

## WORLD VIEW

# Causes of low vision and blindness in rural Indonesia

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**Aim:** To determine the prevalence rates and major contributing causes of low vision and blindness in adults in a rural setting in Indonesia

**Methods:** A population based prevalence survey of adults 21 years or older (n=989) was conducted in five rural villages and one provincial town in Sumatra, Indonesia. One stage household cluster sampling procedure was employed where 100 households were randomly selected from each village or town. Bilateral low vision was defined as habitual VA (measured using tumbling "E" logMAR charts) in the better eye worse than 6/18 and 3/60 or better, based on the WHO criteria. Bilateral blindness was defined as habitual VA worse than 3/60 in the better eye. The anterior segment and lens of subjects with low vision or blindness (both unilateral and bilateral) (n=66) were examined using a portable slit lamp and fundus examination was performed using indirect ophthalmoscopy.

**Results:** The overall age adjusted (adjusted to the 1990 Indonesia census population) prevalence rate of bilateral low vision was 5.8% (95% confidence interval (CI) 4.2 to 7.4) and bilateral blindness was 2.2% (95% CI 1.1 to 3.2). The rates of low vision and blindness increased with age. The major contributing causes for bilateral low vision were cataract (61.3%), uncorrected refractive error (12.9%), and amblyopia (12.9%), and the major cause of bilateral blindness was cataract (62.5%). The major causes of unilateral low vision were cataract (48.0%) and uncorrected refractive error (12.0%), and major causes of unilateral blindness were amblyopia (50.0%) and trauma (50.0%).

**Conclusions:** The rates of habitual low vision and blindness in provincial Sumatra, Indonesia, are similar to other developing rural countries in Asia. Blindness is largely preventable, as the major contributing causes (cataract and uncorrected refractive error) are amenable to treatment.

Blindness is a large public health, social, and economic problem in both developed and developing countries worldwide. It has been estimated by the World Health Organization (WHO) that there are approximately 38 million blind and 110 million who are severely visually impaired and these numbers are increasing every year.<sup>1,2</sup> Approximately 90% of the world's blind live in developing countries. Several epidemiological studies have reported prevalence rates of bilateral blindness in developing Asian countries that vary from 0.3% to 4.4%<sup>3-6</sup>; comparisons across studies are limited by differences in the selection of the study population, sampling techniques, definitions of blindness, and diagnostic methods.

Indonesia is a large tropical archipelago with a population of 195 million and 61.8% of the inhabitants live in rural areas. There are few data on the prevalence rates and causes of visual impairment in Indonesia. The aim of this report is to document the prevalence rates and causes of low vision and blindness among adults in a rural provincial area in Sumatra, Indonesia.

### PATIENTS AND METHODS

A population based low vision survey of adults 21 years or older was conducted in five rural villages (Kuala Terusan Baru, Pelalawan, Delik, SP7, and Segati) and one provincial town (Pangkalan Kerinci) of the Riau province, Sumatra, Indonesia. The methodology of the survey has been described previously.<sup>7-9</sup> A one stage cluster sampling procedure was conducted whereby 100 households (as there were only a total of 60 households in Delik, all 60 were assessed) were randomly selected from a sampling frame of 2170 households in Kerinci, 238 in Kuala Terusan Baru, 215 in Pelalawan, 60 in Delik, 500 in SP7, and 204 in Segati. There were 194 subjects recruited from Kerinci, 205 subjects from Kuala Terusan Baru, 196 from Pelalawan, 107 from Delik, 180 from SP7, and 161 from Segati. Informed verbal consent was obtained from the subjects.

Trained interviewers conducted household interviews and information on total family income per month, completed level of education, dry eye symptoms, history of ocular trauma, and history of unilateral poor vision since childhood were obtained. All subjects were treated in accordance with the tenets of the Declaration of Helsinki. Approval for the study was obtained from the ethics committee, Singapore Eye Research Institute.

### Eye examinations

Habitual distance visual acuity (VA) (that is, vision unaided or, if the participant wears spectacles, vision with spectacles) was measured using tumbling "E" logMAR charts for each eye separately by a trained team of nurses and interviewers. The participant was allowed to proceed to the next line if he or she was able to read more than half of the letters (three or more) on the line. The identifying logMAR level of the last line attempted, combined with the number of mistakes on that and the previous line, was used to calculate the logMAR visual acuity score (each letter carries a 0.02 score). If no letters from the chart could be identified, VA was recorded as counting fingers, hand movements, light perception, or no light perception. Bilateral low vision was defined as habitual VA in the better eye worse than 6/18 (approximate logMAR VA equivalent of 0.48) and 3/60 or better (approximate logMAR VA equivalent of 1.3) in accordance with internationally accepted definitions based on the WHO criteria.<sup>10,11</sup> Bilateral blindness was defined as habitual VA worse than 3/60 in the better eye. Unilateral low vision was defined as low vision according to the WHO criteria in one eye and normal vision in the other eye. Unilateral blindness was defined as blindness according to the WHO criteria in one eye and normal vision in the other eye. Subjects with low vision or blindness were further examined in August 2002 to determine the ocular cause. Altogether, 66 subjects were examined again. Written consent (thumbprint impression if not literate) was obtained from all 66 subjects. The secondary

**Table 1** Prevalence rates of bilateral low vision and blindness by age, sex, income

	No	% (95% CI)	
		Low vision	Blindness
Total	989	4.3 (1.9 to 6.8)	1.5 (0.0 to 3.0)
Age adjusted*		5.8 (4.2 to 7.4)	2.2 (1.1 to 3.2)
Age (years)			
21–30	324	1.2 (0.6 to 1.9)	–
31–40	329	0.6 (0.0 to 1.6)	0.3 (0.0 to 1.1)
41–50	174	2.9 (0.2 to 5.6)	–
Above 50	162	19.8 (14.2 to 25.3)	8.6 (3.4 to 13.9)
p Value		<0.001	<0.001
Sex			
Males	461	4.1 (2.0 to 6.2)	1.1 (0.0 to 2.5)
Females	528	4.5 (1.7 to 7.4)	1.9 (0.0 to 3.9)
p Value		0.49	0.35
Income (rupiah per month) (10 000 rupiah = 1 US\$)			
<500 000	474	5.3 (1.4 to 9.2)	2.3 (0.6 to 4.0)
500 000 to <1 000 000	357	3.4 (1.1 to 5.6)	1.1 (0.0 to 3.1)
1 000 000 or more	158	3.8 (0.1 to 7.5)	–
p Value		0.41	0.03
Completed educational level			
Elementary school	545	6.6 (2.9 to 10.3)	2.4 (0.4 to 4.4)
At least junior high	444	1.6 (0.0 to 3.3)	0.5 (0.0 to 1.3)
p Value		0.009	0.04

\*Age adjusted to the 1990 Indonesia census population.

Bilateral low vision defined as better eye habitual VA 6/120 to <6/18.

Bilateral blindness defined as better eye habitual VA <6/120.

participation rate was 73.3%. Participants and non-participants (secondary participation) in this second ocular examination were similar by age and sex.

An ophthalmologist (RH) examined the anterior segment and lens using a portable slit lamp (Kowa SL-14, Japan) after pupils were dilated using tropicamide 1% eye drops. Clinical lens opacity grading using the slit lamp was performed according to the Lens Opacification Classification System (LOCS) III grading scheme using standard photographs for comparison.<sup>12</sup> Nuclear cataract was defined as a LOCS III score of 4.0 or more for nuclear opalescence or 4.0 or more for nuclear colour; LOCS III score of 2.0 or more for cortical cataract and LOCS III score of 2.0 or more for posterior subcapsular cataract. A decimal grade (LOCS III), ranging from 0.1 to 5.9 or 6.9, using 0.1 unit intervals was assigned to the opacity. Cataract was regarded as the main cause of low vision if the fundus was obscured by changes in the lens or if there was a lens opacity but no evidence of fundus abnormalities. Fundus examination was performed using a portable indirect ophthalmoscope. Age related macular degeneration (AMD) was graded clinically as early or late AMD according to an international classification scheme.<sup>13</sup> Optic atrophy was diagnosed if the appearance of the optic disc was pale and flat with no evidence of glaucomatous cupping. The presence of glaucoma was determined based on a schematic developed by Foster *et al* whereby glaucoma is diagnosed if vertical cup-disc ratio (VCDR) is  $\geq$ 99.5th percentile for the local population (assuming non-dysplastic disc and no significant anisometropia) or, if the disc cannot be seen, VA <3/60 and intraocular pressure >21 mm Hg.<sup>14 15</sup> Since these data are not available for the Indonesian population, they are assumed to be similar to the Chinese Singaporean population—that is, VCDR 99.5th percentile is 0.81 and 99.5th percentile for VCDR asymmetry is 0.32. Refractive error was measured using a handheld Retinomax (Retinomax K-plus; Nikon, Tokyo, Japan), and the average of eight refractive error readings was taken. The best corrected VA was assessed with the participant wearing appropriate trial lenses in a trial frame based on the refractive error as measured above. A case of uncorrected refractive error was confirmed if refractive error was present (defined as myopia: spherical equivalent (SE) at least  $-1.0D$ ; hyperopia: SE at least  $+1.0D$ ; astigmatism: cylinder at least

$-1.0D$ ), and there was an improvement of two or more lines from initial presenting VA to best corrected VA. Amblyopia was diagnosed if there was an obvious cause such as squint or anisometropia and poor vision could not be corrected. If there was more than one cause of low vision, the primary cause was defined as the condition with the most clinically significant influence, attributing to at least 50% of low vision.

#### Data analysis

The prevalence rates and 95% CIs of low vision and blindness were calculated, allowing for study design effects such as clustering by designating sampling units (village and household). Confidence intervals were calculated assuming a Poisson distribution. Age adjusted prevalence rates of low vision and blindness were derived using the decade stratified Indonesia 1990 census population as the reference standard. All statistical analyses were performed using the commercially available software STATA version 7.0.<sup>16</sup>

#### RESULTS

There were 989 participants. The mean age of the villagers was 36.8 years (range 21–88) and 46.6% were males. The overall primary participation rate was 83.4%. Participants and non-participants had similar age distributions, but there was a greater proportion of females (53.4%) among participants compared with non-participants (31.7%) ( $p < 0.001$ ). The secondary participation rate (participated in home ocular examination if low vision or blindness was present) was 73.3% (66 of 90). Participants and non-participants (secondary participation) were similar by age and sex.

The overall age adjusted (adjusted to the 1990 Indonesia census population) prevalence rate of bilateral low vision was 5.8% (95% CI 4.2 to 7.4) and bilateral blindness was 2.2% (95% CI 1.1 to 3.2) (Table 1). The prevalence rate of low vision increased significantly from 1.2% in adults 21–30 years to 19.8% in adults 50 years and above ( $p$  for trend  $< 0.001$ ). The relation between age and low vision remained when males and females were analysed separately. The rates of blindness were 0.3% in adults aged 31–40 years and 8.6% in adults aged 50 years and above ( $p < 0.001$ ). Adults with lower total family income (<500 000 rupiah per month) had higher rates of

**Table 2** Causes of bilateral and unilateral low vision and blindness

	Total (% contributing to low vision)			
	Bilateral low vision	Bilateral blindness	Unilateral low vision	Unilateral blindness
Primary cause of vision loss				
Uncorrected refractive error	4 (12.9)	0 (0.0)	3 (12.0)	0 (0.0)
Cataract	19 (61.3)	5 (62.5)	12 (48.0)	0 (0.0)
Amblyopia	4 (12.9)	0 (0.0)	1 (4.0)	1 (50.0)
Age related macular degeneration	0 (0.0)	1 (12.5)	2 (8.0)	0 (0.0)
Macular hole	0 (0.0)	0 (0.0)	1 (4.0)	0 (0.0)
Optic atrophy	0 (0.0)	0 (0.0)	1 (4.0)	0 (0.0)
Trauma	0 (0.0)	0 (0.0)	0 (0.0)	1 (50.0)
No obvious ocular disease	4 (12.9)	2 (25.0)	5 (20.0)	0 (0.0)
Total	31 (100)	8 (100)	25 (100)	2 (100)

\*Specified cause was present in one or both eyes in patients who met the criteria for visual impairment in the worse eye.  
27 participants were not examined as 14 were not contactable, 8 moved to another area, 1 refused, and 4 died.

blindness (2.3%), compared with adults with higher income (500 000 to less than 1 000 000 rupiah per month) (1.1%) ( $p=0.03$ ). Similarly, the rates of low vision were higher in adults with less education (who had only completed elementary education) (6.6%) compared with adults with more education (1.6%) ( $p=0.009$ ). The rates of blindness were also higher in adults with less education (2.4% versus 0.5%;  $p=0.04$ ). No significant sex differences in low vision and blindness were found.

The rates of low vision in both eyes was highest ( $n=40$ ; 4.0%), followed by low vision in one eye and normal vision in the other ( $n=32$ ; 3.2%), blindness in both eyes ( $n=15$ ; 1.5%), blindness in one eye and low vision in the other ( $n=3$ ; 0.3%), and blindness in one eye and normal vision in the other ( $n=2$ ; 0.2%). The overall rates of unilateral and bilateral visual impairment were significantly higher in adults above 50 years of age compared with adults aged 50 years and below ( $p=0.001$ ).

The causes of unilateral and bilateral low vision and blindness are shown in Table 2. The most common causes of bilateral low vision were cataract ( $n=19$ ), followed by uncorrected refractive error ( $n=4$ ) and amblyopia ( $n=4$ ). Of the 19 adults with cataract as the major contributing cause of bilateral low vision, 15 had cataract in both eyes, while four had cataract in one eye and uncorrected refractive error in the other. All four adults with uncorrected refractive error had symmetrical causes of low vision in both eyes (uncorrected refractive error in both eyes). The most common causes of bilateral blindness were cataract ( $n=5$ ), followed by age related macular degeneration (AMD) ( $n=1$ ). Of the five adults with cataract as the major contributing cause of bilateral blindness, two had cataract in the other eye as well, two had amblyopia in the other eye, and one adult had no obvious disease in the other eye. The largest contributing cause of unilateral low vision was cataract ( $n=12$ ), followed by uncorrected refractive error ( $n=3$ ), AMD ( $n=2$ ), macular hole ( $n=1$ ), amblyopia ( $n=1$ ), and optic atrophy ( $n=1$ ); while the causes of unilateral blindness were amblyopia ( $n=1$ ) and trauma ( $n=1$ ).

## DISCUSSION

The extent of blindness as a public health problem has been estimated in rural Indonesia (bilateral low vision and blindness rates are 5.8% and 2.2%, respectively). Cataract was the leading cause of bilateral low vision, followed by uncorrected refractive error. This is the first large population based survey of blindness in a rural province in Indonesia and data regarding the extent and possible causes of low vision would be useful in the development of programmes to combat preventable and treatable blindness in Asia.

## Blindness in Asia

The results of blindness figures across studies should be interpreted with caution as there are differences in participant selection, sampling strategies, definitions of blindness and ocular assessments. In surveys across Asia, widely differing definitions of blindness have been employed.<sup>3-6</sup> Our present study includes both young and elderly participants (age range 21–88 years), and caution should be exercised in comparisons with other surveys as the causes of low vision vary in different age groups. The surveys in India, China, and Mongolia were conducted in primarily rural areas, while the survey in Malaysia was a random sample of residents in all rural areas and urban cities in the country. The age adjusted bilateral blindness rates in Indonesia (2.2%) are comparable with other developing rural Asian countries, but higher compared with Malaysia, a rapidly developing Asian country. The rates of unilateral blindness (blindness in one eye and normal vision in the other) (0.2%), as well as rates of blindness in one eye and low vision in the other (0.3%), are low, similar to the findings from the Barbados Eye Survey.<sup>17</sup> As expected, the rates of low vision and blindness increase with age, results consistent with previous surveys such as the Barbados Eye Study.<sup>17</sup> This could be attributed to the increased prevalence rate of age related eye disease and poorer access to health care among the elderly. In our present study, there was an inverse association between socioeconomic status (income) and blindness rates, results similar to other surveys in Hong Kong and India.<sup>3 18</sup>

## Cataract blindness

Age related cataract is a leading cause of low vision and blindness in Sumatra, Indonesia, and other parts of Asia.<sup>3 4 6 19 20</sup> Reduction in cataract blindness could be facilitated by improvements in overall eye care delivery in predominantly agricultural countries. Community health workers may be employed in the rural areas to perform simple vision tests and ophthalmologists may be encouraged to participate in community outreach programmes. Barriers to cataract surgery such as distance, costs, awareness of the benefits of surgery, and availability of tertiary ophthalmic facilities need to be identified, and strategies implemented to improve overall access to cataract surgery and promote subsidies for those who cannot afford surgery.

## Refractive error blindness

Uncorrected refractive error is a major cause of unilateral and bilateral low vision in Sumatra, Indonesia, and other Asian countries including China, India, Hong Kong, and Malaysia.<sup>3 4 19 20</sup> The prevalence rates of myopia are higher in rural Indonesia compared with the United States and Australia, as Asians may have a hereditary predisposition to

myopia.<sup>7 21 22</sup> Though myopia may be fully corrected using spectacle lenses and the cost of spectacles is relatively low, the myopic population remains largely uncorrected. To address the needs for refractive correction, the number of refractive services in both rural and urban areas could be increased with programmes developed to train ophthalmic technicians in refraction. One possible alternative is to import at low cost or manufacture locally "off the shelf" spectacles for subjects with refractive error and low or no astigmatism. Community screening programmes may be implemented in underserved areas where regular vision screening is performed by healthcare workers and the public educated about the availability and affordability of correction for refractive errors. Adequate correction of refractive errors may lead to a marked improvement in visual function and quality of life.

A large proportion of blindness in this province in Indonesia is attributable to treatable eye diseases such as cataract and refractive error. In contrast with surveys conducted in Barbados, India, and Scandinavia, age related macular degeneration, glaucoma, and corneal diseases did not significantly contribute to low vision.<sup>3 17 23</sup> Vision 2020: the right to sight, in conjunction with the World Health Organization (WHO) Global Initiative for the Elimination of Avoidable Blindness, is a global concerted effort to control the major causes of blindness, raise the awareness of blindness as a major public health concern, and create the infrastructure to manage the problem.<sup>2</sup> Three strategies are outlined in Vision 2020: the control of ocular disease, staffing development, and infrastructure. As blindness has significant personal, social, and economic costs, it would be wise to use a multipronged, systematic plan to tackle these problems worldwide.

Several methodological issues need to be considered. Although the primary participation rate was high (83.4%), there were more females among participants compared with non-participants. As there was no association between sex and low vision, the female preponderance among participants is unlikely to cause a bias in the estimation of low vision or blindness rates. The sample size was small and there is insufficient power to detect small differences in low vision rates among other sub groups. Furthermore, the age range of the sample is wide (21–88 years) and there are only 162 subjects above 50 years, precluding inferences of the causes of low vision in the elderly population. Ocular examinations were not conducted on the entire cohort but only in subjects with low vision, because of logistic constraints within this rural setting. The major contributing causes of low vision (cataract, uncorrected refractive error) could be overestimated or underestimated as ocular examinations were not conducted on all participants with low vision. This survey was conducted in six villages in a rural provincial area in Sumatra and may not be representative of the entire Indonesian population.

In conclusion, the rates of habitual bilateral low vision (5.8%) and blindness (2.2%) in rural Sumatra, Indonesia, are comparable with other developing countries in Asia. Blindness in Indonesia is largely avoidable as the major contributing causes, cataract and uncorrected refractive error, are essentially treatable.

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