Case-controlled Study

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Determinants of hypertensive retinopathy among non-diabetic adults in comprehensive specialized hospitals of the Amhara region, northwest Ethiopia: a case-control study

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Background: Hypertensive retinopathy is a common microvascular complication of hypertension associated with visual impairment and increased cardiovascular risk, but evidence regarding its associated factors in Ethiopia is limited. This study aimed to identify factors associated with hypertensive retinopathy among adult hypertensive patients in northwest Ethiopia.

Methods: An institution-based unmatched case-control study was conducted from 4 June to 30 June 2024, among 309 participants (76 cases and 233 controls). Cases were hypertensive patients with retinopathy diagnosed by ophthalmologists, while controls were hypertensive patients without retinopathy. Systematic random sampling was used to select study participants. The primary outcome measure was the presence of hypertensive retinopathy (yes/no), as diagnosed and documented in medical records. Data were collected through interviewer-administered questionnaires, medical record reviews, and physical measurements (blood pressure, weight, and height). Self-care and social support were assessed using validated scales. Multivariable logistic regression identified factors associated with retinopathy, and model fit was assessed by the Hosmer-Lemeshow test ($P > 0.05$). Significance was set at $P < 0.05$.

Results: The mean age of study participants was 51.75 ± 8.84 years. Factors associated with hypertensive retinopathy included: urban residence (AOR = 10.6; 95% CI: 2.9–37.9), BMI ≥25 kg/m^2 (AOR = 7.9; 95% CI: 2.6–24.2), diastolic BP > 90 mmHg (AOR = 25.3; 95% CI: 3.1–212.1), poor self-care (AOR = 5.6; 95% CI: 2.1–15.9), and lack of social support (AOR = 5.1; 95% CI: 2.1–12.4).

Conclusion: Urban residence, elevated BMI, uncontrolled diastolic blood pressure, poor self-care, and lack of social support independently increase the odds of hypertensive retinopathy. Comprehensive management that integrates retinal screening, self-care education, and social support is needed, especially in urban areas.

Keywords: adult, Amhara region, associated factors, comprehensive specialized hospitals, Ethiopia, hypertensive retinopathy

Introduction

Hypertensive retinopathy occurs when high blood pressure causes damage to the tiny blood vessels in the retina. Signs include narrowed arteries, arteriovenous nicking, bleeding in the eye, cotton-wool spots, small aneurysms, and, in severe cases, swelling of the optic nerve. These changes result from sustained high blood pressure, which causes blood vessels to spasm, the lining to weaken, and blood flow to decrease, potentially harming retinal health over time[1–5].

Hypertensive retinopathy affects about two-thirds of people with high blood pressure, especially in poorer countries where healthcare access and blood pressure control are more challenging. Early detection and appropriate management of hypertension may reduce the progression of retinal vascular damage and prevent visual complications[1,2].

Hypertensive retinopathy is a common but often overlooked complication of high blood pressure. It plays a major role in causing vision problems and blindness around the world. According to the World Health Organization, by 2020, about 2.2 billion people worldwide, including over 26 million in Africa, had some form of visual impairment, many of which could be prevented or treated. In Ethiopia, vision loss remains a major health issue, with hypertensive retinopathy being an important contributing factor[3–5].

Retinopathy affects more than just eyesight. It can negatively affect mental health, independence, mobility, and financial situation. Especially in cases of hypertensive retinopathy, spotting this condition may indicate widespread blood vessel damage elsewhere in the body. It is linked to higher chances of stroke, heart problems, and even death, no matter how well blood pressure is controlled. These issues can go beyond vision, leading to serious

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conditions such as blocked retinal blood vessels or nerve damage, which can be life-threatening[6,7].

Hypertensive retinopathy often does not get the attention it deserves, especially in areas with limited resources. The World Health Organization recommends regular eye exams for people with stage 2 hypertension, and the Joint National Committee sees retinopathy as a key sign to initiate blood pressure treatment even in stage 1. However, in Ethiopia, there are no specific policies or guidelines focused on diagnosing and managing hypertensive retinopathy. This highlights the need for evidence-based strategies to improve the prevention, early detection, and management of hypertensive retinopathy in Ethiopia[8–10].

Despite the increasing burden of hypertension in Ethiopia, evidence regarding factors associated with hypertensive retinopathy among non-diabetic hypertensive patients remains limited. Furthermore, psychosocial factors such as self-care practices and social support have received little attention in previous studies.

We hypothesized that clinical, behavioral, and psychosocial factors were independently associated with hypertensive retinopathy. Therefore, this study aimed to identify factors associated with hypertensive retinopathy among adult non-diabetic hypertensive patients attending comprehensive specialized hospitals in northwestern Ethiopia. The goal is to provide insights for clinical practice and public health, and to inspire future research.

The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guideline for case-control studies[11].

HIGHLIGHTS

- Major findings of the study.
- This study identified factors associated with hypertensive retinopathy among non-diabetic adult hypertensive patients (an unmatched hospital-based case-control study).
- An institution-based unmatched case-control study was conducted among 309 hypertensive patients.
- An urban residence, BMI ≥25 kg/m^2, and diastolic blood pressure >90 mmHg were significant predictors of hypertensive retinopathy.
- Poor hypertension self-care practice was independently associated with increased odds of hypertensive retinopathy.
- Lack of social support significantly increased the likelihood of developing hypertensive retinopathy.
- These highlights reflect the study's originality by including self-care and social support as determinants, both of which are relatively underexplored factors in hypertensive retinopathy research.

Methodology

Study design and period

An institution-based unmatched case-control study was conducted in the Amhara Region's comprehensive specialized hospitals from 4 June to 30 2024 G.C. Although participant recruitment occurred within 1 month, the study evaluated chronic hypertension and hypertensive retinopathy conditions that had already been clinically established before enrollment.

Population

Source population

All non-diabetic adult patients with hypertension who attended specialized comprehensive hospitals were included. Cases were those diagnosed with hypertensive retinopathy, while controls were those without hypertensive retinopathy.

Study population

Adult non-diabetic patients with hypertension attending the selected comprehensive specialized hospitals during the study period were included in the study. Cases were those diagnosed with hypertensive retinopathy, and controls were those without hypertensive retinopathy.

Eligibility criteria

Inclusion criteria

All non-diabetic patients aged 18 years and older with hypertensive retinopathy were included as cases, while all non-diabetic hypertensive patients aged 18 years and older without retinopathy were included as controls at comprehensive specialized hospitals in the Amhara region during the data collection period. No upper age limit was applied. Participants aged 60 years and older were considered older adults for descriptive analysis.

Exclusion criteria

- Patients with pre-existing retinal vasculopathic changes not due to hypertension.
- Patients taking medications known to have retinotoxic effects, such as chloroquine, ethambutol, and certain chemotherapy drugs, are at risk.
- Patients with pregnancy-induced hypertension.
- Patients who fulfilled the inclusion criteria but were unable to communicate or respond to the questions were excluded.

Sample size determination

Sample size was determined using Epi-Info statistical software version 7.0.5.0, based on the following assumptions of the two-population proportion formula for unmatched case-control studies: uncontrolled blood pressure (used as the main exposure variable because it yielded the maximum sample size compared with other exposure variables), 95% confidence interval, 80% power, a 3:1 control-to-case ratio, and a 10% non-response rate (Table 1).

As shown in the table above, the largest sample size is 319. Thus, the minimum adequate sample size for this study was 319 (80 cases and 239 controls).

Although patients were sampled from four hospitals, the analysis did not account for potential clustering by hospital due to the unmatched case-control design. The effect of hospital-level variability is acknowledged as a limitation.

Sampling technique and sampling procedure

This study utilized systematic random sampling to select participants. Initially, four out of eight comprehensive specialized

Table 1

Sample size for associated factors from previous studies[11–13].

Variables	% of controls exposed	% of cases exposed	AOR	Sample Size	10% NRR	Total sample size
Duration of hypertension ≥5 years	29	55.6	3.06	158	16	174 (12)
Ever alcohol drinking (Yes)	50	73.1	2.72	208	20.8	228.8 (12)
Controlled blood pressure (Yes)	78	92.7	3.6	290	29	319 (11)

hospitals were chosen using a simple random lottery method, representing 50% of the total. The selected hospitals included the University of Gondar, Debretabor, Tibebegiwon, and Felege Hiwot Comprehensive Specialized Hospitals. In these hospitals, both cases (hypertensive patients with retinopathy) and controls (hypertensive patients without retinopathy) were selected through systematic random sampling. A sampling frame was created using patient registration numbers from medical follow-up clinics. To calculate the sampling interval (K), the total source population of hypertensive patients in each hospital was divided by the desired sample size. Participants were then chosen at regular intervals (K^{th} value) from this registry of hypertensive patients receiving follow-up care (Table 2).

Data collection instrument

A semi-structured interview was used to collect data from participants in the local language (Amharic). The questionnaire was adapted after reviewing various literature sources[12–17]. The questionnaire was prepared in English, translated into the local language (Amharic), and back-translated into English to check consistency. By using this tool, data such as family history of HTN, presence of hypertensive retinopathy, other target organ damage, social support, self-care practice, substance usage, duration of hypertension, and history of severe HTN were extracted from previously documented medical charts and directly from study participants attending the medical recheck-up clinic in both the case and control groups at comprehensive specialized hospitals. The tool consists of the socio-demographic characteristics of the study participants, medical review/clinically related variables, social support, self-care practice, and substance usage. Physical measurements were taken of blood pressure, using a mercury sphygmomanometer, and of weight, using a calibrated standard digital weighing scale with a precision of 0.1 kg, as recommended. Height was also measured using a height-measuring device attached to the balance, with participants standing erect in contact with the backboard, with a precision of 0.1 cm.

Data collection procedures

Several medical-related variables, such as history of exposure to severe hypertension, microvascular complications [ischemic heart disease (CKD), ischemic heart disease (IHD), and stroke], and hypertensive retinopathy, were collected from patients' records, while socio-demographic, behavioral, and other medical-related data were collected by interviewing patients. The weight of the study participants was measured with participants wearing light clothing and without shoes, in kilograms (kg), using a calibrated standard digital weighing scale to a precision of 0.1 kg, as recommended, but measurements were not repeated. Height was also measured using a height-measuring device attached to the balance, with the participant in an erect position so that the back of the head, shoulder blades, buttocks, and heels made contact with the backboard, to a precision of 0.1 cm, with shoes removed, as recommended, but measurements were not repeated. Then, BMI was calculated by dividing weight (kg) by height in meters squared (m^2).

Blood pressure was measured using a mercury sphygmomanometer, with the cuff deflating at a rate of 2 mmHg, in line with WHO guidelines. We measured it twice on the left arm while the participant sat comfortably, allowing 5 minutes between readings to reduce variability. The average of these two readings was used for our analysis. Although multiple visits would be ideal for confirming hypertension, we could not do so due to the nature of our data collection during a single clinic visit. We also acknowledge that measuring blood pressure only once can be influenced by the white-coat effect, which we recognize as a limitation (Fig. 1: Participant recruitment, eligibility assessment, exclusion, and final analysis).

Data quality management

At the start of the study, the researcher carefully classified cases and controls to minimize selection bias. Data collectors received 1 day of training on participant data collection techniques, followed by a second day dedicated to standard measurement procedures for blood pressure, weight, and height. To ensure consistency, both digital and mercury sphygmomanometers were used. The entire questionnaire was thoroughly explained to prevent misunderstandings among data collectors and respondents. A pre-test was conducted on 16 hypertensive patients (5% of the sample) in a randomly selected specialized

Table 2

Proportional allocation sampling of hypertensive outpatients at 4 randomly selected comprehensive specialized hospitals.

Name of hospitals	Total number of patients	No. of controls proportionally	K^{th} value for control	Total number of cases	No. of cases proportionally	K^{th} value for cases
Tibebegiwone	1300	49	26	27	14	2
Gondar	1500	56	26	57	27	2
Debre tabor	1450	55	26	40	19	2
Felege hiwot	1900	72	26	35	17	2

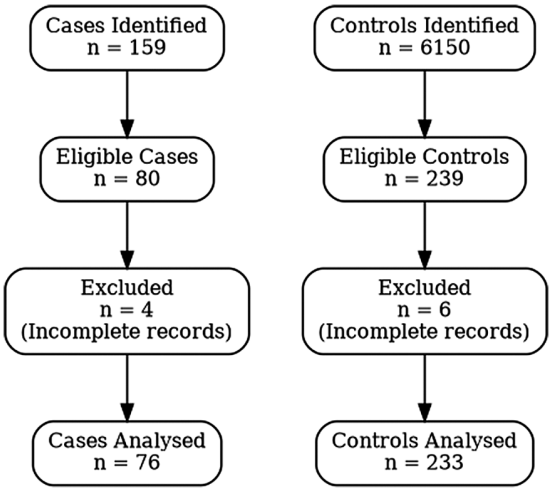


Figure 1. Participant recruitment, eligibility assessment, exclusion, and final analysis.

hospital in Debre Markos to validate the questions and ensure clarity. The questionnaire's validity was assessed by experts to establish construct validity, and its reliability was confirmed with a Cronbach's alpha of 0.86 from the pre-test data[18]. Based on pre-test results, modifications were made, particularly regarding alcohol use questions. Data collection was supervised to ensure accuracy, with completed questionnaires checked for completeness and consistency, then cleaned to address errors, missing values, and outliers, entered into Epi-Data version 4.6, and further processed in Statistical Package for the Social Sciences (SPSS) version 27 to ensure data quality.

Study variables

Dependent variable

- Hypertensive retinopathy (Yes/No).

Independent variable

- Socio-demographic: age, sex, marital status, educational status, occupation, and residence.
- Clinically related variables include BMI, blood pressure, duration of hypertension, history of severe hypertension, family history of hypertension, other target organ damage such as stroke, IHD, and CKD, and use of antihypertensive medications.
- Behavioral and other related variables: alcohol consumption, cigarette smoking, dietary habits, khat chewing, social support, and hypertension self-care practices.

Operational definitions

Cases and controls

Patients with documented retinal vascular changes attributable to hypertension (grades I-IV) were classified as cases, whereas hypertensive patients without evidence of hypertensive retinopathy were classified as controls[19].

Hypertensive retinopathy

Retinopathy was graded using the Keith-Wagener-Barker classification (grades I–IV), as documented by ophthalmologists in the patients' medical records[19].

Duration of hypertension

Patients who had hypertension for less than 5 years were classified as having a short duration of hypertension, whereas those who had hypertension for more than 5 years were classified as having a long duration of hypertension[20].

Severity of hypertension

Patients who had a history of an episode of BP ≥180/110 mmHg with end-organ damage were considered to have a hypertensive emergency or crisis, whereas those who had persistently elevated BP >200/120 mmHg were classified as having malignant hypertension[9].

Blood pressure

Blood pressure was classified based on the International Society of Hypertension 2020 guidelines: patients with BP between 120/80 mmHg and 140/90 mmHg were defined as well-controlled, whereas those with BP >140/90 mmHg were classified as uncontrolled[21]

Smoking history

Patients who had never smoked were defined as never-smokers; patients who smoked at least one cigarette per day for at least 6 months were classified as cigarette smokers[21].

Alcohol history

The CAGE questionnaire, while primarily a screening tool for problem drinking, was used in this study to classify participants as alcohol consumers (scores ≥ 2) versus non-consumers, following WHO recommendations for epidemiological studies where comprehensive alcohol consumption assessment is not feasible[22].

Chat history

Study participants who had chewed chat within the past month were classified as chat chewers, whereas those who had not were classified as non-chat chewers[23].

BMI

BMI categories were defined according to WHO criteria: underweight (<18.5 kg/m^2), normal weight (18.5–24.9 kg/m^2), and overweight/obese (≥25 kg/m^2)[24].

Self-care behaviors

The Hypertension Self-Care Activity Level Effects (H-SCALE) total score ranges from 20 to 80, with scores above the mean indicating better self-care practices, whereas scores below the mean indicate poor self-care practices[17].

Social support

The total score ranges from 12 to 84, with higher scores indicating greater perceived social support. Lower scores indicate little or no social support[16].

Data analysis procedures

The returned questionnaires were checked for completeness, cleaned, manually coded, entered into the statistical software EPI data version 4.6, and exported to the SPSS version 27 for analysis. Frequencies and percentages of variables were presented using tables and charts. Age was categorized into 18–59 years and ≥60 years. Participants aged ≥60 years were considered older adults (elderly). In this study, binary logistic regression analysis was conducted, and predictor variables with a *P*-value less than 0.25 in bivariate analysis were entered into the final multivariable logistic regression analysis to control for potential confounders.

Adjusted odds ratios with 95% confidence intervals and *P*-values were used to identify factors associated with the outcome variables. The bivariate model was then assessed to estimate the response for a fixed value of the explanatory variable. After again checking the linear relationship between the predictors and the outcome, we assessed multicollinearity. The goodness of fit of the model was checked using the Hosmer-Lemeshow test, with $P > 0.05$ indicating adequate fit. Finally, a *P*-value < 0.05 was considered statistically significant. Model discrimination was assessed using the area under the receiver operating characteristic curve, with values >0.70 indicating acceptable and >0.80 indicating excellent discrimination. Hospital-level clustering was not modeled because the study focused on individual-level risk factors and prioritized statistical power in the unmatched case-control design.

Ethical approval

Ethical approval for this study was obtained from the Ethical Review Committee of Injibara University College of Medicine and Health Sciences (reference number: INU/CMHS/779/17) on 5 June 2024. The study was conducted in full compliance with the principles outlined in the Declaration of Helsinki. Permission was also secured from the Amhara Public Health Institute and the respective administrative bodies of the selected comprehensive specialized hospitals prior to data collection.

Patient or volunteer consent

Written informed consent was obtained from all participants prior to their enrollment in the study. Each participant was provided with comprehensive information regarding the study's objectives, procedures, and their rights. Participants were assured that their participation was entirely voluntary, that they could withdraw from the interview at any time without any repercussions, and that strict confidentiality would be maintained by using coded identifiers rather than personal names on all data collection forms.

Results

Socio-demographic characteristics of study participants

In this hospital-based, unmatched case–control study, the main study was preceded by the identification of cases (n = 159) and controls (n = 6150) using the case and control definitions specified at the randomly selected hospitals. Of the planned sample size of 319 (80 cases and 239 controls), a total of 309 (76 cases and 233 controls) hypertensive participants on follow-up were included in this study, yielding a 96.86% response rate.

The mean age of study participants was 51.75 ± 8.84 years (range: 35–85 years). For descriptive analysis, participants were categorized as 18–59 years and ≥60 years, with the latter representing older adults. Overall, 41 (53.94%) of cases and 111 (47.63%) of controls were above the age of 60. Regarding residency, more than two-thirds – 220 (71.2%) – were urban residents (Table 3).

Clinical/health-related characteristics of study participants

The mean systolic blood pressure (SBP) with its standard deviation was 145.32 ± 12.96 for cases and 129 ± 6.04 for controls. The mean diastolic blood pressure (DBP) was also 92.17 ± 6.18 for cases and 82.49 ± 4.30 for controls. The proportion of medication misses was higher in cases than in controls, 25 (32.89%) vs. 5 (2.14%), respectively. The majority, 63 (82.89%), of the cases and, more than half, 149 (63.94%), of the controls had a history of severe hypertension. The proportion of participants who had a family history of hypertension was higher among cases than among controls, 55 (72.36%) vs. 123 (52.78%), respectively (Table 4).

Classification of hypertensive retinopathy among cases

Of the 76 patients with retinopathy, 35 (46.05%) had Grade II hypertensive retinopathy, which was more prevalent than Grades I and III (Fig. 2: Grade classification of hypertensive retinopathy among adult non-diabetic hypertensive cases who participated in this study at Amhara region comprehensive specialized hospitals, northwest Ethiopia, 2024).

Table 3

Socio-demographic characteristics of study participants of adult non-diabetic hypertensive patients in Amhara region comprehensive specialized hospitals, Northwest Ethiopia 2024.

		Group of patients (N = 309)	
Variables	**Category**	**Cases 76, *n* (%)**	**Controls 233, *n* (%)**
Age group years	18–59	35 (45.1%)	122 (52.3%)
	>60	41 (53.9%)	111 (47.7%)
Sex	Female	31 (40 8%)	105 (45.1%)
	Male	45 (59.2%)	128 (54.9%)
Residence	Rural	12 (15.8%)	77 (33.1%)
	Urban	64 (84.2%)	156 (66.9%)
Marital status	Married	31 (40 8%)	177 (75.9%)
	Single	1 (1.3%)	19 (8.2%)
	Widowed	26 (34.2%)	0(0.0%)
	Divorced	18 (23.7%)	37 (15.9%)
Educational status	Cannot read or write	35 (46.1%)	76 (32.7%)
	Can read and write	18 (23.7%)	38 (16.3%)
	Primary school	1 (1.3%)	0(0.0%)
	Secondary school	5 (6.6%)	0(0.0%)
	Diploma	13 (17.1%)	59 (25.3%)
	Degree and above	4 (5.2%)	60 (25.7%)
Occupation	Merchant	42 (55.3%)	57 (24.5%)
	Farmer	7 (9.2%)	19 (8.1%)
	Government employee	20 (26.3%)	120 (51.5%)
	House wife	7 (9.2%)	37 (15.9%)

Self-care, social supports, and substance use behavior characteristics of adult non-diabetic patients in Amhara region comprehensive specialized hospitals

The mean score of all study participants for hypertension self-care practice was 47.5 ± 9.5. Among all study participants, 45 (59.21%) of cases and 57 (24.46%) of controls scored below the mean for hypertension self-care practice, which indicates significantly poor self-care practice. Regarding social support, the mean score was 48 ± 8. Among the participants, 48 (63.15%) of cases and 47 (20.17%) of controls scored below the mean, suggesting a lack of adequate social support (Table 5).

Factors associated with hypertensive retinopathy

Predictor variables with a *P*-value < 0.25 in the bivariable logistic regression, such as residence, family history of hypertension, duration of hypertension after diagnosis, blood pressure (SBP and DBP), history of severe hypertension, BMI, self-care practice, social support, and history of consumption of commonly used food items, were candidates for multivariable logistic regression analysis. However, only urban residence, DBP > 90, BMI > 25, poor self-care practice, and absence of social support maintained their association with hypertensive retinopathy in the multivariable logistic regression model.

Table 4

Clinical/health-related characteristics of adult hypertensive patients in Amhara region comprehensive specialized hospitals, Northwest Ethiopia 2024.

		Group of patients (*N* = 309)	
Variables	**Category**	**Cases 76, *n* (%)**	**Controls 233, *n* (%)**
Duration of hypertension (Years)	<5 years	27 (35.5%)	161 (69.1%)
	≥5 years	49 (64.5%)	72 (30.9%)
Systolic blood pressure (mmHg)	SBP 120–140	24 (32.9%)	210 (90.1%)
	>140	52 (67.1%)	23 (9.9%)
Diastolic blood pressure (mmHg)	DBP 80–90	24 (32.9%)	211 (90.1%)
	>90	51 (67.1%)	22 (9.9%)
Grade	I	26 (34.1%)	0(0.0%)
	II	35 (46.1%)	0(0.0%)
	III	15 (19.8%)	0(0.0%)
Antihypertensive medications	ARB	25 (32.9%)	136 (58.4%)
	CCB	2 (2.6%)	7(3.0%)
	BB	8 (10.5%)	22 (9.4%)
	Diuretics	5 (6.6%)	26 (11.2%)
	ARB and CCB	4 (5.3%)	0(0.0%)
	ARC and BB	15 (19.7%)	24 (10.3%)
	BB and Diuretics	17(22.4%)	18 (7.7%)
Frequency of medication	Once a day	28 (36.8%)	207 (88.8%)
	Twice a day	44 (57.9%)	20 (8 6%)
	Three times	4 (5.3%)	6 (2.6%)
Missing days	Once a week	25 (32.9%)	6(2.6%)
Reason for missing	No missing	50 (65.8%)	227 (97.5%)
	Cost of medication	7 (9.2%)	3 (1.3%)
	Forgetfulness	7 (9.2%)	0(0.0%)
	Feeling well	6 (7.9%)	1 (0.4%)
	Complex regimen	3 (3.9%)	0(0.0%)
	Physicians mode	2 (2.7%)	0(0.0%)
	Lack of trust	1 (1.3%)	1 (0.4%)
Family history of hypertension	No	21 (27.6%)	110 (47.2%)
	Yes	55 (72.4%)	123 (52.8%)
History of severe hypertension	No	13 (17.1%)	84 (36.1%)
	Yes	63 (82.9%)	149 (63.9%)
Type of severe hypertension	No	13 (17.1%)	84 (36.1%)
	Crisis	45 (59.2%)	107 (45.9%)
	Malignancy	18 (23.7%)	42 (18.0%)
BMI (kg/m^2)	<18.5	34 (44.7%)	176(75.5%)
	18.5–24.9	22 (29.0%)	39 (16.8%)
	≥25	20 (26.3%)	18 (7.7%)
Other target organ damage	Yes	40 (52.7%)	84 (36.1%)
	No	36 (47.3%)	149 (63.9%)
Type of target organ damage	No	36 (47.3%)	149 (63.9%)
	IHD	20 (26.3%)	65 (27.9%)
	Stroke	11 (14.5%)	16 (6.9%)
	CKD	9 (11.9%)	3 (1.3%)

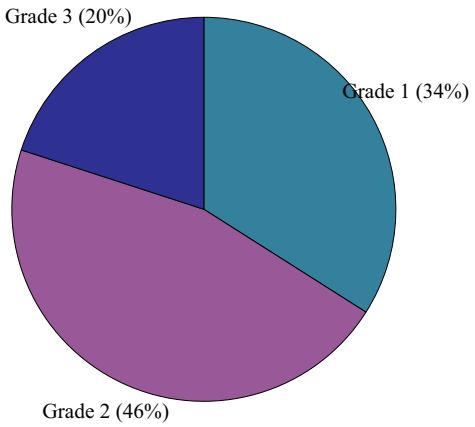


Figure 2. Grade classification of hypertensive retinopathy among adult, non-diabetic, hypertensive cases who participated in this study at comprehensive specialized hospitals in the Amhara Region, Northwest Ethiopia, 2024.

Urban residence (AOR = 10.6; 95% CI: 2.9–37.9); BMI of 25 kg/m^2 or higher compared with normal BMI (AOR = 7.9; 95% CI: 2.6–24.2); participants with diastolic blood pressure >90 mmHg compared with those with diastolic blood pressure ≤90 mmHg (AOR = 25.3; 95% CI: 3.1–212.1); participants with poor hypertension self-care practice compared with those who had good self-care practice (AOR = 5.6; 95% CI: 2.1–15.9); and participants who had no social support compared with those who had social support (AOR = 5.03; 95% CI: 2.1–12.4) were associated with higher odds of hypertensive retinopathy (Table 6).

The final multivariable logistic regression model demonstrated excellent discrimination (AUC = 0.94, 95% CI: 0.90–0.98). The Hosmer–Lemeshow goodness-of-fit test was non-significant (χ^2 = 8.25, df = 8, P = 0.23), indicating good calibration and adequate model fit.

Discussion

This study was designed to explore factors associated with hypertensive retinopathy by assessing socio-demographic, clinical, and health-related factors, self-care, social support, and substance use among hypertensive patients at referral hospitals in the Amhara region.

Our study found that participants' odds of having hypertensive retinopathy were higher among those living in urban areas compared with those living in rural areas. Similar findings were reported in various countries, including a descriptive cross-sectional study in urban Enugu, South East Nigeria[25], and similar reports from Ghana[26]. The reason behind this finding may be that, in Sub-Saharan Africa, rapid urbanization and changing lifestyles have modified the profile and pattern of various medical disorders, including hypertension, a risk factor for hypertensive retinopathy. This is also consistent with studies conducted in China[27] and Indonesia[28]. However, a recent multi-country study in Sub-Saharan Africa revealed that hypertension is the most frequently observed disease in both urban and rural communities in multiple regions[29]. Furthermore, the associated factors of hypertension were similar in rural and urban study populations. This discrepancy may be attributed to the nature of hypertension, which is influenced by modifiable risk factors and hereditary factors. Hypertension itself is the primary cause of hypertensive retinopathy.

However, the strong association between urban residence and hypertensive retinopathy should be interpreted with caution. Because this was a hospital-based study conducted in referral hospitals, urban residents may have had better access to retinal screening, resulting in higher detection rates, whereas rural residents may have been underdiagnosed due to limited ophthalmology services. This access-to-care bias may have inflated the observed association. Future community-based studies are needed to confirm this finding and minimize potential selection bias.

This study found that participants with a BMI of 25 kg/m^2 or higher had greater odds of hypertensive retinopathy compared to those with a normal BMI (AOR = 7.9; 95% CI: 2.6–24.2); however, studies in Bangladesh and Hargeisa, Somaliland[30,31] reported different findings. This inconsistency may be explained by the fact that obesity or elevated BMI is common among urban residents, possibly due to more free time and limited physical activity.

Moreover, in this study, participants with diastolic blood pressure >90 mmHg had higher odds of hypertensive retinopathy than those with diastolic blood pressure ≤90 mmHg. These results are in line with a study conducted in Saudi Arabia[32] but not with studies conducted at Chengalpattu Medical College, India[33], and the Istanbul Medical Faculty, Türkiye[34]. One possible explanation for this difference may be related to differences in study design and participant age groups. The two previous studies used a cross-sectional design and included participants from all age groups. Another possible explanation may be differences in participants' awareness and knowledge regarding blood pressure control compared with participants in our study. Another possible explanation may be differences in health-seeking behavior between developed and developing countries, together with limited access to home blood pressure monitoring devices because of financial constraints.

This study also demonstrated an association between self-care practices and hypertensive retinopathy, indicating that participants with poor self-care practices had higher odds of having hypertensive retinopathy than those with good self-care practices. This finding is consistent with other studies conducted in

Table 5

Self-care, social sports, and substance use behavior characteristics of adult hypertensive patients in Amhara region comprehensive specialized hospitals, northwest Ethiopia, 2024.

		Group of patients (*N* = 309)	
Variables	**Category**	**Cases 76, *n* (%)**	**Controls 233, *n* (%)**
Hypertension self-care practice	Good	31 (40.8%)	176 (75.5%)
	Poor	45 (59.2%)	57 (24.5%)
Social support	Yes	28 (36.8%)	186 (79.8%)
	No	48 (63.2%)	47 (20.2%)
Alcohol use	Yes	13 (17.1%)	0(0.0%)
	No	63 (82.9%)	(100%)
Chat chewing	Yes	3 (3.9%)	0(0.0%)
	No	73 (96.1%)	233 (100%)
Commonly eaten foods	Vegetables	30 (39.5%)	134 (57.5%)
	Non-vegetables	46 (60.5%)	99 (42.5%)

Table 6

Bivariable and multivariable analysis for determinant factors of hypertensive retinopathy among adult non-diabetic hypertensive patients attending Amhara region comprehensive specialized hospitals, June 2024.

		Group of patients (*N* = 309)				
Variables	**Category**	**Cases 76, *n* (%)**	**Controls 233, *n* (%)**	**COR (95% CI)**	**AOR (95% CI)**	***P*- value**
Residence	Rural (Ref)	12 (15.8%)	77 (33.1%)	1.0	1.0	
	Urban	64 (84.2%)	156 (66.9%)	2.6 (1.4–5.16)	10.6 (2.9–37.9)	<0.001[b]
Family history of hypertension	No (Ref)	21 (27.6%)	110 (47.2%)	1.0	1.0	
	Yes	55 (72.4%)	123 (52.8%)	2.3 (1.33–4.12)	2.0 (0.71–5.00)	0.23
Duration of hypertension	<5 years (Ref)	27 (35.5%)	161 (69.1%)	1.0	1.0	
	≥5 years	49 (64.5%)	72 (30.9%)	4.1 (2.4–7.0)	1.6 (0.6–4.3)	0.33
Systolic blood pressure (mmHg)	SBP 120-140 (Ref)	24 (32.9%)	210 (90.1%)	1.0	1.0	
	>140	52 (67.1%)	23 (9.9%)	19.8 (10.4–37.8)	3.1 (0.4–23.3)	0.27
Diastolic blood pressure	DBP ≤ 90 (Ref)	24 (32.9%)	211 (90.1%)	1.0	1.0	
	>90	52 (67.1%)	22 (9.9%)	20.8 (10.8–39.9)	25 (3.1–212.1)	0.003[a]
History of severe hypertension	No (Ref)	13 (17.1%)	84 (36.1%)	1.0	1.0	
	Yes	63 (82.9%)	149 (63.9%)	2.7 (1.4–5.3)	1.96 (0.59–5.00)	0.28
BMI	<25	56 (73.7%)	215 (92.2%)	2.9 (1.5–5.3)	2.02 (0.7–5.6)	0.176
	≥25	20 (26.3%)	18 (7.8%)	5.7 (2.7–11.9)	7.9 (2.64–24.17)	0.001[a]
Hypertension self-care practice	Good (Ref)	31 (40.8%)	176 (75.5%)	1.0	1.0	
	Poor	45 (59.2%)	57 (24.5%)	4.5 (2.59–7.7)	5.6 (2.1–15.9)	<0.001[b]
Social supports	Yes (Ref)	28 (36.9%)	186 (79.9%)	1.0	1.0	
	No	48 (63.1%)	47 (20.1%)	6.8 (3.85–11.9)	5.03 (2.1–12.4)	<0.001[b]
Commonly eaten foods	Vegetables (Ref)	30 (39.5%)	134 (57.5%)	1.0	1.0	
	Non-vegetables	46 (60.5%)	99 (42.5%)	2.1 (1.22–3.5)	1.2 (0.5–3.2)	0.64

[a]Statistically significant at $P < 0.01$ during multivariable analysis.
[b]Statistically significant at $P < 0.001$ during multivariable analysis; 0 (0.0%) indicates that there were zero observations, not missing values.

Ethiopia[35], but not with a study conducted in China[36]. The contradictory results may be due to differences in exposure to information about the importance of self-care practices for the prevention and treatment of chronic illnesses such as hypertension. Another explanation may be the difference in tools used to measure self-care practices. The study conducted in China used six H-SCALE items; however, in this study, 19 H-SCALE items were used.

This study also revealed that participants who had no social support had higher odds of hypertensive retinopathy than those who had social support. This result was supported by a cross-sectional study conducted in Ethiopia[35], a community-based cross-sectional study conducted in southwestern Nigeria[37], and a cross-sectional study conducted in Türkiye[38], but not by studies from Nepal[39] and Malaysia[40]. This discrepancy between our results and those of other studies might be due to differences in individual and cultural characteristics. Many people may value financial support as social support; therefore, financially dependent individuals may report receiving high support. Also, the way expected social support is understood may vary between different societies. One possible explanation for this might be that those receiving higher support spend more time with friends and are thereby more exposed to peer group pressure for unhealthy behavior, which has been indicated as a barrier to effective control of blood pressure, thereby increasing their risk of hypertensive retinopathy.

Conclusion

The findings of this study identified several important factors associated with hypertensive retinopathy among non-diabetic adult hypertensive patients in comprehensive specialized hospitals in the Amhara region, northwest Ethiopia. Urban residence, overweight or obesity (BMI ≥ 25 kg/m^2), elevated diastolic blood pressure (>90 mmHg), poor hypertension self-care practices, and lack of social support were significantly associated with an increased likelihood of hypertensive retinopathy. These findings highlight that hypertensive retinopathy is influenced not only by clinical factors such as blood pressure control and body weight but also by behavioral and psychosocial factors.

This emphasizes the need for comprehensive hypertension management strategies that integrate regular retinal screening, effective blood pressure control, weight management, patient-centered self-care education, and strengthened social support systems.

Limitations of the study

This study has the following limitations that should be considered when interpreting the findings.

Study design limitations

As this was an unmatched case-control study, we did not match cases and controls on age, sex, or duration of hypertension. Although we controlled for these variables in multivariable analysis, residual confounding may remain. The unmatched design was chosen to maximize statistical power to detect multiple risk factors, but matching would have provided better control of these potential confounders.

Selection and referral bias

Only four out of eight comprehensive specialized hospitals in the Amhara region were selected at random, which may introduce

selection bias. Furthermore, as data were collected from referral hospitals, the study population may over represent severe or complicated hypertension cases, potentially limiting generalizability to primary care or community settings.

Clustering by hospital

The study did not account for potential clustering by hospital in the statistical analysis, which may have resulted in underestimated standard errors. Future studies should consider multilevel modeling approaches to account for hospital-level variability.

Measurement bias can occur because blood pressure was measured only during one clinic visit, which might lead to issues like white coat hypertension or variability in measurements. Additionally, relying on self-reported data for alcohol consumption, smoking habits, self-care, and social support can introduce biases related to memory or the desire to present oneself in a favorable light. Also, BMI was calculated from a single measurement rather than multiple measurements.

Residual confounding

We missed some key factors that could influence the results, such as socioeconomic status (income, education beyond basic literacy, and job type), detailed dietary sodium intake, physical activity levels, and health literacy. We did capture some medication nonadherence (participants noted any missed doses in the past).

Statistical limitations

Some confidence intervals were quite broad (such as DBP: 95% CI: 3.1–212.1), suggesting a lack of precision, and some categories contained small numbers of observations, which may have contributed to unstable regression estimates and wide confidence intervals. The data collection period was relatively short (just 27 days), which, while efficient, might not fully reflect the changes in retinopathy over time.

Temporal ambiguity

Like all case-control studies, we cannot definitively establish the timing between exposures (such as self-care practices and social support) and outcomes, since the data on both were gathered at the same time.

External validity

The results might not apply to diabetic hypertensive patients (who were intentionally excluded), those with pregnancy-related hypertension, or individuals on retinotoxic medications.

Recommendations

The study emphasizes the importance of targeted interventions to prevent hypertensive retinopathy by addressing key risk factors such as poor blood pressure management, inadequate self-care, urban residence, and absence of social support.

For the Ministry of Health and Health Bureaus

- Develop national guidelines that incorporate self-care and social support into hypertension management.
- Increase public awareness of the impact of poor self-care and limited social support.
- Improve healthcare resources and training to enhance the early detection and treatment of hypertensive retinopathy.

For hospitals

- Form multidisciplinary teams (including ophthalmologists, psychologists, and social workers) for comprehensive care.
- Screen high-risk patients routinely in hypertension clinics.
- Provide tailored care and continuous support to those diagnosed with retinopathy.

For health professionals

- Educate patients on the link between hypertensive retinopathy and its risk factors.
- Promote healthy lifestyles and early detection to prevent complications, including blindness.

For researchers

- Conduct community-based mixed-methods studies to explore the psychosocial and self-care aspects of chronic diseases such as hypertension.

Ethical approval

Not applicable.

Consent

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Author contributions

S.A., T.F., Z.B.A., A.E., A.A., and K.G.F. made substantial contributions to the conception and design of the study, the acquisition of data, or the analysis and interpretation of data. All authors participated in drafting the article or revising it critically for important intellectual content, and all gave final approval of the version to be submitted.

Conflicts of interest disclosure

The authors declare that they have no competing financial, professional, or personal interests that could have influenced the design, conduct, interpretation, or reporting of this study.

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Not applicable.

Data availability statement

The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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