

## Changing trends in the prevalence of blindness and visual impairment in a rural district of India: Systematic observations over a decade

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**Context:** Globally, limited data are available on changing trends of blindness from a single region. **Aims:** To report the changing trends in the prevalence of blindness, visual impairment (VI), and visual outcomes of cataract surgery in a rural district of Andhra Pradesh, India, over period of one decade. **Settings and Design:** Rural setting; cross-sectional study. **Materials and Methods:** Using a validated Rapid Assessment of Cataract Surgical Services (RACSS) method, population-based, cross-sectional survey was done in a rural district in the state of Andhra Pradesh, India. Two-stage sampling procedure was used to select participants  $\geq 50$  years of age. Further, a comparative analysis was done with participants  $\geq 50$  years from the previously concluded Andhra Pradesh Eye Disease Study (APEDS) study, who belonged to the same district. **Statistical Analysis:** Done using 11<sup>th</sup> version of Stata. **Results:** Using RACSS, 2160/2300 (93.9%) participants were examined as compared with the APEDS dataset (n=521). Age and sex adjusted prevalence of blindness in RACSS and APEDS was 8% (95% CI, 6.9–9.1%) and 11% (95% CI, 8.3–13.7%), while that of VI was 13.6% (95% CI, 12.2–15.1%) and 40.3% (95% CI, 36.1–44.5%), respectively. Cataract was the major cause of blindness in both the studies. There was a significant reduction in blindness following cataract surgery as observed through RACSS (17.3%; 95% CI, 13.5–21.8%) compared with APEDS (34%; 95% CI, 20.9–49.3%). **Conclusion:** There was a significant reduction in prevalence of blindness and VI in this rural district of India over a decade.

**Key words:** Blindness, cataract, outcomes, prevalence, rapid

Globally, there is a changing trend in the prevalence of blindness and visual impairment (VI). Prior to the launch of the VISION 2020: The Right to Sight program of the World Health Organization (WHO) and International Agency for Prevention of Blindness (IAPB) in 1999, it was estimated that the total number of the blind persons globally was around 45 million, and in absence of a definitive and accelerated intervention strategy would increase to 76 million by the year 2020.<sup>[1]</sup> The reports from WHO five years later revealed decreasing trend with the number of blind at 37 million blind and 161 million visually impaired,<sup>[2]</sup> which was 15 million less than the previously projected figure.<sup>[3]</sup> This difference was explained by multiple factors, including (and not limited to) more robust epidemiological studies being done resulting in more accurate estimates. Additionally, there was a genuine reduction in the avoidable causes of blindness, especially in diseases like trachoma and onchocerciasis.<sup>[3]</sup> Similarly, the number of cataract cases were lower than projected, despite a global increase of 30% in the elderly population aged 50 years and above.<sup>[3]</sup>

This global trend of decrease in the prevalence of blindness was also reflected in India over the past decade.<sup>[4-7]</sup> The WHO report also showed a significant reduction in the number of the

blind persons in India from 8.9 million in 1990 to 6.7 million in 2002.<sup>[2]</sup> However, there is limited data on the changing trends in the prevalences of blindness and VI garnered systematically from the same population over a period of time. In order to address this issue, we carried out a comprehensive study across four sub-districts of a rural district (Adilabad) in the state of Andhra Pradesh, India. The choice of this region was based on the fact that the Adilabad district was a major site for the previously conducted Andhra Pradesh Eye Disease Study (APEDS) 10 years earlier.<sup>[8]</sup> Thus, our primary objective was to look at the changes in the prevalences of blindness and VI along with the visual outcomes of cataract surgery over a decade in this district.

### Materials and Methods

In terms of various health indicators, Adilabad District is one of the most underdeveloped districts of the state of Andhra Pradesh as well as India having a significant proportion of tribal population.<sup>[9]</sup> As per the Government of India norms, a region is called tribal based on certain inherent characteristics of that region.<sup>[10]</sup> According to the 2001 census, the total population of the district was 2,479,347, which accounted for 3.1% of the total population of the state, and the tribal population comprises 18% of the total population of this district. The primitive tribal populations usually live in isolation, have a distinct culture, are economically backward and usually keep themselves away from the mainstream.<sup>[10]</sup> The main occupation in this region is agriculture with a literacy rate of 53.5% compared with the state average of 61%.<sup>[11]</sup> Close to 13% of the total population was estimated to be aged 50 years or older.<sup>[11]</sup>

As far as eye care services are considered, there was only one

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government hospital in 1996 located at the district headquarters in Adilabad, where cataract surgeries were performed. Apart from this, there was no other service provider in this region. As it was one of the most backward districts of the state, L V Prasad Eye Institute (LVPEI) set up a secondary eye care centre in this area in 1996 based on its pyramidal model.<sup>[12]</sup> This centre was located in the southern part of the district in Mudhole (a sub-district), which is geographically 170 kilometers away from the district headquarters. Over the past 10 years, there has been no new eye care facility other than the LVPEI secondary centre in this area. The only other service providers are the government sector and occasional services offered by other Non Governmental Organizations (NGO's) from the neighboring districts and private sectors through eye camps.

The APEDS was conducted in the state of Andhra Pradesh between 1996 and 2000, which included participants from three rural and one urban area.<sup>[13]</sup> The detailed methodology has been described elsewhere.<sup>[8]</sup> Based on the 1991 census, the sample size was estimated to be 10,000 to find a prevalence of blindness of 0.5% with a 95% confidence interval between 0.3% and 0.8%. In brief, 10, 293 subjects were examined in four areas using multistage sampling methods. One of the rural areas comprised the four sub-districts in Adilabad district [Fig. 1]. A total of 2690 subjects were examined in this area including 521 subjects who were aged more than or equal to 50 years.

Subsequently, 10 years later, a validated Rapid Assessment of Cataract Surgical Services (RACSS)<sup>[14]</sup> was conducted between December 2006 and February 2007 in these four sub-districts, which were within a 50 kilometer radius of the LVPEI secondary centre. A two stage sampling strategy was used in this survey. In the first stage, clusters (villages within the sub-districts) were selected through Probability Proportionate to Size Sampling (PPSS). In the second stage, households within the clusters were selected through Random Walk Method (RWM).<sup>[15]</sup> We estimated the population sizes in these villages based on the census data (2001), adding an annual growth rate of 1.3% to obtain an estimate of the populations for 2006. We also estimated that around 13% of the population would be aged 50 years and above. Based on a disease prevalence of 6% along with precision of 20% (design effect of 1.7), the required

sample size was 2300 subjects (assuming a 10% nonresponse rate). Informed consent was obtained from all subjects residing in these villages at least for the past 6 months.

We defined blindness and VI as visual acuity (VA) worse than 6/60 and worse than 6/18 to better than or equal to 6/60, respectively, in the better eye with available correction if any and refractive error was defined as VA worse than 6/18, improving to 6/18 or better with a pinhole. Cataract was defined as visible lens opacity impairing vision in absence of red reflex (partly or completely). Posterior segment pathology was diagnosed based on exclusion of cataract and refractive error. All subjects having VA worse than 6/18 in either eye were referred. It may be stated here that the definition of blindness in APEDS and RACSS were identical.

The study team involved a vision technician (1-year trained, post high school) with more than 2 years experience and two trained community eye health workers. A vision technician is a person trained to provide primary eye care in the rural areas in India. A 2-day training session, related to selection of clusters, enumeration methods, coding and data entry and maintenance of daily records was provided. Inter-observer agreement was arrived between the principal investigators and the vision technician for VA assessment and a threshold kappa value of  $\geq 0.7$  was considered as acceptable. The data collected were further quality controlled by the principal investigator (s) who visited the study clusters and reassessed VA in randomly selected subjects, previously examined by the field personnel.

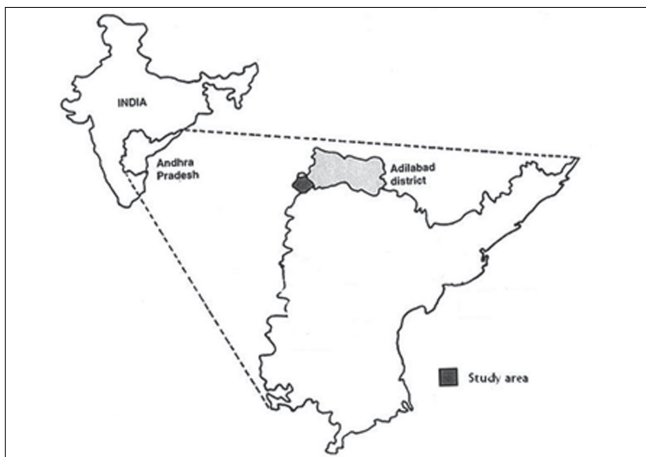
During enumeration, the age of the subject was cross verified using recall of historical events. The examination procedure was explained to the subject and prior informed consent was obtained. All the study protocols were followed as per the standard RACSS methodology.<sup>[14]</sup> VA was assessed using available correction in day light conditions. Modified Snellen's E chart with 6/60 and 6/18 optotype was used to measure VA. If the VA was worse than 6/18 in either eyes, pin-hole was used to assess vision. Undilated evaluation of lens and fundus was done in semi-dark condition using a torch light and direct ophthalmoscope, respectively. A maximum of three site visits were made whenever the subject could not be tracked in the initial survey after which he/she was labeled absent.

The data were entered in the standard RACSS survey forms and all the data was entered on the same day. A total of 10% of the records were randomly verified for consistency of data entry by the principal investigator. Institutional Review Board of L V Prasad Eye Institute approved the study protocol and the protocol adhered to the tenets of the Declaration of Helsinki.

Statistical analysis was performed with STATA (version 11.0).<sup>[16]</sup> It included the comparison between two datasets of RACSS and APEDS, wherein, the tests of significance was assessed by chi-square test for categorical variables and *t*-test for continuous variables and logistic regression for odds ratios. Confidence intervals for prevalence estimates and odds ratios were also calculated. *P* value of  $< 0.05$  was considered to be statistically significant.

## Results

Using RACSS, 2300 subjects were enumerated and 2160 were examined (93.9%); 123 subjects were unavailable and 17 refused examination. In the APEDS dataset, there were 521 subjects  $\geq 50$



**Figure 1:** Map showing the location of study area in the rural district in Andhra Pradesh state, India

years in the same region. Overall, the mean ages of the subjects in the APEDS dataset (60.5±7.6 years) was significantly different from the RACSS (63.7±8.1 years) dataset ( $P<0.001$ ). There was also a significant difference ( $P=0.04$ ) in the proportion of females examined in APEDS (54.9%) and RACSS (60.1%).

Table 1 shows the comparison of prevalence of blindness and VI in APEDS with RACSS. There was significant reduction in the prevalence of blindness ( $P=0.03$ ) and VI ( $P<0.001$ ) in RACSS as compared with APEDS in the same population. This reduction in blindness prevalence was relatively more significant in women ( $P=0.0004$ ), than men ( $P=0.4$ ).

Blindness was increasing with age; however, there was no significant gender difference in blindness in APEDS and RACSS datasets as evident from the age and gender adjusted prevalence [Table 2]. Among the various causes of blindness, cataract was responsible for 72.8% of the blindness in RACSS, and 61.1% in APEDS. While posterior segment pathology was the second leading cause of blindness in APEDS (21%), it contributed to only 2.3% in RACSS [Table 3].

Table 4 compares the outcome of cataract surgeries as analyzed by RACSS and APEDS. In RACSS, 275 subjects had 346 eyes operated (12.7%; 95% CI, 11.4–14.2%) and in APEDS, 42 subjects had 47 eyes operated (8.1%; 95% CI, 6–10.9%). Poor visual outcome was seen in 17.3% eyes (95% CI, 13.5–21.8%) in RACSS while it was in 34% eyes (95% CI, 20.9–49.3%) in the APEDS dataset and this difference was statistically significant ( $P=0.005$ ). Turning to the visual outcomes of surgeries done in different sectors, stratified by aphakia and pseudophakia

[Table 5]; 289 (83.5%) eyes were pseudophakic in RACSS and only 12 (25.5%) in APEDS. In RACSS, 68.5% of surgeries were done in the NGO sectors while the remaining was in the government/private sectors (31%) or makeshift camps (0.5%). At the time of APEDS the surgeries were done either in the government sector in hospital-based settings (34%) or camp-based settings (38.3%) and in the private sector (27.7%).

## Discussion

To the best of our knowledge, this is the first study in India looking at the changes in the prevalence of blindness in a specific geographical region. Previous blindness estimates from India were based on the results of national surveys, which showed a reduction in the prevalence of blindness from 9.4% (1971–1974 survey) to 8.5% (1999–2001 survey).<sup>[17]</sup> Subsequent Rapid Assessment survey in 2007 in the same districts, done between 1999 and 2001, showed a further reduction in the prevalence of blindness from 8.5% to 8%.<sup>[7]</sup> However, these surveys were done in 16 districts located in the 15 most populated states of India. There were huge variations in the prevalences of blindness between these states and regional differences were not reported. Apart from this, there were also differences in the methodology of these two studies. In our study, the reduction in the prevalence of blindness was from 11% to 8%, which is similar to that reported in the national survey in India (8%).<sup>[7]</sup> However, the prevalence of blindness is much higher than reported from the state of Gujarat (6.9%)<sup>[18]</sup> and neighboring countries.<sup>[19–24]</sup> A similar reduction in the prevalence of blindness was seen in the Lumbini zone and

**Table 1: Categories of blindness and visual impairment in Andhra Pradesh Eye Disease Study and Rapid Assessment of Cataract Surgical Services**

Presenting visual acuity in better eye	APEDS (N=521)		RACSS (N=2160)		P value*
	N (%)	95% CI	N (%)	95% CI	
≥6/18	254 (48.8)	44.5–53.0	1694 (78.4)	76.6–80.1	<0.001
<6/18–6/60	210 (40.3)	36.1–44.5	293 (13.6)	12.2–15.1	<0.001
<6/60	57 (11)	8.3–13.7	173 (8)	6.9–9.1	0.03

\*Overall P value <0.05 (2df Chi-square test), 95% CI: 95% confidence interval, APEDS: Andhra Pradesh Eye Disease Study, RACSS: Rapid Assessment of Cataract Surgical Services

**Table 2: Age and gender adjusted comparison of blindness in Andhra Pradesh Eye Disease Study and Rapid Assessment of Cataract Surgical Services**

	APEDS			RACSS		
	Total N=521 (%)	Blindness N=57 (%)	§OR (95% CI)	Total N=2160 (%)	Blindness N=173 (%)	§OR (95% CI)
Age group (years)						
50–59	243 (46.6)	11 (4.5)	Ref	1157 (53.6)	33 (2.9)	Ref
60–69	216 (41.5)	25 (11.6)	2.75 (1.32–5.74)	768 (35.6)	73 (9.5)	3.58 (2.35–5.46)
≥70	62 (11.9)	21 (33.9)	11.52 (5.12–25.89)	235 (10.9)	67 (26.5)	13.58 (8.69–21.24)
Gender						
Male	235 (45.1)	21 (8.9)	Ref	862 (39.9)	67 (7.8)	Ref
Female	286 (54.9)	36 (12.6)	1.70 (0.93–3.09)	1298 (60.1)	106 (8.2)	1.06 (0.77–1.45)

§: Age and gender adjusted odds ratio, 95% CI: 95% confidence interval, APEDS: Andhra Pradesh Eye Disease Study, RACSS: Rapid Assessment of Cataract Surgical Services

**Table 3: Causes of blindness in Andhra Pradesh Eye Disease Study and Rapid Assessment of Cataract Surgical Services**

Primary cause	APEDS N (%)	RACSS N (%)
Cataract	35 (61.4)	126 (72.8)
Refractive error	6 (10.5)	10 (6.0)
Corneal opacity	2 (3.5)	21 (3.5)
Posterior segment pathology	12 (21)	4 (2.3)
Others*	2 (3.5)	12 (7.0)
Total	57 (100.0)	173 (100.0)

\*Others include surgical complications, amblyopia, absent globe and unidentified cause, APEDS: Andhra Pradesh Eye Disease Study, RACSS: Rapid Assessment of Cataract Surgical Services

**Table 4: Visual outcomes after cataract surgery in Andhra Pradesh Eye Disease Study and Rapid Assessment of Cataract Surgical Services**

Visual acuity category	APEDS N*(%)	95% CI <sup>§</sup>	RACSS N*(%)	95% CI <sup>§</sup>	P value <sup>§</sup>
≥6/18	15 (32)	19.1–47.1	227 (65.6)	60.3–70.6	<0.001
<6/18–6/60	16 (34)	20.9–49.3	59 (17.1)	13.2–21.4	0.005
<6/60	16 (34)	20.9–49.3	60 (17.3)	13.5–21.8	0.005
Total	47 (100)		346 (100)		

<sup>§</sup>Overall P value <0.05 (2df Chi-square test), <sup>§</sup>95% CI: 95% confidence interval, \*Includes data for eyes, APEDS: Andhra Pradesh Eye Disease Study, RACSS: Rapid Assessment of Cataract Surgical Services

**Table 5: Visual outcomes of surgeries done in different sectors, stratified by aphakia and pseudophakia**

	Andhra Pradesh Eye Disease Study (APEDS)			
	Aphakia		Pseudophakia	
	Hospital	Private clinic/camps	Hospital	Private clinic/camps
≥6/18	0 (0)	5 (17.3)	8 (80%)	2 (100)
<6/18–6/60	5 (83.3)	9 (31)	2 (20)	0 (0)
<6/60	1 (16.7)	15 (51.7)	0 (0)	0 (0)
Total	6 (100)	29 (100)	10 (100)	2 (100)
	Rapid Assessment of Cataract Surgical Services (RACSS)			
	Aphakia		Pseudophakia	
	NGO	Government/private	NGO	Government/private
	N* (%)	N* (%)	N* (%)	N* (%)
≥6/18	11 (57.9)	23 (40.1)	141 (73.8)	52 (65.8)
<6/18–6/60	4 (21.1)	12 (21)	31 (16.2)	12 (15.2)
<6/60	4 (21.1)	22 (38.6)	19 (9.9)	15 (19)
Total	19 (100)	57 (100)	191 (100)	79 (100)

\*Includes data for eyes, NGO: Nongovernmental organization

Chetwan district of Nepal (from 5.3% to 4.6%).<sup>[22]</sup> Similarly, there was a reduction in the prevalence of VI from 40.3% to 13.6% in the present study, which was much higher than the national surveys in India<sup>[4,7]</sup> and Nepal.<sup>[22,25]</sup>

This overall reduction in the prevalence of blindness and VI is of seminal importance considering the demographic shift, senescence and an ever increasing elderly population in India.<sup>[26]</sup> The mean ages of the subjects were much higher than that found in APEDS. Hence, we assume that this reduction in the prevalence of blindness and VI in this region could be due to better accessibility and affordability of services as well as changes in the health-seeking behavior of the population. Until 1996, there was no eye care service provider in this region, and occasional services were offered from distant service providers, most of which were in the form of makeshift camps. However, after 1996, the services in this region were being provided by the newly set up LVPEI secondary eye care facility. Although, there is no absolute measure to quantitate such changes, nevertheless, other surrogate measures such as affordability and accessibility by the local population coupled

with lack of other service provider in this area over the past decade indicate that this centre may have played a significant role in reducing the prevalence of blindness and VI in this area. Other possible reasons could be the occasional services being provided by other NGO organizations offering services, as well as an improvement in the socio-economic status and health-seeking behaviors of the local population enabling them to seek services outside their locale.

Another possible reason for the difference could be due to difference in methodology of these two studies, including method of measuring visual acuity, which could be argued as a contributor for the difference in prevalences of blindness. The visual acuity assessment in APEDS was done using LogMAR chart in a clinic-based setting using standard illumination, whereas, in RACSS it was assessed using a modified Snellen's chart with tumbling E optotypes in a typical field setting. However, there are no data on the agreement of these two charts and hence, the amount of bias could be difficult to estimate. The bias would be relatively lessened if we look at visual acuity as a categorical variable rather than a continuous variable.

Apart from this, the research in other areas of public health have demonstrated that rapid assessment provide results that are similar to the conventional sample surveys and are more cost-effective.<sup>[27]</sup>

Apart from this, the sample selected in APEDS was a subsample of a bigger study and thus may not be representative of those aged above 50 years of age. It is possible that this sampling variation could have influenced our study results.

Overall, there was an increase in the prevalence of cataract surgery in this area from 8.1% to 12.7%. Earlier, the prevalence of cataract surgery during the time of APEDS was much lower than the prevalence reported from other studies done in Bharatpur in Rajasthan (12.8%) and Sivaganga in Tamilnadu (14.7%) from India.<sup>[28,29]</sup> Similarly, the prevalence of cataract surgery at the time of RACSS was also lower than that reported from Gujarat (17.6%),<sup>[30]</sup> but was comparable to that reported from Turnevelli (11.8%)<sup>[31]</sup> and the rural population of Chennai (13.5%).<sup>[32]</sup> It was observed during APEDS that ocular surgeries in this area were largely done at the government sector (either in makeshift camps or hospital settings) and some private sector, but not in the NGO sector as they were yet to be established. However, during RACSS, nearly two-thirds of the services were offered from a NGO in the form of the secondary eye care facility that was further supplemented by few other NGO service providers in this area. This could be a possible reason for the increase in the prevalence of cataract surgery in this area other than the health-seeking behavior and an improved socio-economic status of the population.

Compared with APEDS, a significant reduction in poor visual outcomes following cataract surgery was noted in RACSS. Similar results have earlier been reported in studies from India<sup>[18,31]</sup> and other neighboring countries.<sup>[22,25,33]</sup> The reduction in relatively poorer outcomes could be attributed to the reduction in the number of subjects with aphakia in RACSS (16.5%) compared with APEDS (74.5%), which may be further associated to surgeries being done in a camp setting to a hospital setting. Notably, during APEDS, 38.3% of surgeries were done in a camp setting, whereas, it reduced to only 0.5% at the time of RACSS. Additionally, this reduction in the prevalence of aphakia could also be one of the possible reasons for reduction in overall prevalence of blindness in RACSS. Intriguingly, when we recalculated the differences in RACSS and APEDS after excluding subject with postcataract surgery blindness, the results pertaining to the prevalence of blindness was still consistent ( $P=0.02$ ) with our previous findings ( $P=0.03$ ).

Looking at the causes of blindness, cataract was the primary cause of blindness in both APEDS (61.4%) and RACSS (72.8%). But posterior segment pathology accounted for 21% blindness in APEDS, but only for 2.3% in RACSS, which could be due to the different methodologies in these two studies. While a detailed dilated comprehensive eye examination was performed in APEDS, on the contrary, a rapid, undilated examination was done in RACSS. Similarly, the cause of blindness was attributed to the primary responsible cause in APEDS, while it was the most avoidable cause in RACSS.

In summary, there was an overall reduction in the prevalence of blindness and VI and an improvement in the outcomes of cataract surgery in this district, over a decade. As there was no other eye care facility in the region over the past decade, it is

likely that this LVPEI secondary care centre played a major role in this initiative. However, the role of other service providers, changes in health-seeking behavior and other temporal trends cannot be denied or excluded as there was scanty information on these issues. The potential limitations notwithstanding, the current study demonstrates a decreasing trend in visual impairment and an improvement of visual outcomes following cataract surgery and exemplifies the use of rapid assessments following a major survey.

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## Continuing Medical Education

6<sup>th</sup> - 7<sup>th</sup> October 2012

The World Ocular Trauma Congress (X<sup>th</sup> Meeting of the International Society of Ocular Trauma) Hosted by the Ocular Trauma Society of India being organised at Jaipur, India  
For Information contact (Prof Dr. Yogesh Shukla) Organising Secretary,  
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3<sup>rd</sup> - 4<sup>th</sup> November-2012

36<sup>th</sup> MP State Ophthalmic Conference-2012  
Venue: Hotel Kalchuri Residency, Jabalpur (MP)  
Host: Jabalpur Divisional Ophthalmological Society  
For further information please contact:- Organising Secretary,  
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