

Unveiling the Silent Threat: Investigating Glaucoma and its Predictors in Adult Ophthalmic Patients

Girish Dutt Chaturvedi¹, Ritu Chaturvedi²

¹M.S., Department of Ophthalmology, PGMO, District Hospital, Shivpuri, M.P.

²M.S., Associate Professor, Department of Ophthalmology, SRVS Medical College, Shivpuri, M.P.

Received: 17-05-2023 / Revised: 19-06-2023 / Accepted: 24-07-2023

Corresponding author: Dr. Girish Dutt Chaturvedi

Conflict of interest: Nil

Abstract:

Introduction: Glaucoma causes progressive damage to the optic nerve and is the leading cause of irreversible blindness worldwide. Blindness from glaucoma is avoidable with early diagnosis and appropriate, sustained life-long treatment. The two most common forms of the disease are primary open-angle glaucoma (POAG) and primary angle-closure glaucoma (PACG), with different patterns of disease occurrence. Despite a large amount of time and resources spent on treatment trials, there are still few effective treatments and limited involvement to reduce the incidence of glaucoma. The purpose of this study was to determine the magnitude of glaucoma and its predictors among adult patients.

Methodology: The study was carried out in District Hospital, Shivpuri from September 2022 to February 2023. An institution-based cross-sectional study design was implemented. All patients aged 40 and above years old who visited the ophthalmic outpatient department were the source population, and patients aged 40 and above years old visited the ophthalmic outpatient department during the time of data collection were the study populations.

Results: This study included 152 participants using a systematic sampling technique with a 90.7% response rate. In this study, (59%) of them were male. The mean (\pm SD) age of the participant was found to be 63 (\pm 12.54) years. (23%) of the Hindu group had glaucoma among detected cases and by religion, Muslim had a high prevalence of glaucoma which is about 53 (20.8%). Accordingly, (6.3%), (3.2%), and (3.2%) of patients had hypertension, diabetes mellitus, and cardiac illness respectively. Sixteen (6.2%) patients with glaucoma had also a positive family history of glaucoma. (10.3%) patients with glaucoma were smokers. Overall prevalence of glaucoma identified in the study, the most common type was primary open-angle glaucoma followed by closed-angle glaucoma which was (48%), and (32%), respectively while (19.7%) of them had secondary glaucoma.

Conclusion: Our study found a higher prevalence of glaucoma, which is primarily a disease of the elderly. Primary open-angle glaucoma is the most common subtype of glaucoma detected in this study. Family history of glaucoma, age, and increased intraocular pressure were significantly associated with risk factors of glaucoma in this study.

This is an Open Access article that uses a funding model which does not charge readers or their institutions for access and distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>) and the Budapest Open Access Initiative (<http://www.budapestopenaccessinitiative.org/read>), which permit unrestricted use, distribution, and reproduction in any medium, provided original work is properly credited.

Introduction

Glaucoma causes progressive damage to the optic nerve and is the leading cause of irreversible blindness worldwide. Blindness from glaucoma is avoidable with early diagnosis and appropriate, sustained life-long treatment. With adequate knowledge, adherence to follow-up care, and proper ocular medication utilization, patients can prevent blindness from this disease. However, many patients fail to adhere to treatment recommendations and lose most of their vision.[1, 2].

The two most common forms of the disease are primary open-angle glaucoma (POAG) and primary angle-closure glaucoma (PACG), with different patterns of disease occurrence [3]. Secondary glau-

coma can result from trauma and certain medications such as corticosteroids, inflammation, tumor, or conditions such as pigment dispersion or pseudoexfoliation [4]. Older age, family history of glaucoma, black race, use of systemic or topical corticosteroids, and high intraocular pressure are some of the risk factors that require prompt assessment by eye care practitioners for evaluation of glaucoma [5].

People with glaucoma may show the following clinical manifestations; blurred vision, eye pain, headache, and hyperemia with or without systemic disease and medication in case of secondary glaucoma [6]. Early diagnosis of glaucoma can be challenging because there is no single perfect reference

standard for establishing the diagnosis. The presence of characteristic visual field defects can confirm the diagnosis, but as much as 30 to 50% of retinal ganglion cells may be lost before defects are detectable by standard visual field testing [7].

Glaucoma can be diagnosed based on the clinical presentation of the patient, examination with Slit-lamp microscopy, tonometric measurement of IOP, evaluating the structural effect of IOP with optic disc imaging [8].

Glaucoma has been termed as the “silent thief of sight” since the loss of vision often occurs gradually over a long period, and symptoms only occur when the disease is quite advanced [9].

It is a preventable cause of blindness. Late diagnosis and inadequate treatment have been attributed as the major causes of blindness in glaucoma. Blindness in glaucoma cannot be cured, but if the disease is detected in its early stages, its progress can be arrested and in most cases, the sight can be saved. As evidence shows, late diagnosis of glaucoma is an important risk factor for subsequent blindness [10].

Tools that help to assess and diagnose glaucoma are Slit-lamp microscopy, Tonometry, Gonioscopy, Ophthalmoscopy, and Perimetry which is used to measure intraocular pressure, central corneal thickness, anterior chamber depth, lens thickness, and axial length [10-15].

Despite a large amount of time and resources spent on treatment trials, there are still few effective treatments and limited involvement to reduce the incidence of glaucoma [16]. In general, evidence-based information is lacking regarding the proportion and contributing factors of glaucoma in India, particularly in the study area despite the existence of the problem in routine health services. In addition, it is important for early detection and prevention of blindness and to improve the quality of life of people with Glaucoma. This study is also important for the Ministry of Health and the local Regional Health Bureaus to draft a policy on the prevention and control of complications associated with glaucoma. Therefore, the purpose of this study was to determine the magnitude of glaucoma and its predictors among adult patients.

Methods

The study was carried out in District Hospital, Shivpuri from September 2022 to February 2023.

Study design and population characteristics

An institution-based cross-sectional study design was implemented. All patients, aged 40 and above years old who visited the ophthalmic outpatient department were the source population, and patients aged 40 and above years old visited the ophthalmic

outpatient department during the time of data collection were the study populations.

Eligibility criteria

All patients, 40 years of age and above were eligible to participate in this study while patients who were failed to communicate because of severe illness were excluded from this study.

Sample size determination

The sample size was determined using a single population proportion formula ($n = Z^2 * p(1-P) / d^2$) for a cross sectional survey based on the following assumptions: the prevalence of glaucoma (p) (3.68%) in INDIA with 95% level of confidence and 3% tolerable margin of error, the sample size required was 152.

Sampling procedure

A systematic random sampling technique was used to select the study participants. A total of 956 patients were visiting the ophthalmic outpatient department over the last six-month period. Therefore, we calculated the sampling interval ($k = N/n = 956/152 \approx 6$). Then the lottery method was used to get the random starter number which was 2. The first individual was taken as n th and the next was by sampling fraction ($k=6$). And then every 6th patients were interviewed until the allocated sample size was achieved.

Data quality control measure

To ensure the quality of the data every day after data collection, the questioner was reviewed for completeness, accuracy, and clarity by the data collectors.

Data processing and analysis

The collected data was cleaned, entered, and analyzed using SPSS version 26. To explain the study population concerning relevant variables, data were described using summary measures (frequency, proportion means). Proportions estimated along with 95% CI level. Both bivariate and multivariable logistic regression analyses were carried out. Variables with a p -value < 0.25 in the bivariate analysis were fitted into the multivariable logistic regression model for the prediction of determinants [19]. The Hosmer-Lemeshow goodness-of-fit statistics were used to assess whether the necessary assumptions for the application of multiple logistic regression were fulfilled and it was non-significant ($p = 0.76$). Crude and adjusted odds ratio with 95% confidence interval was computed.

The Adjusted Odds ratio with a 95% confidence interval is used to measure the strength of association and the actual predictors of the outcome variables. P -values less than 0.05 were used as a cutoff point for declaring statistically significant.

Study variables**Dependent variable**

Glaucoma.

Independent variables

socio-demographic, socioeconomic, clinical, and behavioral factors.

Result**Socio-demographic characteristics of study participants**

This study included 152 participants using a systematic sampling technique with a 90.7% response

rate. In this study, (59%) of them were male. The mean (\pm SD) age of the participant was found to be 63 (\pm 12.54) years. (23%) of the Hindu group had glaucoma among detected cases and by religion, Muslim had a high prevalence of glaucoma which is about 53 (20.8%).

About (21.3%) of married respondents had been detected as having glaucoma. (15.6%) of the respondents having an income of $>$ ₹10000 per month had glaucoma while 46% of respondents having an average monthly income of $>$ ₹10000 had no diagnosis of having glaucoma. Concerning occupational status, (15.6%) of farmers had glaucoma and (30.6%) of them had no glaucoma.

Figure 1: The study participants and the prevalence of glaucoma based on different factors

Socio-demographic Characteristic	Total Participants	Prevalence of Glaucoma (%)
Total Participants	152	9.2%
Gender		
- Male	90	59%
Age (years)	-	-
- Mean (\pm SD)	63 (\pm 12.54)	-
Religion	-	-
- Hindu	35	23%
- Muslim	80	53%
Marital Status	-	-
- Married	32	21.3%
Monthly Income (₹)	-	-
- $>$ ₹10000	24	15.6%
- \leq ₹10000	70	46%
Occupational Status	-	-
- Farmers	24	15.6%
- Others	46	30.6%

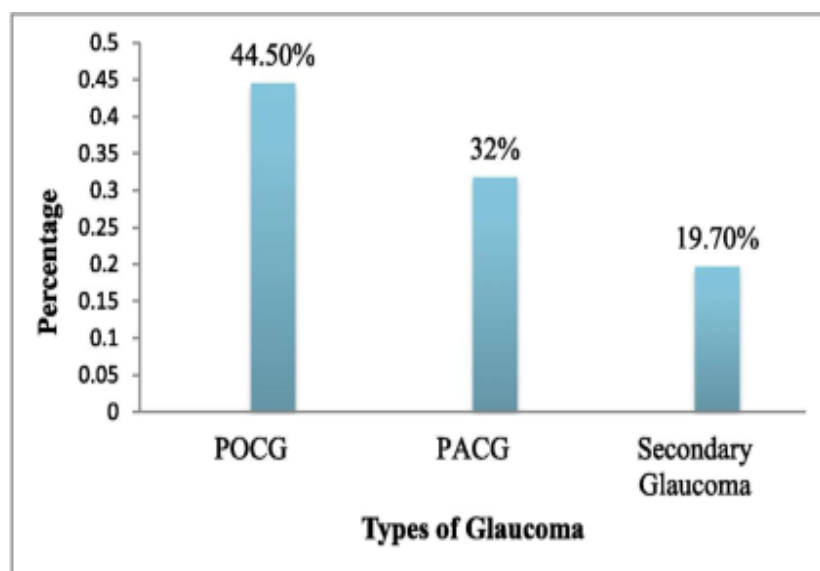
Medical, lifestyle, and family history of respondents

Among glaucoma cases, (13.5%) had some form of chronic illness. Accordingly, (6.3%), (3.2%), and (3.2%) of patients had hypertension, diabetes mellitus, and cardiac illness respectively. Sixteen (6.2%) patients with glaucoma had also a positive family history of glaucoma. (10.3%) patients with glaucoma were smokers (Table 2).

Table 2: Medical, Lifestyle, and Family History of Glaucoma Patients

Category	Percentage (%)
Chronic Illness	13.5
Hypertension	6.3
Diabetes Mellitus	3.2
Cardiac Illness	3.2
Positive Family History of Glaucoma	6.2
Smokers	10.3

Among the overall prevalence of glaucoma identified in the study, the most common type was primary open-angle glaucoma followed by closed-angle glaucoma which was (48%), and (32%), respectively while (19.7%) of them had secondary glaucoma (Figure 1).



POAG: primary open angle glaucoma, PACG: primary angle-closure glaucoma
 Figure 1:

Measures of intraocular pressure and visual acuity

As seen in the table below, most of the participants had normal intraocular pressure and 25% had elevated values of 21 mmHg and above, and 2.1% of them had soft eyes which are defined as IOP < 10 mmHg. Around (40.7%) of the participants had abnormal visual acuity, among which (24%) with low vision and the rest (16.7%) had been blind

(NLP and CF) bilaterally. The above table also showed that most of the glaucomatous patients had elevated IOP with little difference between the right and left eyes and; there were also cases of glaucoma with normal values of IOP. Most of the glaucomatous patients had decreased visual acuity (24%) and (22%) participants in their right and left eyes, respectively (Table 3).

Table 3: Intraocular Pressure (IOP) and Visual Acuity in Glaucomatous Patients

Category	Percentage (%)
Normal IOP	
Elevated IOP (> 21 mmHg)	25
Soft Eyes (IOP < 10 mmHg)	2.1
Abnormal Visual Acuity	40.7
Low Vision	24
Bilateral Blindness (NLP/CF)	16.7
Decreased Visual Acuity (Right Eye)	24
Decreased Visual Acuity (Left Eye)	22

Factors contributing to Glaucoma among adult patients

In the Bi-variable logistic regression analysis, age of the patient, duration of the medical illness, intraocular pressure, presence of chronic illness, blood pressure of the patient, and family history of the patient were found to be significantly associated with glaucoma ($P \leq 0.25$) However in multivariable logistic regression analysis only Age of the patient, duration of the illness, elevated Intraocular pressure and family history of the patient were significantly associated with glaucoma ($P \leq 0.05$). The age of the patient was significantly associated with glaucoma.

The patient who was age greater than or equal to 60 years old was 3.2 times more likely to develop glaucoma compared to age < 60 years old [AOR:3.21,95% CI:1.92–5.99]. Elevated Intraocular pressure is also significantly associated with glaucoma. Patients whose IOP ≥ 21 mmHg were 3.09 times odds of having glaucoma when compared to normal IOP (< 10 mmHg), [AOR: 3.09, 95% CI: 1.45–6.59]. Patients who have a family history of glaucoma were 3.72 times more likely to develop glaucoma when compared to those who have no family history [AOR: 3.72, 95% CI: 1.03–3.53] (Table 4).

Table 4: Summary of Variables Related to Glaucoma

Variable	COR (95%CI)	AOR (95%CI)
Age (year)		
< 60	1	1
≥ 60	2.11 (0.926, 0.998)	3.24 (1.92–5.99)*
Chronic illness		
Yes	4.95 (3.9–16.81)	1.16 (0.401–3.35)
No	1	1
Intraocular pressure		
< 10mmHg	1	1
10-21mmHg	0.1 (3.9–16.81)	0.16 (0.401–3.35)
≥ 21mmHg	2.30 (1.35–3.92)	3.09 (1.45–6.59)*
Duration of illness		
< 6 months	1	1
6 months - 1 year	0.72 (1.21–4.67)	0.57 (0.78–2.76)
> 1 year	1.51 (1.53–3.69)	1.95 (1.00–3.76)
Blood pressure		
Normal	1	1
Hypertensive	1.26 (4.01–14.71)	0.59 (0.58–8.19)
Family history of glaucoma		
Yes	6.68 (1.03, -3.611)	3.72 (1.03–3.53)*
No	1	1

Discussion

This hospital-based cross-sectional study was aimed to determine the prevalence of glaucoma and its predictors. The study found (9.2%) patients suffering from glaucoma during the study period, with 95% CI: 17.7, 35.4%) and Age of the patient, elevated Intraocular pressure and family history of the patient were remained significantly associated with glaucoma.

The prevalence of glaucoma in our study is higher compared to other studies conducted in Iran (2%) [21], Riyadh (5.6%) [22], Myanmar (4.9%) [23], Nepal (1%) [24], China (3.8%) [25], Thailand (3.8%) [26], Ghana (7.89%) [18], Nigeria (5.02%) [27], sub-Saharan Africa (4.5%) [11] and Gondar [17], 9.79%. The higher prevalence of glaucoma in our study might be due to sample size, nature of participants, and age of participants which tend to overestimate the magnitude. Being a referral facility of our study setting also may contribute to the increased prevalence of glaucoma.

After controlling all other variables constant old age, positive family history of glaucoma, and elevated Intraocular pressure remained significant.

Being old age had a more likely hood to cause glaucoma by three-fold than their counterparts. This finding was similar to results in Australia [28, 29], Russia [30], Iran [21], Zambia [32], Nigeria [4] and sub-Saharan Africa [11]. Supporting evidence is also shown in a study conducted in Nigeria [33], Ghana [18, 34], which reports the prevalence of glaucoma significantly increased with increasing age, from 3.7% among those aged 40 to 49 years to

14.6% among those 80 years old. Similar supporting evidence was recorded in a study conducted United Kingdom [35] which reported an increased prevalence of glaucoma with increased age. This might be due to exposure to ocular risk factors over several years of life and an age-related increase in intraocular pressures which in turn increase the chance of getting glaucoma.

Conclusion

In conclusion, our study found a higher prevalence of glaucoma, which is primarily a disease of the elderly. Primary open-angle glaucoma is the most common subtype of glaucoma detected in this study. Family history of glaucoma, age, and increased intraocular pressure were significantly associated with risk factors of glaucoma in this study.

Therefore, increasing public awareness about the identified risk factors for the prevention and early detection of cases is essential. Additionally, this study calls for additional observational studies for a better understanding of factors at play.

References

1. Abraham, O., School vision screening programs for Reducing children with uncorrected refractive error in low and middle-income countries (Lmic) (systematic review). 2019, Faculty of Health Sciences.
2. World Health Organization. Fact Sheet No. 282. Visual impairment and blindness 2012.
3. Durowade K, et al. Prevalence and risk factors of glaucoma among adults in rural and urban communities of Ilorin west local government

- area, north-Central Nigeria. *Int J Clin Med Res.* 2016;3(1):6–12.
4. Weinreb B, Aung RNT, Medeiros FA. The pathophysiology and treatment of glaucoma: a review. *JAMA.* 2014;311(18):1901–11.
 5. Weinreb, et al. The pathophysiology and treatment of Glaucoma. *JAMA.* 2014;311(18):1901–11.
 6. Assefa NL, Admas AW, Adimasu NF. Prevalence and associated factors of visual impairment among adults in DebreBerhan town, north Shewa, Ethiopia. *BMC Ophthalmol.* 2020;20(1):1–8.
 7. Agarwal DR, et al. The relationship between corneal hysteresis and the magnitude of intraocular pressure reduction with topical prostaglandin therapy. *Br J Ophthalmol.* 2012;96(2):254–7.
 8. Omatiga, A.G., Sonographic determination of optic nerve sheath diameter and lens thickness in glaucoma patients at the Oauthcile-ife. *Radiology*, 2019. Volume, 2016, p. 1-3.
 9. Harvard Health News. Treating glaucoma, the “thief of sight,” from Harvard's Aging Eye Special Health Report. 2010.
 10. Mehta M, Mehta S, Bajaj S. Clinical profile, subtypes and risk factors among glaucoma patients in a tertiary hospital in Central India. *Int J Sci Stud.* 2017;4(11):107–12.
 11. Kyari F, et al. A population-based survey of the prevalence and types of glaucoma in Nigeria: results from the Nigeria National Blindness and visual impairment survey. *BMC Ophthalmol.* 2015;15(1):1–15.
 12. Tham Y-C, et al. Global prevalence of glaucoma and projections of glaucoma burden through 2040: a systematic review and meta-analysis. *Ophthalmology.* 2014;121(11):2081–90.
 13. Nangia V, et al. Prevalence and associated factors of glaucoma in rural central India. *The Central India Eye and Medical Study. PLoS One.* 2013;8(9):e76434.
 14. Nkum G, et al. Awareness and knowledge of glaucoma among adult patients at the eye clinic of a teaching hospital. *Ghana Med J.* 2015;49(3):195–9.
 15. Chelkeba L, et al. Epidemiology of intestinal parasitic infections in preschool and school-aged Ethiopian children: a systematic review and meta-analysis. *BMC Public Health.* 2020;20(1):117.
 16. Dharmadhikari S, et al. Magnitude and determinants of glaucoma in type II diabetics: a hospital-based cross-sectional study in Maharashtra, India. *Oman J Ophthalmol.* 2015;8(1):19.
 17. Tegegn MT, et al. Proportion and associated factors of low vision among adult patients attending at University of Gondar Tertiary eye Care and Training Center, Gondar Town, Ethiopia. *J Ophthalmol.* 2020;2020:1-7.
 18. Otobil KB, Tenkorang SB, Mac AL, Otobil EA. Prevalence of glaucoma in an eye clinic in Ghana. *Russian Open Med J.* 2013;2:0310.
 19. Hosmer DW. *Applied logistic regression book*; 2000.
 20. Foster PJ, Buhrmann R, Quigley HA, Johnson GJ. The definition and classification of glaucoma in prevalence surveys. *Br J Ophthalmol.* 2002;86(2):238e242.
 21. Hashemi H, et al. Prevalence and risk factors of glaucoma in an adult population from Shahroud, Iran. *J Curr Ophthalmol.* 2019;31:366e372.
 22. Khandekar R, et al. The prevalence and determinants of glaucoma among 40 years and older Saudi residents in the Riyadh governorate (except the capital) – a community-based survey. *Saudi J Ophthalmol.* 2019;33:332–7.
 23. Casson L, Newland H, Muecke J, et al. Prevalence of glaucoma in rural Myanmar: the Meiktila eye study. *Br J Ophthalmol.* 2007;91:710–4.
 24. Badhu B, et al. Prevalence of glaucoma in Sunsari district of eastern Nepal. *Kathmandu Univ Med J.* 2007;5(19):343–8.
 25. He M, Foster P, Ge J, et al. Prevalence and Clinical Characteristics of Glaucoma in Adult Chinese: A Population-Based Study in Liwan District, Guangzhou. *IOVS.* 2006;47(7):2782–8.
 26. Bourne R, Sukodom P, Foster P, et al. Prevalence of glaucoma in Thailand: a population-based survey in rom Klao District. *Bangkok Br J Ophthalmol.* 2003;87:1069–74.
 27. Kyari, et al. A Population-based survey of the prevalence and types of glaucoma in Nigeria: results from the Nigeria National Blindness and Visual Impairment Survey. *BMC Ophthalmol.* 2015;15:176.
 28. Le A, et al. Risk Factors Associated with the Incidence of Open-Angle Glaucoma: The Visual Impairment Project. *IOVS.* 2003;44(9):3783–9.
 29. Worley A, Grimmer-Somers K. Risk factors for glaucoma: what do they really mean? *Austr J Prim Health.* 2011;17:233–9.
 30. Bikbov M, Gilmanshin T, Zainullin R, et al. Prevalence and associated factors of glaucoma in the Russian Ural eye and medical study. *Sci Rep.* 2020;10:20307.
 31. Khandelwal RR, Raje D, Khandelwal RR. Clinical profile and burden of primary glaucoma in rural camp patients attending a tertiary care center in India. *J Clin Ophthalmol Res.* 2019;7:55–60.
 32. Muma MKI, Michelo C, Bailey R. Determinants of primary open angle Glaucoma: review of records of patients attending university

- teaching hospital, Lusaka, Zambia. *Med J Zambia*. 2015;42(1):16–24.
33. Ashaye A, Ashaolu O, Komolafe O, et al. Prevalence and types of glaucoma among an indigenous African population in southwestern Nigeria. *Invest Ophthalmol Vis Sci*. 2013;54:7410–6.
 34. Budenz DL, Barton K, Vos JW. Prevalence of Glaucoma in an Urban West African Population. *JamaOphthal*. 2013;131(5):651-8.
 35. Foster JP, et al. Glaucoma and intraocular pressure in EPIC-Norfolk eye study: a cross-sectional study. *BMJ*. 2017;358:j3889.