WORLD VIEW

Prevalence and causes of blindness in the rural population of the Chennai Glaucoma Study

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Aim: To study the prevalence and causes of blindness in a rural south Indian population.

Methods: 3924/4800 enumerated (81.75%) subjects, aged 40 years or more from rural Tamil Nadu, underwent comprehensive ophthalmic examination—visual acuity, refraction, intraocular pressure, gonioscopy, cataract grading (LOCS II), retinal examination, and SITA Standard where indicated. Blindness was defined using WHO criteria as best corrected visual acuity of less than 3/60 and/or visual field of less than 10 degrees in the better eye. The influence of age, sex, literacy, and occupation was assessed using multiple logistic regression.

Results: 753 subjects (19.2%; 321 males, 432 females) presented with a visual acuity of <3/60; 132 subjects (3.36%, 95% CI: 2.80 to 3.93) were diagnosed to be blind. Cataract was responsible in 74.62% of eyes; glaucoma, cystoid macular oedema, optic atrophy, and corneal scars accounted for 3.79% each. Bilateral causes of blindness were cataract (78.63%), glaucoma (4.29%), optic atrophy (3.42%), cystoid macular oedema, and corneal scars (2.56% each). In 19 eyes (7.2%) the blindness was probably related to cataract surgery. Blindness was positively associated with increasing age ($p < 0.0001$).

Conclusion: 3.36% of the studied rural population was bilaterally blind, with cataract being the single most important cause.

Correlation between ageing and visual impairment is well established—with increasing numbers of ageing people, the burden of visual impairment correspondingly grows.¹ The number of people with visual impairment worldwide in 2002 was more than 161 million, of whom about 37 million were blind.¹ The prevalence of blindness is not distributed uniformly throughout the world—the lesser developed countries have more people with blindness than the developed countries.¹ Population based data on blindness are useful for appropriate healthcare planning, allocation of resources, and determining research priorities for different populations. There were a few reports from India that provided some population based data on visual status in Indians.^{2–6} India, however, is a vast country with variable socioeconomic status, education levels, and distribution of ophthalmic services. The Chennai Glaucoma Study aimed at furthering our insight into the causes of blindness in a rural population of southern India. The aim of this paper is to describe the causes and prevalence of blindness in a rural population aged 40 years or more.

METHODS

The methods of the Chennai Glaucoma Study (CGS) have been described previously.⁷ Briefly, it is a population based cross sectional study, designed to estimate the prevalence of glaucoma in a rural and urban south Indian population. The current study included only the rural subjects, and was conducted between June 2001 and May 2003. This study was approved by the institutional ethics review board. The rural study area comprised a total population of 22 000 residing in 27 villages spread over Thiruvallur and Kancheepuram districts of Tamil Nadu. Twenty two per cent of the population was above the age of 40 years as per the 1991 Census of India report. Based on this distribution, 4840 subjects aged 40 years or more were expected in our study area, from which we enrolled 4800 people.⁷ All the eligible

subjects were invited to the base hospital for detailed ophthalmic examination.

Written informed consent was obtained from all the subjects. They all underwent a complete ophthalmic examination—record of best corrected visual acuity using the modified ETDRS chart, applanation tonometry, gonioscopy, grading of lens opacities using LOCS II⁸ with a minimum pupillary dilation of 6 mm, stereoscopic evaluation of the optic nerve head and macula using + 78 dioptre lens at the slit lamp, a detailed retinal examination with a binocular indirect ophthalmoscope using a + 20 dioptre lens, optic disc, and fundus photography.

We measured the presenting and best corrected visual acuity using logarithm of minimum angle of resolution (logMAR) charts at 4 metres and those unable to read the top line of the chart were tested at 1 metre. Landolt's C chart was used for those who could not read English. Monocular visual acuity was determined with current spectacle prescription if any. Pinhole acuity was assessed in eyes with presenting visual acuity less than 20/20 (logMAR 0.0). Streak retinoscopy and subjective refraction were performed on all subjects. The best corrected visual acuity was ascertained and the value recorded. If the visual acuity could not be measured we used the following tests sequentially: counting fingers, hand movements, and light perception. Automated threshold visual field test using the SITA Standard 30–2 program (Model 750, Humphrey Instruments, San Leandro, CA, USA) was performed for all the subjects with diseases such as glaucoma, optic atrophy, and retinitis pigmentosa and in glaucoma suspects. After completion of the examination the diagnosis was recorded using the International Classification of Diseases-9.⁹ If more than one disease was present, the disease that was most likely to have a significant effect on vision was considered as the cause for the blindness.

Abbreviations: ARMD, age related macular degeneration; CGS, Chennai Glaucoma Study; CMO, cystoid macular oedema

Table 1 Sex, occupation, and literacy characteristics of study population

		Presenting visual acuity		Best corrected visual acuity	
		>3/60	≤3/60	>3/60	≤3/60
Sex	Male	1441 (45.44%)	321 (42.63%)	1704 (44.94%)	58 (43.94%)
	Female	1730 (54.56%)	432 (57.37%)	2088 (55.06%)	74 (56.06%)
	Total	3171	753	3792	132
Occupation	Manual	2336 (73.66%)	611 (81.14%)	2836 (75%)	111 (84.1%)
	Non-manual	835 (26.33%)	142 (18.54%)	956 (25%)	21 (15.9%)
	Total	3171	753	3792	132
Literacy	Literate	1741 (54.90%)	504 (66.93%)	2161 (57%)	84 (63.64%)
	Illiterate	1430 (45.09%)	249 (33.07%)	1631 (43%)	48 (36.36%)
	Total	3171	753	3792	132

Those with significant cataract were re-evaluated after cataract surgery.

Definitions

Our definition of blindness (similar to WHO definition) was best corrected distance visual acuity of less than 3/60 and/or less than 10° field in the better eye. We classified people with at least primary education as literate and people with no formal education as illiterate.¹⁰

Statistical analysis

Significance was assessed at the $p < 0.05$ level for all parameters. Univariate analysis for sex, literacy, and occupation was carried out using the χ^2 test; age between the two groups was compared using the t test. The age and sex specific rates of blindness in decadal groups starting from the 40–49 year age groups were used to standardise the estimates of blindness to the age and sex distribution of the population of India as per the 2001 census.¹¹ Multivariate analysis was done after adjusting for age (the age group of 40–49 years was used as the reference age group) and sex; blindness was the dependent variable. Statistical analysis was carried out using SPSS for Windows (SPSS Inc, Chicago, IL USA).

RESULTS

A total of 3934 subjects of the 4800 enumerated responded to the study (response rate of 81.95%). Of 3934, 10 subjects were excluded because of incomplete data, leaving the data of 3924 (81.75%) subjects for analysis. The mean age of the study population was 53.78 (SD 10.71) years and 55.1% were women. As per our definitions, 2245 subjects (57.21%) were illiterate and 1679 (42.79%) were literate.

Visual acuity measurements were performed (table 1); 753 subjects (19.2%; 321 males and 432 females) presented with a visual acuity of $\leq 3/60$. Of these the vision improved to better than 3/60 with refraction in 621 subjects (82.5%). The vision improved to 6/18 or better in 369 (59.42%) subjects, and to between 6/18 and 3/60 in 252 (40.58%).

In all, 132 subjects (3.36%, 95% CI: 2.80 to 3.93) were diagnosed as blind—74 females and 58 males with a mean

age of 64.38 (10.56) years. The diagnosis of blindness was based on visual acuity measurements in 130 subjects (98.5%), and on visual field changes in two subjects (1.5%). Eighty four blind subjects (63.64%) were illiterate and 48 (36.36%) were literate; a majority were manual workers (111 subjects 84.1%) (table 2).

The causes of blindness in the 264 eyes are presented in table 3. In both groups cataract was the leading cause; it was responsible for blindness in 197 (74.62%) eyes, with glaucoma, optic atrophy, cystoid macular oedema (CMO), and corneal scars accounting for 10 (3.79%) eyes each. Other leading causes included corneal decompensation (six eyes, 2.27%), age related macular degeneration (ARMD) (five eyes, 1.87%), and retinitis pigmentosa (four eyes, 1.52%).

In 117 subjects the cause for blindness was the same in both eyes. Cataract was responsible for blindness in 92 subjects (78.63%), glaucoma in five subjects (4.27%), optic atrophy in four subjects (3.42%), and cystoid macular oedema and corneal scar in three subjects each (2.56%).

In 19 eyes (7.2%) the blindness was probably related to cataract surgery (corneal decompensation six eyes, CMO 10 eyes, posterior capsule opacification two eyes, and phthisis bulbi one eye). Blindness was significantly positively associated with increasing age ($p < 0.0001$). Multiple logistic regression (table 4) showed that the sex adjusted odds for blindness increased with age. Using the 40–49 year age group as baseline the odds ratio (OR) increased from 1.98 (95% CI 0.97 to 4.04) for the 50–59 years age group to 28.24 (95% CI 12.1 to 65.94) for the subjects aged ≥ 80 years. Sex, occupation, and literacy did not show any association with blindness.

The age and sex adjusted (based on provisional population totals, census of India 2001¹¹) prevalence of blindness among the subjects ≥ 40 years of age in the rural Tamil Nadu population was 3.37% (95% CI 2.80 to 3.93).

DISCUSSION

The rural sample of the Chennai Glaucoma Study compares moderately well with that of the rural population of Tamil Nadu suggesting that our prevalence rates can be applied in a

Table 2 Distribution of presenting and best corrected visual acuity in better eye

Age group (years)	Presenting visual acuity			Best corrected visual acuity		
	>6/18	6/18 to 3/60	≤3/60	>6/18	6/18 to 3/60	≤3/60
40–49	1491 (65.6%)	93 (10.34%)	90 (12%)	1541 (43.6%)	31 (11.5%)	14 (10.6%)
50–59	675 (29.7%)	214 (23.8%)	191 (25.37%)	897 (25.5%)	71 (26.3%)	17 (12.88%)
60–69	245 (10.8%)	332 (36.9%)	298 (39.58%)	740 (21.0%)	106 (39.3%)	47 (35.60%)
70–79	50 (2.2%)	177 (19.7%)	152 (20.2%)	309 (8.8%)	52 (19.3%)	43 (32.57%)
≥80	1 (0.04%)	27 (3.0%)	22 (2.92%)	36 (1.0%)	10 (3.7%)	11 (8.33%)
Total 3924	2272 (57.9%)	899 (22.91%)	753 (19.19%)	3522 (89.75%)	270 (6.88%)	132 (3.36%)

Table 3 Causes of blindness

Cause	Cause of blindness in either eye	Cause of blindness in both eyes
Age related cataract	197 (74.62%)	92 (78.63%)
Glaucoma	10 (3.79%)	5 (4.27%)
Optic atrophy	10 (3.79%)	4 (3.42%)
Corneal decompensation	6 (2.27%)	2 (1.7%)
Corneal scar	10 (3.79%)	3 (2.56%)
Macular disease	2 (0.76%)	1 (0.85%)
CNVM	2 (0.76%)	1 (0.85%)
ARMD	5 (1.89%)	2 (1.7%)
CMO	10 (3.79%)	3 (2.56%)
Macular hole	2 (0.76%)	1 (0.85%)
PDR	1 (0.38%)	Nil
RP	4 (1.52%)	2 (1.7%)
RD	1 (0.38%)	Nil
Post-trauma	1 (0.38%)	Nil
Prephthical	1 (0.38%)	Nil
PCO	2 (0.76%)	1 (0.85%)
Total	264*	117†

*Number of eyes; †Number of subjects; CNVM, choroidal neovascular membrane; ARMD, age related macular degeneration; CMO, cystoid macular oedema; PDR, proliferative diabetic retinopathy; RP, retinitis pigmentosa; RD, retinal detachment; PCO, posterior capsular opacification.

wider sense to the rural population of this state.¹⁰ In the current study, the age and sex adjusted prevalence of blindness was 3.37%.

There is wide variation in the prevalence rates of blindness across the world.¹ Comparison of data from different studies would need to take into account the variations in methodology, definition of blindness age groups studied, and time period of the study (table 5).

The NPCB study was conducted in 15 populous states of India.⁶ In spite of differences in the methodology and population studied, our blindness rate is similar to theirs. However, our prevalence rate of blindness is higher than the ACES blindness rate, in a rural south Indian population.⁵ One probable reason could be the difference in the definition of blindness. However, this alone cannot explain the 3.5-fold increase in our prevalence rate since in our study we diagnosed blindness based only on visual fields in two subjects. The difference is probably related to the population sampling. The ACES excluded villages having fewer than 350 people and selected the areas that had access to one of the two hospitals of Aravind eye care system. Since the majority of causes for blindness we report are preventable, access to ophthalmic care would have an impact on prevalence rates. The APEDS is a population based study from a neighbouring state.⁴ They reported the prevalence of blindness from three rural districts and one urban area. This is almost double that of our blindness rate. One reason could be the difference in

the definition, while the other reason, possibly, could be different population studied.

As expected the prevalence of blindness in our study increased greatly with age. There was a 28-fold increase in blindness rate between the age groups 40–49 years and more than 80 years age. Sex difference in prevalence rates has been reported by many population based studies. The Barbados Eye Study (on a predominantly black population) reported higher blindness prevalence rate in males,¹² whereas most other studies have shown increased rates in females.^{4 6 13 14} The Shipai Eye Study has shown no sex difference in an elderly Chinese population.¹⁵ In our study, prevalence of blindness was similar in both sexes. This wide variability in sex difference may be the result of the inherent differences in the study population and the distribution of causes of blindness.

The leading cause for blindness seems to vary in different races. In the populations of African descent the leading causes were age related glaucoma and cataract.^{12 16} In studies involving predominantly white populations, the cause was age related macular degeneration.^{17 18} Similar to other studies in this region the single most important cause for blindness in our study was cataract.^{4–6} More than two thirds of the bilaterally blind had cataract. According to the WHO report the number of blind people in India in 1990 was 8.9 million, whereas the estimated number of blind people for 2002 was 6.7 million. These figures indicate a decrease in blindness of

Table 4 Multivariate analysis: effect of age, sex, occupation, and literacy

	Number of subjects	Number of blind subjects	Adjusted odds	95% CI
Age (years)				
40–49	1585	14	1.00	
50–59	985	17	1.98	0.97 to 4.04
60–69	892	47	6.26	3.43 to 11.44
70–79	404	43	13.63	7.37 to 25.21
>80	58	11	28.24	12.1 to 65.94
Sex				
Male	1761	58	1.00	
Female	2163	74	0.82	0.57 to 1.17
Occupation				
Manual	2947	111	1.00	
Non-manual	977	21	1.58	0.94 to 2.64
Literacy				
Literate	2245	48	1.00	
Illiterate	1679	84	1.08	0.73 to 1.58

Table 5 Blindness prevalence in various studies from India

	APEDS	ACES	NPCB	Current study
Age group	40 years and above	40 years and above	50 years and above	40 years and above
Definition of blindness	Presenting visual acuity of <6/60 or central visual field <20° in the better eye	Best corrected visual acuity <3/60 in better eye	Best corrected visual acuity <3/60 in better eye	Best corrected visual acuity <3/60 and/or less than 10° field in the better eye
Study period	1996–2000	1995–7	1999–2001	2001–3
Study population	Urban and rural	Rural	Urban and rural	Rural
Blindness (%) (95% CI)	6.6 (5.8 to 7.4)	1.0 (0.79 to 1.2)	3.37 (3.16 to 3.58)	3.36 (2.80 to 3.93)

APEDS, Andhra Pradesh Eye Disease Study; ACES, Aravind Comprehensive Eye Survey; NPCB, National Programme for Control of Blindness.

25% in India.¹ This may be the result of substantial increase in number of cataract surgeries being performed in the country. In spite of these measures; however, cataract blindness seems to be a challenge and with the increase in the ageing population, it will continue to be one in the near future. Even though we do not have data on the details of cataract surgery of the study population, 7.2% of causes of blindness were possibly the result of the cataract surgery as evidenced by corneal decompensation (six eyes), CMO (10 eyes), posterior capsule opacification (two eyes), and phthisis bulbi (one eye) in subjects with history of cataract surgery. Poor outcomes of cataract surgery seem to be a major problem in developing countries. Unless we achieve better outcome by improving the eye care infrastructure, eye care personnel, and provide better follow up for operated people after cataract surgery, complications will remain a major cause for blindness.

The second highest cause for blindness in our study was glaucoma. Bilateral blindness due to glaucoma was seen in five (3.79%) subjects, three of them with primary glaucoma and two with secondary glaucoma. These figures are lower than those reported prevalence from other studies^{15–19} but similar to the reported in the ACES.⁵ Even though glaucoma blindness seems very low in comparison with the cataract blindness, cataract blindness is treatable where as glaucoma blindness is not. Only with improved community eye care facilities, can a silent disease like glaucoma be diagnosed early and blindness rates can at least be minimised. The details regarding reasons for corneal scars and optic atrophy could not be elicited.

The major strength of this study was the comprehensive eye examination performed at base hospital, resulting in a more accurate diagnosis of the disease and the cause for blindness. Participants were slightly older than non-participants¹⁰; as the rate of blindness increased with age, it is possible that the prevalence of blindness has been slightly overestimated.

In conclusion, we report in our rural population aged 40 years and above a high prevalence of blindness (3.36%). Almost 75% of blindness was caused by treatable cataract, while another 7.2% was probably related to the cataract surgery. Indian population studies in the past have identified major social issues responsible for the rural population not seeking ophthalmic medical care—namely, economic conditions, lack of proper transportation, and lack of people to accompany them for treatment.²⁰ Poor outcome of cataract surgery should be minimised; this in turn can persuade more people with cataract to seek treatment. This will be possible if cataract surgical programmes concentrate on quality of surgery and provide extended follow up for operated people. Public health programmes would need to take cognizance of these facts and should address them in the blindness control

programmes in order to make a positive impact on cataract blindness in the rural population of India.

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