WORLD VIEW

Prevalence and causes of visual impairment and blindness in Sistan-va-Baluchestan Province, Iran: Zahedan Eye Study

Hossein-Ali Shahriari, Shahrokh Izadi, Mohammad-Reza Rouhani, Farzaneh Ghasemzadeh, Ali-Reza Maleki

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See end of article for authors' affiliations

Correspondence to:
Dr S Izadi, PO Box 98156–759, Zahedan 0044545185, Iran; izadish@yahoo.comAccepted 1 November 2006
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22 November 2006**Aim:** To determine the prevalence and causes of visual impairment and blindness in the Sistan-va-Baluchestan Province of Iran.**Methods:** A population-based cross-sectional study with a multistage cluster sampling technique was used to identify the study subjects. Visual acuity (VA) was defined for all participants aged ≥ 10 years. Participants with a VA of $<20/60$ were examined by an ophthalmologist to determine the causes of low vision or blindness.**Results:** 5446 (84.0%) of the invited people were examined. The prevalence of visual impairment (VA $<20/60$) was 6.81% (95% CI 5.91% to 7.71%) and of bilateral blindness (VA $<3/60$) was 0.79% (95% CI 0.50% to 1.08%). Visual impairment increased with age and illiteracy. Bilateral blindness doubled in women aged >40 years. The causes of visual impairment and blindness were cataract (37.7%), corneal opacity (15.0%), amblyopia (15.0%), glaucoma (5.7%) and hyperopia (5.0%). 39.5% of the visual impairment cases were potentially curable.**Conclusion:** The estimated magnitude of visual impairment and blindness was much higher than our expectations. Further investigation of the pattern of vision loss in women and children, particularly as a result of trachoma and amblyopia, is warranted. Implementation of measures to treat curable cases of the study population can improve the situation in the region dramatically.

According to the World Health Organization, 37 million people are blind and 124 million have visual impairment worldwide.¹ Blindness and visual impairment represent a public health, social and economic problem for countries, especially developing countries, where 9 of 10 of the world's blind people live. Moreover, there is increasing evidence that women have a disproportionately higher burden of visual disability.² Every minute, one child becomes blind somewhere in the world. Half of these cases are curable or preventable, which means that blindness can be prevented in about 250 000 children every year.³ Approximately 50% of the world's blind have cataract. As an age-related disease, cataract is a disease of the older population, but childhood blindness accounts for almost as many "blind years" as cataract, even though many of its causes are either preventable or treatable.⁴

Recently, several studies were initiated in Iran, the largest being the Tehran Eye Study that analysed the causes of blindness in the densely populated capital of Iran.^{5–6}

The main objective of the present study was to determine the prevalence and causes of visual impairment and blindness in Sistan-va-Baluchestan Province, one of the most underprivileged regions of the country.

MATERIALS AND METHODS

Study site and population

The study was carried out in the Sistan-va-Baluchestan Province in the southwest of Iran. The Province is located in the neighbourhood of Afghanistan and Pakistan to the east. According to the last population census of 1996, 52.7% of the population lives in the rural regions. In all, 1.1% of the population is composed of nomads who are scattered all over the Province. The Province territory is divided into eight districts. Zahedan, the largest district with a population of about 620 000 (95% of them residing in the urban regions), is

the capital of the Province (fig 1). The median of the age distribution of the population is about 16.5 years.

The primary healthcare network, with a stepwise structure consisting of rural health houses, rural and urban health clinics and general district hospitals and headquarters of the district health centre, has a coverage of about 65% in some districts to $>95\%$ in some others. The entire primary healthcare network is under the supervision of the Zahedan University of Medical Sciences. Four of the districts have at least one ophthalmologist and one or two optometrists and the others have only optometrists.

Sample size and sampling

There was no area restriction for sampling and the sampling method was the classic probability-proportional-to-size cluster sampling. To determine the sample size, we estimated the prevalence of visual impairment ($<20/60$) to be 8% for people aged ≥ 10 years. We assumed a design effect of 1.5 (for cluster sampling), a confidence interval (CI) of 95% and a response rate of 90%. These assumptions led to a sample size of 4713. Considering an average household size of 5 individuals (with at least 2.5 eligible people in each household) and a cluster size of 10 households, about 190 clusters were needed to generate the sampled population.

A cumulative list of the study population was produced and a systematic sample from a random start was selected. We obtained the sampling interval by dividing the total population of the communities by the number of communities to be selected. Then we chose a random number between one and the result of the division. This should be fitted into position in the list to identify the first community in the sample. Then, by adding the sampling interval to the initial random number, the other communities were selected. In all districts there is a

Abbreviation: VA, visual acuity

Figure 1 Map of Iran and Sistan-vah-Baluchestan Province.

nearly complete health register of all households and household members. From each selected community we chose the first household of the cluster at random. Enumeration was continued for 10 neighbouring households by proceeding systematically in a clockwise direction from the initial household within the cluster.

All the study staff including the optometrists and ophthalmologists took part in training sessions before the initiation of the survey. There were four teams, each being lead by an optometrist and assisted by an expert health worker from the headquarters of each district health centre.

Definitions

The following definitions were used for classification of the patients:

- Visual impairment: a visual acuity (VA) of $<20/60$ using a pinhole. Visual impairment was categorised to blindness and low vision.
- Blindness: a VA of $<3/60$ in the better eye using a pinhole.
- Low vision: a VA of $<20/60$ to $3/60$ using a pinhole.⁸

In this way each participant was categorised into one the following groups:

- (1) normal vision in both eyes: corrected VA $>20/60$ in both eyes (with pinhole)
- (2) unilateral low vision: VA $>20/60$ in one eye and low vision (VA between $20/60$ and $3/60$ with pinhole) in another

- (3) blindness in one eye (VA $<3/60$ with pinhole) and normal vision in the other (VA $>20/60$ with pinhole)
- (4) blindness in one eye (VA $<3/60$ with pinhole) and low vision (VA between $20/60$ and $3/60$ with pinhole) in the other
- (5) bilateral low vision: VA $<20/60$ to $3/60$ with pinhole in both eyes
- (6) bilateral blindness: VA $<3/60$ with pinhole in both eyes.

Examinations

The steps involved in the study were as follows. All selected households were enumerated. Enumeration included name, age, sex and education level of each household member. After enumeration, all household members who were aged ≥ 10 years were invited to visit a local clinic (usually a rural health house, or urban and rural health clinic) where VA was measured. Enumerated subjects who did not attend the examination process after the initial invitation were contacted twice in the subsequent week by a local health worker in charge of the local health services. Those who failed to appear even after the third invitation were considered non-respondents. There was no replacement for non-participation. Participants who were too ill to come to the clinic were visited in their home, by a team composed of a local health worker and an optometrist.

VA was measured using an "E" chart in outdoor light at 6 m. Individuals with VA $<20/60$ were rechecked with pinhole, and if improved, the improved VA was recorded. An ophthalmologist examined all participants with VA $<20/60$ (with a time lag of at most 1 week in the nearest hospital) using an ophthalmoscope, a biomicroscope (slit lamp) and an applanation tonometer to find the main causes of blindness and low vision.

Humanity and ethics

The research and ethics committee of the Al-Zahra Eye Centre and ethics committee of the Zahedan University of Medical Sciences approved the study. All subjects included in this study were informed about the project and the procedures in their native language before being enrolled. The participant's agreement for examination was obtained verbally.

Table 1 Response rate of study population

District	Invited	Examined	Response rate (%)
Zahedan	2044	1664	81.41
Zabol	1420	1199	84.44
Iranshahr	820	793	96.71
Saravan	645	563	87.29
Sarbaz	354	342	96.61
Nikshahr	604	355	58.77
Chabahar	596	530	88.93
Total	6483	5446	84.00

Table 2 Prevalence of visual impairment, low vision and blindness by sex and age, based on corrected visual acuity (using pinhole)*

	Age groups (years)	Number of participants	Visual impairment	One eye blind and the other normal	Both eyes blind	One eye low vision and the other normal	One eye blind and the other with low vision	Both eyes low vision
Men	10-19	1067	1.59 (0.81 to 2.37)	0.56 (0.05 to 1.07)	0.09 (0.01 to 0.68)	0.75 (0.24 to 1.26)	0.00 (0.00 to 0.00)	0.19 (0.05 to 0.76)
	20-39	754	2.78 (1.60 to 3.96)	1.19 (0.43 to 1.95)	0.27 (0.04 to 1.92)	0.93 (0.26 to 1.60)	0.13 (0.02 to 0.95)	0.27 (0.07 to 1.08)
	40-59	351	6.84 (4.12 to 9.56)	1.14 (0.43 to 3.05)	0.28 (0.04 to 2.05)	3.42 (1.40 to 5.44)	0.57 (0.14 to 2.29)	1.42 (0.20 to 2.64)
	>60	172	48.26 (40.32 to 56.20)	7.56 (3.84 to 11.28)	5.81 (2.36 to 9.26)	12.21 (7.76 to 16.66)	6.98 (3.00 to 10.96)	15.70 (9.78 to 21.62)
Women	10-19	1240	1.45 (0.74 to 2.16)	0.32 (0.12 to 0.85)	0.00 (0.00 to 0.00)	0.81 (0.28 to 1.34)	0.00 (0.00 to 0.00)	0.32 (0.12 to 0.85)
	20-39	1189	3.03 (1.95 to 4.11)	0.92 (0.39 to 1.45)	0.08 (0.01 to 0.60)	1.26 (0.50 to 2.02)	0.00 (0.00 to 0.00)	0.76 (0.13 to 1.39)
	40-59	523	11.47 (8.77 to 14.17)	3.44 (1.97 to 4.91)	0.57 (0.19 to 1.78)	3.63 (2.14 to 5.12)	1.15 (0.11 to 2.19)	2.68 (1.39 to 3.97)
	>60	150	58.00 (49.91 to 66.09)	6.67 (2.85 to 10.49)	12.67 (6.69 to 18.65)	13.33 (7.90 to 18.76)	8.00 (3.81 to 12.19)	17.33 (11.12 to 23.54)
Men and women	10-19	2307	1.51 (0.98 to 2.04)	0.42 (0.15 to 0.69)	0.04 (0.01 to 0.29)	0.78 (0.39 to 1.17)	0.00 (0.00 to 0.00)	0.26 (0.02 to 0.50)
	20-39	1943	2.93 (2.19 to 3.67)	1.04 (0.61 to 1.47)	0.16 (0.04 to 0.71)	1.12 (0.61 to 1.63)	0.06 (0.01 to 0.40)	0.55 (0.16 to 0.94)
	40-59	874	9.40 (7.42 to 11.38)	2.41 (1.45 to 3.37)	0.44 (0.17 to 1.18)	3.54 (2.32 to 4.76)	0.89 (0.22 to 1.56)	2.12 (1.20 to 3.04)
	>60	322	53.07 (46.90 to 59.24)	7.12 (4.38 to 9.86)	9.20 (5.40 to 13.00)	12.76 (9.15 to 16.37)	7.48 (4.48 to 10.48)	16.50 (11.99 to 21.01)
Men	All ages	2344	6.69 (5.49 to 7.89)	1.46 (0.97 to 1.95)	0.66 (0.29 to 1.03)	2.16 (1.53 to 2.79)	0.71 (0.34 to 1.08)	1.70 (1.11 to 2.29)
Women	All ages	3102	6.90 (5.80 to 8.00)	1.37 (0.98 to 1.76)	0.89 (0.50 to 1.28)	2.14 (1.57 to 2.71)	0.65 (0.32 to 0.98)	1.86 (1.33 to 2.39)
All	All ages	5446	6.81 (5.91 to 7.71)	1.40 (1.09 to 1.71)	0.79 (0.50 to 1.08)	2.15 (1.70 to 2.60)	0.68 (0.43 to 0.93)	1.79 (1.36 to 2.22)

Values are presented as percentage (95% CI).

*Age and sex standardised to the 1996 national census results in the Province.

Table 3 Relationship between age, sex and education level with visual impairment

	OR* (95% CI)
Age groups (years)	
10–19	1
20–39	1.38 (0.88 to 2.17)
40–59	3.43 (2.14 to 5.49)
>60	31.13 (19.01 to 50.97)
Sex	
Men	1
Women	1.10 (0.84 to 1.44)
Education (years)†	
0	1
1–5	0.42 (0.27 to 0.64)
6–12	0.31 (0.20 to 0.48)
>12	0.45 (0.18 to 1.13)

*Adjusted odds ratio (logistic regression).

†Years of successful education.

Data analysis

A computerised data bank was produced based on the completed data sheets. The data were analysed using SPSS V.9.0 and Stata statistical software, V.6.0. The prevalence of visual impairment and blindness were estimated, and multiple logistic regression modelling was used to investigate associations with age, sex and education level. Rates have been age and sex standardised to the results of the last national census of 1996 by the direct method.⁷

In calculating standard errors and 95% CI, the cluster sampling design was taken into account and adjusted for.⁹ The 95% CIs were calculated by assuming a normal approximation of binomial distribution for rates with five or more outcome observations, and a Poisson distribution for rates with fewer outcome observations. All *p* values <0.05 were considered significant.

RESULTS

From October 2004 to November 2005, 5446 of 6483 (84.0%) individuals invited for examinations came to the clinic and were examined. Table 1 shows the response rate by districts of the Sistan-va-Baluchestan Province. The last district that had to be sampled was Khash with a population of about 80 000. Since the examined people in the other districts had outnumbered the estimated required sample size, Khash was not sampled. The mean age of men and women up to one decimal point is equal to each other (27.7 years) and the SEs of the mean, respectively, are 0.35 and 0.27.

Considering the corrected vision (using a pinhole), the estimated prevalence of visual impairment would be 6.81% (95% CI 5.91 to 7.71). Table 2 shows the prevalence of visual impairment by age and sex categories, based on the corrected vision and adjusted for age and sex distribution of the last national census of 1996.⁷

Multivariate analysis of the relationship between visual impairment and age, sex and education level, using logistic regression modelling, shows a positive relationship between the chance of having visual impairment with age and a negative relationship with education level (table 3). Table 4 compares the education levels of normal participants and those with visual impairment. There was no relationship between sex and visual impairment, nor between the prevalence of visual impairment and the area of residence (rural or urban).

Table 5 shows the frequency of different causes of visual impairment. It is worth mentioning that final examination by an ophthalmologist (for definition of causes of visual impair-

Table 4 Education level of the study population by involvement

Education	Normal	Visual impairment	Total
Illiterate	1368 (26.8)	263 (78.5)	1631 (30.0)
1–5 years	1370 (26.9)	33 (9.9)	1403 (25.8)
6–12 years	2194 (43.1)	34 (10.1)	2228 (41.0)
>12 years	163 (3.2)	5 (1.5)	168 (3.1)
Total	5095 (100.0)	335 (100.0)	5430 (100.0)

ment) was not possible in three districts, Nikshahr, Saravan and Sarbaz, owing to lack of facilities. Table 6 shows the age distribution of the most prevalent problems. Both cataract and corneal opacity showed the highest proportions in the age group >40 years. For corneal opacity the age group <20 years had higher involvement that may have been due to infection such as trachoma.

DISCUSSION

The results of this study provide valuable population-based data on the prevalence and causes of visual impairment and blindness in one of the deprived societies of Iran. A high response rate among invited people (84.0%) and the representativeness of the enumerated sample were acceptable. As table 1 shows, Nikshahr had the lowest response rate (58.8%). This low response rate was due to some local problems with transportation facilities in the outskirts. Since the size of examined people in the first seven districts outnumbered the required sample size, the Khash district (with a population of about 80 000) was not sampled. The probable reason for this situation could be our

Table 5 Causes of visual impairment based on corrected vision (pinhole)*

Problem	n	%
Cataract	106	37.72
Corneal opacity	42	14.95
Amblyopia	42	14.95
Other lens problems	19	6.76
Retinitis pigmentosa	3	1.07
Retina detachment	3	1.07
Macular scar	9	3.20
Other retinal problems	21	7.47
Glaucoma	16	5.69
Hyperopia	14	4.98
Optic atrophy	3	1.07
Pterygium	1	0.36
Irregular astigmatism	1	0.36
Refractive error hypermetropia	1	0.36
Total	281	100.00

*These data belong to four districts (Zahedan, Zabol, Iranshahr and Chabahar).

Table 6 Causes of visual impairment by age group*

Age groups (years)	Opacity, n (%)	Amblyopia, n (%)	Cataract, n (%)	Others, n (%)	Total, n (%)
10–19	3 (12.0)	6 (24.0)	2 (8.0)	14 (56.0)	25 (100)
20–39	3 (8.8)	15 (44.1)	4 (11.8)	12 (35.3)	34 (100)
40–59	12 (19.4)	13 (21.0)	26 (41.9)	11 (17.7)	62 (100)
>60	24 (18.9)	8 (6.3)	74 (58.3)	21 (16.5)	127 (100)
All	42 (16.9)	42 (16.9)	106 (42.7)	58 (23.4)	248 (100)

*Patients of Saravan, Nikshahr and Sarbaz did not pass the final examinations by ophthalmologist.

Table 7 Comparison of the results of the present study with the Tehran Eye Study

	Age groups (years)	Prevalence of visual impairment/ (95% CI) (Zahedan Study)	Proportion of visual impairment/ (95% CI) (Tehran Eye Study)
Men	10–19	1.59 (0.81 to 2.37)	0.26 (0.06 to 1.06)*
	20–39	2.78 (1.60 to 3.96)	0.91 (0.13 to 1.70)
	40–59	6.84 (4.12 to 9.56)	0.72 (0.23 to 2.26)
	>60	48.26 (40.32 to 56.20)	10.94 (6.86 to 15.01)
Women	10–19	1.45 (0.74 to 2.16)	0.00 (0.00 to 0.00)
	20–39	3.03 (1.95 to 4.11)	0.32 (0.10 to 1.01)
	40–59	11.47 (8.77 to 14.17)	1.69 (0.73 to 2.65)
	>60	58.00 (49.91 to 66.09)	14.35 (9.13 to 19.57)
Men and women	10–19	1.51 (0.98 to 2.04)	0.13 (0.03 to 0.54)*
	20–39	2.93 (2.19 to 3.67)	0.56 (0.18 to 0.94)
	40–59	9.40 (7.42 to 11.38)	1.30 (0.64 to 1.96)
	>60	53.07 (46.90 to 59.24)	12.70 (9.24 to 16.16)
All ages	Men	6.69 (5.49 to 7.89)	1.37 (0.91 to 1.83)
	Women	6.90 (5.80 to 8.00)	1.42 (0.98 to 1.86)
All participants		6.81 (5.91 to 7.71)	1.39 (1.07 to 1.71)

*In the Tehran Eye Study the first age group begins from 0 to 19 years.

mistakes in the estimation of household size (household size of 5) and in the number of eligible people in each household (2.5 people in each household).

The methods of sampling and criteria for classification of the cases are similar to those of the Tehran Eye Study.⁵ Table 7 compares the results of the present study with those of the Tehran Eye Study. In the present study age groups <10 years were not entered in the study, whereas in the Tehran Eye Study there was no age limitation.

Table 8 compares the results of the present study with those of similar population-based studies in other countries.

In the multivariate analysis (logistic regression), there was no age adjusted difference in rates of blindness between men and women; however, as table 2 shows, >40 years rates of blindness (especially bilateral blindness) were higher for women than for men in each age group. The higher rate of blindness in women is supported by the findings of the Tirunelveli (India) Study,¹⁸ Medical Research Council Trial,¹⁹ the Rotterdam Study²⁰ and the Melbourne Visual Impairment Project.²¹ However, other population-based studies such as the Barbados Eye Study¹⁶ and the Blindness Study of Gurage Zone (Ethiopia)¹⁴ indicate a lower rate of blindness in women. Gender differences in rates of blindness and visual impairment, when noted, can be accounted by female longevity (women live longer), intrinsic factors (higher rates of some diseases with

ophthalmological complications in women), inequality in access to healthcare for women in some societies, and behavioural and environmental factors.²²

The three leading causes of visual impairment identified in our study were cataract, corneal opacity and amblyopia (tables 5 and 6). Below the age of 40 years, amblyopia is a leading cause of blindness versus cataract for subjects aged >40 years. Both cataract and corneal opacity increase with age, especially for subjects aged >40 years. Increasing prevalence of cataract with age was expected, and similar results are reported in almost all other population-based studies.^{5 14 16 18–22} However an explanation for corneal opacity, which in this region is mostly a consequence of trachoma, could be that trachoma-related corneal scar and vision loss is on the increase and we observed different effects of trachoma on different age cohorts.

Of 248 subjects who had ophthalmological examinations, 98 (39.5%) were considered as curable and 27 (10.9%) of these curable cases were blind in at least one eye. To ameliorate the present situation across Sistan-va-Baluchestan, specific measures need to be implemented. Such an action is principally oriented towards increasing the currently inadequate cataract surgical coverage. Included among these measures is the appointment of surgically trained ophthalmologists to each district hospital, as by the year 2006 some districts may not have a practising ophthalmologist and cataract surgery may not be performed there.

Table 8 Comparison of the prevalence of blindness and visual impairment in the present study with those of the other population-based studies

	Age range (years)	Prevalence of visual impairment, % (95% CI)	Prevalence of blindness, % (95% CI)
Present study	≥10	6.81 (5.91 to 7.71)	0.79 (1.08 to 0.496)
Tehran Eye Study ⁵	All age groups	2.52 (2.07 to 2.97)	0.39 (0.23 to 0.56)
Lebanon study ¹⁰	≥3	3.9	0.6
Malaysia study ¹¹	All age groups	2.44 (2.18 to 2.69)	0.29 (0.19 to 0.39)
Oman study ¹²	All age groups		1.1 (0.9 to 1.3)
Present study	≥40	23.94 (20.94 to 26.94)	3.36 (2.00 to 4.71)
Present study	≥60	53.07 (46.89 to 59.25)	9.20 (5.40 to 13.00)
Bangladesh ¹³	≥30		1.08 (0.86 to 1.29)
Ethiopia ¹⁴	≥40	12.1% (10.9 to 13.3)	7.9 (6.9 to 8.9)
Hong Cong ¹⁵	≥60	34.5 (32.6 to 36.5)	0.93 (0.52 to 1.33)
Barbados Eye Study ¹⁶	≥40	5.7 (5.1 to 6.5)	1.7 (1.3 to 2.1)
Nigeria ¹⁷	≥60	45.4	5.6

Another measure that needs to be implemented is the purchase and provision of essential surgical equipment to the district hospitals in order to provide fundamental logistical support to the district ophthalmologist. The development and integration of primary eye-care services in the already well-organised primary healthcare structure in the Province is another intervention that would facilitate community-based eye health promotion and the referral of cases for treatment.

Finally, the ocular status of the sample in this part of Iran was worse than expected, and further investigations of the pattern of vision loss especially in women and children is warranted. This study strengthens the rationale of developing sight-saving plans in the study area, and also provides a means to evaluate the effectiveness of such interventions.

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Authors' affiliations

Hossein-Ali Shahriari, Mohammad-Reza Rouhani, Farzaneh Ghasemzadeh, Ali-Reza Maleki, Al-Zahra Eye Centre, Zahedan University of Medical Sciences, Zahedan, Iran
Shahrokh Izadi, School of Public Health, Zahedan University of Medical Sciences, Zahedan, Iran

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