Magnitude and Determinants of Uncontrolled Blood Pressure Among Hypertensive Patients in Northern Ethiopia, 2018: A Cross-Sectional Study

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Abstract: *Background and Aims:* Uncontrolled blood pressure is a strong risk factor for cardiovascular diseases such as angina, myocardial infarction, stroke, peripheral arterial diseases, and it is a leading cause of death. There is limited information on the magnitude of uncontrolled blood pressure and its determinants in Ethiopia particularly to the study setting. This study aimed to assess the magnitude and determinants of uncontrolled blood pressure among hypertensive patients in Northern Ethiopia, 2018. *Methods:* A hospital-based cross-sectional study design was conducted from February to April 2018. During the data collection period, blood pressure was measured twice from each study participants and an average of the two measurements five minutes apart was taken. Socio-demographic and lifestyle data collected using face to face interviews; record reviews, and anthropometric measurements also used for clinical and anthropometric data. Four hundred forty-five hypertensive patients were included in this study through a systematic random sampling technique. Data were entered and analyzed by using SPSS version 23. Bivariate and multivariable logistic regression was done to identify the determinants of uncontrolled blood pressure. Adjusted odds ratio and 95% confidence intervals were used to show the strength of association, and to declare statistical significance at P-value <0.05. *Result:* According to this study, 340 (76.4%) of participants had uncontrolled blood pressure. The determinants of uncontrolled blood pressure were no formal education (AOR=1.89, 95%CI: 1.01-3.52), alcohol drinking (AOR=4.18, 95%CI: 1.81-9.66), and every one-month follow-up (AOR=2.54, 95%CI: (1.19-5.39). *Conclusion:* uncontrolled blood pressure was high. No formal education, alcohol drinking, and every one-month follow-up were determinants of uncontrolled blood pressure. So, health education on lifestyle modifications and hypertension-related complications in each follow-up visit through health professionals are essential for the prevention of hypertension complications.

Keywords: Hypertension, Uncontrolled Blood Pressure, Ethiopia

1. Background

Globally, uncontrolled hypertension is responsible for 18% (9.4 million) of total death [1]. According to the World Health Organization (WHO), 22% (1 billion) of the world's adult population had uncontrolled blood pressure in which Africa has the highest prevalence of uncontrolled blood pressure [2-4]. WHO estimates that by 2025, the prevalence of hypertension will be increased by 30%; of these, two-thirds are in low and medium-income countries (LMICs) [4].

Uncontrolled blood pressure is the most common condition and a substantial risk factor for the cardiovascular disorder (CVD) such as angina, myocardial infarction (MI), heart failure (HF), stroke, peripheral arterial disease, and also it is leading cause of death [5].

Different studies revealed that uncontrolled blood pressure is a common condition among hypertensive patients. A study conducted in Sudan revealed that blood pressure control was 45.3% [6], in Jimma, Ethiopia 52.7% [7], Gonder, Ethiopia 11.4% [8], Zewditu Memorial Hospital, Ethiopia 73.8% [9], in Ayder comprehensive specialized hospital, Ethiopia, 52.5% [10], in Ethiopia, 48% [11].

The most common factors related to uncontrolled blood pressure were age, sex, cholesterol level, body mass index, physical inactivity, diet, alcohol intake, high fat diet, smoking, blood sugar level, medication non-adherence [5, 9, 12-15]. But, the above factors are inconsistent across the studies.

Uncontrolled blood pressure is not only affecting the health outcome, but they are also a significant barrier to economic development [16]. There is limited information on the magnitude of uncontrolled blood pressure and its determinants in Ethiopia particularly to the study setting.

This study aimed to assess uncontrolled blood pressure and its determinants among hypertensive patients in Northern Ethiopia in 2018.

2. Materials and Methods

2.1. Study Setting

The study was done in Ayder Comprehensive Specialized Hospital (ACSH) is located in Northern Ethiopia. ACSH is the biggest hospital in Northern Ethiopia and begins its referral as well as non-referral services in 2008. ACSH serves a function for more than 9 million people found in Tigray, Afar, and parts of the Amhara regional states in Ethiopia [17]. Most patients with hypertension and other chronic illness attend their follow-up in ACSH for better investigation and better care.

2.2. Study Design and Period

The hospital-based cross-sectional study design was done from February to April 2018.

2.3. Source of Population and Study Population

The source of the population was all hypertensive patients attending ACSH. All sampled adult hypertensive patients attending at ACSH during the data collection period were the study population. Participants with less than three follow-ups, Hypertensive patients whose chart did not have all the required information, and pregnant mothers were excluded from the study.

2.4. Sample Size Determination and Sampling Technique

Sample size was calculated using single population proportion formula by considering the following assumptions: n = $(Z \alpha/2)^2$ p (1-p)/ d^2, P = Prevalence of uncontrolled blood pressure = 11.4% [8], 95% confidence interval and d = 3% margin of error. Adding a 3% none response rate the total sample size was 445. In the study setting there were 940 hypertensive patients attending health care during the study period. The sample size of the study was 445. Kth = $\frac{study\ population}{desired\ sample\ size}$, Kth = $\frac{940}{445}$ =2.11. Approximately, every 2 patients have participated through a systematic random sampling technique. The first participant was selected by lottery method and then every two participants were recruited. Finally, 445 participants were recruited using a systematic random sampling technique.

2.5. Data Collection Instruments and Procedures

A pre-tested structured questionnaire tool was used. The tool was developed by reviewing different related literature [8, 18-20]. The questionnaire was designed in English and translated to local Tigrigna language to get the required information from respondents and then translated back into English by the third person to cheek for consistency in the meaning of words. The pre-test was done before a one-week of actual data collection period in 10% of the sample size in Adigrat hospital, and some meaning of words were modified. Finally, the local language Tigrigna version was used to collect the data.

The data collection was conducted by four BSc nurses, under the supervision of one MSc nurses and the principal investigators. Training and practical demonstrations were given to data collectors on interview techniques and anthropometric measurement procedures for two consecutive days.

The questionnaire contains Socio-demographic: Sex, Age, Religion, Ethnicity, Marital status, Level of education, Occupation, Residency, Average family income per month; Medical information: duration hypertension from diagnosis, frequency of follow-up, loss to follow-up, Comorbidity; Medication adherence; Behavioral factors: cigarette smoking, Alcohol consummation, salt in the diet, diet high in fat, regular physical exercise; Physical measurement, and clinical factors: blood pressure, weight, height Cholesterol level, Fasting/random glucose level. Socio-demographic data and behavioral risk factors were obtained from the patient by interview. Medical history, like duration of hypertension, presence of complication/comorbidity, was taken from patient medical records. Anthropometric measurements and laboratory results like height, weight, blood pressure, total cholesterol level, and fasting blood sugar were taken during the data collection time.

The blood pressure measurement was performed according to the eighteen Joint National Committee (JNC 8) criteria. Mercury sphygmomanometer with the correct size arm cuff was used to measure blood pressure. The instruments were validated, calibrated correctly and they were serviced regularly. During measuring the blood pressure participant should be in a sitting comfortable position: feet on the floor, arm supported at heart level as well as a participant should

take rest for 5 minutes with back supported before blood pressure measurement was taken and should free from coffee, strenuous exercise and smoking for 30 minutes. Blood pressure measurements were taken from both arms of the patient to detect the possible differences and the repeat from higher reading. Finally, an average of two measurements five minutes apart was recorded during the data collection

The 8 item Morisky medication adherence score was chosen to assess the study participant's medication adherence status [21].

The weight was measured using calibrated UNICEF Seca digital weighting scale in light closing and without shoes. Stadiometer in centimeter in erect position at a precision of 0.1cm without shoes was used to measure height.

Study variables

Dependent variable: uncontrolled blood pressure

Independent variables: Socio-demographic: Sex, Age, Religion, Ethnicity, Marital status, Level of education, Occupation, Residency, Average family income per month; Medical information: duration hypertension from diagnosis, frequency of follow-up, loss to follow-up, Comorbidity; Medication adherence; Behavioral factors: cigarette smoking, Alcohol consummation, salt in the diet, diet high in fat, regular physical exercise; Physical measurement, and clinical factors: blood pressure, weight, height Cholesterol level, Fasting/random glucose level.

Definition of terms

Uncontrolled blood pressure: Systolic blood pressure ($>=140$) and/or diastolic blood pressure ($>=90$) while on treatment for hypertension [22].

Physical exercise: physically active if the patients made regular physical activities 30 minutes and above, five days and above per week and physically inactive if the patient had made physical exercise less than 30 minutes per week or less than five days per week [24, 25]. Medication non-adherence: adherent if they score 7 and 8 and non-adherent if they score $<=6$ [26].

Alcohol drinker- a person who drinks 10.5 units of alcohol and above per week

Raised Fasting Blood Glucose (FBG) $>=126$ mg/dl [22]. High cholesterol levels if the cholesterol level ((total cholesterol) is 200 mg/dl and above [27].

Body mass index (BMI) was calculated as follow: Weight in kilograms divided by the square of height in meter (kg/m²) and classified as underweight (less than 18.5), normal (18.5-24.9), overweight (25-29.9) and obese (30 and above).

Data analysis and management

Data were entered and analyzed using SPSS version 23. Frequency, and tables and were used to present a descriptive part for categorical variables.

First bivariate logistic regression was done to assess the Crude Odds Ratio (COR) with 95% Confidence Interval (CI) between each independent variable and the dependent variable. Those variables with P-value < 0.25 significance level in bivariate logistic regression was taken to multivariable logistic regression. Finally, multivariable logistic regression used to assess the association between independent variables with the dependent variable and to control confounding variables. Adjusted odds ratio (AOR) and 95% confidence intervals were used to show the strength of association, and P-value <0.05 was used to declare statistical significance.

Ethics approval and consent to participate
Ethical clearance was obtained from Mekelle University, College of health science institutional review board. Further permission was obtained from ACSH chief executive director. The information was collected after obtaining written informed consent from the participant after giving full information about the study. The respondents were also informed as they have the right to refuse or stop participation at any time if unwanted. The information of the participants was recorded anonymously, and confidentiality was assured throughout the study period. The study was performed in according to the ethical principles of Helsinki Declaration of human studies.

3. Result

Socio-Demographic Characteristics

A total of 445 participants were included, and the response rate was 445 (100%). Among the participants, 224 (50.3%) were between 45 and 65 years, with a mean of 52.8 (SD±12.9) years. The study indicates that 169 (38%) of participants had no formal education, and 292 (65.6%) of participants were married (Table 1).

Table 1. *Socio-demographic characteristics of hypertensive patients.*

Variables	Total (%)	Controlled BP (%)	Uncontrolled BP (%)	p-value
Sex				0.22
Male	216 (48.5)	45 (20.8)	171 (79.2)	
Female	229 (51.5)	60 (26.2)	169 (73.8)	
Age				0.60
<45	139 (31.2)	37 (26.6)	102 (73.4)	
45-65	224 (50.3)	50 (22.3)	174 (77.7)	
>65	82 (18.4)	18 (22)	64 (78)	
Religion				0.20
Orthodox Christian	347 (78)	80 (23.1)	267 (76.9)	
Muslim	78 (17.5)	17 (21.8)	61 (78.2)	
Other	20 (4.5)	8 (40)	12 (60)	
Ethnicity				0.67
Tigray	397 (89.21)	93 (23.4)	304 (76.6)	

Variables	Total (%)	Controlled BP (%)	Uncontrolled BP (%)	p-value
Amhara	26 (5.84)	8 (30.8)	18 (69.2)	
Afar	19 (4.28)	3 (15.8)	16 (84.2)	
Other	3 (0.67)	1 (33.3)	2 (66.7)	
Marital status				0.37
Married	292 (65.62)	74 (25.3)	218 (74.7)	
Single	80 (17.98)	14 (17.5)	66 (82.5)	
Divorce	31 (6.96)	9 (29)	22 (71)	
Widowed	42 (9.44)	8 (19)	34 (81)	
Educational status				0.02
No formal education	169 (37.98)	32 (18.9)	137 (81.1)	
Primary school	91 (20.44)	16 (17.6)	75 (82.4)	
Secondary school	51 (11.46)	16 (31.4)	35 (68.6)	
Diploma	35 (7.87)	14 (40)	21 (60)	
University and above	99 (22.25)	27 (27.3)	72 (72.7)	
Occupation				0.71
Farmer	88 (19.77)	18 (20.5)	70 (79.5)	
Household	32 (7.19)	10 (31.3)	22 (68.8)	
Governmental employee	120 (26.96)	30 (25)	90 (75)	
Non-Governmental employee	47 (10.57)	8 (17)	39 (83)	
Self-employee	147 (33.03)	36 (24.5)	111 (75.5)	
Other	11 (2.48)	3 (27.3)	8 (72.7)	
Residency				0.36
Rural	106 (23.82)	21 (19.8)	85 (80.2)	
Urban	339 (76.18)	84 (24.8)	255 (75.2)	

Prevalence of uncontrolled pressure and behavioral characteristics of respondents According to this study, 340 (76.4%) of participants had uncontrolled blood pressure. Of all participants, 81 (18.2%) were alcohol consumers, fifty (11.2%) were did not reduce salt in the diet, and 78 (17.5%) had a history of loss to follow-up.

One hundred sixty-five (37.1%) of the participants were non-adherence to their anti-hypertensive medication and 308 (69.2%) were physically inactive (Table 2).

Table 2. Behavioral factors of uncontrolled blood pressure among hypertensive patients.

Variables	Total (%)	Controlled BP (%)	Uncontrolled BP (%)	p-value
Have you ever smoke a cigarette				0.04
Yes	12 (2.7)	0 (0)	12 (100)	
No	433 (97.3)	105 (24.2)	328 (75.8)	
Current smoking				0.45
Yes	3 (0.67)	0 (0)	3 (100)	
No	442 (99.33)	105 (23.8)	337 (76.2)	
Regular physical exercise				0.97
Yes	137 (30.79)	33 (24.1)	104 (75.9)	
No	308 (69.21)	72 (23.4)	236 (76.6)	
Medication adherence				0.05
Not adherent	165 (37.08)	30 (18.2)	135 (81.8)	
Adherent	280 (62.92)	75 (26.8)	205 (73.2)	
Frequency of follow-up				0.13
1month	106 (23.82)	20 (18.9)	86 (81.1)	
2month	267 (60)	62 (23.2)	205 (76.8)	
3month	72 (16.18)	23 (31.9)	49 (68.1)	
Have you ever drink alcohol				0.71
Yes	322 (72.36)	74 (23)	248 (77)	
No	123 (27.64)	31 (25.2)	92 (74.8)	
Current alcohol drink				0.01
Yes	81 (18.2)	7 (8.6)	74 (91.4)	
No	364 (81.8)	98 (26.9)	266 (73.1)	
Have you reduce salt in the diet				0.42
Yes	395 (88.77)	96 (24.3)	299 (75.7)	
No	50 (11.23)	9 (18)	41 (82)	
Do you eat foods high in fat				0.52
Yes	98 (22.03)	26 (26.5)	72 (73.5)	
No	347 (77.97)	79 (22.8)	268 (77.2)	
Loss to follow-up				0.02
Yes	78 (17.53)	10 (12.8)	68 (87.2)	
No	367 (82.47)	95 (25.9)	272 (74.1)	
Duration of hypertension				

Variables	Total (%)	Controlled BP (%)	Uncontrolled BP (%)	p-value
4 years or less	105 (23.6)	73 (24.2)	229 (75.8)	0.77
More than 4 years	340 (76.4)	32 (22.4)	111 (77.6)	
Comorbidities				1.00
Yes	105 (23.6)	24 (23.5)	78 (76.5)	
No	340 (76.4)	81 (23.6)	262 (76.4)	

Clinical and anthropometric measurements of hypertensive patients

The mean duration of hypertension was 4.09 (SD±3.22) years. Three hundred two (67.9%) of the participant were less than four years duration on the treatment of hypertension. Three hundred seventy-nine (85.2%) of the participant had normal blood sugar levels. Seventy-three (16.4%) of the participants were overweight, 362 (81.3%) had normal weight, and 10 (2.2%) were obese. One hundred seven (24%) had a high cholesterol level.

Bivariate and multivariable logistic regression for uncontrolled hypertensive patients

The bivariate analysis result revealed that sex, educational status, frequency of follow-up, lost to follow-up, current alcohol consumption, BMI, and medication non-adherence were found to be significant determinants of uncontrolled blood pressure.

The strength of association was measured using Curd Odds Ratio (COR) in the bivariate logistic regression and Adjusted Odds Ratio (AOR) in the multivariable logistic regression. On multivariable logistic regression, no formal educational (AOR=1.89, 95% CI: 1.01-3.52), alcohol drinker (AOR=4.18, 95%CI: 1.81-9.66), and every one-month follow-up (AOR=2.54, 95%CI: 1.19-5.39) were significant determinants of uncontrolled blood pressure (Table 3).

Table 3. Bivariate and multivariable logistic regression for uncontrolled hypertensive patients.

Variable		Frequency	COR (95%CI)	AOR (95%CI)
Sex	Male	216 (48.5%)	1.35 (0.87-2.10)	1.08 (0.66-1.77)
	Female	229 (51.5%)	1	1
Educational status	No formal education	169 (38%)	1.60 (0.89-2.89)	1.89 (1.01-3.52)
	Primary school	91 (20.4%)	1.76 (0.88-3.532)	1.834 (0.885-3.799)
	HSecondary school	51 (11.5%)	0.82 (0.39-1.72)	0.83 (0.38-1.81)
	Diploma	35 (7.9%)	0.56 (0.25-1.26)	0.64 (0.27-1.51)
	University and above	99 (22.2%)	1	1
Frequency of follow up	Every 1month	106 (23.8%)	2.02 (1.01-4.04)	2.54 (1.19-5.39)
	Every 2month	267 (60%)	01.55 (0.884-2.75)	1.91 (1.03-3.53)
	Every 3month	72 (16.2%)	01	1
Have you ever lost to follow	Yes	78 (17.5%)	2.38 (1.18-4.80)	1.60 (0.76-3.36)
	No	367 (82.5%)	1	1
Current alcohol consumption	Yes	81 (18.2%)	3.90 (1.73-8.75)	4.18 (1.81-9.66)
	No	364 (81.8%)	1	1
Medication adherence	No adherent	165 (37.1%)	1.65 (1.02-2.65)	1.58 (0.95-2.61)
	Adherent	280 (62.9%)	1	1
BMI	Normal weight	362 (81.3%)	1.26 (0.32-4.97)	1.56 (0.37-6.68)
	Overweight	73 (16.4%)	2.7 (0.6-12.2)	3.70 (0.76-18.13)
	Obesity	10 (2.2%)	01	1

COR: Crude Odds Ration, AOR: Adjusted Odds Ratio

4. Discussion

This cross-section study aimed to assess the magnitude and determinants of uncontrolled blood pressure among hypertensive patients in Northern Ethiopia. According to this study, 340 (76.4%) of participants had uncontrolled blood pressure. On multivariable logistic regression, no formal educational, alcohol drinker, and every one-month follow-up were significant determinants of uncontrolled blood pressure.

In this study, the prevalence of uncontrolled hypertension was 76.4% [95% CI (72.8–80.2)]. This result is similar to a study conducted in Zewditu Memorial Hospital, Ethiopia, 73.8% [9] and Cameroon, 73.2% [28]. This similarity might be due to similar study design. This result is higher than previous studies in Sudan, 54.7% [6]; in Ayder comprehensive specialized hospital, Ethiopia, 52.5% [10]; in Ethiopia, 48% [11]; and Jimma University, Ethiopia 52.7%

[7]. This might be attributed to the difference in the study population the previous article's sample was taken from hypertensive follow-up but our study's sample was taken from all departments (follow-up, neurology unit, medical ward, medical ICU) means not only from the hypertensive follow-up, and also includes unconscious patients in order to make more representative. Also, it might be due to study design difference (systematic review).

In this study, participants who were alcohol drinkers were 4.18 times more likely to be at high risk for uncontrolled blood pressure than their counterparts [AOR (95% CI AOR (1.81-9.66)]. This is in line with a study conducted in Jimma, Ethiopia [7], Tikur Anbessa, Addis Ababa, Ethiopia [29]. This similarity might be because too much drinking alcohol can raise blood pressure to unhealthy levels [30]. But a study conducted in Cameroon showed that alcohol has no association with uncontrolled blood pressure [28]. This difference might be due to the study design and sample size difference.

Participants who had no formal education were 1.89 (1.01-3.52), more likely to be at high risk for uncontrolled blood pressure compared to those who attended university and above [AOR (95% CI (0.41-1.37))]. This is in line with the studies done in Cameroon, South China, Ghanaians, and South Ethiopia [7, 28, 29, 31-33]. This similarity might be due to literacy patients have a good awareness of lifestyle changes and adherence to anti-hypertensive treatment.

In this study, participants whose follow-ups every month were 2.5 times more likely to be at high risk for uncontrolled blood pressure than whose follow-ups every three-month [AOR (95% CI (1.19-5.39))]. This might be due to the appointment schedule is adjusted based on the blood pressure control status.

Medication non-adherence is a risk factor for uncontrolled hypertension [10, 14, 15]. Unfortunately, the current study did not show medication non-adherence as a factor for uncontrolled blood pressure. This difference might be due to the method of medication adherence assessment tool difference. We used the updated and validated tool which is the eight-item Morisky Medication Adherence Scale (MMAS), but the previous study uses only three questions to assess medication adherence. Another it might be due to sample size difference and range from the background of the participants.

5. Conclusion and Recommendations

Generally, uncontrolled blood pressure at Ayder comprehensive specialized hospital was high. No formal educational, alcohol drinker, and every one-month follow-up were significantly associated with uncontrolled blood pressure. So, health education on lifestyle modifications and hypertension-related complications in each follow-up visit through health professionals are essential for primary hypertension complications prevention. Since the sample size of the study is limited further large-scale study in Ethiopia to confirm the observed trend of uncontrolled blood pressure even in urban and rural settings is needed.

Limitations

A self-reported measure of medication adherence was used, which could have caused the overestimation of adherence to medications. There is a limited sample size, single recruitment setting which is not objectively representative of the magnitude of uncontrolled hypertension in Ethiopia. Numbers of medications were not addressed in this study. Mercury sphygmomanometer used to measure blood pressure might be a source of bias because of its inaccuracy and operator dependency.

List of Abbreviations

ACSH: Ayder Comprehensive Specialized Hospital, AOR: Adjusted Odds Ratio, BMI: Body Mass Index, CI: Confidence Interval, OR: Odds Ratio, SPSS: Statistical Package for the Social Science, SSA: Sub Saharan Africa, UNICEF: United Nations International Children's Emergency Fund, WHO: World Health Organization.

Author Contributions

HH: Conceptualization, design of the work, methodology, data analysis, interpretation, investigation, supervision, writing – original draft.

TH, KG, YA, TG, DG, MH, BT, MG, GT, EA: formal analysis, methodology, supervision, review & editing the manuscript.

Data Availability Statement

The dataset used and/or analysed during the current study are available from the corresponding author on reasonable request.

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Conflicts of Interest

The authors declare that there is no competing interest.

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