



Very High Intraocular Pressure and Associated Factors among Patients at Menelik II Hospital, Addis Ababa, Ethiopia: A Case-Control Study

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How to cite this paper: Teferi, K.M., Giorgis, A.T. and Tefera, W.A. (2026) Very High Intraocular Pressure and Associated Factors among Patients at Menelik II Hospital, Addis Ababa, Ethiopia: A Case-Control Study. *Open Access Library Journal*, **13**: e15089.
<https://doi.org/10.4236/oalib.1115089>

Received: March 2, 2026

Accepted: May 25, 2026

Published: May 28, 2026

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Abstract

Background: Intraocular pressure (IOP) normally ranges between 10 and 21 mmHg. Very high IOP (≥ 40 mmHg) represents a critical condition that, if not promptly managed, can result in irreversible blindness in short period of time. This study aims to assess the clinical profile and associated factors of very high IOP. **Methods:** A hospital-based case-control study was conducted from August 2022 to July 2023. Patients with very high IOP (≥ 40 mmHg) were compared to controls with high or normal IOP (< 40 mmHg), with a focus on determining whether sociodemographic, clinical, and medical conditions are associated with very high IOP as compared to IOP less than 40 mmHg. **Results:** A total of 212 participants were included, comprising 82 cases with very high IOP and 130 controls. The mean IOP among cases was 46.6 mmHg (SD ± 6), ranging from 40 to 65 mmHg, while the mean IOP in the control group was 18 mmHg (SD ± 6.19). The most common glaucoma subtypes associated with very high IOP were primary open-angle glaucoma (28%), pseudoexfoliative glaucoma (24.3%), and juvenile open-angle glaucoma (17%). The distribution of glaucoma subtypes was generally similar between cases and controls, except that the third most common subtype in the control group was chronic angle-closure glaucoma rather than juvenile open-angle glaucoma. About half of the patients on follow-up were receiving anti-glaucoma medication at the time of evaluation. Severe visual impairment was observed in 62% of patients with very high IOP. No statistically significant association was found between very high IOP and the sociodemographic, clinical, or medical factors assessed. **Conclusion:** Very high IOP is strongly associated with severe visual impairment, emphasizing the need for early diagnosis and effective management. Sociodemographic, ocular, and medication-related factors are not associated with very high intraocular pressure.

Subject Areas

Ophthalmology

Keywords

Glaucoma, Very high Intra Ocular Pressure, Pseudoexfoliative Glaucoma, POAG, ACG, JOAG

1. Introduction

Glaucoma is a chronic and progressive optic neuropathy associated with characteristic structural damage to the optic nerve and visual field dysfunction. It is caused by multifactorial disease, which includes genetic and environmental factors [1] [2].

Recent studies from sub-Saharan Africa show that glaucoma remains highly prevalent, with poor outcomes largely due to late presentation and health system constraints.

Among the various known risk factors, increased intraocular pressure (IOP) and advanced age are well-known and important risk factors for glaucoma development [3]-[5].

Very high IOP (intraocular pressure) refers to significantly elevated pressure within the eye, which can be dangerous if not managed properly and early. When the pressure is too high, it will cause optic neuropathy within a short period of time and lead to blindness [6].

While normal IOP typically ranges from 10 to 21 mmHg (millimeters of mercury), very high IOP is usually considered to be greater than 40 mmHg, although some sources may set this threshold slightly lower, depending on individual circumstances. Pressures significantly above this range require urgent medical attention to prevent optic nerve damage and preserve vision [7]-[10].

Very high IOP can be observed in various eye conditions, with glaucoma being the most common, although it can also be associated with trauma or surgery and steroid-induced ocular hypertension [6] [11].

IOP is typically measured using tonometry. The gold standard for IOP measurement is Goldmann tonometry; however, I care rebound tonometry (IRT) is widely used due to its ease of use, high reliability, and comparable results to Goldmann tonometry [11]-[15].

There is limited research on the prevalence and risk factors associated with very high IOP, both globally, sub-Saharan Africa and within Ethiopia [16]-[19]. Therefore, this study aims to explore the major risk factors contributing to very high IOP in our setting. Additionally, the research will provide an overview of the characteristics of patients presenting with very high IOP and improved clinical practices, providing valuable insights to healthcare professionals in Ethiopia.

2. Method

A hospital-based case control study was conducted at a glaucoma clinic department of ophthalmology, Menelik II hospital, Ethiopia, from August 22, 2022 to July 30, 2023.

2.1. Inclusion and Exclusion Criteria

Inclusion criteria:

Case: All consecutive patients that visited the glaucoma clinic with an intraocular pressure greater than or equal to 40 mmHg.

Control: A glaucoma patient, matched for age and sex, with intraocular pressure (IOP) ranging from 8 to 39 mmHg, was included.

Exclusion criteria: childhood glaucoma, dense corneal scars or recent intraocular surgery were excluded.

2.2. Operational Definitions

1) Very high intraocular pressure was defined as IOP greater than or equal to 40 mmHg.

2) Patients were considered to have glaucoma if they had elevated IOP in the presence of glaucomatous optic nerve head damage. Glaucoma severity was graded based on the vertical cup-to-disc ratio (VCDR) according to the Canadian glaucoma grading system.

3) A recent history of surgery was defined as surgery within 1 month.

4) Juvenile open-angle glaucoma-open angle glaucoma, which manifests between the ages of 5 - 40 years, is characterized by the absence of eyeball enlargement and corneal changes.

5) Glaucoma severity was classified according to the Canadian Glaucoma Classification. Mild glaucoma was defined as very high IOP with a vertical cup-to-disc ratio of 0.65, moderate glaucoma as high IOP with a VCDR ranging from 0.7 to 0.85, and Severe glaucoma as high IOP with a VCDR greater than 0.9.

2.3. Hypotheses

Research Question: What sociodemographic, clinical, and medical factors are associated with very high intraocular pressure (≥ 40 mmHg) compared to lower IOP among glaucoma patients?

Null Hypothesis (H_0): There is no significant association between very high intraocular pressure (≥ 40 mmHg) and sociodemographic, clinical, or medical factors.

Alternative Hypothesis (H_1): Very high intraocular pressure (≥ 40 mmHg) is significantly associated with at least one sociodemographic, clinical, or medical factor.

2.4. Sampling Technique and Sample Size

We use purposive sampling for cases. The source population for the case group

consisted of glaucoma patients who received services at the glaucoma unit, regardless of the duration of follow-up. All consecutive patients seen during the study period who met the inclusion criteria were included in the case group.

For the control group, participants were selected using systematic random sampling till 1:1.6 proportional number was found. Specifically, 65 newly diagnosed glaucoma patients and 65 glaucoma patients on follow-up were included.

Confidence Level: 95%, Margin of Error: 5%, Population Proportion: 20%. Total Samples size is calculated is 79 (for cases) and 126 for controls, with a ratio of 1:1.6, making a total of 205. However, we included 212 participants with 82 cases and **130 controls**.

$$n = (Z\alpha/2 + Z\beta)^2 [P_1(1 - P_1) + P_0(1 - P_0)] / (P_1 - P_0)^2$$

If ratio = r, (controls per case) then $n_{\text{controls}} = r \times n_{\text{cases}}$

where:

n = sample size in each group (cases or controls)

P_0 = proportion of exposure among controls

P_1 = proportion of exposure among cases

$Z\alpha/2$ = Z value for confidence level, 95% => 1.96

$Z\beta$ = Z value for power, 90% power => 1.28, 80% power => 0.84

2.5. Recruitment of Study Participants

During routine glaucoma clinic appointment days, ophthalmic nurses measure both visual acuity and IOP. Patients with very high IOP were referred to the principal investigator for screening. Eligibility was determined using inclusion and exclusion criteria. For patients meeting the inclusion criteria, the investigator explained the purpose of the study and obtained informed consent for participation.

The investigator evaluated the patients at the glaucoma clinic and consulted consultants to plan further management. The eye that met the inclusion criteria was selected; if both eyes were eligible, the one with the higher IOP was chosen. Relevant information obtained from patient interviews and evaluations was collected using a structured data collection tool.

2.6. Data Collection Instruments and Analysis

The structured data collection tool included information such as age, sex, educational status, occupation, address, family history of glaucoma, as well as systemic illnesses like diabetes mellitus, hypertension, and other diseases. Ocular history on previous ocular surgeries, trauma, and ocular diseases was recorded. Symptoms such as vision reduction, pain, discomfort, redness, headache, and their duration were recorded.

Ocular condition data on visual acuity (VA), intraocular pressure (IOP) that was measured using I care rebound tonometry, corneal clarity, optic nerve head (ONH) status, and type of glaucoma, were also collected.

Intraocular pressure was measured using I care rebound tonometry under

standardized conditions. For each eye, three times consecutive readings were obtained, and the average value was recorded for analysis. Measurements were performed at a consistent time of day (between 9:00 and 11:00 AM) to minimize diurnal variation. If any reading differed by more than 2 mmHg, additional measurements were taken and the median value was used. All elevated or borderline values (approaching the ≥ 40 mmHg threshold) were repeated and confirmed in the same session. The tonometer was calibrated daily according to the manufacturer's guidelines, and routine quality checks were performed to ensure measurement accuracy and reliability.

The data were entered, coded, and analyzed using SPSS (Statistical Package for the Social Sciences) version 26. Statistical comparisons were made using appropriate tests, with a p-value of < 0.05 considered statistically significant. The chi-square test (X^2) was employed to assess associations between dependent and independent variables.

The analysis focused on associations between sociodemographic characteristics and very high IOP, and relationships with type of glaucoma, glaucoma medication, treatment duration, ocular characteristics, systemic associations, and ONH status.

2.7. Ethical Considerations

This study was conducted in accordance with the principles outlined in the Declaration of Helsinki. Ethical approval was obtained from the Research and Publication Ethics Committee of the Department of Ophthalmology, College of Health Sciences, Addis Ababa University. Informed consent was obtained from each participant prior to inclusion in the study. Participants were fully informed about the purpose of the study, and patients with very high IOP were managed by glaucoma specialist for urgent and appropriate management.

3. Results

3.1. Sociodemographic Characteristics

A total of 212 participants were included in this study, comprising 82 patients with very high IOP and 130 patients with IOP less than 40 mmHg, who served as controls. The majority of the study participants (44.3%) were 41 - 60 years of age, while most of the controls (32%) were above 60 years old. The mean age of the study participants was 56 years (SD ± 13.83). (See **Figure 1**)

The mean IOP was 29 mmHg (SD ± 15), ranging from 7 to 65 mmHg. The mean IOP for cases was 46.6 mmHg (SD ± 6), with a range of 40 to 65 mmHg. In contrast, the mean IOP for the control group was 18 mmHg (SD ± 6.19).

The Female-to-male ratio was 1:1.5, with a male predominance (59%). Regarding educational status, 39% of the participants were illiterate or had no formal education. The majority of the cases 53.7% were rural dwellers, whereas 52.6% of the control group were from urban areas. In terms of occupation, most of the cases were farmers, with a mean IOP of 48 mmHg, while the majority of the controls

were retired or no formal occupation. (See **Table 1**)

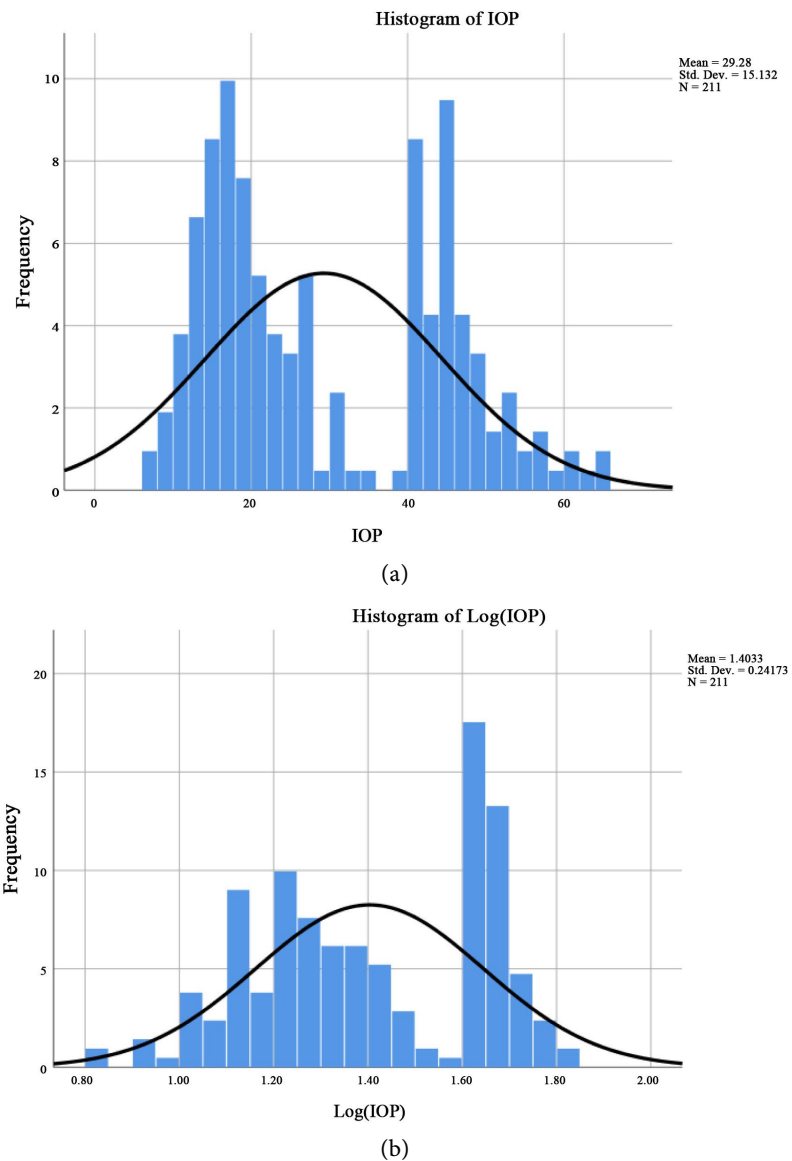


Figure 1. Histogram of mean IOP (a) and log of IOP (b) of the study participants.

Table 1. Scio-demographic characteristics of the study participants.

Variable	Categories	No of participants (%)	IOP (Means \pm SD)
Age	20 - 40	31(14.6)	37.90(12.7)
	41 - 60	94(44.1)	31.05(15.6)
	≥ 61	87(40.8)	24.31(13.5)
Gender	Female	86(40.4)	29.94(15.2)
	Male	126(59.2)	28.82(15.1)
Residency	Rural	103(48.4)	30.04(15.4)
	Urban	109(51.2)	28.56(14.8)

Continued

Educational level	Illiterate	83(39)	29.17(15.7)
	Elementary School	43(20.2)	29.79(14.5)
	Secondary School	47(18.3)	28.38(15.0)
	College and above	39(18.3)	30.05(14.8)
Occupation	Farmer	66(31)	31.03(15.8)
	Daily Laborer	29(13.6)	33.93(16.7)
	Retired	39(18.3)	32(15.88)
	Civil servant	40(18.8)	27.23(13.5)
	Merchant	36(16.9)	22.81(11.0)
Family history of glaucoma	Yes	6(2.8)	31.17(17.8)
	No	206(96.7)	29.22(15.08)
Systemic steroid use	Yes	4(1.9)	45.00(21.8)
	No	208(97.7)	28.98(14.88)

3.2. Associated Factors of the Study Participants

Among the study participants, 52% were newly diagnosed glaucoma patients, with a mean IOP of 31 mmHg (SD \pm 14.7). Only 2.4% of the cases and 3% of the controls reported a family history of glaucoma.

3.3. Review of Ocular Characteristics and Anti-Glaucoma Medication of the Study Participants

Forty-nine percent of the case used anti-glaucoma medication and 52.5% took two or more medications. Seventeen percent discontinued anti-glaucoma medications for at least one week. Forty-three percent of the controls used mono-therapy. (See [Table 2](#))

Table 2. Factors associated with high IOP among study participants.

Variables		Case (%)	Control (%)	Chi-X ²	P value
Duration of follow up	New	47(57.3)	65(50)	57.4	0.166
	Follow up	35(42)	65(50)		
Diabetes Mellitus	Yes	19(23.2)	8(5.2)	17.4	0.68
	No	63(76)	74(90)		
Hypertension	Yes	24(29.3)	11(8)	24.9	0.252
	No	58(70)	119(91)		

3.4. Type of Glaucoma, Visual Acuity and VCDR

The majority of study participants (30%) exhibited significant visual impairment

(See **Figure 2**). Among the cases, 69.5% had a VCDR greater than 0.85, whereas only 28% of the controls had a VCDR of 0.85 or higher (See **Figure 2, Table 3**). Primary Open-Angle Glaucoma was identified as the most common cause of very high IOP, with a mean IOP of 46.5 mmHg (SD \pm 6), followed by Pseudoexfoliative Glaucoma (PXG) (See **Figure 3**). Overall, 55% of the participants diagnosed with advanced glaucoma, characterized by a VCDR greater than 0.85 (See **Figure 4** and **Figure 5**).

Table 3. Glaucoma Medical treatment of case group.

Variables	Category	No (%)	Mean IOP (SD)
Anti-glaucoma medication	Yes	40 (48.8)	47.07 (6.63)
	No	42 (51.2)	46 (5.58)
Glaucoma medication	Timolol	13 (15.9)	45.31 (4.67)
	Brimonidine	3 (3.7)	57.33 (13.27)
	Latanoprost	6 (7.3)	45 (4.60)
	Timolol + Dorzolamide	9 (11)	46.56 (4.21)
	Brimonidine + Brinzolamide	2 (2.4)	45
	Systemic Acetazolamide	7 (8.5)	49 (8.48)
Number of Anti-glaucoma Medication	1 glaucoma Medication	22 (26.8)	46.26 (5.90)
	2 glaucoma medication	7 (8.5)	47.92 (7.93)
	>3 medication	11 (13)	47.75 (7.41)
Discontinued medication	Yes	12 (14.6)	46.58 (6.62)
	No	28 (34.1)	47.29 (6.74)
Duration of discontinuation	<3 weeks	8 (9.7)	47.29 (3.90)
	>3 weeks	4 (1)	49.89 (10.34)

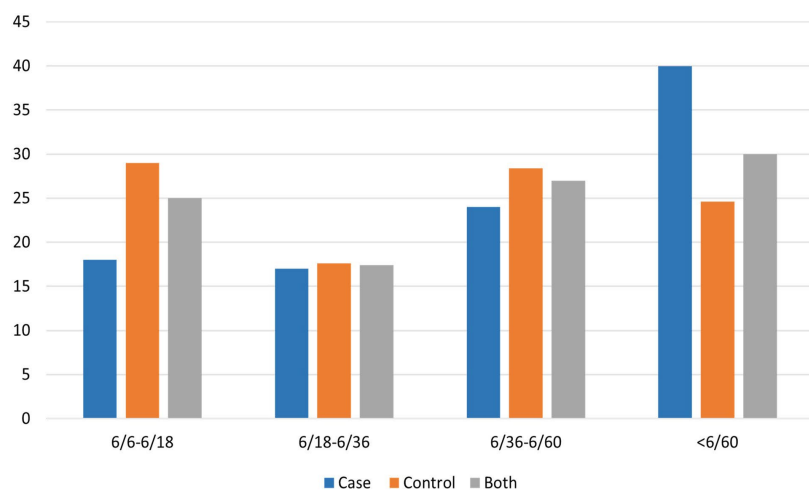


Figure 2. Visual acuity distribution of study participants.

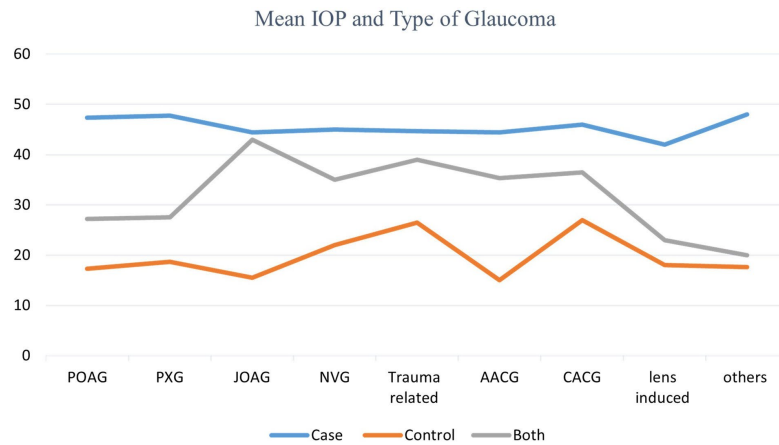


Figure 3. Relation between types of glaucoma and mean IOP.

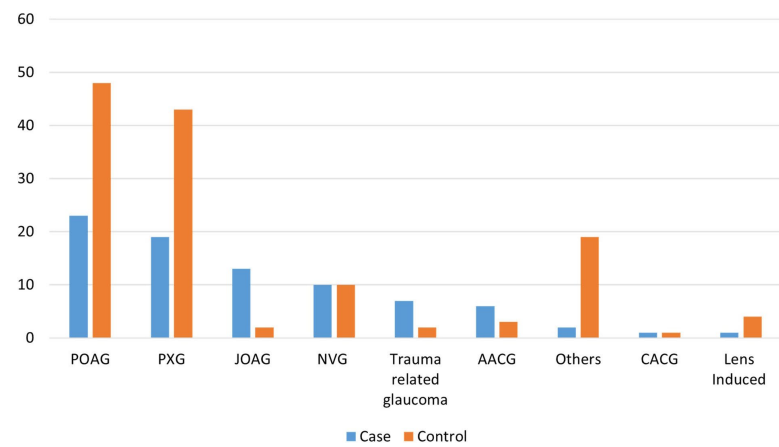


Figure 4. List of types of glaucoma of study participants.

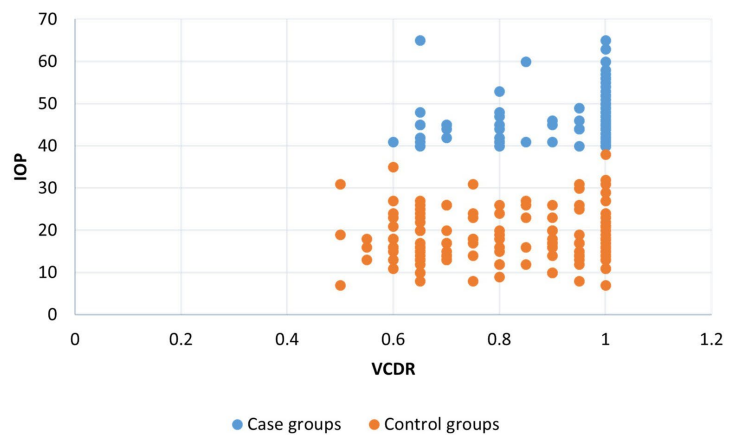


Figure 5. Distribution of intraocular pressure and vertical cup disc ratio.

4. Discussion

This study aimed to explore the clinical profile, sociodemographic characteristics, and associated factors of patients with very high intraocular pressure (IOP) in Ethiopia.

Among the 212 eligible participants, more than 80% were over the age of 41, with a mean age of 56 ± 13.8 years. These findings are consistent with several global studies that have reported a higher prevalence of glaucoma among older individuals. This trend is primarily attributed to age being a major risk factor for the development of glaucoma and elevated IOP [12] [16].

There are more men than women in both groups ($n = 126$, 59%), resulting in a male-to-female ratio of 1.46:1. The mean IOP among men is 46.1 ± 5.84 mmHg. These findings align with previous studies [10] [12] [14].

The most prevalent type of glaucoma associated with very high IOP is primary open-angle glaucoma (28%), followed by pseudoexfoliative glaucoma (24%) (**Figure 3**). These results are consistent with studies conducted in Zimbabwe [14] and India [9]. The lower prevalence of juvenile open-angle glaucoma among cases may be attributed to two factors: the relative rarity of the condition and a possible selection bias favoring adult patients attending the clinic, leading to fewer juvenile cases being included.

Glaucoma severity is classified based on the Canadian Glaucoma Strategy. The majority of participants with very high IOP are in advanced stages of the disease, characterized by a vertical cup-to-disc ratio >0.85 , which is similar in both case and control groups.

A significant proportion of the cases (57.3%) consist of newly diagnosed glaucoma patients, with a mean IOP of 46.5 mmHg. Additionally, 51.2% are not using any anti-glaucoma medications at the time of the study. This high IOP suggests that their condition was likely inadequately managed before referral to the glaucoma clinic.

To address this issue, the referral system should be revised to enhance the early detection and management of glaucoma patients with very high IOP. Potential strategies include implementing stricter referral guidelines and ensuring that primary care providers are equipped with the necessary knowledge and resources for timely diagnosis and intervention.

Among patients receiving anti-glaucoma medications, the majority (52.5%) are on combination therapy. This finding is consistent with studies conducted in Bahir Dar, Ethiopia [12]. The preference for combination therapy attributed to its greater efficacy in managing very high IOP. However, adherence challenges and the complexity of managing multiple medications may pose difficulties for some patients. In such cases, monotherapy—being simpler to administer and manage—could be a more viable option, depending on the patient's condition and adherence capacity.

The majority of cases (70%) has advanced glaucoma, characterized by a vertical cup-to-disc ratio of >0.85 , whereas most of the control has mild to moderate glaucoma with a VCDR of <0.85 . This finding underscores the importance of prioritizing patients with very high IOP, as they are at significant risk of rapid disease progression.

High IOP is a well-established risk factor for both the development and pro-

gression of glaucoma. Early intervention in these patients is crucial to prevent further visual impairment and blindness. Strengthening screening and referral mechanisms, along with timely treatment mitigate the impact of very high IOP on vision loss.

5. Limitations

The study was conducted in a glaucoma clinic where referred glaucoma patients being evaluated and managed which often focus on detecting and treating adult-onset glaucoma.

6. Conclusion

This study has shown very high intraocular pressure (IOP) is a significant contributor to visual impairment and blindness. Sociodemographic, ocular, and medication-related factors were not found to be significantly associated with elevated IOP levels. These findings highlight the critical importance of timely diagnosis and prompt, appropriate management to prevent irreversible vision loss due to glaucoma associated with very high IOP.

Acknowledgements

The authors express their heartfelt gratitude to all the study participants for their valuable contributions. Special thanks go to Addis Ababa University and the dedicated nurses of the glaucoma unit for their invaluable assistance during the data collection process.

Authors' Contributions

KM conceptualized the study, prepared the proposal, collected data, conducted the analysis, interpreted the results, and drafted the manuscript for submission. ATG contributed to the study's conception, writing, supervision and revision. AWT provided supervision, contributed to methodology development, and reviewed the manuscript. All authors have read and approved the final manuscript.

Availability of Data and Materials

The datasets used and analyzed during the current study are available from the first author on reasonable request.

Declarations

Ethics approval and consent to participate

The study was undertaken after obtaining ethical clearance from the research and publication ethics committee of the Department of Ophthalmology, School of Medicine, College of Health Sciences, and Addis Ababa University. Written informed consent was also obtained from the glaucoma patients and control. The study adhered to the declaration of Helsinki.

Conflicts of Interest

The authors declare no conflicts of interest.

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Abbreviations

DM	Diabetes mellitus
HTN	hypertension
IOP	Intraocular pressure
OHT	Ocular Hypertension
ONH	optic nerve head
POAG	Primary open angle glaucoma
PXG	Pseudoexfoliative glaucoma
SD	standard deviation
SPSS	Statistical Package for the Social Science
VA	visual acuity
VCDR	Vertical Cup Disc Ratio