

# Visual Impairment and Its Associated Factors Among Hypertensive Patients in Amhara Region Referral Hospitals, Ethiopia

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**Background:** Visual impairment is one of the most common long-term effects of high blood pressure. It affects one's quality of life, independence, and mobility. There is a paucity of information regarding the prevalence of visual impairment due to hypertension in Ethiopia. Therefore, this study aimed to determine the prevalence of visual impairment and its associated factors among hypertensive patients in referral hospitals of the Amhara region, Ethiopia, 2021.

**Methods:** An institution-based cross-sectional study was conducted among 423 study participants, which were selected by systematic random sampling technique. Data were collected by using an interviewer-administered structured questionnaire and physical measurements. The collected data were entered into Epi-data version 4.6. Then, exported into SPSS Version 26 for analysis. The crude and adjusted odds ratios and 95% Confidence intervals were calculated. Both bivariable and multivariable logistic regression analyses were done. Variables with a p-value of  $\leq 0.05$  were stated as significantly associated with visual impairment.

**Results:** The overall prevalence of visual impairment among hypertensive patients was 32.4% (95% CI: 27.9–37.9). Duration of hypertension  $\geq 5$  years (AOR = 3.06, 95% CI: 1.86–4.95), history of ocular trauma (AOR = 2.50, 95% CI: 1.3–4.73), and ever alcohol drinking (AOR = 2.72, 95% CI: 1.32–5.62) were significantly associated with visual impairment.

**Conclusion:** Nearly one-third of hypertensive patients were visually impaired from the study participants. Duration of hypertension  $\geq 5$  years, history of ocular trauma, and ever alcohol drinking was significantly associated with visual impairment among hypertensive patients. Therefore, in addition to providing medical care and follow-up services for hypertension patients, health education is needed for early and proper management of visual impairment, and to decrease their level of alcohol consumption. Furthermore, better to do this study by prospective cohort study design to identify cause-and-effect relationships.

**Keywords:** visual impairment, visual acuity, hypertension, Ethiopia

## Introduction

Visual impairment (VI) is a condition in which the presenting distance visual acuity (VA) of the better eye is worse than 6/12.<sup>1</sup> The leading causes of vision impairment are uncorrected refractive errors, cataracts, age-related macular degeneration, glaucoma, diabetic retinopathy, corneal opacity, hypertension, and trachoma.<sup>2–8</sup>

High blood pressure (BP) damages the heart, kidneys, and eyes, resulting in vision loss.<sup>2,9</sup> Systemic hypertension has been linked to a variety of major eye diseases and can affect the structure and function of the eye.<sup>10,11</sup> It is linked to a lower number of perfoveal arterioles and venules, as well as pathology and retinal vasculature.<sup>12,13</sup> Chronically elevated BP can cause arteriosclerosis and changes in the size of the precapillary arterioles, resulting in increased resistance to blood flow and decreased perfusion to the retina, causing retinal microvascular defects, retinal vein occlusion, and diabetic retinopathy.<sup>14–16</sup>

According to the World Health Organization (WHO) in 2020, 2.2 billion people globally and 26.3 million people in African countries are visually impaired.<sup>1,17</sup> VI is more prevalent in low- and middle-income countries (LMICs), accounting for 80–90% of the world's visually impaired people.<sup>17,18</sup> Ethiopia is estimated to have one of the highest rates of blindness (1.6%) and poor vision (3.7%) in the world, of which more than 80% are either treatable or preventable.<sup>19</sup>

VI is a common problem among hypertensive patients. The prevalence of visual impairment among hypertensive patients in China,<sup>20</sup> Taiwan,<sup>21</sup> India,<sup>22</sup> Sri Lanka,<sup>23</sup> and Malaysia,<sup>24</sup> was indicated to be 8.2%, 14.7%, 26.4%, 28.1%, and 50.4%, respectively. In the case of Africa, a 35.5%, 56%, and 70% prevalence of visual impairment among hypertensive patients was reported by a study in South Africa,<sup>25</sup> Nigeria,<sup>2</sup> and the Central Republic of Congo,<sup>26</sup> respectively.

This implies VI has a huge impact on hypertensive patients, as well as their families and friends. The complete loss or worsening of existing eyesight can be frightening and discouraging, causing worry about independence, paying for the required medical care, retaining jobs, and providing for themselves and their families.<sup>1,27</sup> Vision loss can also affect one's quality of life (QOL), independence, and mobility, and has been associated with falls, injuries, and deterioration in mental health, memory, social function, jobs, and educational attainment.<sup>27</sup>

Evidence from different kinds of literature revealed that visual impairment is associated with factors like age, sex, income, educational level, duration of hypertension,<sup>2,5</sup> obesity, duration of sleep, cigarette smoking, and alcohol consumption.<sup>19,28–32</sup>

Although there is various literature done on the prevalence and causes of visual impairment with its associated factors worldwide, there is not enough literature done on the prevalence of visual impairment among hypertensive patients. Furthermore, there is no single established study that determines the prevalence of VI among hypertensive patients in Ethiopia. Therefore, this study aimed to determine the prevalence and associated factors of visual impairment among hypertensive patients attending follow-up visits in referral hospitals of the Amhara region, Ethiopia. This study implicates hypertension patients should give attention to the visual problem due to hypertension and its prevention mechanisms.

## Methods and Materials

### Study Setting and Period

This study was conducted in referral hospitals of the Amhara region, Ethiopia, from April 1, 2021, to May 30, 2021. Amhara region is one of the nine regions in Ethiopia, and its capital city is Bahir Dar, which is located 565 km away, northwest of Addis Ababa, the capital city of Ethiopia. Most of the population are Christian Orthodox followers and Amharic speakers. In this region, there are eight referral hospitals. Those hospitals are providing comprehensive care and support services for more than 25 million people on follow-up and daily activities. Within these hospitals, 12,500 (unpublished data) hypertensive patients had follow-up and comprehensive services.

### Study Design and Population

An institutional-based cross-sectional study was conducted among hypertensive patients in the referral hospitals of Amhara region, Ethiopia. All hypertensive patients who had a follow-up in referral hospitals of the Amhara region were considered the source population, and hypertensive patients who had a follow-up during the study period in randomly selected referral hospitals were considered the study population.

### Inclusion and Exclusion Criteria

Study participants whose ages were 18 and above, and diagnosed with hypertension were included in this study, and study participants who were severely ill had mental disorders, and had hearing impairment were excluded from this study.

### Sample Size and Sampling Procedures

#### Sample Size Determination

The sample size was determined using a single population proportion formula as follows:

$$n = \frac{(Z_{\alpha/2})^2 \times p(1-p)}{d^2} = \frac{(1.96)^2 \times (0.5)(0.5)}{(0.05)^2} = 384 + 10\% = 423.^{33}$$

#### Assumption:

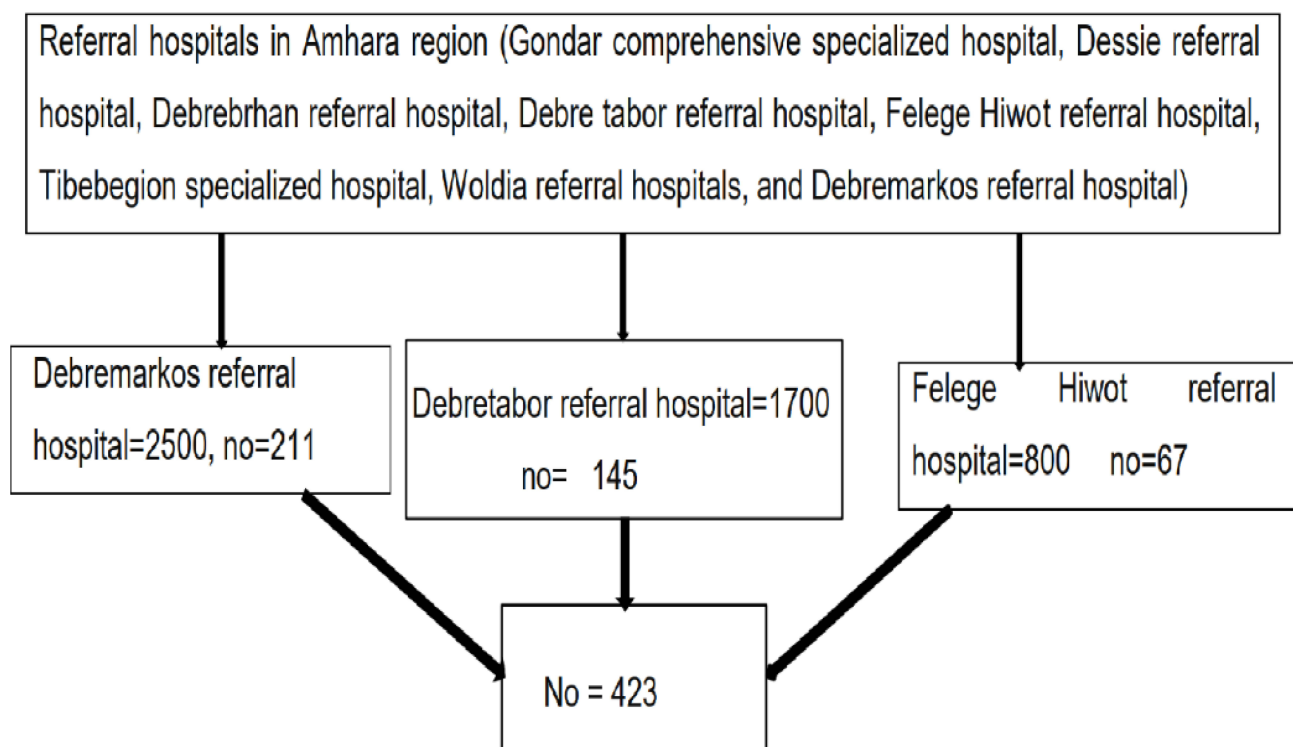
$n$  = sample size,  $P$  = proportion of visual impairment = 50% since the study on visual impairment was not conducted in the study area,  $d$  = Margin of sampling error tolerated – 5% (0.05),  $\alpha$  = Critical value at 95% confidence interval of certainty (1.96). After adding a non-response rate of 10%, the total sample size became 423.

#### Sampling Procedure

Both simple random sampling and systematic random sampling methods were used in this study to select study participants. Three referral hospitals were randomly selected by lottery methods (Debre Markos referral hospital, Debre Tabor referral hospital, and Felege Hiwot referral hospitals). From study populations in the selected referral hospitals, study participants were selected using the systematic random sampling method. Every 12<sup>th</sup> participant was selected during data collection ( $K = N/n=12$ , calculated as the total hypertensive patients who had followed up during the data collection period in selected referral hospitals (5000) divided by sample size 423). A random number 3 between 1 and 12 was selected by the lottery method as a starting number, and to make the study population a good representative of the source population, a proportional number of hypertensive patients on follow-up were selected from each referral hospital. From who had followed up, those were selected as follows (Figure 1).

#### Study Variables

The dependent variable was visual impairment (yes or no). Participants were considered to have a visual impairment if their visual acuity level in the better eye was less than 6/12 after they were examined to read letters in “Snellen’s” illiterate “E” chart.<sup>34</sup> The independent variables for this study were age, sex, residence, income, occupation, educational level, marital status, duration of hypertension, diabetes Mellitus (DM), body mass index (BMI), history of ocular trauma, family history of visual problem, chat chewing, cigarette smoking, alcohol intake, duration of sleep, frequency of television (TV) exposure per day, regular mobile exposure, and distance of exposure.



**Figure 1** Sample size selection of study participants among hypertensive patients at three referral hospitals of Amhara region, Ethiopia 2021.

## Operational Definitions

Visual impairment: Having presenting visual acuity less than 6/12 in the better eye.<sup>1</sup>

Mild visual impairment: Having visual acuity worse than 6/12 but better than or equal to 6/18 in the better eye.<sup>1</sup>

Moderate visual impairment: Presenting distance visual acuity (VA) worse than 6/18 but better than or equal to 6/60 in the better eye.<sup>1</sup>

Severe visual impairment: Presenting distance VA worse than 6/60 but better than or equal to 3/60 in the better eye.<sup>1</sup>

Blindness: Presenting VA worse than 3/60.<sup>1</sup>

BMI: Underweight is  $< 18.5 \text{ kg/m}^2$ ; normal weight is  $18.5\text{--}24.99 \text{ kg/m}^2$ ; overweight is  $25\text{--}29.99 \text{ kg/m}^2$ , obese is  $\geq 30 \text{ kg/m}^2$ .<sup>35</sup>

Current smoker: An adult who has smoked 100 cigarettes in his or her lifetime and who currently smokes cigarettes.<sup>36</sup>

Ever alcohol user: Use of alcohol, at least once in an individual's lifetime.<sup>33</sup>

Current alcohol user: A person who consumed alcohol at least once within the last 30 days.<sup>33</sup>

Duration of hypertension: History of hypertension is classified as  $\geq 5$  years and  $< 5$  years.<sup>37</sup>

Duration of sleep: A short length of sleep of  $\leq 5$  h and long sleep of  $\geq 9$  hours.<sup>38</sup>

Exposure to mobile and television: Reading/ watching at least once a day for not less than 2 h.

## Data Collection Procedure and Tools

Data were collected from March 20 to May 20 by using an interviewer-administered structured questionnaire, which was adapted from different works of the literature. The tool consists of the socio-demographic characteristics of the study participants, substance usage, medical reviews, physical measurements of blood pressure, and visual examination. Blood sugar level was extracted from the patient chart. Snellen's illiterate "E" chart for the visual acuity test, adult-sized sphygmomanometer for blood pressure, tap meter for height, and beam balance for the measurement of weight were used. One BSc ophthalmic nurse for data collection, one optometrist for a proper eye examination, and one MSc holder in optometry as a supervisor were recruited in each selected hospital.

## Examinations and Measurements

### Eye Examinations

Visual acuity test was done in each eye separately, "Snellen's" illiterate "E" chart was used by hanging on a wall at a distance of 6 meters in a well-illuminated room at a height of 2 meters.<sup>39</sup> During the test, participants were sitting or standing 6m away from the chart and cover one eye, and they read and determine the direction (for the illiterate) of the letters they see with their uncovered eyes. They repeated this process with another eye. The examiner will ask them to read smaller and smaller letters until they can no longer accurately distinguish letters.

The examination was taken place by three senior optometrists one in each selected referral hospital. Those visually impaired participants who had undetermined eye problems were consulted by the Ophthalmologist for detailed eye examination and the required data were collected after the Snellen's chart examination was completed. All study participants who had VI were linked to the ophthalmology unit for the appropriate management and follow-up.

### Anthropometric Measurements

The weight of the study participants was measured using a standard balance (MDS2100, Platform 10.5" W x 22" L x 4" H) and the height was measured by using a height-measuring device attached to the balance. Then, BMI was calculated by dividing weight (kg) by height ( $\text{m}^2$ ).

### Blood Pressure Measurement

Blood pressure was measured using a sphygmomanometer (XMEQSPHYRIAC14: length 54.5cm, width 14cm). A single measurement was recorded.

## Data Analysis Procedure

The collected data were checked for completeness and entered into Epi data version 4.6. Then, it was exported into SPSS version 26 for analysis. Descriptive measures such as median, interquartile range, and frequencies were calculated. The

crude and adjusted odds ratios were used to measure the association between study variables, and 95% confidence intervals were calculated. Model fitness was checked by Hosmer and Lemeshow test at  $p$ -value  $>0.05$ . Both bivariable and multivariable binary logistic regression models were done to identify factors associated with visual impairment. Those variables having a  $p$ -value of  $<0.25$  in the bivariable binary logistic regression analysis were selected for multivariable binary logistic regression. Those variables with a  $p$ -value of  $\leq 0.05$  in multivariable binary logistic regression were declared as having a statistically significant association with visual impairment.

## Data Quality Management

To assure the data quality, high prominence was given to designing the data collection instrument. The questionnaire was pre-tested in a setup having similar socio-cultural characteristics with the 22 study participants at Bichena primary hospitals before the actual study begins. It helps to check its wording and sort out language barriers and contextual variations on the structured questionnaire. Training for both data collectors and supervisors regarding the purpose of the study, interview, measurement techniques, and ethical issues was given for 1 day. Throughout the data collection, data collectors were supervised.

## Results

### Socio-Demographic Characteristics of Study Participants

A total of 423 hypertensive patients participated in the study with a 100% response rate. The age range of the participants was from 23 to 90 years with a median age of  $60 \pm 18$  (IQR= 50–68) years. Among the study participants, 233 (55.1%) were females. More than two-thirds (67.8%) of the respondents were married, and 234 (55.08%) of the respondents were urban dwellers. Among the respondents, 269 (63.6%) were illiterate (Table 1).

### Clinical, Substance Use, and Behavioral Characteristics of the Study Participants

Among the study participants, 222 (52.2%) had a history of follow-up hypertension for less than five years. Most of the study participants (86.1%) had no history of ocular trauma, and 412 (97.40%) of the respondents had no family history of

**Table 1** Sociodemographic Characteristics of Hypertensive Patients at Amhara Region Referral Hospitals, Ethiopia, 2021 (n=423)

Variables	Frequency	Percentage (%)
Age of participants (years)		
<40	22	5.20
40–64	234	55.3
>64	167	39.4
Sex of participants		
Female	233	55.1
Male	190	44.9
Marital status		
Married	285	67.38
Divorced	35	8.27
Widowed	95	22.46
Single	8	1.89
Residence		
Urban	234	55.3
Rural	189	44.7
Educational level		
Unable to read and write	269	63.6
Primary	62	14.7
Secondary and preparatory	36	8.5
College and university	56	13.2

(Continued)

**Table 1** (Continued).

Variables	Frequency	Percentage (%)
Occupation		
Farmer	132	31.2
Civil servant	47	11.10
Merchant	47	11.10
Housewife	127	30.00
Unemployed	15	3.50
Retire	55	13.00
Income (Ethiopian Birr)		
<2000	245	57.9
2000–5000	95	22.5
>5000	83	19.6

eye problems. Of the study participants, 81 (19.15%) had diabetes mellitus as a comorbidity with hypertension. Two hundred and sixty-four (53.66%) of the respondents had a sleep duration of 5–8 hours. Among the respondents, one hundred and eighty-six (44%) of the respondents had exposure to TV. More than three-quarters (79.7%) of the respondents had a history of drinking alcohol in their lifetime, and only 65 (15.4%) had a history of drinking alcohol, mainly tela/tej, in the last 30 days. More than two-thirds (69.74%) of the respondents had a body mass index in the category of 18–24.99 kg/m<sup>2</sup> (Table 2).

**Table 2** Clinical and Behavioral Characteristics of Hypertensive Patients at Amhara Region Referral Hospitals, Ethiopia, 2021 (n=423)

Variables	Frequency	Percentage (%)
Duration of follow-up for hypertension		
<5 years	222	52.2
≥5 years	201	47.9
History of ocular trauma		
Yes	59	13.9
No	364	86.1
Family history of eye problem		
Yes	11	2.60
No	412	97.40
Hypertension patients with diabetes mellitus		
Yes	81	19.1
No	342	80.9
Duration of sleep per day		
<5 hours	7	1.70
5–8 hours	264	62.4
≥9 hours	152	35.9
Exposure for TV		
Yes	186	44
No	237	55
Exposure distance from the TV		
<2m	74	17.5
≥2 m	112	26.5

(Continued)

**Table 2** (Continued).

Variables	Frequency	Percentage (%)
Exposure to mobile phone		
Yes	184	43.5
No	239	56.5
Chewing chat		
Yes	8	1.9
No	415	98.1
Ever alcohol drinker		
Yes	337	79.7
No	86	20.3
Current alcohol drinker		
Yes	65	15.4
No	360	84.6
Type of alcohol intake in the last 30 days		
Beer and Katicala	16	24.6
Tela/tej	49	75.4
Cigarette smoking		
Yes	1	0.020
No	422	99.8
SBP (mmHg)		
<140	176	41.6
≥ 140	247	58.4
DBP (mmHg)		
< 90	234	55.3
≥ 90	189	44.7
Body mass index (kg/m <sup>2</sup> )		
< 18.5	14	3.30
18.5–24.99	295	69.7
25–29.99	101	23.9
≥30	13	3.10

## Prevalence of Visual Impairment

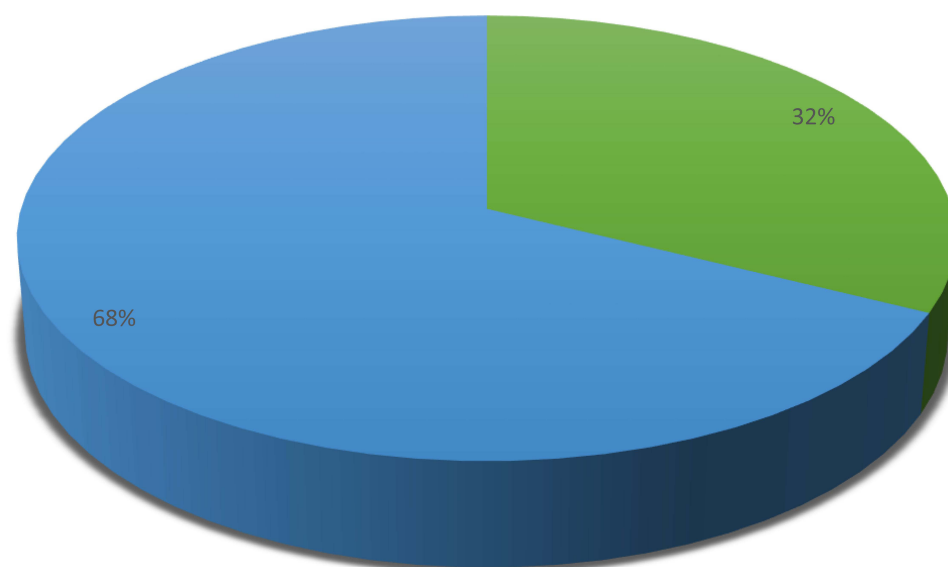
The overall prevalence of visual impairment among hypertensive patients was 32.4% (95% CI: 27.9–36.9) (Figure 2). Among the visually impaired respondents, 53 (38.7%) had mild, and 57 (41.6%) had moderate visual impairment (Figure 3).

## Factors Associated with Visual Impairment Among Hypertensive Patients

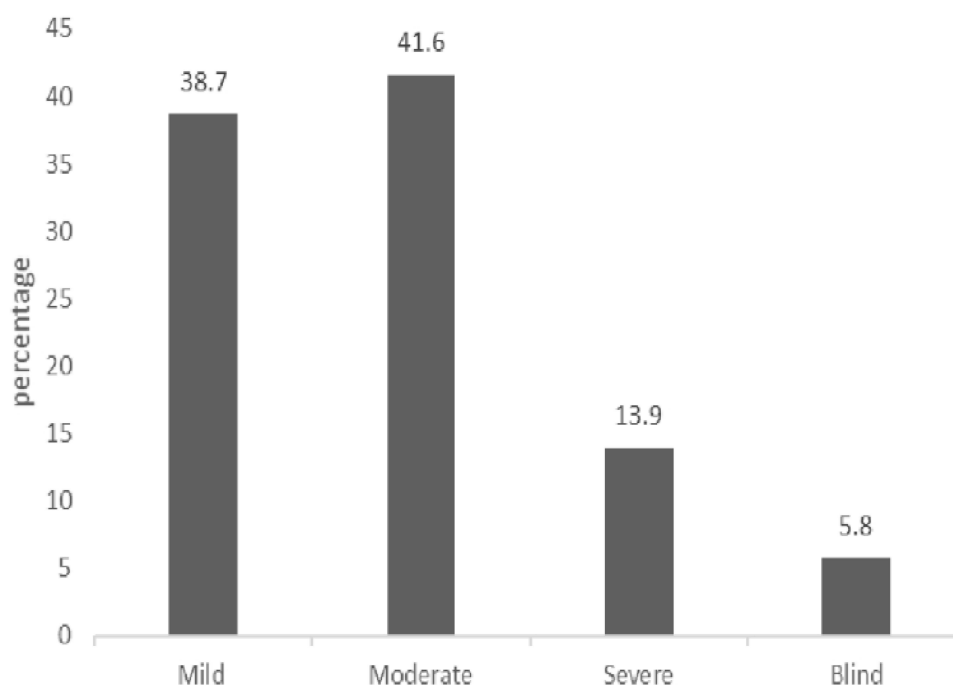
In the bivariable analysis, age, residence, educational status, occupation, income level, previous history of ocular trauma, duration of hypertension, exposure to TV, mobile exposure, ever alcohol drinking, and current alcohol drinking were associated with visual impairment. In multivariable analysis, a history of ocular trauma, duration of hypertension of five or more years, and ever alcohol drinking had a statistically significant association with visual impairment.

Those respondents who had a duration of hypertension of five or more years were 3.06 times (AOR = 3.06, 95% CI: 1.86–4.95) more likely to have visual impairment as compared to respondents who had a duration of hypertension of fewer than five years. The odds of visual impairment among the respondents who had a history of ocular trauma were 2.5 times (AOR = 2.5, 95% CI: 1.3–4.73). The odds of visual impairments in the respondents who had a history of drinking alcohol was 2.72 (AOR = 2.72, 95% CI: 1.32–5.62) times higher than those who had no history of drinking alcohol (Table 3).





**Figure 2** Prevalence of visual impairment among hypertensive patients at Debre Markos, Felege Hiwot, and Debre Tabor referral hospitals, Amhara regional state, Ethiopia, 2021.



**Figure 3** Category of visual impairment among hypertensive patients at Debre Markos, Felege Hiwot, and Debre Tabor referral hospitals, Amhara regional state, Ethiopia, 2021.

## Discussion

This study was designed to determine the prevalence of visual impairment and its associated factors among hypertensive patients in referral hospitals of the Amhara region, Ethiopia, 2021.

The prevalence of VI among hypertensive patients was 32.4%, which is higher than studies done in India at 26.4%,<sup>22</sup> China at 8.2%,<sup>20</sup> Eastern Taiwan at 14.7%,<sup>21</sup> and Saudi Arabia at 13.4%.<sup>40</sup> The possible reason for this discrepancy might be due to the differences in the definition of VI and the cut point of VA. In our study, the presenting visual acuity of the better eye was used to define VI, which can lead to a relatively higher prevalence than the above studies where



**Table 3** Bivariable and Multivariable Binary Logistic Regression Analysis of Factors Associated with Visual Impairment Among Hypertensive Patients at Amhara Region Referral Hospitals, Ethiopia, 2021 (n=423)

Variables	Visual Impairment		COR (95% CI)	AOR (95% CI)
	Yes (%)	No (%)		
Age				
<40	5(20.83)	19(79.16)	1.00	1.00
40–64	90(38.46)	144(61.54)	0.81(0.28–2.31)	0.48(0.15–1.59)
≥65	111(66.47)	56(33.53)	3.7(1.3–10.49)	1.73(0.52–5.74)
Residence				
Urban	104(44.4)	130(55.6)	1.00	1.00
Rural	102(53.97)	87(46.03)	1.4(0.93–2.11)	0.97(0.48–1.97)
Educational level				
Unable to read and write	151(56.13)	118(43.87)	2.77(0.95–8.36)	1.07(0.2–5.77)
Primary	27(43.55)	35(56.45)	2.1(0.63–7.00)	0.92(0.17–4.97)
Secondary and preparatory	14(38.9)	22(61.1)	1.36(0.36–5.15)	0.54(0.09–3.2)
College	8(24.24)	25(75.76)	1.28(0.33–5.00)	0.8(0.14–4.45)
University	6(26.09)	17(73.91)	1.00	1.00
Occupation				
Civil servant	6(12.77)	41(87.23)	1.00	1.00
Farmer	74(56.06)	58(43.94)	0.01(0.03–0.3)	2.3(0.49–10.88)
Merchant	21(44.68)	26(55.32)	0.65(0.35–1.23)	2.4(0.51–11.42)
Housewife	67(52.76)	60(47.24)	0.36(0.15–0.83)	2.27(0.5–10.33)
Unemployment	8(53.33)	7(46.67)	0.46(0.24–0.88)	1.59(0.24–10.46)
Retire	30(7.1)	25(5.9)	0.38(0.1–1.33)	3.52(0.8–13.01)
Income (ETB)				
<2000	73(61.86)	45(38.14)	1.79(1.00–3.18)	0.7(0.3–1.57)
2000–5000	47(49.47)	48(50.53)	1.79(0.92–3.48)	0.88(0.38–2.13)
>5000	27(32.5)	56(67.5)	1.00	1.00
Duration of HTN				
<5 years	72(32.14)	152(67.86)	1.00	1.00
≥ 5 years	134(67.33)	65(32.67)	3.27(2.13–5.02)	3.06(1.86–4.95)***
History of ocular trauma				
Yes	44(74.58)	15(25.42)	2.92(1.67–5.11)	2.5(1.3–4.73)**
No	162(44.5)	202(55.5)	1.00	1.00
TV exposure				
Yes	71(37.37)	119(62.62)	0.55(0.36–0.83)	1.37(0.52–3.6)
No	135(57.94)	98(42.06)	1.00	1.00
Mobile phone Exposure				
Yes	65(35.33)	119(64.67)	0.45(0.29–0.69)	0.56(0.23–1.36)
No	141(59)	98(41)	1.00	1.00
Ever Alcohol drinking				
Yes	180(54)	153(46)	2.96(1.6–5.46)	2.72(1.32–5.62)**
No	26(28.9)	64(71.1)	1.00	1.00
Current alcohol drinking				
Yes	38(58.46)	27(41.54)	0.55(0.29–1.03)	0.72(0.36–1.42)
No	179(50)	179(50)	1.00	1.00

**Notes:** \*\*\*Extremely significant association at p-value <0.001, \*\*Very significant association at p-value <0.01.

**Abbreviations:** COR, crude odds ratio; AOR, adjusted odds ratio; CI, confidence interval; HTN, hypertension; ETB, Ethiopian Birr; SBP, systolic blood pressure; DBP, diastolic blood pressure; BMI, body mass index.

they used best-corrected visual acuity to define VI. The other possible reason might be due to the visual acuity cut-point used by this study, which is less than 6/12 unlike the other studies using visual acuity cut-point of less than 6/18. These might overestimate the prevalence of visual impairment in this study. Quality of health care, health-seeking behavior,

educational status, and socioeconomic differences were other variations, which might overestimate the prevalence of visual impairment in this study. Another possible reason for the discrepancy in the prevalence of VI in this study and the study done in China might be due to the age difference of the study participants. The study done in China includes all age groups, while participants included in this study were aged greater than 18, and most of the respondents were aged greater than 40 years. The other possible justification for the higher prevalence of VI in this study than in the study done in Saudi Arabia might be due to the sample size used (195), which is smaller than the sample size used by this study, and the study design used was a retrospective study design but a cross-sectional study design was used in this study.

On the contrary, the prevalence of visual impairment in this study was lower than in studies done in Malaysia 50.4%,<sup>24</sup> Afghanistan 39.3%,<sup>29</sup> Nigeria (56%),<sup>2</sup> and the central republic of Congo (70.8%).<sup>26</sup> The discrepancy might be due to the difference in age of participants, which is greater than 65 years used by studies done in Malaysia, Afghanistan, Nigeria, and the central republic of Congo while participants' age groups greater than 18 years old were included in this study. As advancing age, the normal function of eye tissues decreases and there is an increased incidence of ocular pathology,<sup>41</sup> which might be the reason for underestimating the prevalence of visual impairment in this study. An additional possible reason might be the population-based survey that was done in studies conducted in Afghanistan, the Central Republic of Congo, and Malaysia, but this study was a hospital-based cross-sectional study, which might have decreased the magnitude of VI. The other possible reason for the discrepancy between this study and the study done in Nigeria might be due to most of the participants in the study done in Nigeria had an ocular disease in association with hypertension like cataracts, glaucoma, diabetic retinopathy, corneal opacity, and macular degeneration. However, in this study, most of the participants had not known about visual problems diagnosed before the data collection, which might underestimate the prevalence of visual impairment among hypertensive patients.

The study conducted in Sri Lanka, 28.1%,<sup>23</sup> and South Africa 35.1%<sup>25</sup> was in line with this study, which might be due to the use of similar study design, and diagnostic methods, ie Better eye presenting visual acuity.

When we come to factors associated with visual impairment, a duration of hypertension  $\geq 5$  years was associated with higher odds of visual impairment which is supported by studies done in Bangladesh<sup>37</sup> Pakistan,<sup>42</sup> and India,<sup>15</sup> This could be because chronic high blood pressure can harm the retina. When the blood pressure is too high, the retinal walls may thicken, causing the retinal blood vessels to restrict blood flow to the retina and limit its function, resulting in potentially permanent vision problems, including blindness.<sup>9,12,13,15,37,43</sup>

Similarly, the history of ocular trauma was associated with visual impairment which is supported by studies done in China,<sup>44</sup> and Malawi,<sup>45</sup> this could be because any injury to the eye, eyelid, or surrounding bone around the eye, resulting in a permanent vision loss, including blindness.<sup>46,47</sup>

The history of ever alcohol drinking was positively associated with visual impairment, which is supported by studies done in China,<sup>5,48</sup> the United States of America,<sup>49</sup> and Turkey.<sup>50</sup> This might be because of the effect of alcohol on the gamma-aminobutyric acid (GABA) receptors. Alcohol does not increase GABA but mimics the effects of GABA by binding to GABA receptors in the brain (GABA agonist).<sup>51,52</sup> GABA's effect is to reduce neural activity by allowing chloride ions to enter the post-synaptic neuron. These ions have a negative electrical charge, which helps to make the neuron less excitable. This physiological effect is amplified when alcohol binds to the GABA receptor, probably because it enables the ion channel to stay open longer and thus lets more  $\text{Cl}^-$  ions into the cell resulting in hyperpolarizing the cell and inhibiting the transmission of an action potential.<sup>39,53–55</sup> Resulting in visual information being transmitted slowly to the visual information processing area and so visual impairment is going to happen. Moreover, by binding on GABA receptors, alcohol inhibits the superior colliculus and is involved in the control of ocular movement. This results in visual impairment due to the difficulty of rapid eye movement and failure to fixation.<sup>53</sup>

This study assessed visual acuity only, which did not include visual field testing and fundus photography examination. The majority of questions in the data-collection instrument asked about the participant's history and would have been exposed to recall bias. This study was a cross-sectional study that might not show a cause-and-effect relationship. Since it was, a hospital-based study, a conclusion on the prevalence of visual impairment in the community cannot be made.

## Conclusions

From this study, we can conclude that nearly one-third of hypertensive patients in this study were visually impaired. Duration of hypertension, history of ocular trauma, and ever alcohol drinking was positively associated with visual impairment. Even though the data were collected from all study participants with a 100% response rate, and from multi-sites, but it is better to do this study by prospective cohort study design to identify cause-and-effect relationships and use additional eye examinations like visual field assessment and fundus photography for better diagnosis.

## Abbreviations

AOR, adjusted odds ratio; BMI, body mass index; BP, blood pressure; COR, crude odds ratio; DBP, diastolic blood pressure; DM, diabetes mellitus; kg, kilogram; kg/m<sup>2</sup>, kilogram per meter square; SBP, systolic blood pressure; TV, television; VA, visual acuity; VI, visual impairment.

## Data Sharing Statement

All materials that were used to do this research are included in the manuscript.

## Ethical Approval and Consent to Participate

All the methods were carried out in complied with the Declaration of Helsinki. Ethical clearance was obtained from the Institutional Review Committee (IRC) of the School of Medicine, University of Gondar (ref. no. 460/04/2021). A letter of cooperation was obtained from the Amhara Institution of public health (APHI) (ref. no. APHI 3/1082) and selected referral hospitals before the actual data collection was started. Written informed consent was obtained from the study participants. Privacy and confidentiality of information were kept properly, and names were not recorded. The data were collected by considering the COVID-19 protection protocol.

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## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis, and interpretation, or all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

## Disclosure

The authors report no conflicts of interest in this work.

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