

Prevalence of Primary Open-angle Glaucoma in an Urban South Indian Population and Comparison with a Rural Population

The Chennai Glaucoma Study

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Objective: To estimate the prevalence and risk factors of primary open-angle glaucoma (POAG) in an urban population and compare the same with that of our published rural population data in southern India.

Design: Population-based cross-sectional study.

Participants: Four thousand eight hundred subjects 40 years or older were selected using a multistage random cluster sampling procedure in Chennai city.

Intervention: Three thousand eight hundred fifty (80.2%) subjects underwent a complete ophthalmic examination, including applanation tonometry, gonioscopy, pachymetry, optic disc photography, and automated perimetry.

Main Outcome Measures: Glaucoma was diagnosed using the International Society of Geographical and Epidemiological Ophthalmology Classification.

Results: The distribution of intraocular pressure (IOP) and vertical cup-to-disc ratio (VCDR) was obtained from the right eye of the 2532 subjects with normal suprathreshold visual fields. Mean IOP was 16.17 ± 3.74 mmHg (97.5th and 99.5th percentiles, 24 mmHg and 30 mmHg). The mean VCDR was 0.43 ± 0.17 (97.5th and 99.5th percentiles, 0.7 and 0.8). One hundred thirty-five (64 men, 71 women) subjects had POAG (3.51%; 95% confidence interval [CI], 3.04–4.0). Primary open-angle glaucoma subjects (58.4 ± 11.3 years) were older ($P < 0.0001$) than the study population (54.8 ± 10.6 years). One hundred twenty-seven (94%) subjects were diagnosed to have POAG for the first time. Two subjects (1.5%) were bilaterally blind, and 3 (3.3%) were unilaterally blind due to POAG. The urban population prevalence was more than that of the rural population (1.62%; 95% CI, 1.4%–1.8%; $P < 0.0001$). In both populations, increasing IOP (per millimeter of mercury) and older age were associated with the disease. There was no association with gender, myopia, systemic hypertension, diabetes, or central corneal thickness.

Conclusions: The prevalence of POAG in a ≥ 40 -year-old south Indian urban population was 3.51%, higher than that of the rural population. The prevalence increased with age, and $>90\%$ were not aware of the disease. *Ophthalmology* 2008;115:648–654 © 2008 by the American Academy of Ophthalmology.



The Chennai Glaucoma Study is a population-based cross-sectional study designed to estimate the prevalence

of glaucoma in rural and urban populations of the southern Indian state of Tamil Nadu.¹ Figure 1 (available at <http://aaojournal.org>) shows a map of the area. The prevalence of primary open-angle glaucoma (POAG) in the rural population was 1.62%.² Urban and rural India potentially differ in many factors, such as the demographic profile, disease pattern, systemic diseases, and access to ophthalmic care.^{3–5} These factors probably can affect the prevalence of a disease. The glaucoma prevalence data for urban populations from India are sparse. The Andhra Pradesh Eye Diseases Study⁶ reported the prevalence of POAG in the urban population to be 2.56% in those 40 years and older. In this article, we report the prevalence of POAG and possible associated risk factors from an urban population 40 and over. We further describe the differences between the published rural prevalence² and urban prevalence of POAG.

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Materials and Methods

Study Design and Population

The details of the study design and sampling plan were published elsewhere.¹ In brief, the Chennai Glaucoma Study was designed to estimate the prevalence of glaucoma. A sample size of 4758 was arrived at assuming an 85% response rate for an assumed 3% population prevalence of glaucoma with a relative precision of 25% and a design effect of 2. Therefore, 4800 subjects each from the rural and urban populations were enumerated. Sample selection for the urban component of the study was done using a multistage random cluster sampling procedure. The total population of Chennai was 3.8 million according to the 1991 census. Considering that 22% of the population was over 40 years old, the approximate number of persons in Chennai over 40 was 0.85 million. The city was divided into 10 corporation zones, comprising 155 divisions. One division was randomly selected from each of these 10 zones, and 5 divisions were randomly picked from these 10 divisions. A simple random sample of 960 each from the above 5 randomly selected divisions was enumerated. The total number of subjects enumerated was 4800.

Trained social workers performed the enumeration by door-to-door survey. During enumeration, demographic information was collected by household questionnaire. All the eligible subjects were allotted a unique 9-digit identification number and were invited to come to the base hospital for a detailed ophthalmic examination. The urban division of the study was done between May 2002 and May 2004. This study was approved by an institutional ethics review board and was performed in accordance with the tenets of the Declaration of Helsinki for research involving human subjects.

Clinical Examination

All subjects who responded underwent a detailed ophthalmic examination at a dedicated facility in the base hospital. The examination team consisted of 2 optometrists and 2 ophthalmologists, the same people who examined the rural population.² Written informed consent was obtained from all subjects who responded. A detailed history was elicited pertaining to medical and ophthalmic problems. The details of the examination procedure protocol were described in a previous article.² In brief, a comprehensive eye examination was done that included best-corrected visual acuity (BCVA) measurements using logarithm of the minimum angle of resolution (logMAR) 4-m charts (Light House Low Vision Products, New York, NY), central corneal thickness (CCT) measurements, applanation tonometry, gonioscopy, grading of lens opacities using the Lens Opacities Classification System II, dilated fundus examination, optic disc photography, and visual field (VF) examination. On gonioscopy, an angle was considered occludable if the pigmented trabecular meshwork was not visible in $>180^\circ$ of angle in dim illumination. Laser iridotomy was performed in subjects with occludable angles after consent was obtained, and they had the rest of the examination on some other day.

Visual Fields

Automated VFs were performed for all the subjects with BCVA of 4/16 (logMAR 0.6) or better, using frequency-doubling perimetry (Carl Zeiss Meditec, Inc., Dublin, CA). All eligible subjects underwent C-20-1 screening (if the results were unreliable or abnormal, the test was repeated) and the N-30 threshold test. The reliability criteria were no fixation or false-positive errors for the C-20-1 screening test and $<20\%$ fixation errors and $<33\%$ false-positive and false-negative errors for the threshold N-30 test.

Visual fields with no depressed points to any level of sensitivity were considered to be normal.

A provisional diagnosis of suspected glaucoma was made when the subject had one or more of the following conditions: intraocular pressure (IOP) ≥ 21 mmHg in either eye; vertical cup-to-disc ratio (VCDR) ≥ 0.7 in either eye or CDR asymmetry ≥ 0.2 ; and focal thinning, notching, or a splinter hemorrhage. All these subjects were asked to perform a threshold VF test using the Swedish interactive threshold algorithm Standard 30-2 program (model 750, Carl Zeiss Meditec). A glaucomatous field defect was diagnosed using a single reliable threshold VF examination of the central 30° (Swedish interactive threshold algorithm Standard 30-2). The field was considered to be abnormal if the glaucoma hemifield test results were outside normal limits and ≥ 3 abnormal contiguous non-edge points (except the nasal horizontal meridian) were depressed to $P < 5\%$.⁷ Reliability criteria were as recommended by the instrument's algorithm (fixation losses $< 20\%$; false-positive and false-negative $< 33\%$).

Diagnostic Definitions

The distribution of VCDR and IOP was obtained from those subjects with reliable and normal supratherreshold VF testing using frequency-doubling perimetry. Cases of glaucoma were defined using the International Society of Geographical and Epidemiologic Ophthalmology classification.⁸ Glaucoma was classified according to 3 levels of evidence. In category 1, diagnosis was based on structural and functional evidence. It required CDR or CDR asymmetry ≥ 97.5 th percentile for the normal population or a neuroretinal rim width reduced to ≤ 0.1 CDR (between 11- and 1-o'clock or 5- and 7-o'clock) with a definite VF defect consistent with glaucoma using the Swedish interactive threshold algorithm 30-2.

Category 2 was based on advanced structural damage with unproved field loss. This included those subjects in whom VFs could not be determined or were unreliable, with CDR or CDR asymmetry ≥ 99.5 th percentile for the normal population. Lastly, category 3 consisted of persons with an IOP ≥ 99.5 th percentile for the normal population, whose optic discs could not be examined because of media opacities.

Blindness was defined as a best-corrected logMAR visual acuity of $<2/40$ (log MAR 1.3) and/or constriction of the VF to $<10^\circ$ from fixation in the better eye.⁹ Hyperopia was defined as spherical equivalent > 0.50 diopter (D) in a phakic eye.¹⁰ Diabetes mellitus was detected based on current use of antidiabetic medication and/or random blood sugar level > 200 mg/dl.¹¹ We defined systemic hypertension as current use of systemic antihypertensive medications or a measured systolic blood pressure (BP) ≥ 140 mmHg and/or diastolic BP ≥ 90 mmHg.

Significance was assessed at the $P < 0.05$ level for all parameters, and odds for POAG are presented with 95% confidence intervals (CIs). Confidence intervals for the prevalence estimates were corrected for the sampling design.¹² Categorical variables between groups were compared using the chi-square test, the *t* test was used for continuous variables, and continuous variables for multiple groups were compared using analysis of variance (ANOVA). Multivariate analysis was performed after adjusting for age (the 40- to 49-year age group was used as the reference age group) and gender. Statistical analysis was carried out using SPSS for Windows (SPSS Inc., Chicago, IL).

Results

A total of 3850 subjects of the enumerated 4800 participated in the study (response rate, 80.2%). One thousand seven hundred ten (44.4%) were male, and 2140 (55.6%) were female. The mean age

Table 1. Prevalence of Primary Open-angle Glaucoma (POAG) by Age and Gender

Age (yrs)	Males			Females			Overall		
	Subjects	POAG*	Prevalence (95% CI)	Subjects	POAG*	Prevalence (95% CI)	Subjects	POAG*	Prevalence (95% CI)
40-49	524	11 (1, 10)	2.1 (0.87-3.3)	895	21 (2, 19)	2.3 (1.4-3.3)	1419	32 (3, 29)	2.25 (1.5-3)
50-59	486	19 (5, 14)	3.9 (2.2-5.6)	634	21 (7, 14)	3.3 (1.9-4.7)	1120	40 (12, 28)	3.57 (2.5-4.7)
60-69	468	16 (2, 14)	3.4 (1.8-5.1)	438	21 (6, 15)	4.8 (2.8-6.8)	906	37 (8, 29)	4.08 (2.8-5.4)
70-79	205	15 (5, 10)	7.3 (3.8-10.9)	151	6 (1, 5)	4.0 (0.9-7.1)	356	21 (6, 15)	5.89 (3.5-8.3)
≥80	27	3 (1, 2)	11.1 (0-23)	22	2 (0, 2)	9.1 (0-21.1)	49	5 (1, 4)	10.2 (1.7-18.7)
Total	1710	64 (14, 50)	3.74 (2.8-4.6)	2140	71 (16, 55)	3.32 (2.6-4.1)	3850	135 (30, 135)	3.51 (3.04-3.98)

CI = confidence interval.

*(Category 1, category 2).

of the study population was 54.8 ± 10.6 years (range, 40-103). Of 950 nonparticipants (19.8%), 577 were male (60.7%) and 373 (39.3%) were female. There were 2532 subjects with normal and reliable suprathreshold VF testing using frequency-doubling perimetry in both eyes. Using the right eye of these subjects, the distribution of VCDR, IOP, and CCT was derived for the population. The mean VCDR was 0.43 ± 0.17 (median, 0.4), with 97.5th and 99.5th percentiles being 0.7 and 0.8, respectively. The 99.5th percentile for the CDR asymmetry was 0.2. Mean IOP was 16.17 ± 3.74 mmHg (median, 16), with the 97.5th and 99.5th percentiles being 24 and 30 mmHg, respectively. Mean CCT was 520.7 ± 33.4 μ m.

Primary Open-angle Glaucoma

One hundred thirty-five subjects (64 men, 71 women) were diagnosed as having POAG. The prevalence of POAG was 3.51% (95% CI, 2.9%-4.1%). There was no gender difference. However, the mean age of POAG subjects (58.4 ± 11.3 years) was significantly ($P < 0.0001$) higher than that of the study population (54.8 ± 10.6). There was increase in the prevalence with age. Prevalences were 2.25% (95% CI, 1.5%-3.0%) in the 40- to 49-year age group and 10.2% (95% CI, 1.7%-18.7%) in the ≥ 80 -year age group (Table 1). Diagnosis of POAG was based on category 1 in 30 subjects (22.2%) and category 2 in 105 subjects

(77.8%). Between category 1 and category 2, there was no significant difference in age (60.3 ± 10.0 and 57.9 ± 11.6 years; $P = 0.29$), IOP (19.2 ± 5.0 and 17.7 ± 4.6 mmHg; $P = 0.12$), and male:female distribution (14:16 and 50:55; $P = 0.64$). Twenty-four subjects (17.8%) had IOP ≥ 24 mmHg (97.5th percentile), and the rest (111 subjects [82.2%]) had IOP < 24 mmHg. Mean CCT in POAG subjects (522 ± 31.5 μ m) did not differ from that in the normal study population (520.7 ± 33.4 μ m). Primary open-angle glaucoma subjects with an IOP ≥ 24 mmHg had slightly greater CCT (529.8 ± 31.4 μ m) in comparison to POAG subjects with IOP < 24 mmHg (529.3 ± 31.3 μ m). This difference, however, was not statistically significant ($P = 0.30$).

Two subjects (1.5%) were blind in both eyes, and 3 subjects (2.2%) had unilateral blindness due to POAG. Eight subjects (5.9%) were previously known cases of POAG; of them, 1 had glaucoma surgery and 7 were on medical therapy. The remaining (127 subjects [94.1%]) were diagnosed in the study. Humphrey VFs were advised in 405 subjects based upon criteria listed in the methods. Of them, 308 (76%) underwent the test, and in 248 (80.5%) the test was reliable.

The age- and gender-adjusted (based on provisional population totals, 2001 census of India¹³) prevalence of POAG among subjects 40 or older in the urban Tamil Nadu population was 3.47% (95% CI, 2.9%-4.1%). The association of age, gender, myopia,

Table 2. Multiple Logistic Regressions for Risk Factors for Primary Open-angle Glaucoma (POAG) in Rural and Urban Populations

	No. of Subjects		Odds Ratio for POAG, Rural (95% CI)	Odds Ratio for POAG, Urban (95% CI)
	Rural	Urban		
Age (yrs)				
40-49	1585	1419	1	
50-59	985	1120	2.6 (1.2-5.7)	1.6 (1.0-2.6)
60-69	892	906	4.2 (2.0-8.8)	1.8 (1.1-3.0)
≥70	462	405	5.3 (2.3-11.8)	3.0 (1.7-5.0)
Male	1761	1710	1	
Female	2163	2140	0.98 (0.58-1.6)	0.97 (0.7-1.4)
IOP (mmHg)	3864	3841	1.1 (1.1-1.2)	1.0 (1.0-1.1)
CCT (μ m)	3851	3820	1.0 (0.99-1.0)	1.0 (0.99-1.0)
Myopia				
Absent	2214	2953	1	
Present	1710	897	0.7 (0.4-1.2)	1.4 (0.97-2.1)
Hypertension				
Absent	2651	2426	1	
Present	1273	1403	1.0 (0.6-1.7)	1.1 (0.7-1.6)

CCT = central corneal thickness; CI = confidence interval; IOP = intraocular pressure.

Table 3. Comparison of Rural and Urban Study Populations

Parameter	Rural	Urban	P Value
Participants (%)	3924 (81.95)	3850 (80.21)	
Participant mean age (yrs)	53.8±10.6	54.8±10.6	<0.0001*
Nonparticipant mean age (yrs)	52.5±10.5	53.8±10.9	<0.008*
Male:female	1760:2174	1710:2140	
IOP (mmHg) [†]			<0.0001*
Mean	14.29±3.32	16.17±3.74	
97.5th percentile	21	24	
99.5th percentile	25	30	
Mean CCT (μm) [‡]	505.9±31.1	520.7±33.4	<0.0001*
VCDR [‡]	0.39±0.17	0.43±0.17	
97.5th percentile	0.7	0.7	<0.0001*
99.5th percentile	0.8	0.8	
CDR asymmetry 99.5th percentile	0.2	0.2	
Hypertension	1273	1403	0.0001 [§]
Diabetes	291	795	<0.0001 [§]
POAG prevalence (%) [§]	64 (1.62) (33, 30, 1)	135 (3.51) (30, 105, 0)	<0.0001 [§]
Diagnosed in the study (%)	63 (98.5)	127 (94.1)	NS
Bilateral blindness (%)	2 (3.1)	2 (1.5)	NS

CCT = central corneal thickness; CDR = cup-to-disc ratio; IOP = intraocular pressure; NS = not significant; POAG = primary open-angle glaucoma; VCDR = vertical CDR.
 *t test.
[†]For the normal study population.
[‡]Chi-square test.
[§](Category 1, category 2, category 3).

IOP, CCT, and systemic hypertension with POAG is shown in Table 2. After adjusting for gender, POAG was found to be significantly associated with increasing age. Using the 40- to 49-year age group as a reference population, the odds ratio (OR) increased from 1.60 (95% CI, 1.0–2.6) for the 50- to 59-year age group to 3.0 (95% CI, 1.7–5.0) for ≥70-year-old subjects. Intraocular pressure was positively associated with the diagnosis of POAG (OR, 1.0; 95% CI, 1.0–2.6). We found no association of POAG with CCT, gender, myopia, or systemic hypertension (Table 2). Diabetes mellitus was not associated with POAG (OR, 1.1; 95% CI, 0.8–1.3).

Urban versus Rural

Table 3 provides the comparative data of the rural and urban populations. There was no difference between the groups in the participation and nonparticipation rates. However, the mean age of

the urban population was significantly greater than that of the rural population in both participants (54.8±10.6 vs. 53.8±10.6; $P<0.0001$) and nonparticipants (53.8±10.9 vs. 52.5±10.5; $P<0.008$). Gender distributions were similar in both populations. Mean IOP, CCT, and VCDR significantly differed for both populations. There were more diabetics and hypertensives in the urban population than in the rural population. The prevalence of POAG in the urban population (3.51%) was significantly greater ($P = 0.0001$) than that in the rural population (1.62%). In both populations, POAG was associated with increasing age and higher IOP (Table 2). The decade-wise distribution of mean IOP across different age groups in the normal study population and those with POAG is shown in Table 4 for both populations. Intraocular pressure significantly differed in different age groups (1-way ANOVA, $P = 0.001$). Mean IOP was significantly higher ($P = 0.001$) in subjects with POAG than in the normal subjects. Figure 2 shows the relation between IOP and POAG—82.2% of

Table 4. Distribution of IOP across Age Groups for Persons with Normal Suprathreshold Visual Field Results and Primary Open-angle Glaucoma (POAG) Patients in Rural and Urban Populations

Age (yrs)	IOP (mmHg) (SD)			
	Rural		Urban	
	Normals* (n = 1810)	POAG (n = 64)	Normals* (n = 2532)	POAG (n = 135)
40–49	14.2 (3.2)	18.8 (4.3)	15.8 (3.4)	16.8 (3.2)
50–59	14.7 (3.6)	20.1 (7.3)	16.4 (3.9)	18.0 (4.8)
60–69	14.1 (3.4)	16.9 (5.6)	16.6 (4.1)	18.1 (4.9)
70–79	13.3 (3.2)	17.6 (4.0)	16.6 (3.7)	19.5 (5.9)
≥80	11.7 (4.7)	13.5 (2.1)	15.3 (3.3)	19.6 (6.2)

IOP = intraocular pressure; POAG = primary open-angle glaucoma; SD = standard deviation.
 *Subjects with reliable normal frequency-doubling perimetry screening test results. Significantly different for different age groups (1-way analysis of variance, $P = 0.001$). Linear regression for IOP vs. age, $r = -0.08$ ($P = 0.001$).

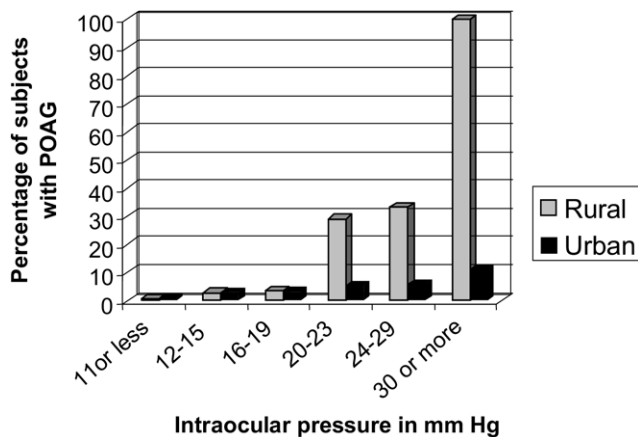


Figure 2. Prevalence of primary open-angle glaucoma (POAG) at each intraocular pressure (IOP) level (the higher IOP of the two eyes was used for analysis).

the urban population with POAG and 67.2% of the rural population with POAG had an IOP \geq 97.5th percentile (i.e., 24 mmHg for the urban population and 21 mmHg for the rural population). However, an increased prevalence of POAG was noted among persons with IOP $>$ the 97.5th percentile for the population. The number of people diagnosed to have POAG for the first time and blindness due to POAG were similar in both populations.

Discussion

The main purpose of the Chennai Glaucoma Study was to estimate the prevalence of glaucoma in rural and urban populations in southern India. Interesting findings in the present study are a higher prevalence of POAG in the urban population and differences between the rural and urban populations in various parameters. The age- and gender-adjusted prevalence of POAG in the urban population was 3.47% (95% CI, 2.9%–4.1%). There was a significant increase in prevalence of POAG with age, and there was no gender difference. Of the subjects, 94.1% had undiagnosed disease. This prevalence is higher than those in the other reports from the Indian subcontinent^{2,6,14,15} and east Asia^{16–18} but similar to that of the urban Japanese population.¹⁹

The diagnosis criteria were not always the same among the epidemiological studies of glaucoma. In view of this, direct comparison between the studies becomes difficult. The Andhra Pradesh Eye Disease Study⁶ reported the age- and gender-adjusted prevalence of POAG to be 2.56% (95% CI, 2.2%–3.91%) in a \geq 40-year-old urban population in southern India. This prevalence is lower than that of the present study. However, there was an overlap of the CIs. One possible reason for this disparity could be the diagnostic definitions used (Table 5). In the Andhra Pradesh Eye Disease Study, the definition of POAG was the presence of glaucomatous optic disc damage along with VF loss, consistent with the disc findings in the presence of an open angle. In our study, the International Society of Geographical and Epidemiologic Ophthalmology classification was

used and diagnosis was based on category 2 in 77.8%. In the absence of reliable VFs, glaucoma would have been overdiagnosed in category 2. However, of the subjects who were advised Humphrey VFs, 24% (97 subjects) did not undergo the test, and of the subjects who had the test, 20% had unreliable fields. This would have caused exclusion of some subjects with VCDRs between the 97.5th and 99.5th percentiles, leading to an underdiagnosis of glaucoma in category 1. Conversely, the category 2 diagnosis could result in an overestimate of the diagnosis of glaucoma, as some of those with a VCDR 0.8 or greater could be normal. This is a limitation of the International Society of Geographical and Epidemiologic Ophthalmology classification system. However, poor performance on VFs is a possible confounding factor in assessing disease prevalence.

The prevalence of POAG increase with age has been reported.^{2,6,15,19–23} A similar trend was seen in the present study. Subjects 70 years or older were 3 times more likely to have POAG than those younger than 50. After adjusting for age, we found no gender difference in the prevalence. We observed an increased prevalence of POAG among subjects with IOP $>$ 97.5th percentile for the normal population. However, only 17.8% of subjects with POAG had an IOP of $>$ 24 mmHg (97.5th percentile) in our study. We do admit the limitation of using single presenting IOP measurements for the analysis in such derivations. However, our results reemphasize the observation of previous studies that higher IOP is an important risk factor for POAG.^{2,6,14,15,19–23}

According to the estimates made by Quigley and Brnman, the previous diagnosis rate for POAG in developed countries was 34%, whereas in developing countries it was 8%.²⁴ In our urban population, 8 subjects (5.9%) had been previously diagnosed with POAG. This is similar to the previous studies from rural and urban India.^{2,6,15} The reported undiagnosed rates for POAG were $>$ 90%.² The number of practicing ophthalmologists in urban India is

Table 5. Comparison of Age-Specific POAG Prevalence Rates in an Urban Population in India

	APEDS	CGS (Current Study)
Diagnostic criteria	Disc changes with field changes on automated perimetry	ISGEO recommendations
Age	Above 40 yrs	Above 40 yrs
Total subjects (response rate)	934 (85.4%)*	3850 (80.2%)
Age groups (yrs)	n/n ¹ (p)	n/n ¹ (p)
40–49	5/395 (1.26%)	32/1419 (2.25%)
50–59	6/260 (2.31%)	40/1120 (3.57%)
60–69	9/184 (4.89%)	37/906 (4.08%)
\geq 70	6/95 (6.32%)	26/405 (9.14%)
Total	26/934 (2.78%)	135/3850 (3.51%)

APEDS = Andhra Pradesh Eye Disease Study; CGS = Chennai Glaucoma Study; ISGEO = International Society of Geographical and Epidemiological Ophthalmology; n = no. of subjects with POAG; n¹ = no. of subjects examined; p = prevalence; POAG = primary open-angle glaucoma. *Response rate for the entire study population of 2522.

greater than that in rural India,⁵ but the rates seem to be similar for both populations. This is possibly due to the lack of comprehensive eye examination for all people seeking eye care services and also to the health-seeking behavior of the average Indian. People tend to seek health services only in time of need. In such a situation, a silent disease like glaucoma can go unnoticed. Unless people go for periodic eye checkups that advocate a comprehensive eye examination at each visit, the rate of undiagnosed POAG in India will remain high.

Rural versus Urban

Participant and nonparticipant rates were similar in both groups. Mean IOP and mean CCT were significantly greater in the urban group. The mean difference in CCT was 15 μm , and the mean IOP difference was 2 mmHg. The observed difference in CCT may partially explain the difference in IOP. However, different CCTs for different populations are well known, and the reasons are multifactorial, such as ethnic, genetic, environmental, and climatic factors.²⁵ Socioeconomic status was never considered to be a factor for the lesser CCT. But a close look at the published data suggests that the various populations that had lesser CCT—African-derived populations,²⁶ Hispanics,²⁷ and Mongols²⁸—probably belong to lower socioeconomic groups. We assumed that possible reasons for the difference in CCT between the populations in our study were environmental or socioeconomic status. The mean VCDR significantly differed between the populations, but percentiles were the same. The 97.5th and 99.5th percentiles were 0.7 and 0.8, respectively. The CDR asymmetry of the 99.5th percentile was 0.2. Most studies have reported that the 97.5th percentile for VCDR in the population was 0.7.^{2,8,17,18} Probably VCDR > 0.7 should be viewed with suspicion of glaucoma, and further perimetric evaluation needs to be done.

The prevalence of POAG in our urban population was more than double that in the rural population. One possible reason for this could be inherent socioeconomic and lifestyle differences between the 2 populations. In both, the undiagnosed POAG rates and blindness due to POAG were similar. As in other population-based studies, both groups showed association of POAG with increasing age and higher IOP.^{2,6,15,19–23} Systemic diseases such as diabetes³ and coronary heart diseases⁴ are more prevalent in urban India than in rural India. Similarly, we observed more diabetics and hypertensives in our urban population. However, we noted no statistically significant association between the above conditions and prevalence of POAG.

In summary, the overall prevalence of POAG was 3.52% in this population of urban southern India. This prevalence rate is much higher than our reported prevalence rate of 1.62% for the rural population.² The increase in prevalence with age is a cause of concern, as India's adult population is expected to increase dramatically over the next few decades. According to a recent publication, the number of people older than 40 years with open-angle glaucoma (OAG) in India would account for 18.6% of the world's OAG patients.²⁴ This was derived from the assumed prevalence of 1.75%. These figures are likely to

be higher if present study results are also used in the projections. Very low case detection rates in our population are a major health concern. Unless we improve the detection rates significantly, the associated morbidity and blindness due to POAG cannot be curtailed.

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