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Research Article

Epidemiology and Clinical Spectrum of Glaucoma at a Tertiary-Care Center in Eastern Uttar Pradesh, India: a Hospital-Based Cross-Sectional Study

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ABSTRACT
Background: Glaucoma is a leading cause of irreversible blindness and remains underdiagnosed until advanced optic neuropathy occurs. In India, population-based studies report adult prevalence in the range of ~2.7–4.3%, but regional clinic-level epidemiology from Eastern Uttar Pradesh remains limited. Contemporary evidence confirms that intraocular pressure (IOP) reduction slows progression, making early detection clinically meaningful.
Methods: A hospital-based cross-sectional study was conducted in the Department of Ophthalmology at Uma Nath Singh Autonomous State Medical College, Jaunpur, from June 2025 to November 2025. Adults aged ≥40 years presenting to the ophthalmology outpatient department (OPD) with symptoms suggestive of glaucoma (watering/redness, ocular pain, headache, or frequent refractive correction changes) underwent standardized evaluation. Examination included best-corrected visual acuity (Snellen), IOP measurement by applanation tonometry, slit-lamp biomicroscopy, gonioscopy for angle assessment, and dilated fundus examination with 90D lens for optic disc evaluation. Glaucoma subtypes were classified clinically as primary open-angle glaucoma (POAG), primary angle-closure glaucoma (PACG), primary angle-closure disease (PACD), and secondary glaucoma based on history and examination. Data were analyzed in SPSS v26. Categorical variables were reported as frequencies/percentages; prevalence estimates were presented with 95% confidence intervals (CI).
Results: Among 1,470 eligible OPD attendees evaluated during the study period, 80 were diagnosed with glaucoma, yielding a clinic-based prevalence of 5.44% (95% CI 4.39%–6.72%). Glaucoma cases were predominantly male (46/80; 57.5%). Mean age among glaucoma cases was 58.0 ± 7.2 years. POAG was the most frequent subtype (36/80; 45.0%). Secondary glaucomas constituted 7/80 (8.75%), with pigmentary glaucoma the commonest secondary etiology. A history of long-term steroid use was documented in 16/80 glaucoma patients; steroid-associated glaucoma prevalence in the evaluated OPD cohort was 1.09% (16/1,470).
Conclusion: In this symptomatic tertiary-care OPD cohort from Eastern Uttar Pradesh, glaucoma burden was substantial, dominated by POAG, with increasing frequency in older age groups and a clinically relevant contribution from steroid exposure. These findings support targeted screening of high-risk patients and systematic monitoring of steroid users.

Keywords: Glaucoma; Epidemiology; Primary Open-Angle Glaucoma; Angle-Closure; Steroid-Induced Glaucoma; India; Uttar Pradesh.

INTRODUCTION

Glaucoma represents a heterogeneous group of chronic optic neuropathies characterized by progressive retinal ganglion cell loss and corresponding structural and functional deterioration [1,3]. The public health impact is disproportionate because visual loss is irreversible and often asymptomatic until late stages [1,3]. Contemporary reviews emphasize that, although glaucoma may occur across a range of measured IOP levels, IOP remains the principal modifiable risk factor, and its reduction is associated with slower disease progression and reduced risk of vision loss [1,3,22].

In clinical practice, the detection gap is a major driver of preventable blindness [3,5]. Evidence from India underscores substantial underdiagnosis: in population-based surveys, a large fraction of individuals with primary open-angle glaucoma (POAG) were unaware of their condition, and a clinically important subset already had blindness in at least one eye at

presentation [2,7,8,14]. This pattern mirrors global epidemiology, where projections indicate marked growth in glaucoma burden over coming decades, especially in Asia, driven largely by demographic ageing [10,20].

Glaucoma risk is influenced by age, family history, and ocular anatomy; additional systemic conditions and medication exposures can also modify risk [3,4]. Adults may present with headaches, ocular discomfort, or refractive changes, while angle-closure disease may present more abruptly in some contexts [3]. Reviews addressing glaucoma screening and management highlight the importance of careful optic disc evaluation, gonioscopy for angle assessment, and accurate IOP measurement to avoid delayed diagnosis [3,5]. Corneal biomechanics add further complexity: central corneal thickness (CCT) affects applanation IOP measurement, and landmark prevention studies have demonstrated that thinner CCT predicts conversion to glaucoma among ocular hypertensives, reinforcing that "measured IOP" is not synonymous with "true risk" [6,12]. These insights are clinically relevant in outpatient settings, where screening frequently relies on IOP and disc assessment, and where misestimation can result in underdiagnosis or undertreatment [3,5].

Epidemiological studies among Indians aged ≥40 years have estimated glaucoma prevalence between approximately 2.7% and 4.3%, with regional variation across rural and urban populations [2,7,8,9,14]. Eastern India has contributed high-quality data through population surveys such as the Hooghly River Glaucoma Study, while southern India has reported robust prevalence and subtype distributions in the Andhra Pradesh Eye Disease Study and the Chennai Glaucoma Study [7,8,14]. Despite these contributions, clinic-level epidemiology from Eastern Uttar Pradesh—particularly in symptomatic OPD cohorts—remains sparse, limiting local planning for case-finding, steroid monitoring, and referral pathways [3,19].

Accordingly, this study aimed to assess the prevalence and clinical distribution of glaucoma among adults evaluated in a tertiary-care ophthalmology OPD in Jaunpur, Eastern Uttar Pradesh, and to describe key epidemiological characteristics including age/sex patterns, subtype distribution, and the contribution of secondary and steroid-associated glaucoma within this care-seeking population [3,19].

MATERIALS AND METHODS

Study Design, Setting, and Duration

A hospital-based cross-sectional study was conducted in the Department of Ophthalmology, Uma Nath Singh Autonomous State Medical College, Jaunpur, Uttar Pradesh, India, over 6 months (June 2025 to November 2025).

Participants and Sampling

Participants were adults aged ≥40 years who presented to the ophthalmology OPD during the study period with symptoms prompting glaucoma evaluation, including watering/redness, ocular pain, headache, or frequent changes in glasses (as documented in the clinical history). A non-probability convenience sampling approach was used, based on consecutive eligible OPD attendees evaluated during the study period.

Inclusion and Exclusion Criteria

Inclusion: age ≥40 years; OPD attendance during study period; clinical evaluation completed with IOP measurement, gonioscopy, and optic disc assessment.
Exclusion: individuals who did not provide informed consent or did not complete the minimum examination set required for classification were excluded from analysis.

Ethics and Consent

The study was conducted in accordance with the tenets of the Declaration of Helsinki. Institutional ethics committee approval was obtained prior to initiation. Written informed consent was obtained from each participant.

Clinical Evaluation and Operational Definitions

A detailed history was recorded, including demographic variables and medication exposure, with specific attention to topical steroid use. Ocular examination included:

1. best-corrected visual acuity using Snellen chart;
2. intraocular pressure measurement using applanation tonometry;
3. slit-lamp biomicroscopy for anterior segment evaluation;
4. gonioscopy to assess anterior chamber angle configuration;
5. dilated fundus examination with 90D lens for optic disc evaluation (cup–disc ratio, rim changes, hemorrhages, and vessel abnormalities). Blood pressure was recorded for all diagnosed glaucoma patients.

Clinical signs considered consistent with glaucomatous optic neuropathy included vertical cup–disc ratio >0.5, inter-eye cup–disc ratio asymmetry >0.2, neuroretinal rim narrowing/notching/pallor, and disc hemorrhages. Elevated IOP was defined as >21 mmHg. PACG was defined by elevated IOP and/or glaucomatous optic disc damage in the presence of an occludable angle. Secondary glaucomas were defined by an occludable angle or glaucomatous findings attributable to an identifiable cause (e.g., pseudoexfoliation, pigment dispersion, uveitis, trauma, surgery, or lens-related mechanisms). For epidemiological comparability, the classification principles were aligned with standard survey definitions that require structural and/or functional evidence, while acknowledging the pragmatic clinical basis of classification in OPD settings.

Sample Size Statement

A minimum sample size of 80 glaucoma cases was estimated using a standard prevalence-based formula, incorporating a nonresponse allowance, based on prior Indian prevalence estimates. However, the operational study cohort comprised 1,470 evaluated OPD attendees, among whom glaucoma cases were identified.

Statistical Analysis

Data were analyzed using SPSS v26. Categorical variables were summarized as frequencies and percentages. The clinic-based prevalence of glaucoma was calculated as the proportion of glaucoma diagnoses among the 1,470 evaluated OPD attendees, with 95% CI. A two-sided p-value <0.05 was considered statistically significant where inferential testing was applicable; however, the primary focus was descriptive epidemiology.

RESULTS

A total of 1,470 OPD attendees aged ≥40 years who presented with symptoms prompting glaucoma evaluation were assessed during the study period. Eighty patients met clinical criteria for glaucoma, yielding a clinic-based prevalence of 5.44% (80/1,470; 95% CI 4.39%–6.72%). This estimate reflects a symptomatic tertiary-care OPD cohort rather than a community prevalence.

Among glaucoma cases (n=80), the mean age was 58.0 ± 7.2 years, and males constituted 57.5% (46/80), indicating modest male predominance within this care-seeking group. The distribution of cases increased with age, with the highest concentration observed in older age bands (notably 71–80 years). Mean IOP was 20.1 mmHg (range 9–54) in the right eye and 19.6 mmHg (range 8–52) in the left eye. Mean vertical cup–disc ratio was 0.4, with a maximum recorded value of 0.8, consistent with a spectrum from early to advanced structural changes.

Regarding clinical subtype distribution, POAG was the most frequent diagnosis (36/80; 45.0%), followed by PACD (26/80; 32.5%), PACG (11/80; 13.75%), and secondary glaucoma (7/80; 8.75%). When expressed across the full evaluated OPD cohort (n=1,470), the prevalence of POAG was 2.45%, PACD 1.77%, PACG 0.75%, and secondary glaucoma 0.48%. Secondary glaucoma etiologies were heterogeneous; pigmentary glaucoma predominated (3/7), followed by pseudoexfoliation-related glaucoma (2/7), uveitic glaucoma (1/7), and phacomorphic mechanism (1/7).

Steroid exposure was clinically prominent: 16 of 80 glaucoma patients (20.0%) reported long-term steroid use, corresponding to 1.09% (16/1,470) of the evaluated OPD cohort meeting criteria for steroid-associated glaucoma within this clinical screening framework.

Table 1. Baseline Characteristics of Glaucoma Cases (N=80)

Variable	Value
Mean age, years (±SD)	58.0 ± 7.2
Sex, male	46 (57.5%)
Sex, female	34 (42.5%)
Mean IOP (right eye), mmHg (range)	20.1 (9–54)
Mean IOP (left eye), mmHg (range)	19.6 (8–52)
Mean vertical cup–disc ratio (max)	0.4 (max 0.8)
Long-term steroid exposure	16 (20.0%)

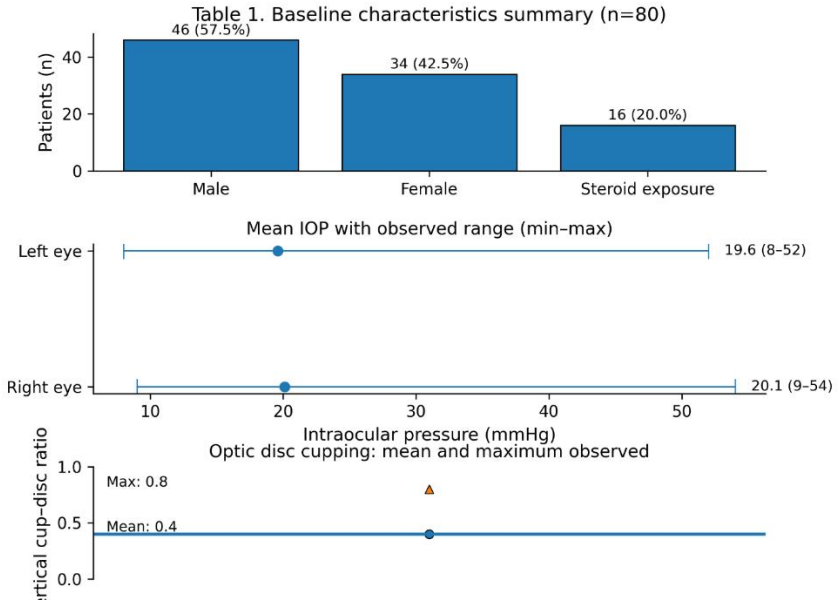

Figure 1. Participant Flow and Diagnostic Yield (Diagram Description)

Interpretation:

The glaucoma cohort was late-middle-aged (58.0±7.2 years) with modest male predominance (57.5%). Mean IOPs were near the conventional threshold (20.1 and 19.6 mmHg), yet the broad observed ranges (up to 54/52 mmHg) indicate substantial pressure heterogeneity, supporting the presence of both high-pressure and comparatively normal-pressure phenotypes. The mean vertical cup–disc ratio of 0.4 suggests many cases were detected before end-stage excavation, although the maximum of 0.8 denotes a clinically important subset with advanced structural damage. Steroid exposure in 20% highlights a preventable risk pathway.

Table 2. Age-Group Distribution among Glaucoma Cases (N=80)

Age group (years)	Number of cases	Percentage
40–50	3	3.75%
51–60	7	8.75%
61–70	17	21.25%
71–80	53	66.25%

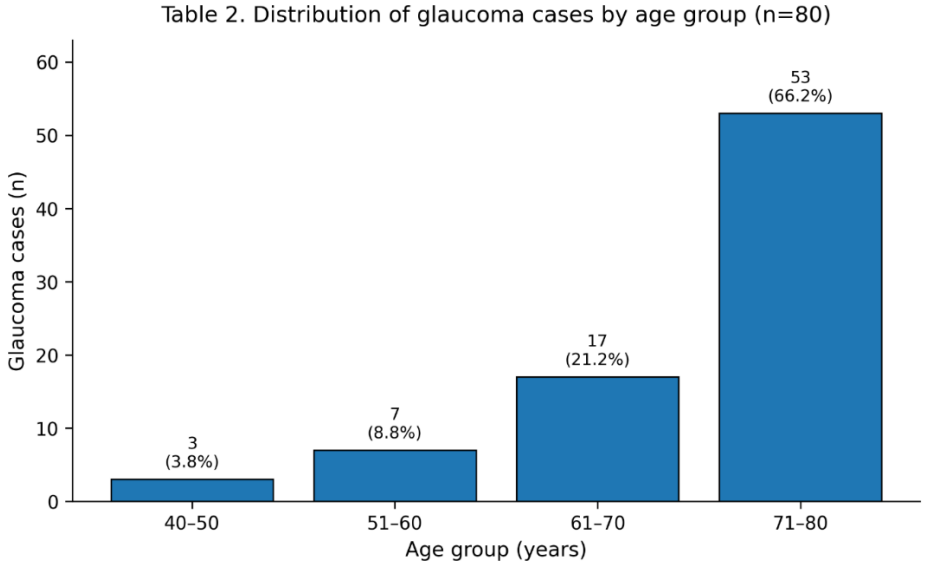

Figure 2. Distribution of Glaucoma Cases by Age Group and Subtype (Two-Panel Figure Description)

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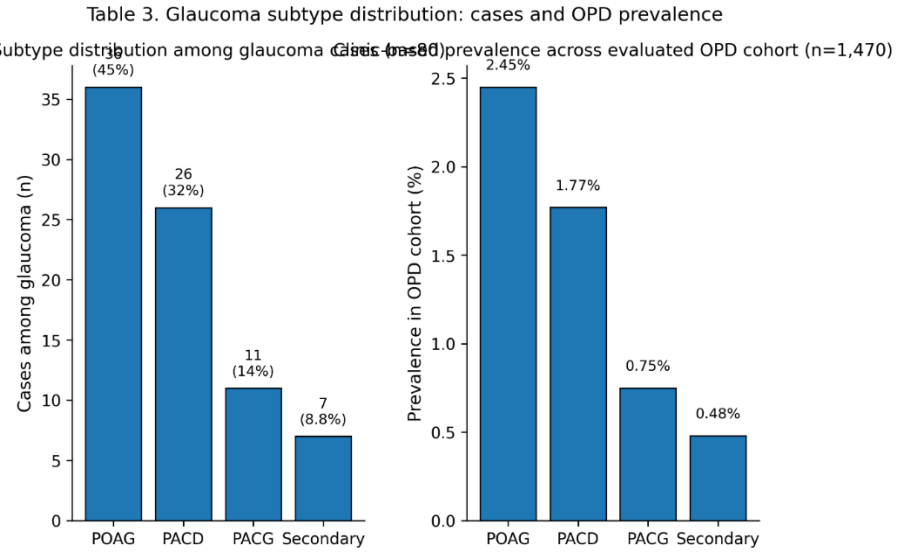
Interpretation:
Case distribution demonstrated a steep age-related rise, with 71–80 years contributing two-thirds of diagnoses (66.3%), contrasting with minimal representation below 60 years (12.5%). This pattern is consistent with cumulative optic nerve susceptibility and greater likelihood of symptomatic presentation at older ages, implying delayed detection in earlier decades. The low burden in 40–60 years may reflect under-recognition of asymptomatic or early disease rather than true absence, supporting targeted opportunistic screening and risk-based assessment in midlife to reduce late-age diagnostic clustering.

Table 3. Glaucoma Subtype Distribution among Cases and Across the Evaluated OPD Cohort (N=1,470)

Subtype	Cases (n=80)	% among glaucoma cases	Prevalence among OPD cohort (n=1,470)
POAG	36	45.0%	2.45%
PACD	26	32.5%	1.77%
PACG	11	13.75%	0.75%
Secondary glaucoma	7	8.75%	0.48%
Total glaucoma	80	100%	5.44%

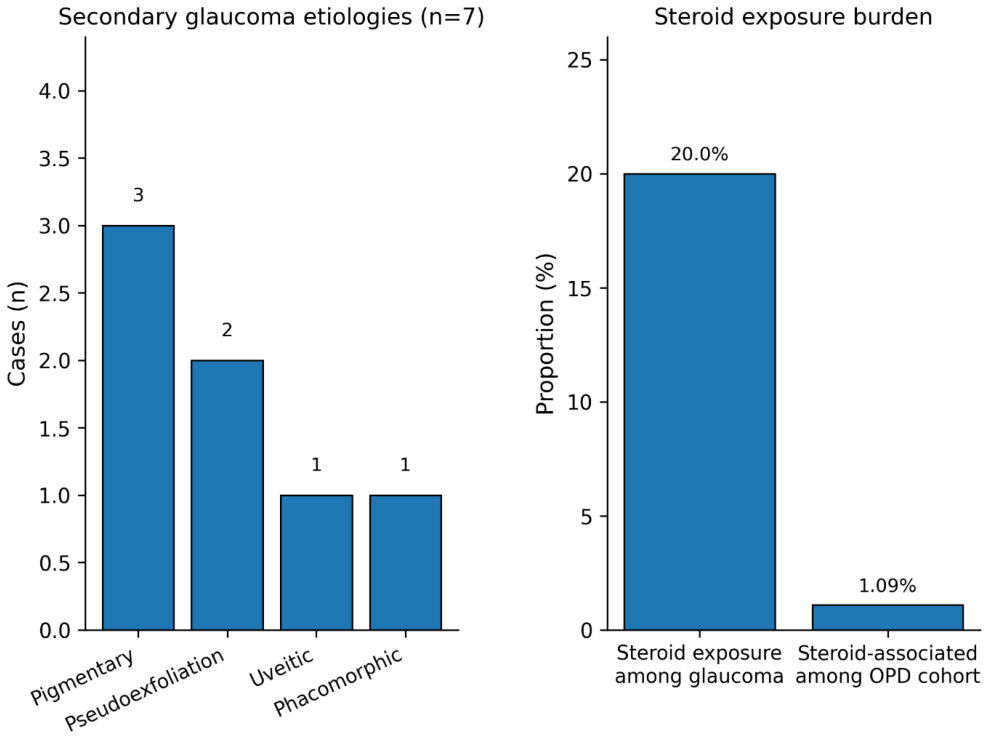


Interpretation:
POAG was the dominant subtype (45%), while angle-closure spectrum disease (PACD 32.5% plus PACG 13.75%) constituted nearly half of all cases, indicating a mixed anatomical risk profile within this symptomatic OPD cohort. The OPD-level prevalence mirrored this distribution (POAG 2.45%, PACD 1.77%, PACG 0.75%), underscoring that clinically meaningful disease arises from both open-angle and angle-closure mechanisms. The substantial PACD fraction is clinically consequential because early identification may enable prophylactic intervention before progression to PACG.

Table 4. Secondary Glaucoma Etiologies and Steroid Exposure (N=80 Glaucoma Cases)

Variable	Number	Percentage
Secondary glaucoma (total)	7	8.75%
• Pigmentary glaucoma	3	3.75%
• Pseudoexfoliation-related glaucoma	2	2.50%
• Uveitic glaucoma	1	1.25%
• Phacomorphic glaucoma	1	1.25%
Long-term steroid exposure (any glaucoma subtype)	16	20.0%
Steroid-associated glaucoma prevalence among OPD cohort (n=1,470)	16	1.09%

Table 4. Secondary glaucoma etiologies and steroid exposure



Interpretation:
Secondary glaucoma accounted for a minority of cases (8.75%) but showed etiologic diversity, with pigmentary mechanisms most frequent, followed by pseudoexfoliation, uveitic, and phacomorphic causes. This heterogeneity supports systematic slit-lamp evaluation for pigment dispersion and pseudoexfoliative material, alongside targeted inflammatory and lens-status assessment to guide mechanism-specific management. Steroid exposure was common across subtypes (20%), and its 1.09% clinic-level prevalence among OPD attendees indicates a tangible, modifiable risk burden, justifying routine documentation of steroid use and proactive IOP monitoring protocols.

Caption: Of 1,470 OPD attendees aged ≥40 years evaluated for glaucoma-suggestive symptoms during June–November 2025, 80 were diagnosed with glaucoma (clinic-based prevalence 5.44%). Diagnoses were distributed across POAG (n=36), PACD (n=26), PACG (n=11), and secondary glaucoma (n=7).

Interpretation:
The flow diagram emphasizes that, within a symptomatic OPD population, glaucoma yield was clinically meaningful—approximately 1 in 18 evaluated patients received a glaucoma diagnosis. This reinforces the value of structured glaucoma assessment pathways in tertiary-care outpatient services, particularly when patients present with non-specific symptoms such as headache or refractive changes. Subtype decomposition further demonstrates that both open-angle and angle-closure disease contributed substantially, supporting routine gonioscopy rather than relying on IOP alone.

Panel A: Bar chart of case counts by age group (40–50, 51–60, 61–70, 71–80).
Panel B: Pie chart of subtype distribution (POAG, PACD, PACG, secondary glaucoma).
Interpretation:
The age-panel visually highlights the steep rise in glaucoma diagnoses among older adults, suggesting that late presentation remains common in this care-seeking cohort. The subtype-panel shows POAG as the dominant category but with substantial representation of angle-closure spectrum disease. Together, these visuals communicate a combined clinical message: earlier case-finding in midlife could reduce the late-age diagnostic surge, and subtype diversity justifies a comprehensive examination strategy incorporating gonioscopy and optic disc assessment in routine OPD workflows.

DISCUSSION

This hospital-based cross-sectional study described glaucoma frequency and clinical spectrum among symptomatic OPD attendees aged ≥40 years at a tertiary-care center in Eastern Uttar Pradesh. The clinic-based prevalence of glaucoma (5.44%) was higher than many community prevalence estimates reported from Indian population-based surveys, which generally fall around ~2.7–4.3% [2,7,8,9,14]. This difference is expected because the present denominator comprised symptomatic care-seekers rather than a randomly sampled community cohort, enriching the population for disease probability and increasing diagnostic yield [3,5].

The observed male predominance aligns with several epidemiological cohorts reporting higher open-angle glaucoma risk or detection among men, including findings from the Hooghly River Glaucoma Study and long-running international cohorts such as the Barbados Eye Studies and Rotterdam Study [14–16]. However, sex effects in glaucoma are heterogeneous across settings and may be influenced by care-seeking behaviors, occupational exposure, and differential access to eye care, particularly in low-resource contexts [1,3]. Consequently, the male predominance in this study should be interpreted as a combined effect of underlying risk and health-system interaction rather than purely biological susceptibility [3,5].

Age demonstrated a strong gradient, with the majority of cases identified among adults aged 71–80 years. This pattern is consistent with global modeling and systematic reviews projecting increasing glaucoma burden with population ageing, especially in Asia [10,20]. Indian burden estimates similarly emphasize that glaucoma affects millions of adults ≥40 years and will increasingly strain health services without effective early detection [21]. The marked clustering of diagnoses at older ages in the current study likely reflects both biological risk accumulation and delayed detection—an interpretation supported by evidence that substantial proportions of individuals with POAG in India remain undiagnosed until late disease [2,7,8,14].

Subtype distribution showed POAG as the most frequent diagnosis, which parallels findings from multiple Indian population studies including the Andhra Pradesh Eye Disease Study and the Chennai Glaucoma Study [7,8]. The substantial proportion of PACD and PACG in this cohort is clinically relevant because angle-closure mechanisms can progress silently before acute symptomatic events, and standardized classification frameworks were developed specifically to improve epidemiologic comparability and clinical recognition [11].

A notable finding was the frequency of long-term steroid exposure among glaucoma patients and the measurable prevalence of steroid-associated glaucoma within the evaluated OPD cohort. This aligns with contemporary reviews that describe steroid-induced glaucoma as a preventable cause of glaucomatous optic neuropathy, with risk influenced by route, potency, duration, and host susceptibility [19]. In real-world settings, steroid exposure may be underreported or unmonitored; therefore, embedding steroid-use documentation and IOP surveillance into routine outpatient care represents a practical, scalable intervention [3,19]. In addition, the wide IOP range observed in this cohort reinforces that IOP alone is an incomplete screening marker, consistent with large studies demonstrating that other factors—including optic nerve structure and corneal thickness—meaningfully shape risk and detection [3,6,12].

Limitations include the hospital-based, symptom-triggered sampling strategy, which limits generalizability to community prevalence and may preferentially identify more symptomatic or advanced disease. Visual field testing was not systematically documented for all cases, so classification relied primarily on clinical examination and optic disc findings, which may introduce misclassification compared with strict epidemiologic case definitions [11]. Finally, corneal pachymetry (CCT) was not available in the dataset, limiting adjustment for IOP measurement bias and risk stratification based on known predictors [6,12]. Future work should incorporate population sampling, standardized perimetry, pachymetry, and longitudinal follow-up to estimate incidence and progression while strengthening causal inference [3,11].

CONCLUSION

In a symptomatic tertiary-care OPD cohort from Eastern Uttar Pradesh, glaucoma was detected in 5.44% of evaluated adults aged ≥40 years, with clear age-associated clustering and a modest male predominance. POAG was the leading subtype, but angle-closure spectrum disease accounted for a large proportion, underscoring the need for routine gonioscopy and comprehensive optic nerve assessment rather than IOP-only screening. Steroid exposure was common among glaucoma

patients and translated to a clinically meaningful prevalence of steroid-associated glaucoma within the evaluated cohort. These findings support targeted opportunistic screening of older adults and systematic IOP monitoring among steroid users to enable earlier diagnosis and reduce irreversible vision loss.

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