Moderate visual impairment in India: the Andhra Pradesh Eye Disease Study

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Aim: To assess the prevalence and demographic associations of moderate visual impairment in the population of the southern Indian state of Andhra Pradesh.

Methods: From 94 clusters in one urban and three rural areas of Andhra Pradesh, 11,786 people of all ages were sampled using a stratified, random, cluster, systematic sampling strategy. The eligible people were invited for interview and detailed dilated eye examination by trained professionals. Moderate visual impairment was defined as presenting distance visual acuity less than 6/18 to 6/60 or equivalent visual field loss in the better eye.

Results: Of those sampled, 10,293 (87.3%) people participated in the study. In addition to the previously reported 1.84% prevalence of blindness (presenting distance visual acuity less than 6/60 or central visual field less than 20° in the better eye) in this sample, 1237 people had moderate visual impairment, an adjusted prevalence of 8.09% (95% CI 6.89 to 9.30%). The majority of this moderate visual impairment was caused by refractive error (45.8%) and cataract (39.7%). Increasing age, female sex, decreasing socioeconomic status, and rural area of residence had significantly higher odds of being associated with moderate visual impairment.

Conclusions: These data suggest that there is a significant burden of moderate visual impairment in this population in addition to blindness. Extrapolation of these data to the population of India suggests that there were 82 million people with moderate visual impairment in the year 2000, and this number is likely to be 139 million by the year 2020 if the current trend continues. This impending large burden of moderate visual impairment, the majority of which is due to the relatively easily treatable refractive error and cataract, would have to be taken into account while estimating the eye care needs in India, in addition to dealing with blindness. Specific strategies targeting the elderly population, people with low socioeconomic status, those living in the rural areas, and females would have to be implemented in the long term to reduce moderate visual impairment.

METHODS

Various aspects of the study design of APEDS have been described previously.1–4 Briefly, a multistage sampling procedure was used to select 24 urban clusters and 70 rural clusters from one urban and three rural areas from different parts of the southern Indian state of Andhra Pradesh, with the aim of having a study sample representative of the urban-rural and socioeconomic distribution of the population of this state. These four areas were located in Hyderabad (urban), West Godavari district (“well off” rural), and Adilabad and Mahabubnagar districts (poor rural). APEDS was conducted from October 1996 to February 2000. The sampling strategy for APEDS has been described earlier.1–5

In brief, the major difference between the urban and rural sampling was that the former was selected from blocks stratified by socioeconomic status and religion, whereas the latter were selected from villages stratified by caste as described previously.5–7 A total of 94 clusters were selected for APEDS using stratified random sampling, such that the proportion of each socioeconomic status in the sample would be similar to that in the population of the state.1–5 These clusters were mapped and the number of households and members in each household listed. The households were then systematically selected within each cluster to obtain roughly equal number of households in all clusters. The systematic selection of households ranged from every second to fifth household in a cluster depending on the size of the cluster. Approximately half the clusters in each of the four areas were randomly assigned to have people of all ages in the selected households.
Table 1: Criteria for moderate visual impairment due to visual field loss

<table>
<thead>
<tr>
<th>Visual field loss criteria</th>
<th>Humphrey 24-2 threshold visual field (% of points &lt;10 dB)</th>
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</thead>
<tbody>
<tr>
<td>&lt;6/18–6/30</td>
<td>&gt;75 or 51–75</td>
</tr>
<tr>
<td>or 25–50</td>
<td>or 51–75 and 25–50</td>
</tr>
<tr>
<td>or 25–50</td>
<td>or 51–75 and 25–50</td>
</tr>
<tr>
<td>or &gt;75</td>
<td>or 51–75 and &gt;75</td>
</tr>
</tbody>
</table>

*For upper hemifield 25–50%, 51–75%, and >75% are 6–13, 14–20, and >20 points, respectively, and for lower hemifield these are 6–13, 14–19, and >19 points, respectively. This table is adapted from Dandona et al.*

RESULTS

Study population

A total of 10,293 (87.3%) subjects participated in the study in the four areas of APEDS of the eligible 11,786 subjects. Of these 7,775 (75.5%) were from the three rural areas and 5,439 (42.8%) were from the four urban areas. A total of 1,221 (1.2%) subjects were examined at home of whom 23 (18.9%) were in the urban study area. The results that follow are for moderate visual impairment and visual field loss grades were different, and the cause of acuity loss was considered if the grades of acuity and visual field loss were similar.

Data were entered on self-coded forms by the investigators and the examiners which were then entered into a computer by two data entry operators using a program with internal consistency checks. Data entered by one data entry operator were checked by the other data entry operator after completion of each cluster. This was done randomly on 10% of all the data entered for each cluster. To determine and verify outliers, monthly range, and consistency checks were done using SPSS (Windows). Analyses were done using SPSS software (SPSS for Windows, Rel. 10.0.5. 1999, Chicago: SPSS Inc.).

The prevalence of moderate visual impairment was adjusted for the age, sex, and urban-rural distribution in India for the year 2000 to obtain composite estimates for the overall prevalence of moderate visual impairment. The design effect of the sampling strategy was calculated using the moderate visual impairment prevalence in each cluster, and the 95% confidence intervals of the estimates were adjusted accordingly.

The demographic associations of moderate visual impairment with age, sex, socioeconomic status, and area of residence were assessed with univariate analysis using Chi-square test followed by multivariate analysis using multiple logistic regression. The effect of each category of a multicategorical risk factor variable was assessed by keeping the first or the last category as the reference. The 275 participants in this study population reported earlier as blind were excluded from the univariate and multivariate analyses for moderate visual impairment.

These data on moderate visual impairment were extrapolated to the population of India for the year 2000. In addition, the prevalence of moderate visual impairment was estimated for the years 2010 and 2020 if the current age-sex specific rates continue, by applying these rates to the estimated age, sex, and urban-rural distribution of the population of India in 2010 and 2020.
impairment defined as presenting distance visual acuity <6/18–6/60 or equivalent visual field loss as described previously.  

**Prevalence and causes of moderate visual impairment**

In addition to the 201 people reported previously with moderate visual impairment from the urban area, 1036 (10.3%) in the three rural areas had moderate visual impairment. The prevalence of moderate visual impairment adjusted for age, sex, and urban-rural distribution was 8.1% (95% confidence interval 6.9 to 9.3; design effect 5.2) for the four areas combined. Visual field loss was responsible for 0.96% of the moderate visual impairment. On considering only the three rural areas of APEDS, the age and sex adjusted prevalence of moderate visual impairment was 8.9% (95% confidence interval 7.5 to 10.3; design effect 4.7). Visual field loss was responsible for 0.72% of the moderate visual impairment.

The distribution of the causes of moderate visual impairment is shown in Table 2. The leading cause of moderate visual impairment was refractive error (45.8%) followed by cataract (39.9%). Comparison between the prevalence of moderate visual impairment due to various causes for the urban area and the rural areas of APEDS is shown in Figure 1. Prevalence of moderate visual impairment due to refractive error, cataract, amblyopia, and corneal diseases was higher in the rural areas compared with the urban area whereas that caused by retinal diseases, optic atrophy, and glaucoma was similar. The category of “others” includes endophthalmitis, higher visual pathway lesion, posterior capsule opacity following cataract surgery, and indeterminate cause of visual impairment. Refractive error and cataract were responsible for majority of the moderate visual impairment. The prevalence of moderate visual impairment caused by refractive error and cataract was 2.90% (95% confidence interval 1.83 to 3.97%) and 2.16% (95% confidence interval 1.00 to 3.32%) respectively in the urban area, and was 4.0% (95% confidence interval 3.3 to 4.7%) and 3.6% (95% confidence interval 2.9 to 4.4%) for refractive error and cataract respectively in the three rural areas combined.

Figure 2 shows the age specific prevalence of moderate visual impairment for the causes of moderate visual impairment for the four areas of APEDS combined. Refractive error was the most frequent cause of moderate visual impairment below 60 years of age and cataract was the most common cause 60 years of age onwards.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Distribution of causes of moderate visual impairment for the four areas of APEDS</th>
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<tbody>
<tr>
<td><strong>Cause of moderate visual impairment</strong></td>
<td><strong>Prevalence (95% CI)</strong></td>
</tr>
<tr>
<td>Refractive error</td>
<td>3.71% (3.11% to 4.30%)</td>
</tr>
<tr>
<td>Myopia</td>
<td>2.81%</td>
</tr>
<tr>
<td>Hyperopia</td>
<td>0.71%</td>
</tr>
<tr>
<td>Aphakia</td>
<td>0.14%</td>
</tr>
<tr>
<td>Pseudophakia</td>
<td>0.05%</td>
</tr>
<tr>
<td>Cataract</td>
<td>3.23% (2.58% to 3.87%)</td>
</tr>
<tr>
<td>Age related</td>
<td>3.20%</td>
</tr>
<tr>
<td>Steroid induced</td>
<td>0.01%</td>
</tr>
<tr>
<td>Traumatic</td>
<td>0.01%</td>
</tr>
<tr>
<td>Uveitis related</td>
<td>0.01%</td>
</tr>
<tr>
<td>Retinal disease</td>
<td>0.27% (0.16 to 0.39%)</td>
</tr>
<tr>
<td>Amblyopia</td>
<td>0.22% (0.12 to 0.31%)</td>
</tr>
<tr>
<td>Corneal disease</td>
<td>0.19% (0.08 to 0.29%)</td>
</tr>
<tr>
<td>Optic atrophy†</td>
<td>0.15% (0.07 to 0.23%)</td>
</tr>
<tr>
<td>Glaucoma</td>
<td>0.08% (0.03 to 0.14%)</td>
</tr>
<tr>
<td>Others</td>
<td>0.25% (0.14 to 0.36%)</td>
</tr>
<tr>
<td>Total</td>
<td>8.10% (6.90 to 9.30%)</td>
</tr>
</tbody>
</table>

*Adjusted for the estimated age, sex, and urban-rural distribution of India in the year 2000. † Other than caused by glaucoma.

**Demographic associations for moderate visual impairment**

After excluding the 275 people reported as blind (presenting distance visual acuity <6/60 or central visual field less than 20 degrees in the better eye) in this study population, the sample considered for the demographic association analysis for moderate visual impairment was 10 018. Of these 10 018 people, 7545 (75.3%) were from the three rural areas, 5322 (53.1%) were 30 years of age or more, and 5281 (52.7%) were female.

Distribution of those with moderate visual impairment by age, sex, socioeconomic status, and area of residence is shown in Table 2. On applying multiple logistic regression (Table 3), the odds of having moderate visual impairment increased with increasing age and with decreasing socioeconomic status. Females (odds ratio 1.47; 95% confidence interval 1.27 to 1.71) compared with males and those living in the rural areas (odds ratio 2.12; 95% confidence interval 1.75 to 2.57) compared with the urban area had significantly higher odds of having moderate visual impairment.
DISCUSSION

APEDS was a population based study representative of the population of the Indian state of Andhra Pradesh with a good participation rate.

We have previously reported data on moderate visual impairment from the urban area of APEDS using two definitions of moderate visual impairment.7 In the previous report, the prevalence of moderate visual impairment in the urban area was estimated at 7.2% with definition one (presenting distance visual acuity <6/12–6/60 or equivalent visual field loss), and 4.8% with the other more conservative definition two (presenting distance visual acuity <6/18–6/60 or equivalent visual field loss).7 These estimates were adjusted for the population distribution of India available from the year 1991 census.7 For this report, we have adjusted the estimates for the most recent data for the estimated population distribution of India in the year 2000.6,7 On adjusting the urban area estimates for the estimated population distribution of India in the year 2000, the prevalence of moderate visual impairment in the urban area is estimated at 8.9% with definition one and 6.0% with definition two. In this report on the combined results from four areas of APEDS, we have used only the latter more conservative definition as three of the four areas of APEDS were rural.

We have reported the prevalence of blindness at 1.84% for this population.6 In addition to the high prevalence of blindness in this population, these data suggest that there is also a significant burden of moderate visual impairment.

The main finding is the higher prevalence of moderate visual impairment in the rural areas (8.9%) compared with the urban area (6.0%). Though this finding is not surprising as we have also found blindness higher in the rural areas compared with the urban area in the same population, it does indicate the poor eye care scenario in the rural areas of the state.6 The higher prevalence in the rural areas is possibly related to less availability of eye care services in these areas compared with the urban area. Based on the data presented in this paper, it is not possible for us to comment on whether there are reasons other than availability of eye care services for high prevalence in the rural areas. The majority of the moderate visual impairment in the urban and rural areas was treatable, as refractive error and cataract were responsible for 85% of the moderate visual impairment. We have previously reported 60% of blindness in this population was caused by cataract or refractive error.6

Among the younger age groups, refractive error was the main cause of moderate visual impairment. Refractive error has also been reported as a significant cause of visual impairment from the developed world.15-17 Treatment of refractive error is perhaps the most simple and effective form of eye care. To deal with the burden of refractive error related moderate visual impairment certain issues that need to be addressed are affordable reasonable quality spectacles; availability of adequate number of trained personnel to perform reasonable quality refraction; creating demand and awareness for refractive services; and implementation of vision screening programmes on a large scale to detect those suffering from refractive error.

Cataract was the main cause of moderate visual impairment in the older population. There was a notable increase in the prevalence of moderate visual impairment due to cataract in
people 60 years of age and older. The Baltimore Eye Survey also documented an increase in cataract as cause of visual impairment in people 60 years of age and older, and the Visual Impairment Project in Melbourne documented an increase in people 70 years of age and older. The issues regarding reducing moderate visual impairment due to cataract are: adequate infrastructure to facilitate the logistics of providing good quality cataract services; affordability of cataract services by the population at large; availability of adequately trained staff to provide cataract services; and creating demand for cataract surgical services.

We have reported the demographic associations for moderate visual impairment. Knowledge about these associations can help in identifying the groups in the population, which need particular attention in the strategies to reduce moderate visual impairment. The demographic associations of moderate visual impairment are not very different from those of blindness reported earlier. The chances of having moderate visual impairment increased with increasing age. Females and those belonging to the extreme lower and lower socioeconomic strata were more likely to have moderate visual impairment. These groups are disadvantaged in our society. As ours is a patriarchal society, females are socially and financially dependent on the male members of the family for their needs, which results in their disadvantaged position. Those belonging to the extreme lower and lower socioeconomic strata are disadvantaged with regard to access to healthcare services, including eye care services, mainly for economic reasons. Therefore, an attempt has to be made to actively target these groups to reduce moderate visual impairment. Attention of the eye care programmes needs to be more actively in the rural areas as these data suggest a higher prevalence of moderate visual impairment in the rural areas. In addition, these data also suggest variation within the rural areas themselves, as those living in Adilabad, a poor rural area, were less likely to have moderate visual impairment as compared with the other two rural areas. This variation within the rural areas needs to be understood further.

The World Health Organization has previously defined blindness as best corrected visual acuity less than 3/60 or corresponding visual field loss in the better eye, and low vision as best corrected visual acuity less than 6/18–3/60 in the better eye. The World Health Organization has also estimated previously that the burden of low vision is three times that of blindness. The prevalence of visual impairment in the less than 6/18–3/60 category, using the presenting visual acuity definition and equivalent visual field loss, is 8.5% in our population. This includes 8.0% prevalence of less than 6/18–6/60 category reported in this article, plus the 0.5% prevalence of less than 6/60–3/60 category reported earlier. The prevalence of blindness, defined as presenting visual acuity less than 3/60 or central visual field less than 10 degrees in the better eye, from our data is 1.34%. These data suggest that the burden of less than 6/18–3/60 category of visual impairment in our population is six times higher than that of blindness of less than 3/60. This six times higher burden is twice that estimated by the World Health Organization with the definitions using best corrected visual acuity.

The implications of these data on planning of eye care services are noteworthy. The extrapolations of these data to the years 2010 and 2020 estimate the burden of moderate visual impairment if effective strategies are not put in place. It should be noted, however, that the projection of 107 million in 2010 and 140 million in 2020 for India if current trends continue have 95% confidence intervals of 30 and 36 million people respectively. Therefore, specific data would be required for more precise planning at the state and district levels. However, in the background of the enormous burden of blindness, scantly infrastructure, and inadequate staff for provision of eye care services, especially for our rural population, it may not be justifiable to put resources into dealing with moderate visual impairment at this time. It would be necessary, however, to take into account these data on moderate visual impairment when planning for eye care services in the long term. The current strategies already focus on blindness, but the long term strategies should include moderate visual impairment in addition to blindness.

In conclusion, there is a significant burden of treatable moderate visual impairment in this population in addition to blindness. The predominant causes of moderate visual impairment change with age. Refractive error is the main cause of moderate visual impairment among the younger groups and cataract in the older age groups. These data could help in planning long term strategies for eye care services in India.

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