)		0.97 (0.73–1.28)	0.615
Secondary education	0.48 (0.33–0.72)	0.003	1.06 (0.68–1.63)	
College/university	1.05 (0.51–2.15)		1.59 (0.71–3.53)	
Place of residence				
Kilombero district	Ref		Ref	
Ulanga district	1.15 (0.98 (1.34)	0.092	1.17 (0.98–1.39)	0.079
Occupation				
Farmer	Ref			
Housewife	0.65 (0.38–1.13)			
Employed	1.00 (0.44–2.30)	0.594	—	—
Business	0.90 (0.55–1.49)			
Others	1.19 (0.61–2.33)			
Current smoking status				
No	Ref		Ref	
Yes	1.37 (0.99–1.88)	0.053	1.12 (0.77–1.63)	0.540
Current alcohol drinking status				
No	Ref		Ref	
Yes	1.25 (1.03–1.52)	0.023	0.93 (0.74–1.15)	0.495
Use of raw table salt				
No	Ref		Ref	
Yes	2.12 (1.64–2.75)	<0.001	2.27 (1.73–2.99)	<0.001
Fruits consumption/week				
5–7 days	Ref			
1–4 days	1.16 (0.83–1.63)	0.599	—	—
Never	1.17 (0.86–1.58)			
Consumption of vegetable/week				
5–7 days	Ref		Ref	
1–4 days	1.32 (0.69–2.50)	0.077	1.45 (0.72–2.94)	0.084
Never	0.84 (0.71–0.99)		0.84 (0.70–1.00)	
History of diabetes				
No	Ref		Ref	
Yes	2.61 (1.25–5.43)	0.010	1.53 (0.69–3.35)	0.293
Body mass index (BMI (kg/m^2))				
Normal	Ref		Ref	
Overweight	1.41 (1.17–1.70)		1.53 (1.26–1.88)	
Obese	2.17 (1.75–2.67)	<0.001	2.58 (2.04–3.28)	<0.001
Underweight	0.45 (0.24–0.82)		0.41 (0.21–0.78)	

TABLE 4: Crude and multivariate adjusted logistic regression models for determinants of awareness of hypertension status among hypertensive individuals ($N = 880$).

Variable	Crude odds ratio, COR (95% CI)	p value	Adjusted odds ratio, AOR (95% CI)	p value
Age (years)				
25–34	Ref		Ref	
35–44	0.97 (0.62–1.54)		0.92 (0.57–1.51)	
45–54	1.45 (0.93–2.67)	0.016	1.68 (1.04–2.74)	<0.001
55–64	1.67 (1.05–2.64)		2.05 (1.24–3.39)	
Gender				
Male	Ref		Ref	
Female	2.39 (1.69–3.38)	<0.001	2.47 (1.67–3.66)	<0.001
Wealth status				
Poorest	Ref		Ref	
Poor	0.62 (0.38–1.01)		0.59 (0.35–1.00)	
Middle	0.79 (0.51–1.24)	0.001	0.68 (0.42–1.10)	0.003
Rich	112 (0.74–1.69)		0.94 (0.59–1.48)	
Richest	1.61 (1.07–2.43)		1.48 (0.94–2.32)	
Marital status				
Never married	Ref			
Married	1.25 (0.77–2.01)	0.375	—	—
Separated/divorced/widowed	148 (0.85–2.53)			
Education level				
No formal education	Ref			
Primary education	1.16 (0.74–1.81)			
Secondary education	1.28 (0.63–2.59)	0.292	—	—
College/university	0.18 (0.02–1.44)			
Place of residence				
Kilombero district	Ref		Ref	
Ulanga district	0.71 (0.53–0.93)	0.015	0.80 (0.59–1.09)	0.156
Occupation				
Farmer	Ref			
Housewife	1.03 (0.38–2.83)			
Employed	1.14 (0.27–4.80)	0.519	—	—
Business	0.42 (0.14–1.26)			
Others	1.63 (0.54–4.89)			
Current smoking status				
No	Ref		Ref	
Yes	0.63 (0.35–1.13)	0.124	1.51 (0.76–2.97)	0.238
Current alcohol drinking status				
No	Ref		Ref	
Yes	0.49 (0.34–0.71)	<0.001	0.49 (0.32–0.74)	0.001
Use of raw table salt				
No	Ref		Ref	
Yes	2.61 (1.44–4.73)	0.002	3.20 (1.69–6.06)	<0.001
Fruits consumption/week				
5–7 days	Ref			
1–4 days	1.07 (0.57–1.98)	0.825	—	—
Never	1.15 (0.66–2.01)			
Consumption of vegetables/week				
5–7 days	Ref		Ref	
1–4 days	0.31 (0.07–1.37)	0.138	0.35 (0.07–1.64)	0.140
Never	1.19 (0.89–1.60)		1.26 (0.91–1.75)	
History of diabetes				
No	Ref		Ref	
Yes	0.08 (0.02–0.34)	0.001	12.58 (2.61–60.55)	0.002
Body mass index (BMI (kg/m^2))				
Normal	Ref		Ref	
Overweight	1.50 (1.07–2.09)	<0.001	1.51 (1.05–2.16)	0.025
Obese	2.27 (1.59–3.23)		2.24 (1.44–3.17)	
Underweight	1.34 (0.39–4.54)		2.14 (0.60–7.60)	

Surprisingly, individuals who reported using raw table salt had higher levels of awareness of their hypertension status, indicating lack of knowledge regarding healthy lifestyles for prevention and control of hypertension in this rural Tanzanian population. Overall shortage of healthcare personnel [36], and more importantly, lack of trained staff for provision of hypertension services at lower health facilities [31], is the underlying reason for continued unhealthy behaviors among hypertensive individuals. Thus, efforts to prevent and control hypertension should ensure enabling lower health facilities to impart knowledge about risk factors, conduct routine screening, and proper management of hypertension.

Treatment among individual who were aware of their hypertension was 35.4%, which is lower compared to other reports in Tanzania [15–17]. Treatment rate among hypertensive individuals regardless of their awareness status was only 12.2%, which is also lower than the pooled treatment rate of 18.0% from systematic review of studies conducted in SSA [9]. Treatment rates were higher among older and diabetic individuals and those who used raw table salt. Rachel et al. found main reasons for not being on treatment to be lack of symptoms, not being prescribed, and finishing a single course of treatment [37].

Less than one-third of study participants on treatment had controlled blood pressure. In contrast, other studies in Tanzania have reported much lower hypertension control rates than found in this study [15, 37, 39]. Blood pressure control has been reported to be higher among individuals with health insurance [38, 48]. Although, the two study districts have good coverage of community health fund (CHF), which offers limited health benefit package to primary healthcare level, we did not assess ownership of CHF cards to draw its associations with hypertension treatment and control. Nonetheless, regular clinic attendance alone cannot guarantee blood pressure control [49]. Lack of trained health personnel and unavailability or frequent stock out of antihypertensive medications are health system challenges facing treatment and control of hypertension in rural Tanzanian settings [31, 50]. As such, community-based primary prevention strategies are the best buys in such settings where access and quality of healthcare services is still low.

This study has both strengths and limitations. Key strengths of this study are large sample size and repeat blood pressure measurements to confirm high blood pressure. Use of three measurements taken on a single session to define hypertension is likely to overestimate the prevalence of hypertension by 5.4%–23.4% [51, 52]. Thus, our study provides a better estimate on the burden of hypertension in this population. Limitations to our analysis include its cross-sectional design, which does not allow drawing conclusions on causal associations between hypertension and independent variables. The sampled population may not be truly representative of the Tanzanian rural population, and these finding should be interpreted with caution. Moreover, we did not collect detailed information of dietary intake using food frequency questionnaire and physical activity, both of which are known to be associated with hypertension.

5. Conclusion

The prevalence of hypertension in this rural Tanzanian population was high. Levels of awareness, treatment, and control were unacceptably low. Older age, marital status, education level, smoking and alcohol use, use of raw table salt, a history of diabetes mellitus, and overweight/obesity were identified to be associated with hypertension. These findings call for screening and prevention strategies to curb this increasing burden of hypertension. Community-level health promotion campaigns should be implemented to increase awareness, treatment, and control rates for hypertension, while ensuring routine screening for hypertension is conducted to all individuals regardless of their presenting complaints. Priority should be given to older and overweight and or obese individuals due to their increased risk for hypertension. Healthy lifestyle changes should be encouraged for prehypertensive individuals to halt their progression to full blown hypertension. If implemented fully, such strategies would ensure prevention and control not only of hypertension but also other CVD risk factors.

Abbreviations

BMI: Body mass index
CHF: Community health fund
CHW: Community health worker
CVDs: Cardiovascular diseases
DBP: Diastolic blood pressure
DHS: Demographic health surveys
HICs: High-income countries
LMICs: Low- and middle-income countries
NCDs: Noncommunicable diseases
SBP: Systolic blood pressure
SSA: Sub-Saharan Africa
WHO: World Health Organization.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Ethical Approval

This study was approved by the Muhimbili University of Health and Allied Sciences (MUHAS-REC-1-2017-070).

Consent

Objectives, procedures, importance, risks, and benefits of the study were explained to potential participants in advance. Voluntary participation and freedom to withdraw were emphasized, and all participants signed an informed consent form prior to joining the study. Participants with identified risk factors received health education and those with raised blood pressure were referred to nearby health care facility for further investigation, diagnosis, and management as per national guidelines.

Disclosure

Conflicts of Interest

The authors declare that they have no conflicts of interest.

Authors' Contributions

AJM, MN, and DPU conceived the study. AJM and AA led the data collection process. AJM wrote the analysis plan and conducted data analysis with support from RNM and MN. AJM conducted literature review and wrote the first draft of the manuscript with support from AA under the supervision of MN and DPU. RNM, BFS, GL, DK, ATK, MMS, MN, and DPU critically reviewed and provided intellectual input to the manuscript. RNM and MN suggested additional analyses. AJM made the proposed revisions and finalized the manuscript. All authors read and approved the final version of the manuscript.

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