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Title: Fifteen year incidence, causes and risk factors of visual impairment and blindness in Andhra Pradesh Eye Diseases Study

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ABSTRACT

Purpose: To report 15 year(range:13-17 years) incidence rate of visual loss(blindness and visual impairment (VI)), causes and risk factors for all ages, and for those 40 years or above at baseline for participants in Andhra Pradesh Eye Disease Study(APEDS).

Design: Population based cohort study

Methods: All rural participants were interviewed and underwent a comprehensive eye examination. Presenting visual acuity(PVA) was measured using a standard logarithm of minimum angle of resolution chart at 3 meters. Unaided, presenting, pinhole and best-corrected visual acuity(BCVA) were also recorded. World Health Organization(WHO) and United States of America(USA) categories of VI and blindness were used for analysis. Incident visual loss was defined as the development of, or worsening of visual loss of one or more categories.

Results: At baseline, 7,771 participants were examined and in APEDS III, 5,395(69.4%) were re-examined. Using WHO categories, the crude incidence rate of any visual loss based on PVA and BCVA were 14.6 and 6.3 per 100 person-years, respectively. Using US criteria, the values were 22.6 and 10.6 per 100 person-years, respectively. More than 90% of visual loss was due to cataract and uncorrected refractive error. Using WHO categories, significant independent risk factors for the incident visual loss were increasing age, female, illiterate, past or current smoker and current use of alcohol. Using the USA definition, additional risk factor was lower level of education.

Conclusions: The high incidence likely reflects poor access to eye care in this population which needs to be taken into account when planning eye care programs.

INTRODUCTION

Blindness and visual impairment (VI) are major public health problems with a significant impact on quality of life[1-4], economic productivity, mental health,[5,6] safety[7-10] and mortality.[11] According to recent global data, 36 million people are blind, and 217 million have moderate to severe VI.[12] Although the overall prevalence of blindness fell between 1990 and 2015, the number of people who are blind increased by 17.6%, and the number with moderate to severe VI increased by 35.4%. This increase is attributed to population growth and aging,[12] and increasing urbanization and life style charges.

Data on the magnitude and causes of blindness and VI are derived from cross sectional prevalence surveys and provide useful information for planning services and resource allocation to address current gaps. However, to plan for the future longitudinal incidence data are required. These studies can also provide more robust data on risk factors for eye diseases from which causality can be inferred more reliably, and can be used to describe the natural history of the disease. However, there are only a limited number of incidence studies, as they entail complex logistics, require more complex data analysis and are costly. Most studies have been undertaken in high income countries,[13-18] with fewer from India[19] and other regions;[20-25] all focussed on adults, and had relatively short follow up with only a few with 10 or more years.[16-18,26] The studies also differ in relation to inclusion criteria, age group, and the definitions of risk factors and of end points. We have previously reported the prevalence and causes of blindness and VI from our baseline survey, the Andhra Pradesh Eye Disease Study 1 (APEDS I).[27,28] In this paper, we report the incidence of blindness and VI over a mean of 15 years, stratified by age-group, sex, causes and risk factors (APEDS III).

METHODS AND DESIGN

Details of the methods for APEDS I and APEDS III have already been published.[29,30] In brief, APEDS I was conducted between 1996 and 2000, and recruited individuals from three rural and one urban cluster in undivided Andhra Pradesh (AP) state (i.e., before it was divided into two states) in southern India.[30] In APEDS I, 10,293 participants were examined (2,552 urban and 7,771 rural). Socio-demographic data and systemic risk factors were recorded for each individual and all underwent a detailed, comprehensive eye examination. Before planning the follow up study, in 2009-10 a feasibility study (APEDS II) was carried out, to trace participants examined in APEDS I. However, due to rapid urbanization over the past decade, it was not possible to trace the urban cluster in Hyderabad.[11] Hence, only the three rural areas in APEDS I were revisited, i.e. Tanuku (West Godavari district), Mudhol (Adilabad district) and Thoodukurthy (Mahabubnagar district). The result of APEDS II showed that 5,447 (70.1%) participants were available for follow-up, 1,453 (18.7%) had migrated and 871 (11.2%) had died.[11]APEDS III was carried out between 2012 and 2016 when participants from these three rural areas were re-examined using the same methodology as in APEDS I.[30] The aim of APEDS III was to estimate the incidence and risk factors for blindness and VI, including cataract, diabetic retinopathy (DR), uncorrected refractive error (URE) and glaucoma in participants who were disease free at APEDS I. In this paper we report the incidence, causes and risk factors for VI and blindness.

Socio-demographic data were collected from participants at their residence, as described earlier.[29] For participants aged 30 years and above the following data were collected: demographic data, history of ocular and systemic conditions such as hypertension and diabetes, risk factors, visual function, information related to barriers to the uptake of eye care services, and knowledge about a range of eye diseases. For those below 30 years of age, personal details, parent's education and occupation, spectacle use, reading habits, previous eye examination, consanguinity between parents, and their economic status in childhood were recorded. After the interview participants underwent a detailed eye examination at the base hospital.

The clinical team comprised four ophthalmologists, and an optometrist and vision technician (VT). The VTs were trained to examine the anterior and posterior segment, to measure visual acuity (VA) and undertake refraction. Height, weight and blood pressure were each measured three times using standard methods, and mean values were used. Presenting distance VA in each eye and then binocularly were measured using a standard, illuminated (at least 200lux) logarithm of minimum angle of resolution (logMAR) chart at 3 metres, using participants distance correction, if applicable. For participants who were not literate, a logMAR "E" chart was used. Unaided and pinhole distance VA were recorded. Near VA was measured at a distance of 40 cm using a logMAR near vision chart with near correction, if applicable, and unaided. Monocular and binocular near vision were assessed. If the individual was using spectacles, the power of the spectacles was measured. Retinoscopy was undertaken for those with a presenting distance or near VA of less than logMAR 0.0 (6/6) and best corrected VA was measured. Undilated slit lamp examination (SL 120 Carl Zeiss Meditec, Inc, Dublin, CA) was performed by the ophthalmologist, including intraocular pressure measurement using Goldman applanation tonometry (Carl ZeissMeditec, Inc, Dublin, CA), before and after pupil dilatation. For participants examined at home, IOP was measured using a Perkins tonometer. Gonioscopy was performed on all participants and graded by the ophthalmologist following the APEDS I protocol, using NMR-K two mirror lens (Ocular Instrument Inc., Bellevue, WA, USA).[31] Four-mirror gonioscopy was also performed with an indirect gonioscopic lens (Volk Opticals Inc., Mentor, OH, USA). After gonioscopy, pupils were dilated with tropicamide 1% and phenylephrine hydrochloride 2.5% for lens grading and posterior segment examination unless contraindicated (i.e. risk of angle closure or active infection). In eyes at risk of angle closure (occludable angles), laser iridotomy was performed and the dilated examination was done at a later date. Phenylephrine was not used in participants with hypertension or cardiac disease. Dilated eye examination included grading of changes in the lens, optic disc and retina (diabetic retinopathy and ARMD) using standard grading systems, as described earlier.[29] Following dilated examination, biometry was undertaken and visual fields were assessed using a Humphrey visual field analyser (model 720E, Carl Zeiss Meditec, Inc, Dublin, CA). Stereo-photographs of the disc, macula and retina were taken using a Zeiss FF 450-plus fundus camera with VISUPAC digital image archiving system (Carl Zeiss, Jena, Germany). Corneal, anterior segment and lens photographs were taken using a Topcon photo-slit lamp camera (Topcon DC 3, Bauer Drive, Oakland, NJ). Cirrus high-definition-OCT (Carl Zeiss Meditec, Jena, Germany) was used to measure retinal nerve fibre layer thickness, optic nerve head and optic disc cupping.

Categories of visual impairment
In order to provide comparable data, the World Health Organization (WHO) categories of VI and blindness were used as well as the United States of America (USA) criteria. Data are presented using presenting and best corrected VA in the better eye.[32] Using WHO criteria, moderate VI was defined as a VA of less than 6/18 down to 6/60; severe VI as a VA of less than 6/60 down to 3/60; and blindness as a VA of less than 3/60. Using the USA definition, moderate VI was defined as VA of less than 6/12 to better than 6/60; and blindness as a VA of equal to or worse than 6/60.

Definitions of incident visual loss and causes
In this paper we use the term visual loss to encompass all categories of visual impairment and blindness, and used the same definitions of incidence as in other studies.[14,33] The incidence of "any visual loss" was defined as any category of visual loss at APEDS III among those who were not impaired at baseline. The incidence of mild VI also relates to those who were not impaired at baseline. The other definitions use a combination of progression of visual loss from baseline of one or more categories, and new cases of visual loss. For example, the incidence of moderate VI includes those who progressed from mild to moderate VI as well as those who were not impaired at baseline. Similarly, the incidence of blindness includes those with less severe VI at baseline which had progressed to blindness by APEDS III as well as those who were not impaired at baseline.

The causes of any VI were documented for each eye and for the person, as in the original APEDS protocol.[27] The causes identified by the examining ophthalmologist were discussed with the principal investigator (RCK) and other co-investigators to reach a consensus. If there was inadequate information to make a decision, the participant was re-examined by the principal investigator. If cataract and ARMD were both present, and in the clinical judgement of the ophthalmologist cataract surgery would not improve the VA, the cause was recorded as ARMD. Similarly, if index myopia was present and the vision improved with refraction, the cause of VI was recorded as cataract and not uncorrected refractive error.

Analysis
Stata 13 was used for statistical analysis (StataCorp, Texas, USA). Participants who had VA data recorded at APEDS I and APEDS III were included in the analysis, and the age and sex specific incidence rate was calculated using person time at risk. All subjects examined and having visual acuity data at APEDS I and APEDS III were included in analysis, which also included those who had undergone cataract surgery during the follow up period. Logistic regression modelling was used to assess associations between risk factors and VI and blindness. All data were analysed for all ages, and for participants aged ≥40 years at baseline. For categorical variables in univariable analysis, chi-square test or Fisher's exact test was used. A two tailed value of <0.05 was considered statistically significant. T-tests and one-way ANOVA were used to compare continuous variables. Multi-collinearity between variables was assessed by looking at the variance inflation factor; and fitness of the model was assessed using Hosmer Lemeshow test for goodness of fit.

Ethics

The study was approved by the Ethics Committees of the L V Prasad Eye Institute (LVPEI), Hyderabad, India and the London School of Hygiene & Tropical Medicine (LSHTM), London. Written informed consent was obtained from all participants and legal guardians gave consent for minors (<18 years of age).

RESULTS

At baseline, 7,771 participants from the three rural clusters aged 0 to 95 years were examined. At follow up (mean 15 years, range 13-17), 5,395 (69.4%) participants were re-examined (Figure 1). Reasons for non-response at APEDS III were death (1,324, 17.0%), migration (778, 10.0%), declined examination (165, 2.1%), and not traceable (109, 1.4%). Among 2,790 participants aged ≥40 years at baseline, 1,470 (52.7 %) were examined. Reasons for non-response were death (1,106, 39.6%), migration (92, 3.3%), declined examination (71, 2.5%), and not traceable (51, 1.8%).

The mean age of participants at baseline was 28 (SD ± 17.5) years (Table 1). 52.9% were female and 49.0% had not received any formal education. The majority of participants did not have diabetes or hypertension, and most did not smoke or take alcohol. Those who had died between APEDS I and APEDS III were significantly older ($p<0.001$), and more likely to be male ($p<0.001$), uneducated ($p<0.001$), have diabetes ($p<0.001$) and hypertension ($p<0.001$), and to smoke ($p<0.001$) and drink alcohol ($p<0.001$). Those who declined to participate in APEDS III were more likely to be female ($p=0.002$), better educated ($p<0.001$), a non-smoker ($p<0.001$) and non-alcohol drinker ($p<0.001$).

Table 1. Baseline Characteristics among Participants and Nonparticipants in Andhra Pradesh Eye Disease Study III (APEDS III)

Incidence rate of any visual loss for all ages

Using WHO categories, the crude incidence rate of any visual loss based on presenting VA and best correct VA were 14.6 (95% confidence interval (CI): 13.6-15.7) and 6.3 (95% CI: 6.1-6.4) per 100 person-years, respectively. Using US criteria, the values were 22.6 (95% CI: 22.3-23.0) and 10.6 (95% CI: 10.3–10.8) per 100 person-years, respectively. The crude and age- and sex-adjusted incidence of any visual loss was significantly higher in women than men ($p<0.05$) for WHO and US criteria. The incidence increased with age at baseline (Table 2). Figure 2A and 2B show the incidence of any visual loss for men and women for different age groups, using WHO and US criteria respectively

Table 2: 15-year incidence rate of any visual impairment in APEDS III according to World Health Organization (WHO) and United States (US) criteria.

Incidence of sub-categories of incidence for all ages

Using the sub-categories of incidence, WHO definitions and presenting VA, the crude age- and sex-adjusted rates were as follows: moderate VI 13.4 (95% CI: 13.1-13.6), severe VI 2.1 (95% CI: 2-2.2) and blindness 0.9 per 100 person-years (95% CI: 0.9-1.0)(Supplementary table 1). Women had significantly higher crude incidence of moderate VI ($p=0.02$), and severe VI ($p=0.001$) than men, but for blindness there was no significant difference by sex ($p=0.5$). Using best corrected VA, the age- and sex-adjusted the crude incidence rates were: moderate VI, 5.5 (95% CI: 5.3-5.7), severe VI 0.5 (95% CI: 0.4-0.6) and blindness 1.0 per 100 person-years (95% CI:

0.9-1.1) (Supplementary table 2). Women had a significantly higher incidence of moderate VI (p=0.02) and severe VI (p=0.01) than men, but for blindness there was no significant difference by sex (p=0.7).

Using the USA definitions the findings were similar for the crude and age- and sex-adjusted incidence rates of moderate VI and blindness using presenting and best-corrected VA, with similar differences between men and women (Supplementary tables 3 and 4).

Incidence rate of visual impairment for participants aged aged ≥40 at baseline
Using WHO definitions and PVA and BCVA, the incidence rate of any visual loss was 38.9 (95% CI: 35.9-41.8) and 19.2 (95% CI: 17.1 - 21.4) per 100 person-years, respectively. The incidence of blindness (VA <20/400) using PVA and BCVA was 2.6 (95% CI: 1.8 - 3.5) and 2.7 per 100 person-years (95% CI: 1.9 - 3.6), respectively. Using the USA definition and PVA and BCVA the incidence of any visual loss was 54.9 (95% CI: 51.6 - 58.2) and 32.5 per 100 person-years (95% CI: 29.9 - 35.2), respectively. The incidence of blindness (VA <=20/200) using PVA and BCVA was 8.4 (95% CI: 7.0 - 10.0) and 4.1 per 100 person-years (95% CI: 3.1 - 5.2), respectively.

Causes
Using WHO and USA categories of visual loss, cataract and uncorrected refractive error were the commonest causes of incident visual impairment and blindness for all ages and for those aged ≥40 years at baseline (Table 3), accounting for more than 90% of all causes. Cataract was the leading cause of blindness in each group, accounting for more than 70% of the blindness. Other, less important causes of blindness were retinitis pigmentosa, corneal pathology, glaucoma, ARMD and other retinal conditions.

Table 3. Causes of incident visual impairment and blindness by age and category of visual loss.

Risk factors
Using WHO categories, significant independent risk factors for the incidence of any visual loss were increasing age and being female, not literate, a past or current smokers and a current user of alcohol (Table 4). Increasing age was also an independent risk factor for blindness as were hypertension, diabetes and a low BMI (less than 18.5) but not sex, smoking or alcohol use. The risk factors for any visual loss were similar using the USA definition, with lower level of education as an additional risk factor. Current use of alcohol was not significant. For blindness, significant risk factors were increasing age, female sex and current use of alcohol.

Table 4: Mulivariable analysis of risk factors using WHO and US categories for A. incident visual impairment B incident blindness

DISCUSSION
This is the first population-based study to report the incidence of visual loss (VI and blindness) in a cohort of all ages. Differences between incidence rates estimated using PVA and BCVA indicate that uncorrected refractive error is a major cause of incident VI, as reflected in the causes data. However, comparison with other studies

is limited as they differ in terms of the age group studied, the level of socio-economic development of the countries where the studies were undertaken, ethnicity, follow-up time, and different definitions of risk factors and incidence were used. For example, most used WHO and USA categories of visual impairment,[15,20,22-25] while some used one definition, limiting comparability across studies.[13,17,18,21]

Studies of those aged 40 years or above at baseline which reported the incidence of VI and blindness using PVA are shown in Table 5 where all the incidence data have been converted to an annual % incidence.[14,18,20,21,23-25] Using the WHO categories of visual loss, the APEDS III study had the highest annual incidence of VI and the second highest incidence of blindness. Using the USA categories, APEDS III had the highest incidence of blindness and the second highest incidence of VI. These findings need to be seen against the relatively low mean age of participants at baseline (54.7 years). As cataract and refractive error were the two most common causes of incident visual loss, the higher incidence in APEDS III can be explained by low access to eye care services; a higher incidence on account of greater exposure to risk factors such as environmental factors (ultraviolet exposure), dietary differences as well as genetics, cannot be ruled out.

Table 5: Annual incidence of visual impairment and blindness using presenting visual acuity in high, middle and low income countries

As expected, and as in other studies, the incidence of any visual loss increased substantially with age (Figures 2A and 2B).[13-25] More than 50% of those 50 years and above at baseline developed some degree of VI, which reinforces the need for eye health programme planning to target the older population.

In studies from high income countries, ARMD is one of the leading causes of incident VI,[14,15,17,34] but in our study ARMD was a very uncommon cause. This likely reflects racial, ethnic and demographic differences between studies, and the high incidence of cataract which may have masked the presence of ARMD. As in other studies, cataract was an important cause of incident VI[13,18,25] as was uncorrected refractive error. In our study cataract and uncorrected refractive error were the major causes of any visual loss for all age groups as well as those 40 years and above, and together they accounted for nearly 90% of any incident visual loss. The high incidence of visual loss due to cataract in our study likely reflects that, in rural areas of India, individuals either do not access eye care services, or only do so once they have considerable loss of vision. The incidence could also be higher in this rural population where agriculture is an important occupation, due to exposure to ultraviolet light, a poor diet, episodes of severe dehydrational crises and exposure to biomass cooking fuel.[35]

Some studies, but not all, reported a higher incidence of visual loss in females, as we found in our study, [16,25,33].[13-15,20,21,23] but some reported a higher incidence in males.[22,26,36] As the major causes of incident blindness in our study were cataract and uncorrected refractive error, the gender difference in incidence likely reflects gender differences in access to optical and cataract surgical services, although there some evidence that females are at greater risk of cataract than males after taking account of age, but the reasons are not clear.[37]

Lower levels of education were another risk factor in our study, with a clear trend for incident visual loss. This association has been reported in cross sectional studies and in the Beijing Eye Study, another cohort study.[25] Prospective studies provide greater evidence of causality than cross sectional studies, and in our study the better educated were more likely to have occupations with less exposure to known risk factors for cataract, and be more aware of and able to access services for cataract surgery and spectacle correction. A history of past and current smoking and current alcohol consumption were also associated with incident visual loss. Smoking was one of the major risk factor for cataract in APEDS I,[38] as has been reported in a large number of other studies.[39] Smoking raises the cadmium levels in the blood which inactivates the superoxide dismutase as well as causes oxidative stress, thus affecting the lens and causing cataract. Although the association between alcohol consumption and cataract is controversial, the alcohol consumed in rural areas in India may contain toxins as it is locally brewed and distilled from molasses, a by-product of sugarcane.

Using the WHO definition, nearly two-third of blindness and VI was due to cataract i.e. an annual incidence of 1.85%. In Andhra Pradesh there are approximately 190,000 adults per million population who are aged 40 years and above (27%) who live in rural areas (70%). With an annual incidence of cataract of 1.85%, this would translate to 3,500 new cataract blind or VI per million population in rural areas. This is despite a high cataract surgical rate of approximately 6,000 per million population per year.

The strengths of this study include the large sample size which was representative of all ages at baseline, the long follow up, and the detailed clinical examination. In addition, quality control measures implemented during the study minimized errors and bias. The response rate amongst those who survived was 80.5% which is high. The quality and standards applied were similar to studies conducted in high income settings.[14,16,17,23]

Limitations of the study included non-response bias as those who had died were older, those who had migrated were younger, and those who declined not to take part were also younger, and more likely to be female, better educated, non-smokers and non-consumers of alcohol. In addition, it was not possible to trace participants in the urban cluster. Given the variability of the non-response it is difficult to say in which non-response bias may have influenced the estimate, but an over-estimate cannot be ruled out. In the risk factor analysis, all the factors were fixed at baseline, whereas in real life these factors can vary over time. Another limitation is that the definition of visual loss did not include visual field loss, thus underestimating the incidence, particularly of glaucoma. However, as most population based studies on the incidence of VI refer only to VA measurements, the data in this study can be compared with previous studies conducted on other ethnic groups.

In conclusion, the incidence of visual loss in this rural population in Indian was high, with cataract and uncorrected refractive error as the main causes. Increasing age, female sex, lack of education, smoking and alcohol intake were significant risk factors. The findings highlight the need to increase access to eye care and optical services in rural areas, particularly for females and the less well educated.

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Table 1. Baseline Characteristics among Participants and Nonparticipants in Andhra Pradesh Eye Disease Study III (APEDS III)

Characteristic	Participants	Nonparticipants	
		Alive	Deceased
Age in years, mean (SD)*	28.0 (17.5)	23.0 (18.0)	55.2 (16.6)
Age group	n (%)	n (%)	n (%)
0 - 29	2768 (51.3)	703 (66.8)	112 (8.5)
30 - 39	1157 (21.5)	135 (12.8)	106 (8.0)
40 - 49	774 (14.4)	94 (8.9)	161 (12.2)
50 - 59	454 (8.4)	64 (6.1)	269 (20.3)
60+	242 (4.5)	56 (5.3)	676 (51.1)
Sex*			
Women	2853 (52.9)	610 (58.0)	629 (47.5)
Men	2542 (47.1)	442 (42.0)	695 (52.5)
Education*			
None	2404 (49.0)	369 (38.9)	873 (66.4)
Primary (1-5)	1407 (28.7)	314 (33.1)	306 (23.3)
Secondary (6-10)	883 (18.0)	202 (21.3)	110 (8.4)
Higher (11+)	217 (4.4)	63 (4.3)	25 (1.9)
Hypertension*			
No	2696 (73.3)	384 (70.9)	657 (52.6)
Yes	984 (26.7)	158 (29.2)	592 (47.4)
Diabetes*			
No	5372 (99.6)	1047 (99.5)	1274 (96.2)
Yes	23 (0.4)	5 (0.5)	50 (3.8)
Smoking status*			
Never	4361 (80.8)	918 (87.3)	718 (54.2)

Past	153 (2.8)	15 (1.4)	120 (9.1)
Current	881 (16.3)	119 (11.3)	486 (36.7)
Alcohol status*			
Never	4105 (76.1)	873 (83.0)	744 (56.2)
Past	134 (2.5)	20 (1.9)	141 (10.7)
Current	1156 (21.4)	159 (15.1)	439 (33.2)

* P value < 0.05.

Table 2: 15-year incidence rate of any visual impairment in APEDS III according to World Health Organization (WHO) and United States (US) criteria.

Visual Impairment	Age at baseline (years)	Incidence in Men				Incidence in Women				Total Incidence			
		N	n	%	95% CI	N	n	%	95% CI	N	n	%	95% CI
Presenting (WHO)	0 - 29	1011	14	1.3	1.2 - 1.5	1083	38	3.4	3.1 - 3.7	2094	52	2.5	2.2-2.6
	30 - 39	496	53	10.4	9.8 - 11.2	623	104	16.7	15.9 - 17.4	1119	157	13.9	13.4 - 14.5
	40 - 49	309	94	30.3	28.9 - 31.6	366	126	34.6	33.3 - 35.9	675	220	32.6	31.7 - 33.5
	50 - 59	154	66	42.9	40.9 - 45.0	149	71	47.9	45.7 - 49.9	303	137	45.4	43.9 - 46.8
	60+	51	31	42.6	39.1 - 46.3	52	32	61.1	57.5 - 64.5	103	63	60.5	58.0 - 62.9
	Crude overall*	2021	258	12.6	12.3 - 13.0	2273	371	16.3	15.9 - 16.7	4294	629	14.6	13.6 - 15.7
	Age & sex adjusted*	2021	311	15.4	13.8 - 17.0	2273	421	18.5	16.9 - 20.2	4294	730	17.0	15.9 - 18.2
Best-corrected (WHO)	<30	1027	3	0.3	0.2 - 0.4	1103	3	0.3	0.2 - 0.4	2130	6	0.3	0.2 - 0.3
	30 - 39	500	5	0.9	0.7 - 1.1	640	25	4.1	3.7 - 4.5	1140	30	2.5	2.2 - 2.7
	40 - 49	336	23	6.4	5.8 - 7.1	412	50	12.0	11.2 - 12.9	748	73	9.6	9.1 - 10.2
	50 - 59	194	47	24.1	22.6 - 25.7	213	66	30.4	28.8 - 32.0	407	113	28.0	26.9 - 29.2
	60+	84	28	33.1	30.6 - 35.9	93	42	45.3	42.6 - 47.9	177	70	39.4	37.6 - 41.3
	Crude overall*	2141	106	4.8	4.6 - 5.1	2461	186	7.6	7.3 - 7.9	4602	292	6.3	6.1 - 6.4
	Age & sex adjusted*	2141	135	6.3	5.3 - 7.4	2461	224	9.1	7.8 - 10.3	4602	359	7.8	7.0 - 8.6
Presenting (US)	0 - 29	998	29	2.8	2.6 - 3.1	1068	91	8.5	8.1 - 8.9	2066	120	5.8	5.1 - 5.6
	30 - 39	479	115	24.2	23.2 - 25.2	593	178	30.7	29.8 - 31.7	1072	293	27.8	27.1 - 28.5
	40 - 49	283	125	44.9	43.4 - 46.4	313	165	53.1	51.7 - 54.6	596	290	49.1	48.1 - 50.2
	50 - 59	123	76	62.2	60.0 - 64.5	119	78	65.5	63.2 - 67.7	242	154	63.8	62.2 - 65.4
	60+	39	29	73.6	69.8 - 77.1	28	24	85.2	81.5 - 88.6	67	53	78.4	75.7 - 81.0
	Crude overall*	1922	374	19.6	19.2 - 20.1	2121	536	25.4	24.9 - 25.9	4043	910	22.6	22.3 - 23.0
	Age & sex adjusted*	1922	430	22.4	20.5 - 24.3	2121	631	29.8	27.8 - 31.7	4043	1054	26.1	24.7 - 27.5
	0 - 29	1026	6	0.6	0.4 - 0.7	1099	7	0.6	0.5 - 0.7	2125	13	0.6	0.5 - 0.7

Best-corrected (US)	30 - 39	499	21	4.2	3.7 - 4.6	637	40	6.1	5.6 - 6.5	1136	61	5.2	4.9 - 5.6
	40 - 49	331	59	17.8	16.7 - 18.9	402	98	24.5	23.5 - 25.7	733	157	21.5	20.7 - 22.3
	50 - 59	182	69	38.3	36.5 - 40.2	189	90	48.3	46.4 - 50.2	371	159	43.4	42.1 - 44.8
	60+	67	43	63.6	60.5 - 66.6	70	44	62.8	59.8 - 65.8	137	87	63.2	61.1 - 65.3
	Crude overall*	2105	198	9.4	9.1 - 9.7	2397	279	11.6	11.3 - 11.9	4502	477	10.6	10.3 - 10.8
	Age & sex adjusted*	2105	253	12.0	10.7 - 13.5	2397	350	14.6	13.2 - 16.1	4502	602	13.4	12.4 - 14.4

N = number at risk at baseline; n = incident cases; PVA = presenting visual acuity; VI = Visual Impairment; % (95% CI) = incidence and 95% confidence interval.
United States criteria. Incidence of any presenting VI is measured as PVA at baseline of 20/40 or better with follow up PVA worse than 20/40. Incidence of best-corrected VI is measured as baseline BCVA of 20/40 or better with follow-up BCVA worse than 20/40.
World Health Organization Criteria. Incidence of any presenting VI is measured as PVA at baseline of 20/60 or better with follow up PVA worse than 20/60. Incidence of best corrected VI is measured as baseline BCVA of 20/60 or better with follow-up BCVA worse than 20/60.
* P value < 0.05.
Age and sex standardized to the undivided Andhra Pradesh state population as per 2010-11 census.

Table 3. Causes of incident visual impairment and blindness by age and category of visual loss.

	WHO categories of VI		USA categories of VI	
	Visual impairment	**Blindness**	**Visual impairment**	**Blindness**
All age groups at baseline	**N (%)**	**N (%)**	**N (%)**	**N (%)**
Cataract	**392 (62.3)**	**27 (62.8)**	**394 (43.3)**	**108 (76.1)**
Uncorrected refractive error	**187 (29.7)**	0 (0)	**473 (52.0)**	2 (1.4)
Retinitis pigmentosa	1 (0.2)	**5 (11.6)**	1 (0.1)	3 (2.1)
Corneal pathology	8 (1.3)	3 (7)	6 (0.7)	**8 (5.6)**
Aged ≥40 years at baseline				
Cataract	**308 (73.3)**	**26 (70.3)**	**299 (60.2)**	**92 (76.7)**
Uncorrected refractive error	**77 (18.3)**	0 (0)	**171 (34.4)**	1 (0.8)
Corneal pathology	5 (1.2)	**2 (5.4)**	2 (0.4)	**7 (5.8)**
Retinitis pigmentosa	1 (0.2)	**2 (5.4)**	1 (0.2)	1 (0.8)
Glaucoma	4 (1)	**2 (5.4)**	2 (0.4)	3 (2.5)
Age related macular degeneration	4 (1)	**2 (5.4)**	2 (0.4)	3 (2.5)
Other retinal diseases	7 (1.7)	**2 (5.4)**	7(1.4)	5 (4.2)

Table 4: Mulivariable analysis of risk factors using WHO and US categories for A. incident visual impairment B incident blindness

	A	A	B	B
	WHO definition	US definition	WHO definition	US definition
	Odds ratio (95% CI)			
Age group				
<40 years	Reference	Reference	Reference	Reference
40-49 years	3 (2.4 - 3.8)	2.6 (2.1 - 3.2)	2 (0.6 - 7.2)	2.4 (1.3 - 4.4)
50-59 years	5.1 (3.8 - 6.9)	5.1 (3.7 - 7.0)	5.4 (1.6 - 17.6)	7.0 (3.9 - 12.6)
>=60 years	9.3 (5.9 - 14.7)	9.4 (5.1 - 17.4)	22.2 (7.2 - 68.3)	13.6 (7.4 - 25)
Gender				
Male	Reference	Reference	Reference	Reference
Female	1.8 (1.2 - 2.5)	1.5 (1.1 - 2.0)	1.7 (0.6 - 4.7)	2.4 (1.2 - 4.5)
Education				
Class 11 and above	Reference	Reference	Reference	Reference
Class 6 to 10	1.0 (0.4 - 2.2)	1.9 (0.96 - 3.8)	0.4 (0.3 - 5.0)	0.6 (0.3 - 1.5)
Class 1 to 5	2 (0.9 - 4.3)	3.2 (1.6 - 6.3)	1 (0.1 - 8.4)	1 (0.6-1.7)
Uneducated	2.5 (1.2 - 5.4)	3.8 (1.9 - 7.4)	0.5 (.1 - 4.6)	
Hypertension				
No	Reference	Reference	Reference	Reference
Yes	1.2 (0.95 - 1.5)	1.1 (0.9 - 1.4)	2.1 (1.1 - 4.4)	1.4 (0.9 - 2.0)
Diabetes				
No	Reference	Reference	Reference	Reference
Yes	0.7 (0.2 - 2.2)	1.7 (0.5 - 5.6)	4.7 (1.1 - 20)	2.5 (0.6 - 9.5)
Body mass index				
18.5-24.99	Reference	Reference	Reference	Reference
<18.5	1.2 (0.9 - 1.5)	1.1 (0.9 - 1.4)	2.3 (1.1 - 4.8)	1.4 (0.9 - 2.0)
25-29.9	0.9 (0.6 - 1.4)	1.0 (0.7 - 1.6)	0.9 (0.2 - 3.2)	0.9 (0.4 - 1.9)
>30	0.6 (0.2 - 1.5)	0.4 (0.2 - 1.0)		1.1 (0.3 - 5.0)
Smoking				
Never smoker	Reference	Reference	Reference	Reference
Past smoker	1.9 (1.1 - 3.3)	1.8 (1.1 - 3.1)	1.1 (0.3 - 4.5)	1.1 (0.4 - 2.8)
Current smoker	1.5 (1.1 - 2.3)	1.4 (1.0 - 1.9)	1.4 (0.5 - 3.9)	1.1 (0.6 - 2.2)

Alcohol consumption				
Never	Reference	Reference	Reference	Reference
Past	1.1 (0.6 - 1.9)	0.8 (0.4 - 1.3)	1.6 (0.4 - 6.3)	1.7 (0.8 - 4.0)
Current	1.5 (1.2 - 1.9)	1.1 (0.9 - 1.4)	0.9 (0.4 - 2.0)	1.7 (1.1 - 2.6)
Hosmer Lemeshow test	0.18	0.72	0.37	0.13

Table 5: Annual incidence of visual impairment and blindness using presenting visual acuity in high, middle and low income countries

Study, Country	Baseline data collection	Age at baseline (mean, min. years)	Mean follow up (years)	Participants at baseline (% at follow up)	Category of VI used	Annual incidence (presenting visual acuity	
						Visual impairment	Blindness
Ponza Eye Study, Italy[18]	1986-1988	55.5 (40)	12	1028 (40%)	WHO	0.79	0.1
Melbourne Visual Imp. Project, Australia[14]	1992-1994	59.0 (40)	5	3271 (79%)	Melbourne	0.84	0.06
Los Angelos Latino Eye Study, USA[23]	2000-2003	54.7 (40)	4	6357 (73%)	WHO	0.45	0.05
					USA	0.73	0.08
Beijing Eye Study, China[25]	2001	55.3 (40)	5	4439 (73%)	WHO	0.28	0.02
					USA	0.76	0.04
Liwan Eye Disease Study, China[24]	2003	63.4 (50)	5	1405 (88%)	WHO	2.48	0.06
					USA	4.12	0.36
Nakuru Eye Disease Study, Kenya[20]	2007-2008	62.5 (50)	6	4414 (49%)	WHO	1.98	0.25
					USA	NR	0.45
Shahroud Eye Cohort Study, Iran[21]	2009-2010	50.9 (40-64)	5	5190 (91%)	WHO	0.20	0.02
*Andhra Pradesh Eye Disease Study, India	1996-2000	54.7 (40)	15	2790 (53%)	WHO	2.59	0.17
					USA	3.66	0.56

*Current study; WHO = World Health OrganizaStion; USA = United States of America; NR = not reported

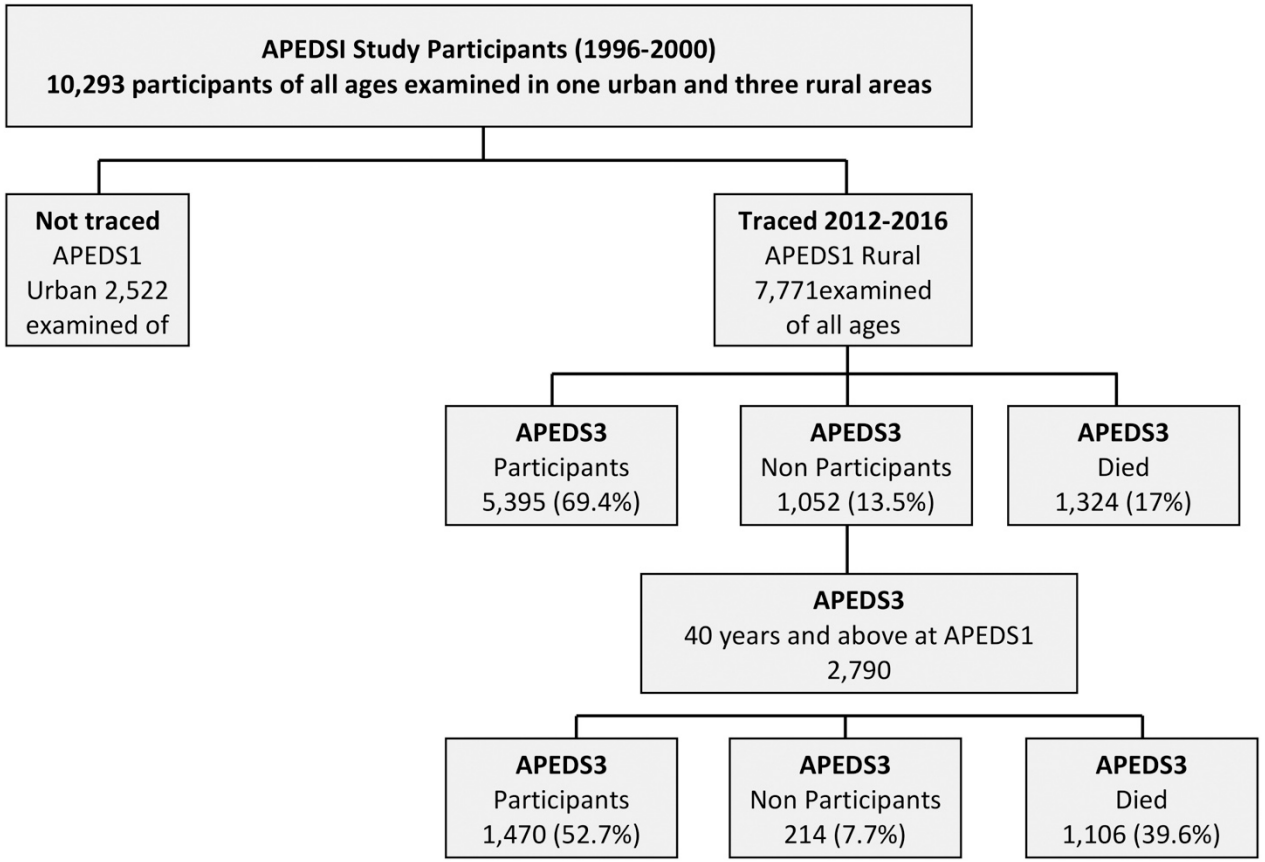

Figure 1: Availability of participants at the time of APEDS III

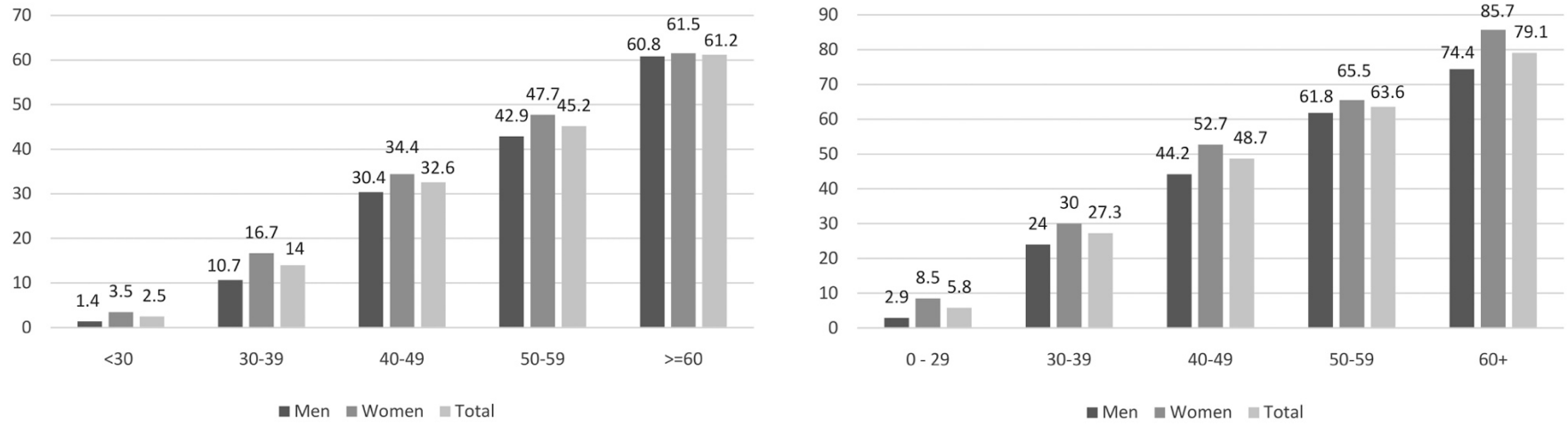

Figure 2A: Incidence rate of any visual loss by WHO categories. Figure 2B: Incidence rate of any visual loss by USA categories

Supplementary table 1: 15-Year incidence rate of presenting visual impairment and blindness in Andhra Pradesh Eye Disease Study cohort according to World Health Organization criteria

Visual Impairment		Incidence in Men				Incidence in Women				Total Incidence			
		N	N	%	95% CI	N	n	%	95% CI	N	n	%	95% CI
Moderate	Age at baseline (years)												
	0 - 29	1011	14	1.3	1.2 - 1.5	1081	36	3.2	3.0 - 3.5	2092	50	2.3	2.2 - 2.5
	30 - 39	493	50	10.0	9.3 - 10.7	614	95	15.6	14.8 - 16.3	1107	145	13.1	12.6 - 13.6
	40 - 49	306	91	29.7	28.4 - 31.1	350	110	31.6	30.4 - 32.9	656	201	30.7	29.8 - 31.6
	50 - 59	148	60	40.6	38.5 - 42.7	137	59	43.2	41.0 - 45.4	285	119	41.8	40.4 - 43.4
	60+	49	29	58.0	54.3 - 61.9	45	25	54.3	50.4 - 58.1	94	54	56.2	53.5 - 58.8
	Crude overall*	2007	244	12.0	11.7 - 12.4	2227	325	14.5	14.2 - 14.9	4234	569	13.4	13.1 - 13.6
	Age & sex adjusted*	2007	293	14.6	13.1 - 16.2	2227	383	17.2	15.7 - 18.8	4234	677	16.0	14.9 - 17.1
Severe	Age at baseline (years)												
	0 - 29	1027	1	0.1	0.05 - 0.1	1105	2	0.2	0.1 - 0.3	2132	3	0.1	0.01 - 0.2
	30 - 39	501	2	0.3	0.2 - 0.5	642	12	1.7	1.5 - 2.0	1143	14	1.1	1.0 - 1.3
	40 - 49	343	8	2.1	1.8 - 2.6	414	17	3.9	3.4 - 4.4	757	25	3.1	2.8 - 3.4
	50 - 59	205	13	6.0	5.2 - 6.9	228	24	11.0	10.0 - 12.1	433	37	8.6	8.0 - 9.3
	60+	97	6	6.2	5.0 - 7.5	107	15	14.5	12.8 - 16.3	204	21	10.6	9.5 - 11.7
	Crude overall*	2173	30	1.3	1.2 - 1.4	2496	70	2.8	2.6 - 3.0	4669	100	2.1	2.0 - 2.2
	Age & sex adjusted*	2173	32	1.5	1.0 - 2.1	2496	80	3.2	2.6 - 4.0	4669	110	2.4	1.9 - 2.8
Blindness	Age at baseline (years)												
	0 - 29	1029	1	0.1	0.05 - 1.5	1106	1	0.1	0.05 - 0.2	2135	2	0.1	0.05 - 0.1
	30 - 39	505	3	0.6	0.4 - 0.8	643	1	0.2	0.1 - 0.3	1148	4	0.4	0.3 - 0.5
	40 - 49	345	1	0.3	0.1 - 0.5	423	5	1.3	1.0 - 1.6	768	6	0.9	0.7 - 1.0
	50 - 59	210	5	2.5	2.0 - 3.2	236	5	2.1	1.6 - 2.6	446	10	2.3	2.0 - 2.7
	60+	107	8	7.6	6.3 - 9.0	125	13	10.8	9.4 - 12.3	232	21	9.3	8.4 - 10.3
	Crude overall	2196	18	0.8	0.7 - 0.9	2533	25	1.0	0.9 - 1.1	4729	43	0.9	0.9 -1.0
	Age & sex adjusted	2196	23	1.1	0.7 - 1.6	2533	37	1.5	1.0 - 2.0	4729	60	1.3	1.0 - 1.6

N = number at risk at baseline; n = incident cases; PVA = presenting binocular visual acuity; % (95% CI) = incidence and 95% confidence interval.
World Health Organization criteria. Incidence of moderate visual impairment: persons with baseline PVA of 20/60 or better with follow-up PVA worse than 20/60 but better than or equal to 20/200 (not including 20/60). Severe visual impairment: persons with baseline PVA of better than or equal to 20/200 with follow-up PVA worse than 20/200 but better than or equal to 20/400 (not including 20/200). Incidence of blindness: persons with baseline PVA better than or equal to 20/400 but follow-up PVA worse than 20/400 (not including 20/400).

*P value < 0.05
Age and sex standardized to the undivided Andhra Pradesh state population

Supplementary table 2: 15-Year incidence rate of best-corrected visual impairment and blindness in Andhra Pradesh Eye Disease Study cohort according to World Health Organization criteria

Visual Impairment		Incidence in Men				Incidence in Women				Total Incidence			
		N	n	%	95% CI	N	n	%	95% CI	N	n	%	95% CI
Moderate	Age at baseline (years)												
	0 - 29	1026	2	0·2	0·1 - 0·3	1102	2	0·2	0·1 - 0·3	2128	4	0·2	0·1 - 0·2
	30 - 39	499	4	0·7	0·5 - 0·9	640	25	3·7	3·3 - 4·0	1139	29	2·4	2·2 - 2·6
	40 - 49	335	22	6·2	5·5 - 6·8	405	43	10·7	9·9 - 11·4	740	65	8·6	8·1 - 9·1
	50 - 59	190	43	22·4	20·9 - 24·0	206	59	29·2	27·6 - 30·9	396	102	26·0	24·9 - 27·1
	60+	80	24	30·0	27·3 - 32·6	82	31	37·1	34·4 - 39·9	162	55	33·6	31·7 - 35·5
	Crude overall*	2130	95	4·4	4·1 - 4·5	2435	160	6·5	6·3 - 6·8	4565	255	5·5	5·3 - 5·7
	Age & sex adjusted*	2130	118	5·6	4·6 - 6·6	2435	200	8·2	7·2 - 9·4	4565	316	6·9	6·2 - 7·7
Severe	0 - 29	1028	0	0·0	NA	1105	1	0·1	0·04 - 0·1	2133	1	0·04	0·02 - 0·06
	30 - 39	503	0	0·0	NA	643	0	0·0	NA	1146	0	0·0	NA
	40 - 49	344	2	0·5	0·3 - 0·7	420	4	0·9	0·7 - 1·2	764	6	0·8	0·6 - 0·9
	50 - 59	206	1	0·5	0·3 - 0·8	233	7	3·2	2·6 - 3·8	439	8	1·9	1·6 - 2·3
	60+	100	2	1·9	1·3 - 2·7	117	6	5·6	4·6 - 6·8	217	8	3·9	3·3 - 4·6
	Crude overall*	2181	5	0·2	0·1 - 0·3	2518	18	0·7	0·6 - 0·8	4699	23	0·5	0·4 - 0·6
	Age & sex adjusted*	2181	2	0·1	0·1 - 0·6	2518	24	0·9	0·6 - 1·4	4699	30	0·6	0·5 - 6·6
Blindness	Age at baseline (years)												
	0 - 29	1029	1	0·1	0·04 - 0·1	1106	1	0·1	0·05 - 0·1	2135	2	0·1	0·005 - 0·1
	30 - 39	506	3	0·6	0·4 - 0·8	644	1	0·2	0·1 - 0·3	1150	4	0·4	0·3 - 0·5
	40 - 49	347	3	0·9	0·7 - 1·2	424	4	1·0	0·8 - 1·3	771	7	1·0	0·8 - 1·2
	50 - 59	211	5	2·5	2·0 - 3·1	240	6	2·5	2·0 - 3·1	451	11	2·5	2·2 - 2·9
	60+	107	7	6·5	5·3 - 7·8	131	14	11·1	9·7 - 12·5	238	21	9·0	8·1 - 10·0

	Crude overall	2200	19	0·9	0·7 - 10·0	2545	26	1·1	1·0 - 1·2	4745	45	1·0	0·9 - 1·1
	Age & sex adjusted	2200	23	1·0	0·7 - 1·6	2545	38	1·5	1·1 - 2·0	4745	61	1·3	1·0 - 1·6

N = number at risk at baseline; n = incident cases; BCVA = presenting binocular best corrected visual acuity; % (95% CI) = incidence and 95% confidence interval; NA = no incident cases.
World Health Organization criteria· Incidence of moderate visual impairment: persons with baseline BCVA of 20/60 or better with follow-up BCVA worse than 20/60 but better than or equal to 20/200 (not including 20/60). Severe visual impairment: persons with baseline BCVA of better than or equal to 20/200 with follow-up BCVA worse than 20/200 but better than or equal to 20/400 (not including 20/200). Incidence of blindness: persons with baseline BCVA better than or equal to 20/400 but follow-up BCVA worse than 20/400 (not including 20/400).
* P value < 0·05
Age and sex standardized to the undivided Andhra Pradesh state population

Supplementary table 3: 15-Year incidence rate of presenting visual impairment and blindness in Andhra Pradesh Eye Disease Study cohort according to United States criteria

Visual Impairment		Incidence in Men				Incidence in Women				Total Incidence			
		N	n	%	95% CI	N	n	%	95% CI	N	n	%	95% CI
Moderate	Age at baseline (years)												
	0 - 29	998	29	2·8	2·6 - 3·1	1066	89	8·3	7·9 - 8·8	2064	118	5·7	5·4 - 5·9
	30 - 39	477	113	24·0	22·9 - 24·9	585	170	29·9	28·9 - 30·8	1062	283	27·2	26·5 - 27·9
	40 - 49	281	123	44·6	43·1 - 46·1	301	153	51·2	49·8 - 52·7	582	276	48·0	46·9 - 49·0
	50 - 59	118	71	60·6	58·3 - 62·9	111	70	62·9	60·5 - 65·3	229	141	61·7	60·0 - 63·4
	60+	38	28	72·8	68-9 - 76·4	24	20	82·7	78·2 - 86·5	62	48	76·5	73·6 – 79.3
	Crude overall*	1912	364	19·2	18·8 - 19·7	2087	502	24·1	23·7 - 24·7	3999	866	21·8	21·5 - 22·1
	Age & sex adjusted*	1912	422	22·1	20·2 - 24·0	2087	602	28·9	26·9 - 30·8	3999	1018	25·5	24·1 - 26·8
Blindness	Age at baseline (years)												
	0 - 29	1028	2	0·2	0·1 - 0·2	1105	2	0·2	0·1 - 0·3	2133	4	0·2	0·1 - 0·2
	30 - 39	503	4	0·7	0·5 - 0·9	643	14	2·0	1·8 - 2·3	1146	18	1·5	1·3 - 1·7
	40 - 49	343	8	2·1	1·8 - 2·6	419	22	5·1	4·6 - 5·8	762	30	3·8	3·5 - 4·2
	50 - 59	210	18	8·4	7·4 - 9·4	232	29	12·8	11·7 - 14·0	442	47	10·7	10·0 - 11·5
	60+	103	13	12·7	11·1 - 14·5	119	30	25·9	23·8 - 27·9	222	43	19·8	18·4 - 21·2
	Crude overall*	2187	45	2·0	1·8 - 2·1	2518	97	3·9	3·7 - 4·0	4705	142	30	28·5 - 31·0
	Age & sex adjusted*	2187	51	2·3	1·7 - 3·1	2518	118	4·7	3·9 - 5·6	4705	168	3·6	3·1 - 4·1

N = number at risk at baseline; n = incident cases; PVA = presenting binocular visual acuity; 95% CI = 95% confidence interval

United States criteria· Incidence of moderate visual impairment: persons with baseline PVA of 20/40 or better with follow-up PVA worse than 20/40 but better than 20/200 (not including 20/40 or 20/200). Incidence of blindness: persons with baseline PVA better than 20/200 but follow-up PVA 20/200 or worse (including 20/200).
* P value < 0·001
Age and sex standardized to the undivided Andhra Pradesh state population

Supplementary table 4: 15-Year incidence rate of best-corrected visual impairment and blindness in Andhra Pradesh Eye Disease Study cohort according to United States criteria

Visual Impairment		Incidence in Men				Incidence in Women				Total Incidence			
		N	n	%	95% CI	N	n	%	95% CI	N	n	%	95% CI
Moderate	Age at baseline (years)												
	0 - 29	1025	5	0·5	0·4 - 0·6	1098	6	0·5	0·4 - 0·6	2123	11	0·5	0·4 - 0·6
	30 - 39	498	20	4·0	3·6 - 4·5	637	40	6·0	5·6 - 6·5	1135	60	5·1	4·8 - 5·5
	40 - 49	330	58	17·6	16·5 - 18·7	396	92	23·3	22·2 - 24·4	726	150	20·7	20·0 - 21·4
	50 - 59	179	66	37·2	35·3 - 39·1	181	82	46·0	44·1 - 47·9	360	148	41·6	40·3 - 43·0
	60+	65	41	62·6	59·5 - 65·7	64	38	58·9	55·7 - 62·0	129	79	60·8	58·5 - 63·0
	Crude overall*	2097	190	9·0	8·7 - 9·4	2376	258	10·8	10·4 - 11·1	4473	448	10·0	9·7 - 10·2
	Age & sex adjusted*	2097	246	11·7	10·4 - 13·2	2376	329	13·9	12·5 - 15·3	4473	575	12·9	11·9 - 13·9
Blindness	Age at baseline (years)												
	0 - 29	1029	1	0·1	0·004 - 0·1	1106	2	0·2	0·1 - 0·2	2135	3	0·1	0·09 - 0·1
	30 - 39	505	2	0·4	0·2 - 0·5	644	1	0·2	0·1 - 0·3	1149	3	0·3	0·2 - 0·3
	40 - 49	346	4	1·1	0·8 - 1·3	423	9	2·2	1·9 - 2·6	769	13	1·7	1·5 - 1·9
	50 - 59	211	6	3·0	2·4 - 3·7	238	13	5·6	4·9 - 6·4	449	19	4·4	3·9 - 4·9
	60+	107	9	8·8	7·0 - 9·7	129	18	14·7	13·2 - 16·4	236	27	11·8	10·8 - 12·9
	Crude overall*	2198	22	1·0	0·9 - 1·1	2540	43	1·8	1·6 - 1·9	4738	65	1·4	1·3 - 1·5
	Age & sex adjusted*	2198	28	1·3	0·9 - 1·8	2540	58	2·3	1·7 - 2·9	4738	84	1·8	1·4 - 2·2

N = number at risk at baseline; n = incident cases; BCVA = best corrected visual acuity; 95% CI = 95% confidence interval.
United States criteria· Incidence of moderate visual impairment: persons with baseline BCVA of 20/40 or better with follow-up BCVA worse than 20/40 but better than 20/200 (not including 20/40 or 20/200)· Incidence of blindness: persons with baseline BCVA better than 20/200 but follow-up BCVA 20/200 or worse (including 20/200).

* P value < 0·05

Age and sex standardized to the undivided Andhra Pradesh state population