

# Unilateral visual impairment in rural south India–Andhra Pradesh Eye Disease Study (APEDS)

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## Abstract

• **AIM:** To report the prevalence and causes of unilateral visual impairment (UVI) in rural population of all ages in rural Andhra Pradesh, India.

• **METHODS:** A population-based cross sectional study using a multi-stage cluster sampling methodology was carried out in West Godavari, Adilabad and Mahbubnagar districts in south India. A comprehensive eye examination that included presenting and best corrected visual acuity and dilated fundus examination was conducted by trained professionals. UVI is defined as presenting visual acuity <6/18 in one eye but ≥6/18 in other eye. Multiple logistic regression analysis was used to test association of UVI with socio-demographic risk factors.

• **RESULTS:** Data were analyzed for 6634/7771 participants after excluding those with bilateral visual impairment. The mean age of the participants was 27.4y (Standard deviation: 17.9y), 51.9% were women and 49.1% were educated. The prevalence of UVI was 7.8% (95% CI: 7.2% – 8.5%). Uncorrected refractive error (60.8%), cataract (17.4%) and retinal causes (6.6%) were the leading causes of UVI. On multiple logistic regression analyses, older age, not having education, living in well-off district had significantly higher odds of being associated with UVI. UVI was not associated with gender.

• **CONCLUSION:** UVI is common in rural south India. Most of it is due to cataract and refractive errors, both of which can be addressed at primary and secondary levels

of eye care. Burden of UVI should also be considered in planning eye care services.

• **KEYWORDS:** visual impairment; cataract; refractive errors; India; Andhra Pradesh Eye Disease Study

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## INTRODUCTION

Globally, over 32.4 million people are blind and another 191 million people have moderate to severe visual impairment (VI)<sup>[1]</sup>. India is the home of over 8.3 million people with VI, the highest number in the world. Typically these VI estimates are based on definition using presenting visual acuity and/or visual field in the better eye; hence those with unilateral VI (UVI) are missed out in these estimates. The use of better eye in VI definitions underestimates the true burden of VI in a given population. Studies have shown the impact of UVI on visual function and health related quality of life in different settings<sup>[2-3]</sup>. Studies have also shown the benefits of second eye cataract surgery<sup>[4-8]</sup>. Data that include both unilateral and bilateral VI would provide complete spectrum of VI in a given region.

The Andhra Pradesh Eye Disease Study (APEDS) I was a large epidemiological study that was conducted between 1996 and 2000 in which 10 293 participants were examined from one urban and three rural locations in the south Indian state of Andhra Pradesh. This study found the prevalence of 1.84% and 8.09% for blindness and moderate VI respectively<sup>[9-10]</sup>. A review of major findings from this study was reported<sup>[11]</sup>. This study also reported a prevalence of UVI of 3.8% in urban population of all ages where UVI was defined as presenting distance visual acuity <6/18 in the worse eye and 6/12 or better in the better eye<sup>[12]</sup>.

During 2010-2011, a feasibility study (APEDS II) was carried out to assess the availability of the participants examined in 1996-2000<sup>[13]</sup>. The results from this study revealed that over 70% of the participants from the original cohort were available in rural clusters and were willing to participate in a follow-up study. However the participants from the urban cohort could not be traced due to significant infrastructural

changes. This feasibility study also found that mortality is associated with VI<sup>[13]</sup>. As over 70% of the participants examined in the initial cohort in rural areas were available, a follow-up study of the surviving cohort was initiated in June 2012 (APEDS III) to understand the incidence and progression of VI in the surviving cohort. In this paper we report the prevalence and causes of UVI in rural population aged > 15y in Andhra Pradesh, India, from the APEDS I as a baseline for the follow-up study (APEDS III) that is currently being carried out. The urban data on prevalence of UVI is published<sup>[12]</sup>.

## **SUBJECTS AND METHODS**

The study protocol was reviewed and approved by Institutional Review Board of L V Prasad Eye Institute, Hyderabad, India. The study followed the tenets of the Declaration of Helsinki. All the participants provided written informed consent for participating in the study. Data collection was accomplished from 1996 to 2000.

Details of the study protocol and the findings of the APEDS were reported elsewhere<sup>[14]</sup>. In brief, a multi stage systematic cluster random sampling methodology was used to select a representative sample from three rural locations (West Godavari, Adilabad and Mahbubnagar districts) in Andhra Pradesh<sup>[14]</sup>. Adilabad and Mahbubnagar districts are now in the newly formed state of Telangana. The comprehensive eye examination was conducted by trained professionals. The detailed eye examination protocol is published elsewhere<sup>[14]</sup>. The data collection included personal and socio-demographic details such as age, gender, education, area of residence. In short, the clinical examination included presenting distance and near visual acuity assessment using a logarithm of minimum angle of resolution (logMAR) chart under standard testing conditions. Best corrected visual acuity was recorded after refraction. Detailed anterior segment assessment was conducted using a slit lamp biomicroscope. Fundus examination through dilated pupils was done on all participants unless contraindicated.

UVI is defined presenting visual acuity worse than 6/18 in one eye but better than 6/18 in other eye. Those with bilateral VI were excluded from analysis. UVI is included moderate UVI (< 6/18 to 6/60) and unilateral blindness (< 6/60).

A second definition of UVI is also used to compare the prevalence estimates of this study with the earlier published urban segment of the same study. As per this, UVI was defined as presenting distance visual acuity < 6/18 in the worse eye and 6/12 or better in the better eye<sup>[12]</sup>.

**Statistical Analysis** Data were analyzed using Stata statistical package for windows version 12 software. Univariate analysis was done using a Chi-square test. Multiple logistic regression models were used to examine the association between UVI and risk factors such as age, gender,

education and area of residence. Hosmer-Lemeshow goodness of fit test was used to assess the goodness of the model fit. The odds ratio (OR) with 95% confidence intervals (CI) is presented. The prevalence estimates were adjusted for the age and gender distribution of the population of the three districts in year 2001.

## **RESULTS**

**Characteristics of the Study Participants** Data were analyzed for 6634 participants after excluding those with bilateral VI. The mean age of the participants was 27.4y (standard deviation 17.9y; ranged < 1y to 90y), 44% ( $n=2922$ ) participants were older than 30y, 51.9% ( $n=3443$ ) were women, 50.9% ( $n=3377$ ) had no formal education. About 31.5% ( $n=2091$ ) participants were from West Godavari district, 36.0% ( $n=2391$ ) from Adilabad and 32.4% ( $n=2152$ ) were from Mahbubnagar district.

**Prevalence of Unilateral Visual Impairment** The prevalence of UVI was 7.8% ( $n=518$ ; 95% CI: 7.2%-8.5%), which included unilateral blindness in 152 participants (2.3%; 95% CI: 2.0%-2.7%) and moderate UVI in 366 participants (5.5%; 95% CI: 5.0%-6.1%). The crude prevalence of UVI stratified by age groups, gender, education and area of residence are presented in Table 1. On univariate analysis, UVI was higher in older age groups ( $P<0.01$ ), among those with no formal education ( $P<0.01$ ), those residing in West Godavari district ( $P<0.01$ ). The UVI was not associated with gender ( $P=0.593$ ).

On multivariable analysis, the odds of having UVI were higher in among those older than 30y compared to less than 30y age group. While gender showed no significant association ( $P=0.593$ ), having no formal education had higher OR for UVI (OR: 1.3; 95% CI: 1.0-1.6;  $P=0.02$ ). Compared to relatively well-off, West Godavari district, participants in poorer regions such as Mahbubnagar and Adilabad had a lower odds (OR: 0.7; 95% CI: 0.6-0.9;  $P<0.01$ ) and (OR: 0.8; 95% CI: 0.6-1.0;  $P=0.03$ ) respectively (Table 2).

Using the definition two for UVI, the prevalence of UVI was 3.6% ( $n=239$ ; 95% CI: 3.2%-4.1%), which included unilateral blindness in 106 participants (1.6%; 95% CI: 1.3%-1.9%) and moderate UVI in 133 participants (2.0%; 95% CI: 1.7%-2.4%).

**Causes of Unilateral Visual Impairment** Table 3 shows the causes of UVI by categories of VI. Refractive errors were the leading cause of moderate UVI (82.2%); cataract was the leading cause of unilateral blindness (43.4%).

Table 4 shows the main causes of moderate UVI and unilateral blindness stratified by age, gender, education and area of residence. While the proportion of causes of moderate UVI and blindness varied across the age groups ( $P<0.001$ ), it was similar among the genders, education status and area of residence.

**Table 1 Characteristics of the participants and prevalence of UVI (univariable analysis)**

Parameters	Participants	Prevalence of UVI	<i>n</i> (%)	<i>P</i>
Age groups (a)				<0.01
<15	2178	27 (1.2)		
16-29	1359	27 (2.0)		
30-39	1358	78 (5.7)		
40-49	899	109 (12.1)		
50-59	489	114 (23.3)		
60-69	291	122 (41.9)		
≥70	60	41 (68.3)		
Gender				0.593
M	3191	255 (8.0)		
F	3443	263 (7.6)		
Education				<0.01
Any education <sup>1</sup>	3257	210 (6.4)		
No education <sup>2</sup>	3377	308 (9.1)		
Area of residence				<0.01
West Godavari	2091	199 (9.5)		
Adilabad	2391	170 (7.1)		
Mahbubnagar	2152	149 (6.9)		
Total	6634	518 (7.8)		

UVI: Unilateral visual impairment. %: Row percentages presented; <sup>1</sup>Any education is defined as attending at least primary school among those aged 5y and older; <sup>2</sup>Includes 597 participants who were aged ≤5y on whom data on education was not collected.

**Table 2 Effect of demographic variables on UVI by multiple logistic regression analysis**

Parameters	Odds ratio (95% CI)	<i>P</i>
Age groups (a)		
≤30	1.0	
>30	8.5 (6.4-11.2)	<0.01
Gender		
M	1.0	
F	0.9 (0.7-1.1)	0.29
Education		
Any education	1.0	
No education	1.3 (1.0-1.6)	0.02
Area of residence		
West Godavari	1.0	
Adilabad	0.8 (0.6-1.0)	0.03
Mahbubnagar	0.7 (0.6-0.9)	<0.01

Hosmer-Lemeshow test for goodness of fit for the regression model: *P*=0.66, variance inflation factor for the multiple logistic regression model: *P*=1.23.

## DISCUSSION

UVI is common in rural south India affecting eight out of every hundred individuals after excluding those with bilateral VI. The reports on UVI are important as several causes such as corneal scars post infectious keratitis, and other consequences of trauma get excluded when VI definition are based on better eye are used. For example, we found that

**Table 3 Causes of moderate UVI and unilateral blindness**

Causes of UVI	Moderate UVI	Unilateral blindness	All UVI
Refractive error	301 (82.2)	14 (9.2)	315 (60.8)
Cataract	24 (6.6)	66 (43.4)	90 (17.4)
Corneal disease <sup>1</sup>	7 (1.9)	22 (14.5)	29 (5.6)
Glaucoma	0 (0.0)	7 (4.6)	7 (1.4)
Amblyopia	6 (1.6)	11 (7.2)	17 (3.3)
Retinal disease <sup>2</sup>	18 (4.9)	16 (10.5)	34 (6.6)
Others	10 (2.7)	16 (10.5)	26 (5.0)
Total	366 (100)	152 (100)	518 (100)

UVI: Unilateral visual impairment. <sup>1</sup>Corneal disease includes corneal scars due to infection or trauma; <sup>2</sup>Retinal disease includes age related macular degeneration, other retinal degenerations and other retinal conditions such as vascular occlusions.

corneal blindness contributed to over 14.5% in the unilateral blindness. Ocular trauma is also common and mostly reported to be unilateral in this population<sup>[15]</sup>.

Using a similar definition, the prevalence of UVI in our study was similar to that reported from urban population<sup>[12]</sup>. Similar to bilateral VI, UVI was more common in older age groups. This was expected as VI has been shown to be associated with older age in earlier studies done elsewhere and in Andhra Pradesh <sup>[9,10,16]</sup>. It is possible that the older individuals do not seek eye care services for UVI due to several barriers. A recent study from the same state has shown that "one vision adequate and no need felt" were leading person-related barriers that prevented people seeking services<sup>[17]</sup>.

Contrary to bilateral VI earlier reported from this study, we did not find an association between gender and UVI both on univariable and multivariable analysis<sup>[9-10]</sup>. The urban segment of this study that was published earlier also did not find an association between gender and UVI <sup>[12]</sup>. The association between gender and VI are not very consistent across the studies done in India. While few studies found a positive association between VI and gender while other recent studies did not find any association <sup>[9-10,16,18]</sup>. This could possibly be attributed to the regional variations in availability and uptake of eye care services among women.

Education is often linked with socio-economic status. We found a lower prevalence of UVI among those with any education. This finding is similar to that of bilateral VI earlier reported from the same state <sup>[9]</sup>. This may be due to higher visual demands among those with any education; better economic status and then seeking care to get rid of their VI. Lower prevalence of UVI in comparatively poorer areas such as Mahbubnagar and Adilabad compared to well-off West Godavari district was a surprise finding. Both the blindness and moderate VI were also reported to be higher in this district <sup>[9-10]</sup>. This could be due to differences in life style and family support structure in these districts. This phenomenon needs to be investigated further.

Refractive errors were the largest cause of UVI followed by

**Table 4 Main causes of moderate UVI and unilateral blindness stratified by personal and demographic characteristics of the study population**

Parameters	Moderate UVI			P	Unilateral blindness			P
	Refractive error (%, n=301)	Cataract (%, n=24)	Other causes (%, n=41)		Refractive error (%, n=14)	Cataract (%, n=66)	Other causes (%, n=72)	
Age groups (a)				<0.001				0.001
<40	64	1	34		11	21	68	
41-59	90	3	7		10	54	36	
≥60	81	16	3		7	58	35	
Gender				0.59				0.79
M	83	7	10		9	41	50	
F	82	6	13		10	46	44	
Education				0.24				0.15
Any education	77	10	14		12	35	53	
No education	85	6	9		12	35	53	
Area				0.87				0.41
West Godavari	82	7	10		8	51	41	
Adilabad	83	5	12		7	43	51	
Mahbubnagar	81	7	12		15	35	50	

UVI: Unilateral visual impairment. %: Row percentages presented.

cataract both of which can be corrected using spectacles and surgery respectively. Refractive errors can be detected and corrected at the primary eye care level such as vision centres while cataract surgeries can be performed at secondary eye care facilities. Cataract and refractive errors can also be detected through door to door surveys and community screening programmes. Apart from development of infrastructure such as vision centres and secondary centres, emphasis should also be laid on increasing the awareness levels in the community, as recent studies have found predominance of "person-related" barriers that prevent the uptake of services. These may be applicable to UVI as well. One can presume that barriers would be even more common in cases of UVI as impact of UVI is comparatively less compared to bilateral VI.

Our study involved a large representative sample and achieved a high response rate. A comprehensive eye examination was conducted to ascertain the causes of VI. Our definition of UVI included only visual acuity loss and not the visual field loss. This may have resulted in under estimation of the prevalence of UVI. The results of the study reflect the UVI situation 16y ago and it is possible that the prevalence must have changed over the years. Only the results from the APEDS III which is being carried can provide insights in the incidence and progression of UVI in the state. In conclusion, this paper supplements the earlier reports on bilateral VI and urban component of UVI published earlier<sup>[9-10,12]</sup> and will be a baseline for comparison of results from APEDS III.

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