Prevalence and distribution of glaucoma in central India (Glaucoma Survey - 2001)

Anand Palimkar, MS; Rajiv Khandekar, MS; V Venkataraman, MS, DCEH

Purpose: A community-based survey was conducted in Rajnandangaon district of Chhattisgarh state of central India in 2001 to assess the prevalence of glaucoma in the age group of ≥35 years.

Design: Community-based cross-sectional survey

Materials and Methods: Ophthalmologists measured ocular pressure using Perkins applanation tonometer. Best corrected visual acuity was checked by ETDRS chart. After dilating the pupil the fundus was examined. A sketch diagram was drawn to note glaucomatous changes in optic disc and the surrounding retina. The field of vision was tested on Bjerrum screen. Gonioscopy was performed to determine type of glaucoma. Persons and their relatives were interviewed to find out risk factors and glaucoma treatment in the past.

Results: Seven thousand four hundred and thirty-eight (87.3%) persons were examined. The age-sex standardized prevalence of glaucoma was 3.68% (95% CI 3.27 to 4.07). Gender variation of glaucoma was not significant. [OR = 1.13 (CI 95% 0.88 to 1.44)] Glaucoma varied significantly by age groups. ($\chi^2 = 48.2$, degree of freedom = 3 $P < 0.001$) Among those patients diagnosed to suffer from glaucoma, the proportion of open angle, closed angle, secondary glaucoma, ocular hypertension and glaucoma suspects was 13.1%, 21.2%, 21.2%, 14.5% and 30% respectively. Different types of visual disabilities were associated with glaucoma. However, unilateral blindness in glaucoma was unusual. Twenty-five per cent of the glaucoma cases were detected for the first time during the survey.

Conclusions: The prevalence of glaucoma was high and the angle closure type was more compared to the open angle glaucoma.

Key words: Blindness, glaucoma, India, low vision, prevalence study

Indian J Ophthalmol 2008;56:57-62

Glaucoma is a major public health problem, causing visual impairment which hampers day to day work.[1] Glaucoma is the largest cause of bilateral blindness, second only to the cataract, however, the disability caused by glaucoma is irreversible. It is a 'silent killer' as most of the time, it is asymptomatic up to the very advanced stage and at the time of presentation to the ophthalmologist, the visual loss is often irrecoverable.[2] The World Health Organization recommended to its member countries to combat this public health problem through a program approach.[3] To plan the strategies, it is of utmost importance that the prevalence, distribution and risk factors of glaucoma are identified. Such a study has been a challenge due to variation in the definitions and diagnostic criteria for glaucoma.[3] There are a few population-based studies on glaucoma in India.[4-7] But none of them were conducted in central India.

Rajnandangaon district is situated in the recently formed state of Chhattisgarh in central India. According to the census estimates in 2001, its population was 1,283,225.[8] Around 40% of the population was more than 35 years of age. There were five health facilities in the district with a maximum of 25 km distance from any of the 52 villages/towns. Sixty-two per cent of the population could be considered as economically poor as they were classified below the poverty line. Among the adult population, 42% were farmers, 13% were farm laborers and 16% were homemakers.

A prevalence study of blindness, low vision and glaucoma was conducted in 2001 in this district by the researchers of Wardha University. The authors present a part of this project covering the prevalence, distribution and determinants of glaucoma in the ≥35-year-old population of the Rajnandangaon district of central India.

Materials and Methods

The state government and research committee of the Mahatma Gandhi Institute of Medical Sciences, Sevagram, Wardha approved this study. Health and local administrators gave written consent for conducting the study. In view of the high illiteracy rate and logistic problem in taking thumb impressions of participants, the field investigators received verbal consent of the participants. It was a community-based cross-sectional prevalence study.

H V Desai Eye Hospital, Pune, India (AP); Eye and Ear Health Care, NCD, DGHA, Ministry of Health, Oman (RK); Mahatma Gandhi Institute of Medical Sciences, Sevagram, Wardha, Maharashatra, India (VV).

Correspondence to Dr. Rajiv Khandekar, Eye and Ear Health Care, NCD, DGHA, MOH (HQ), POB: 393, Pin: 113, Muscat, Oman. E-mail: rajshpp@omantel.net.om

Manuscript received: 17.03.06; Revision accepted: 27.02.07

The estimates aimed to determine the prevalence of glaucoma in the target population at district level. We assumed that glaucoma in the ≥35-year-old population would be around 3%. To achieve 95% confidence interval with an acceptable error of margin of 15%, the required sample for our study was 5,748. To compensate dropouts, we increased the sample by 20%. Thus the final minimum sample planned was 6,898.

The demographic data of the 1991 census was used for the sampling frame.[9] The names of villages and their populations were listed. Each cluster comprised population between 850 and 1,700. Villages having < 750 people were grouped together. For towns with a population of more than 1,700 we subdivided the area of the town into more clusters. The geographic boundaries of these clusters based on the local layout were defined. Twenty-five clusters were selected from the list by using simple random table. Each house in the cluster was given a unique number. All residents ≥35 years of age and staying in these houses for more than six months were enrolled in the survey.

We excluded the residents if they did not agree to participate or were mentally challenged or did not report to the examination center in the village even after requesting thrice.

A team of enumerators visited each house. Two ophthalmologists (one third-year postgraduate ophthalmic resident and one ophthalmologist with diploma in ophthalmology) with two years of experience in diagnostic and eye care procedures at the ophthalmology department were included as our field staff for ophthalmic evaluation. Personal interview was conducted to determine profile, exposure to the risk factors of glaucoma like family history of glaucoma, ocular trauma, past eye surgery, treatment for glaucoma. History was taken and general checkup was done to rule out diabetes, anemia and hypertension.

The visual acuity of each eye; both with and without corrections was noted using ETDRS chart. Dynamic refraction was carried out manually using direct retinoscope followed by subjective corrections. Anterior segment was examined both by torch light and slit-lamp (M/S Appasamy) to note status of cornea, anterior chamber, lens and pupillary reaction. Ocular pressure was measured with the help of Perkins applanation tonometer. Tonometry was repeated if pressure was noted to be < 10 mm Hg or > 25 mm Hg. Pupil was dilated and direct ophthalmoscopy (Keelers) was carried out to evaluate the posterior segment of eye. Based on the predefined criteria like ocular pressure more than 22 mm Hg, cup: disc ratio more than 0.6, presence of hemorrhage on or near disc, nerve fiber defect, nicking of vessels at the rim of the optic cup and presence of overpass phenomenon, persons were suspected to suffer from glaucoma in either eye [Table 1]. Two hundred and eighty-two such patients were reexamined in detail to elicit risk factors and symptoms related to glaucoma. We used four mirror (Zies) gonio-lens and slit-lamp to perform gonioscopy. We assessed the depth of the anterior chamber by van Herick method. If any of the assessment could not be carried out, its reason was noted. The pupils were dilated subsequently and the disc and surrounding retina were evaluated by fundus contact lens and slit-lamp so that stereoscopic view could be obtained. For dilating the pupil, we instilled one drop of 10% phenylephrine in each eye and repeated this procedure after 15 min if pupils were not dilated adequately. For persons with defective vision, we also evaluated refractive status and for cycloplagia, we instilled an additional drop of 0.5% hom-atropine. The disc and surrounding retina's sketch was drawn on a paper with grid of 0.1 mm vertical and horizontal dotted lines. A drawing of optic disc was also made with 0.5 mm diameter of the optic cup. We assessed nerve fiber layer defect with the help of direct ophthalmoscopy and red-free filter.

Four hundred and forty-two eyes of 246 persons had disc changes suggestive of glaucoma, ocular pressure of more than 22 mm Hg, pressure difference of more than 6 mm Hg in both eyes or presence of risk factor suggestive of glaucoma. They were tested for their field of vision. Central field was assessed on the Bjerrum's screen using 1 mm white target. Peripheral field was tested by Lister's semi-automated arc perimeter. Temporal island of 10 and 20 degrees around fixation point, central and

Table 1: Parameters used in the survey (Glaucoma survey -2001) for suspecting glaucoma

During house to house survey		
1	Disc changes	Vertical cup disc ratio of > 0.6 in either eye.
		Asymmetry of cup disc ratio of more than 0.2
		Other disc changes like polar notch, hemorrhage on or near disc, bean pot cupping, nerve fiber layer defect.
2	Intraocular pressure	Pressure of ≥ 22 mm of Hg in either eye
		Difference of more than 6 mm of Hg pressure in both eyes
3	History	Present and Past treatment of glaucoma
		Eye doctor diagnosed glaucoma in either eye in the past
Only for those subjects suspected to have glaucoma and referred to the eye department for further investigations		
4	Field changes in either eye	Central//paracentral scotomas
		Bjerrum scotoma
		Arcuate scotoma
		Ring scotoma
		Ronne's nasal step
		<20 degree field
		peripheral field constriction

paracentral scotoma, arcuate scotoma, Ronne's nasal step type of field defects and constriction of peripheral field were considered as glaucomatous field changes.

A person having glaucomatous field defect, glaucomatous disc changes or ocular pressure of ≥ 22 mm Hg in the presence of an open angle in either eye, was defined to suffer from Primary Open Angle Glaucoma (PAOG). A person having glaucomatous field defects with glaucomatous disc changes or ocular pressure of ≥ 22 mm Hg, in the presence of occludable angle in either eye was considered as a case of Primary Angle Closure Glaucoma (PACG). If the field assessment was not possible, symptoms suggestive of glaucoma (pain, redness, inability to see car while driving, past attack of severe eye pain with nausea and vomiting) along with ocular pressure and angle closure found by gonioscopy were the criteria to define PACG. Persons with optic disc changes suggestive of glaucoma but without field defects were labeled as glaucoma suspects. If ocular pressure was ≥ 22 mm Hg and angle was open but no field changes or disc changes were suggestive of glaucoma, the person was considered to have ocular hypertension. If a person was having increased intraocular pressure, retinal/disc changes of glaucoma as mentioned in Table 1 and evident ocular co-morbidity like hyper-mature cataract, chronic iridocyclitis, intraocular tumor or hemorrhage in vitreous, he/she was considered to suffer from secondary glaucoma.

To ensure high quality of the survey, we conducted a pilot study in a village of Wardha district that was not included in the survey. Ocular pressure measurement and sketches of optic cup and disc were used to test inter-observer variation. The field staff's observations were compared to the findings of a senior ophthalmologist who was an expert in glaucoma care. Two hundred eyes of 103 persons were tested. The agreement rate for ocular pressure measurement was found in 96% while cup disc ratio and presence of other evidence of glaucoma in fundus matched in 90% of eyes examined. A standardization workshop was also carried out prior to the field part of the survey.

The participants with eye problems were given medications and medical advice free of cost. The identity of the participant was de-linked from other information to maintain confidentiality. The outcome of the survey and recommendations to improve the glaucoma care were discussed with the district and state health authorities.

Pre-tested data collection forms were used in the field and after auditing them, the forms were computed using EPI6 software. We used Statistical Package for Social studies (SPSS-9) software for analysis. The outcome variable was glaucoma per person. (Glaucoma could be in both the eyes of a person but only one person was considered to be suffering from glaucoma.) The dependent variables were gender, age group and type of glaucoma. Since the distribution of our large sample was uniform, we carried out parametric type of univariate analysis and calculated frequencies, percentage proportions, 95% confidence intervals and Odd's ratios.

Results

Of the 8,397 enumerated persons, 7,438 (87.3%) were examined, 7,231 of them were examined at the examination center while 207 were examined at home. Of the 'not examined' persons, 981 (87.8%) persons were absent, 70 (6.1%) refused and 68 (6.0%) could not participate due to physical/mental incapability.

The age group, gender, literacy status, area of residence and blindness status of our study sample is given in Table 2. Profile suggests that our examined sample resembled the population of a developing country. The mean age of examined sample was 51.44 years. (Minimum age was 35 years and maximum age was 84 years.)

The examined persons, frequencies, prevalence, 95% confidence intervals and estimated glaucoma sufferers in the district are given in Table 3. The age-sex standardized prevalence of glaucoma was 3.67% (95% CI 3.27 to 4.07) in the ≥ 35 years old population of Rajnandangaon district of Chhattisgarh state of India. Gender variation of glaucoma was not significant [OR = 1.13 (CI 95% 0.88 to 1.44)]. Glaucoma varied significantly by age groups. ($\chi^2 = 48.2$, degree of freedom = 3 p <0.001) The prevalence of glaucoma of our study is compared to that of other studies in Table 4.

Of the 283 persons with glaucoma, 37 (13.1%) had POAG, 60 (21.2%) had PACG, secondary glaucoma and ocular hypertension were found in 60 (21.2%) and 41 (14.5%) persons respectively. As many as 85 (30%) of the examined persons were 'glaucoma suspects.'

The best corrected visual status in the better eye was used to categorize the persons into different visual disabilities which were grouped as absolute blind (no perception of light), blindness (Vision <10/200), legal Blind (Vision<20/200) and Low

Table 2: Characteristics of the examined persons (Glaucoma survey - 2001)

Variants	Number	%
Gender		
Male	4,316	51.4
Female	4,238	48.6
Age group		
35 to 49 years	3,625	48.7
50 to 64 years	2,811	37.8
65 and more	1,002	13.4
Area of residence		
Urban	1,488	20
Rural	5,950	80
Literacy		
Illiterate	4,620	62.1
Primary schooling	1,960	26.4
Higher schooling	700	9.4
college education	158	2.1
Occupation		
Agriculture	3,115	41.9
Laborers	1,366	18.4
Home-makers	1,204	16.2
Retired/too old to work	988	13.3
Other	765	10.3
Economic status		
Below poverty line	4,588	61.7
others	2,850	38.3
Total		7,438

Table 3: Glaucoma prevalence among ≥ 35 years population of Rajnandangaon district (Glaucoma survey -2001)

Variant	Enumerated	Examined cases	Glaucoma %	Prevalence	95% CI	Age-sex adjusted rate	Glaucoma cases in district
Gender							
Male	4,239	3,570	143	4.03	3.38 4.68	3.86	6,800
Female	4,158	3,868	138	3.59	3.00 4.18	3.53	7,000
Age-group							
35 to 44 years	3,000	2,195	27	1.07	0.66 1.49	1.08	2,335
45 to 54 years	2,500	2,145	65	3.33	2.54 4.11	3.27	3,420
55 to 64 years	2,200	2,196	118	5.49	4.51 6.46	5.50	4,045
65 and more	1,055	1,002	75	7.58	5.95 9.22	7.58	4,000
Type							
POAG*	8,397	7,438	37	0.50	0.34 - 0.66		2,000
PACG#			60	0.81	0.60 - 1.01		3,265
SEC GL±			60	0.81	0.60 - 1.01		3,265
GL SUSP∞			85	1.14	0.90 - 1.38		4,450
OC HYP€			41	0.55	0.38 - 0.72		2,220
Total	8,397	7,438	283	3.78	3.37 4.24	3.67	13,800

*Primary open angle glaucoma; #Primary angle closure glaucoma; ±Secondary Glaucoma; ∞Glaucoma suspect; €Ocular hypertension

Table 4: Glaucoma survey in different studies (Glaucoma survey -2001)

Country	Year	Sample size	Type of glaucoma	Age group	Prevalence	Reference
Central India	2001	7438	All types	≥ 35	3.67	Present study
South India	2003	5,150	All types	≥ 40	2.6%	4
Andhra Pradesh, India	2000	1,399	POAG	≥ 30	1.7%	5
Andhra Pradesh, India	2000	1,399	PACG	≥ 30	0.71%	6
South India (urban)	1998	972	POAG, PACG	30 to 60	0.4 and 4.3%	7
Bangladesh	2004	2,347	All types	≥ 40	3.1%	18
Thailand	2003	701	All types	≥ 50	3.8%	19
Japan (Tajimi study)	2004	3,021	POAG	≥ 40	3.9%	21
Mongolia	1996	1,000	POAG, PACG	≥ 40	9.7%	22
Oman	2005	3,324	All types	≥ 30	4.75%	23
USA (Latino pop)	2004	6,142	POAG	≥ 40	4.74%	24
USA (Hispanic community)	2001	4,774	POAG	≥ 40	1.97%	25
Austr alia Blue Mountain study	1996	3654	POAG	≥ 49	3.0%	26
Netherland -rotterdam study	2000	6,756	POAG	≥ 55	1.5%	27

POAG - Primary open angle glaucoma, PACG - Primary angle closure glaucoma

vision (vision <20/60) disabled and normal (vision ≥ 20/60) [Table 5]. The risk of visual impairment with blindness and low vision was significantly more among those suffering from glaucoma than those who were not having glaucoma.

Five cases (1.8%) of glaucoma had family history of glaucoma. Thirty-one persons (11%) had undergone eye surgery in the past. Sixteen persons (5.7%) had aphakic glaucoma while 28 persons (9.9%) had glaucoma with un-operated cataract as its possible cause. In 70 persons (24.7%) ocular trauma was a co-morbidity and in 19 persons (6.7%) intraocular inflammation was found along with glaucoma.

In 13 eyes of seven patients of glaucoma among 7,438 persons, we noted history and/or evidence of glaucoma medication/laser/ocular surgery. Thus the coverage of glaucoma care was < 1%.

Discussion

Glaucoma has been recently added in the disease control strategy of the VISION 2020 initiative.[10] After combating communicable diseases, it was found that the magnitude of blindness did not change substantially but causalities had changed.[11] Compared to earlier studies, it was found that blindness among ≥50 years old had declined in India.[12] Therefore, the policies of focusing only on cataract were questioned and it was recommended that future planning should be according to the current dimension and nature of eye problems.[13] The proportion of chronic and

Table 5: Glaucoma and visual impairment (Glaucoma survey -2001)

Vision	Glaucoma		Not having glaucoma		Validation
	Number	%	Number	%	difference of % proportion (95% CI)
<10/200 (WHO blindness)	26	9.2%	124	1.7	7.5 (7.47 - 7.53)
<20/200 (Blindness India)	64	22.6	664	9.3	13.3 (13.2 - 13.5)
<20/60 (Low vision)	106	37.5	879	12.3	25.1 (25.0 - 25.2)
Normal	77	27.2	5,182	72.4	
Total	283		7,155		

age-related blinding diseases is high and in coming years it is likely to further increase due to rise in aging population globally. In this context, assessment of the magnitude and risk factors of glaucoma in the relatively poorer community of India was useful to the health planners of the newly formed state. The demographic structure of the study area is having a large proportion of children and < 15% proportion of the elderly population. This matches with the demographic trends of other developing countries.

Uniform definition of glaucoma for the survey and to compare the magnitude is a matter of debate. Newer technological tools like 'Frequency Doubling Perimetry',[14] optical coherent tomography,[15] blood flow measurement at optic discs[16] and scanning laser ophthalmoscopy,[17] are available in specialized ophthalmic clinics for diagnosis as well as for monitoring the progress of glaucoma. Unfortunately, many of these tools are not easily available to clinicians in developing countries. For the community-based surveys, they are not easy to use. Hence simple methods were used to detect changes in the fundus and the field of vision in this study. Manual noting of disc changes through undilated/dilated pupil, assessing central field changes and measuring intraocular pressure by reliable tools have been recommended in other studies.[18,19] Definitions and classification for the community-based glaucoma survey were proposed by Foster *et al*.[20] in 2002. However, our study was carried out prior to this publication. In addition international health authorities had not endorsed this methodology for the glaucoma survey.

Comparison of our study outcomes to results of other studies was a challenge. The age groups, the definitions used and type of glaucoma covered in different studies had wide variations.[21-32] This shows that standardization of data collection on glaucoma is urgently needed. The Andhra Pradesh eye disease study (APEDS) closely matched our study and the glaucoma rates were also similar.[6,7] However, the population in our study was primarily a rural one while in APEDS, the persons were from Hyderabad city. Urban/rural setups and socioeconomic conditions perhaps do not influence glaucoma. But racial differences might be the main reason for the wide variations in the prevalence of glaucoma that we found when we compared our results with rates of studies conducted in different countries.[33]

Our study was a part of assessment of blindness and low vision in the district. In a newly developed state with competing demands for the resources, such an initiative of joining the surveys with common target population could be cost-effective and the methods as well as outcomes could be used as advocacy tools in a better way. Improving eye care of a possible 13,800 glaucoma cases should be an integral part of developing a comprehensive primary and secondary eye care approach to combat avoidable blindness and improve their quality of life.

The ≤ 1% coverage of the existing eye care services for glaucoma care in the district is a matter of concern for the health planners. In addition to providing accessible facilities, it is important that rural masses are made aware of this health problem. As our sampling procedure was to get the prevalence of all types of glaucoma at the national level, the gender and age group variations and prevalence of different types of glaucoma found in our study show trends only and should be compared with outcomes of other studies with caution.

The characteristics of those examined and those not participating in the survey were closely matching. However, the health status and awareness among the two groups are likely to differ. This could have introduced bias in our study. If we consider that all who have not attended the survey had no glaucoma or having the same rate as among the examined sample, our study could have prevalence of glaucoma ranging from 3.37 to 3.80%. A large proportion of cases in the 'glaucoma suspect' group indicates the limitation of a community-based survey in the absence of sophisticated tools. The patients suspected to have glaucoma should be monitored periodically as many of them may develop glaucoma either in that eye or in the fellow eye in future.

Personal interviews of the elderly persons to elicit history of treatment in the past could have been affected by recall bias. Hence in our study, information of risk factors and family history of glaucoma should be viewed with caution. The field of vision was tested for a portion of the study sample. Although criteria to suspect glaucoma were based on most of the known factors associated with glaucoma, cases with low pressure and minimal disc changes might have been missed. Hence our study could have underestimated the prevalence of confirmed glaucoma. Thirteen per cent of our glaucoma cases had poor prognosis of vision. The risk of visual disabilities of different grades was significantly higher in glaucoma cases compared to normal population. Thus to reduce the blindness in the study areas, proper preventive and curative measures for glaucoma must be established. However, the strategy of mass screening to detect glaucoma in a place with prevalence of <5% and limited skilled manpower and tools should be studied further before making such suggestions.

It is concluded that the prevalence of glaucoma was 3.68% in Rajnandangaon district of Chhattisgarh in central India in the age group of ≥ 35 years. In the same population PACG was more common than POAG.

Acknowledgment

Dr. Shukla guided us in this project. We thank Dr RC Gupta, Dr. S Singh, Dr. S Banait, Dr. M Mehta and Dr. S Das for their support and suggestions. Dr. Garg BS, Dr. Tyagi, Dr. S Gupta and Mr. Bharambe assisted in statistical analysis. Dr. Lobsang assisted in the field part of the survey.

References

1. Goldberg I, Graham SL, Healey PR. Primary open-angle glaucoma. Med J Aust 2002;177:535-6.
2. Hitchings RA. Glaucoma screening. Br J Ophthalmol 1993;77:326.
3. Thylefors B, Negrel AD. The global impact of glaucoma. Bull World Health Organ 1994;72:323-6.
4. (WHO-EMR/CPB/E). Report on a regional planning workshop 'Implementation of VISION 2020 in the Eastern Mediterranean Region' Cairo, Egypt; 2003.
5. Ramakrishnan R, Nirmalan PK, Krishnadas R, Thulasiraj RD, Tielsch JM, Katz J, *et al.* Glaucoma in a rural population of southern India: The Aravind comprehensive eye survey. Ophthalmology 2003;110:1484-90.
6. Dandona L, Dandona R, Srinivas M, Mandal P, John RK, McCarty CA, *et al.* Open-angle glaucoma in an urban population in southern India: The Andhra Pradesh eye disease study. Ophthalmology 2000;107:1702-9.
7. Dandona L, Dandona R, Mandal P, Srinivas M, John RK, McCarty CA, *et al.* Angle-closure glaucoma in an urban population in southern India: The Andhra Pradesh eye disease study. Ophthalmology 2000;107:1710-6.
8. Jacob A, Thomas R, Koshi SP, Braganza A, Muliyil J. Prevalence of primary glaucoma in an urban south Indian population. Indian J Ophthalmol 1998;46:81-6.
9. Census India 2001 population profile of Rajnandangaon district of Chhattisgarh state, India. Available from: http://rajnandgaon.nic.in/cen2001.htm. [Last accessed on 2005 Jun 21].
10. Census India 1991, Chhattisgarh series 13. In: District census handbook. Part XII, A and B. p. 62-92.
11. Khandekar R, Mohammed AJ, Raisi AA. Prevalence and causes of blindness and low vision; before and five years after 'VISION 2020' initiatives in Oman: A review. Ophthalmic Epidemiol 2007;14:9-15.
12. Murthy GV, Gupta SK, Bachani D, Jose R, John N. Current estimates of blindness in India. Br J Ophthalmol 2005;89:257-60.
13. Dandona L, Dandona R, Naduvilath TJ, McCarty CA, Nanda A, Srinivas M. Is current eye-care-policy focus almost exclusively on cataract adequate to deal with blindness in India? Lancet 1998;351:1312-6.
14. Robin TA, Muller A, Rait J, Keeffe JE, Taylor HR, Mukesh BN. Performance of community-based glaucoma screening using Frequency Doubling Technology and Heidelberg Retinal Tomography. Ophthalmic Epidemiol 2005;12:167-78.
15. Leung CK, Yung WH, Ng AC, Woo J, Tsang MK, Tse KK. Evaluation of scanning resolution on retinal nerve fiber layer measurement using optical coherence tomography in normal and glaucomatous eyes. J Glaucoma 2004;13:479-85.
16. Ben Simon GJ, Moroz I, Goldenfeld M, Melamed S. Scanning laser Doppler flowmetry of nonperfused regions of the optic nerve head in patients with glaucoma. Ophthalmic Surg Lasers Imaging 2003;34:245-50.
17. Lauande-Pimentel R, Carvalho RA, Oliveira HC, Goncalves DC, Silva LM, Costa VP. Discrimination between normal and glaucomatous eyes with visual field and scanning laser polarimetry measurements. Br J Ophthalmol 2001;85:586-91.
18. Rahman MM, Rahman N, Foster PJ, Haque Z, Zaman AU, Dineen B, *et al.* The prevalence of glaucoma in Bangladesh: A population based survey in Dhaka division. Br J Ophthalmol 2004;88:1493-7.
19. Bourne RR, Sukudom P, Foster PJ, Tantisevi V, Jitapunkul S, Lee PS, *et al.* Prevalence of glaucoma in Thailand: A population based survey in Rom Klao District, Bangkok. Br J Ophthalmol 2003;87:1069-74.
20. Foster PJ, Buhrmann R, Quigley HA, Johnson GJ. The definition and classification of glaucoma in prevalence surveys. Br J Ophthalmol 2002;86:238-42.
21. Iwase A, Suzuki Y, Araie M, Yamamoto T, Abe H, Shirato S, *et al.* The prevalence of primary open-angle glaucoma in Japanese: The Tajimi Study. Ophthalmology 2004;111:1641-8.
22. Foster PJ, Baasanhu J, Alsbirk PH, Munkhbayar D, Uranchimeg D, Johnson GJ. Glaucoma in Mongolia: A population-based survey in Hovsgol province, northern Mongolia. Arch Ophthalmol 1996;114:1235-41.
23. Khandekar R, Mohammed AJ, Al Raisi A. Prevalence and risk factors of Glaucoma in Oman - A community based study (Oman eye study 2005) proceedings of 43rd World Ophthalmology Congress. Chapter abstracts of posters. Printers Sao Paolo: Brazil; 2006.
24. Varma R, Ying-Lai M, Francis BA, Nguyen BB, Deneen J, Wilson MR, *et al.* Prevalence of open-angle glaucoma and ocular hypertension in Latinos: The Los Angeles Latino Eye Study. Ophthalmology 2004;111:1439-48.
25. Quigley HA, West SK, Rodriguez J, Munoz B, Klein R, Snyder R. The prevalence of glaucoma in a population-based study of Hispanic persons: Proyecto VER. Arch Ophthalmol 2001;119:1819-26.
26. Mitchell P, Smith W, Attebo K, Healey PR. Prevalence of open-angle glaucoma in Australia: The Blue Mountains Eye Study. Ophthalmology 1996;103:1661-9.
27. Wolfs RC, Borger PH, Ramrattan RS, Klaver CC, Hulsman CA, Hofman A, *et al.* Changing views on open-angle glaucoma: Definitions and prevalence: The Rotterdam Study. Invest Ophthalmol Vis Sci 2000;41:3309-21.
28. Le A, Mukesh BN, McCarty CA, Taylor HR. Risk factors associated with the incidence of open-angle glaucoma: The visual impairment project. Invest Ophthalmol Vis Sci 2003;44:3783-9.
29. Zhao J, Sui R, Jia L, Ellwein LB. Prevalence of glaucoma and normal intraocular pressure among adults aged 50 years or above in Shunyi county of Beijing. Zhonghua Yan Ke Za Zhi 2002;38:335-9.
30. Foster PJ, Oen FT, Machin D, Ng TP, Devereux JG, Johnson GJ, *et al.* The prevalence of glaucoma in Chinese residents of Singapore: A cross-sectional population survey of the Tanjong Pagar district. Arch Ophthalmol 2000;118:1105-11.
31. Kozobolis VP, Detorakis ET, Tsilimbaris M, Siganos DS, Vlachonikolis IG, Pallikaris IG. Crete, Greece glaucoma study. J Glaucoma 2000;9:143-9.
32. Salmon JF, Mermoud A, Ivey A, Swanevelder SA, Hoffman M. The prevalence of primary angle closure glaucoma and open angle glaucoma in Mamre, Western Cape, South Africa. Arch Ophthalmol 1993;111:1263-9.
33. Wadhwa SD, Higginbotham EJ. Ethnic differences in glaucoma: Prevalence, management and outcome. Curr Opin Ophthalmol 2005;16:101-6.

Source of Support: Nil, **Conflict of Interest:** None declared.