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CLINICAL STUDY

The prevalence of visual impairment and blindness in underserved rural areas: a crucial issue for future

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Abstract

Purpose **To determine the prevalence of visual impairment and blindness in underserved Iranian villages and to identify the most common cause of visual impairment and blindness.**

Patients and methods **Multistage cluster sampling was used to select the participants who were then invited to undergo complete examinations. Optometric examinations including visual acuity, and refraction were performed for all individuals. Ophthalmic examinations included slit-lamp biomicroscopy and ophthalmoscopy. Visual impairment was determined according to the definitions of the WHO and presenting vision.**

Results **Of 3851 selected individuals, 3314 (86.5%) participated in the study. After using the exclusion criteria, the present report was prepared based on the data of 3095 participants. The mean age of the participants was 37.6 ± 20.7 years (3–93 years). The prevalence of visual impairment and blindness was 6.43% (95% confidence interval (CI): 3.71–9.14) and 1.18% (95% CI: 0.56–1.79), respectively. The prevalence of visual impairment varied from 0.75% in participants aged less than 5 years to 38.36% in individuals above the age of 70 years. Uncorrected refractive errors and cataract were the first and second leading causes of visual impairment; moreover, cataract and refractive errors were responsible for 35.90 and 20.51% of the cases of blindness, respectively.**

Conclusion **The prevalence of visual impairment was markedly high in this study. Lack of access to health services was the main reason for the high prevalence of visual impairment in this study. Cataract and refractive errors are responsible for 80% of visual impairments which can be due to poverty in underserved villages.**

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Introduction

Visual impairment is a major health challenge.[1] Visual impairment is found in 285 million people worldwide of whom 39 are blind and 246 million have low vision. An important point mentioned by the WHO is the unequal distribution of visual impairment according to WHO regions.[1] Visual impairment is responsible for 27.7 million disability-adjusted life years (DALY) which comprises 1.8% of the total DALY in the world. This disorder ranks 14th in the world and 11th in developing countries. It is estimated that it will rank 8th in 2020 (2.7% of DALY).[2] Uncorrected refractive error and cataract comprise 75% of the causes of visual impairment, which are all preventable[1] Cataract is the leading cause of blindness in most low to moderate income countries[1] while it has been replaced by macular degeneration and uncorrected refractive error in developed countries.[3,4] Factors such as the socioeconomic status, geographic location, access to health services and resources, and having private insurance can affect visual impairment.[5] Global rates of visual impairment have been reducing since the Vision 2020 Initiative was established by WHO coordinates throughout the world, especially in urban settings.

In rural areas, there is less access to health care services compared to urban areas due to bad road conditions and poverty. Recent studies have pointed to higher prevalence rates of visual impairment in rural areas on account of lack of

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access to health care services (lack of cataract surgery). This is while a substantial proportion of the population in many countries resides in rural areas. The lower access rate is also responsible for the paucity of rural studies. A study on the rural population of Northen Iran showed that the higher prevalence of visual impairment and blindness could be addressed by enhancing facilities to support cataract surgery and provision of prescription eyeglasses to decrease the prevalence of visual impairment.[6]

In light of the importance of the prevalence of visual impairment among rural-dwellers, we conducted this study to evaluate the prevalence of blindness and visual impairment and their determinants in underserved villages of Iran.

Materials and methods

In this cross-sectional study, conducted in Iran from March 2015 to July 2015, the target population was underprivileged rural populations. The Rural Development Bureau within the presidential administration in the Islamic Republic of Iran provided us with the roster of deprived rural villages which we used as the sampling frame of the study. As a population-based study, samples were selected from the residents of selected deprived villages in two provinces in Iran.

Sampling method

Sample selection was done through multistage cluster sampling. Using national data, two districts were randomly chosen from the north (Shahyoun a district of Dezful County, Khuzestan Province) and southwest (Kajour, a district of Noshhar County, Mazandaran Province) of the country. Then, a number of villages were randomly selected from the roster of each district.

Since we aimed to study visual impairment, the sample size was calculated based on the prevalence of visual impairment in a village in Iran. The sample size was 2267 for a rate of 6.3%, a precision level of 0.01, and a 95% confidence level. Considering the sampling method, a 1.5 design effect was applied, and then a 10% non-response rate was assumed which brought the final sample size to 3740.

Sampling from each district was proportional to their total population with respect to the sample size. Thus, 15 villages in Shahyoun and 5 in Kajour were sampled to maintain the balance, because the villages in the former district were smaller and less populated. In each selected village, all over-one-year old residents were considered. In the selected households, all members over 1 year of age were invited to participate in the study, and an appointment date was fixed for their examinations.

To perform a pilot study, 35 people were tested for visual acuity and objective refraction by the two study optometrists. On the basis of the intraclass correlation coefficients, inter-examiner agreement was high (0.923 for uncorrected visual acuity and 0.897 for spherical equivalent refraction). All examinations were performed by these two optometrists who had a high agreement in detecting spherical refractive errors by retinoscopy and uncorrected visual acuity by a Snellen chart. Examinations were conducted in one place under standard illumination conditions after obtaining informed consents from all participants and conducting an interview to collect certain demographic data. For those under 18 years, the consent was signed by the head of the household. Interviews were completed by a trained interviewer. Collected information included age, education level, the occupation of the head of the household, history of ocular surgery, history of eye problems, number of household members, smoking status, and systemic disease.

Optometric examinations were performed after the interview. First, refraction was measured using an auto refractometer (Nidek). Then, a Snellen chart at 6 m was used for visual acuity measurement. Lensometry was performed if the participant used glasses and the presenting visual acuity was recorded. All participants underwent retinoscopy using the results of auto refraction. If the visual acuity was not 20/20 in either eye, subjective refraction was performed. Then, all participants underwent slit-lamp biomicroscopy and of intraocular pressure measurement by an ophthalmologist before dilation. Then, cycloplegia was induced to perform cycloplegic refraction using cyclopentolate 1% in all individuals under 20 years. Cyclopentolate was instilled two times at a 5-minute interval and cycloplegic refraction was performed with an auto refractometer 35 min after the second instillation. The ophthalmologist completed the remainder of the examinations after dilation. These included grading clinical lens opacities, slit-lamp assessment of vitreous opacities, and the fundus exam with an ophthalmoscope.

Definitions

The WHO definition was used for visual impairment. Visual impairment included low vision and blindness and reported as presenting visual acuity (PVA). PVA is defined as uncorrected visual acuity for those who do not have corrective eyeglasses, and with current glasses for those who have them.

Low vision was defined as visual acuity between 0.5 LogMAR (20/60) and $\leq$1.3 LogMAR (20/400) in the better eye. Blindness was defined as visual acuity worse than 1.3 LogMAR (20/400) in the better eye. If a patient

had several causes of visual impairment or each eye suffered different causes, the more correctable cause was considered as the cause of visual impairment.

Statistical analysis

The prevalence of visual impairment is reported as percentage with 95% confidence interval (CI) considering the design effect. Multiple logistic regression was used to detect the association between visual impairment and the study variables. Independent variables included in the logistic regression model included age, gender, education level, and place of residence. If the prevalence was low and the distribution was not normal, binomial distribution was used to calculate the 95% CI.

Ethical issues

The Ethics Committee of Tehran University of Medical Sciences approved the study protocol, which was conducted in accord with the tenets of the Helsinki Declaration. All participants signed a written informed consent.

Results

A total of 3851 individuals were selected through sampling of whom 3314 (86.5%) participated in the study. Since visual acuity was not measured in 220 participants (lack of cooperation), analysis was performed on the data of 3095 individuals. Of them, 1747 (56.5%) were female and the rest were male. The mean age of the participants was 37.6 ± 20.7 years (range: 3–93 years). About 57.4% (1776 participants) lived in southern villages and the rest were from northern villages.

Table 1 shows the prevalence of visual impairment, blindness, and low vision by age, gender, educational level, and place of living.

The prevalence of visual impairment was 6.43% (95% CI: 3.71–9.14) with no significant difference between male and female participants. Its prevalence was 0% in individuals below the age of 5 years to 38.36% in individuals above the age of 70 years. The prevalence of visual impairment was 8.71% (95% CI: 3.97–13.46) in the north and 4.37% (95% CI: 3.39–6.08) in the south of Iran ($P<0.00$). The highest prevalence of visual impairment was observed in illiterate participants ($P<0.001$).

Blindness was observed in 1.18% (95% CI: 0.56–1.79) of the participants with no significant difference between male and female participants. The prevalence of blindness increased significantly with aging from 0.19% in individuals below the age of 5 years to 11.32% in participants aged 70 years and over. The highest prevalence of blindness was observed in illiterate participants and in northern villages.

A multiple logistic regression model was used to investigate the relationship of visual impairment and blindness with the study variables. The results showed that only age and education were significantly associated with visual impairment (Table 2).

According to Table 3, uncorrected refractive errors and cataract were the first and second cause of visual impairment; moreover, cataract, and refractive errors were responsible for 35.90 and 20.51% of the cases of blindness in our study.

Discussion

This population-based study was conducted to evaluate visual impairments in all age groups in the rural population of Iran. Rural areas comprise one third of the Iranian population. Increased migration of the young people, especially from underserved rural areas, to the cities has caused age inhomogeneity and therefore the population of rural areas is older than their urban counterparts, causing differences in their health needs. Considering the high prevalence of visual disorders in developing countries and the role of economic poverty on visual impairment, it was necessary to conduct this study in the rural population.[7]

According to a review of the literature presented in Table 4, the prevalence of visual impairment varies from 0.097 in Nepal to 30.5% in India. The prevalence of visual impairment in our study was in the middle of the reported ranges but the differences in the study populations and the inclusion and exclusion criteria should be considered before any comparison is made.

In addition to age groups, differences are seen between developed and developing countries; the prevalence of visual impairment in countries like Korea, Spain, and Iceland is much lower when compared with similar populations in developing countries like Libya, India, and Suriname. Studies performed in rural populations in India, Egypt, and China have shown a high prevalence of visual impairment in these countries, even higher than the prevalence of visual impairment in our study. Numerous studies have been performed on visual impairment in Iran but their results cannot be compared with the results of our study due to differences in the study population. Table 4, presents the studies conducted in Iran. The prevalence of visual impairment in our study was higher than Tehran and Shahroud studies but similar to studies performed in Zahedan, Sari, and villages in the north of Iran which all have a poor economic status.

Table 4, shows the prevalence of blindness in different parts of the world. The prevalence of blindness is $<1\%$ in developed countries like Korea, Iceland, Spain, Australia,

Table 1 The prevalence of visual impairment, blindness and low vision in underserved rural of Iran by gender, location of rural, age and educational level

	n (%)	*Visual impairment % (95% CI)*	*Blindness % (95% CI)*	*Low vision % (95% CI)*
Total	3095 (100)	6.43 (3.71–9.14)	1.18 (0.56–1.79)	5.25 (3.01–7.5)
Gender				
Female	1747 (56.5)	6.34 (2.96–9.71)	1.2 (0.54–1.87)	5.13 (2.17–8.1)
Male	1348 (43.5)	6.55 (4.31–8.79)	1.14 (0.43–1.86)	5.41 (3.7–7.11)
Age (years)				
≤5	53 (1.7)	0	0	0
6–20	747 (24.1)	0.75 (0.12–1.38)	0.19 (0.04–0.94)[a]	0.56 (0.15–2.09)[a]
21–30	433 (14)	2.26 (0.75–6.78)[a]	0	2.27 (0.75–6.87)[a]
31–40	481 (15.5)	2.04 (0.56–3.52)	0.29 (0.05–1.58)[a]	1.75 (0.62–4.93)[a]
41–50	507 (16.4)	2.76 (1.38–4.14)	0.55 (0.15–2.07)[a]	2.21 (0.81–3.61)
51–60	437 (14.1)	7.05 (4.19–9.92)	0.32 (0.06–1.68)[a]	6.73 (4.18–9.28)
61–70	213 (6.9)	20.39 (14.29–26.5)	1.97 (0.49–3.45)	18.42 (11.93–24.92)
>70	223 (7.2)	38.36 (30–46.73)	11.32 (4.98–17.67)	27.04 (19.63–34.46)
Education				
Illiterate	937 (30.3)	15.84 (8.62–23.07)	3.14 (1.15–5.13)	12.71 (7.07–18.34)
Primary school	962 (31.1)	3.49 (1.65–5.34)	0.73 (0.24–1.22)	2.77 (1.16–4.37)
Guidance school	345 (11.1)	1.63 (0.5–2.75)	0	1.63 (0.5–2.75)
High school	607 (19.6)	1.15 (0.08–3.78)[a]	0	1.15 (0.37–2.68)[a]
College	244 (7.9)	1.72 (0.03–3.58)[a]	0	1.72 (0.06–3.51)[a]
Area				
Southwest	1776 (57.4)	4.73 (3.39–6.08)	0.79 (0.18–1.4)	3.94 (2.5–5.39)
North	1318 (42.6)	8.71 (3.97–13.46)	1.7 (0.69–2.72)	7.01 (3.29–10.74)

Abbreviation: CI, confidence interval. [a] The CI was calculated by binomial distribution.

Table 2 Association between visual impairment with age, gender, education, and area

	OR (95% CI)	P-*value*
Sex		
Male/female	1.02 (0.62–1.67)	0.933
Age		
years	1.07 (1.05–1.09)	0
Education		
Illiterate	1	
Primary school	0.66 (0.45–0.95)	0.03
Guidance School	0.35 (0.17–0.7)	0.006
High school	0.32 (0.15–0.67)	0.005
College	0.48 (0.17–1.37)	0.154
Area (Southwest/north)	1.02 (0.62–1.67)	0.933

Abbreviations: CI, confidence interval; OR, odds ratio.

Table 3 Prevalence of different causes of visual impairment and blindness based on presenting visual acuity in the better eye

	Visual impairment		*Blindness*	
	Number	*%*	*Number*	*%*
Uncorrected refractive error	108	54.27	8	20.51
Cataract	54	27.14	14	35.90
Diabetic retinopathy	9	4.52	3	7.69
Age-related macular degeneration	7	3.52	3	7.69
Amblyopia	4	2.01	1	2.56
Retinitis pigmentosa	3	1.51	1	2.56
Albinism	1	0.50	1	2.56
Corneal opacity	2	1.01	0	0.00
Glaucoma	3	1.51	2	5.13
Unknown	8	4.02	3	7.69
Total	199	100.0	36	92.31

and Poland, which is much lower than its prevalence in developing countries like Nepal, India, China, Nigeria, and Suriname. The prevalence of blindness is higher than 1% in most studies performed in developing countries. The prevalence of blindness was 1.5% in our study, which is similar to the results of other developing countries and a study performed in villages in the north of Iran but higher than local studies performed in Tehran, Shahroud, and Zahedan.

In our study, although the prevalence of visual impairment and blindness was a little higher in men than women, the difference was not significant. Some other studies have reported higher prevalence in women.[8,9] Factors such as the biological effects of female hormones

Table 4 Prevalence of visual impairment, blindness, and causes of blindness reported in other studies according WHO definition

Place	*Sample size*	*Age*	*Criteria*	*VI (%)*	*Blindness (%)*	*Causes of blindness*
China (Harbin)[35]	5057	50–96	WHO	3.8	1.9	Cataract, corneal opacity
Hong Kong[36]	3441	≥60	WHO	7.9	1.8	Refractive errors, cataract
Cameroon (Muyuka)[37]	1787	≥40	WHO	6.4	1.6	Cataract, refractive errors
Cameroon (Limbe)[38]	2215	≥40	WHO	3	1.1	Posterior segment disease, Cataract
Iran (Sari)[39]	1185	≥55	WHO	11.1	3.7	Refractive errors, cataract
Iran (Tehran)[40]	1074	40–59	WHO	2.51	0.59	Refractive errors, cataract
Iran (Tehran)[40]	385	>60	WHO	19.98	3.55	NA
Australia (Victoria)[23]	4744	≥40	WHO	0.325	0.156	AMD, glaucoma
China (Beijing)[41]	5118	≥50	WHO	8.38	1.27	Cataract, retinal diseases
China (Shanxi)[42]	75 016	≥80	WHO	0.4	0.2	Cataract, retinopathy, and choroidopathy
India (Urban)[43]	2421	>40	WHO	10.2	1.2	Cataract, uncorrected refractive error
China (rural)[44]		>40	WHO	9.8	2.2	Cataract, uncorrected refractive error
Nepal[45]	10 950	0–10	WHO	0.079	0.068	Amblyopia, cataract
China (Nine-Province)[46]	5481	≥50	WHO	7.23	1.90	Cataract
India (Andhra Pradesh)[47]	7281	≥50	WHO	19.8	2.3	cataract
India (western coastal strip)[48]	2750	>50	WHO	30.5	4.8	Cataract, corneal scars, diabetic retinopathy
Egypt (rural)[49]	600	≥40	WHO	23.9	9.3	cataract, uncorrected refractive errors, corneal opacities
Suriname (interior Maroon population)[50]	586	All	WHO	17	4.4	Cataract, glaucoma
China (Guangdong)[51]	5531	≥50	WHO	9.44	2.38	Cataract
China (Chongqing)[52]	5663	≥50	WHO	5.40	2.12	Cataract
Libya[53]	8538	≥50	WHO	21.7	3.25	Cataract, glaucoma, other corneal scars
India (Rural central)[54]	4711	>30	WHO	7	0.5	Cataract, postoperative posterior capsular opacification,
Icelanders[55]	1045	≥50	WHO	1	0.6	Amblyopia, cataract
Iran (Shahroud)[56]	5190	40–64	WHO	1.8	0.5	Uncorrected refractive errors, cataract, amblyopia

or socioeconomic indexes with their effects on the access to or quality of the ophthalmic health services in women may result in differences between men and women, which requires regional studies.[9]

As mentioned in previous studies, we also found that the prevalence of visual impairment increased with aging.[10,11] This increase in the prevalence is logical due to an increase in the factors affecting visual impairment. Aging and thinning of the macular tissue, lens opacity, cataract, diabetic retinopathy, and glaucoma, increase with age.[12–14] About 65% of the visually impaired people are older than 50 years of age while they comprise 20% of the population.[15] This point is very important in countries like Iran where the aging population is growing. Therefore, subsequent steps to decrease low vision and blindness should be aimed at older age groups.

In our study, cataract was identified as the leading cause of blindness, which is similar to other developed and developing countries. Table 4, shows the causes of blindness according to different studies. Accordingly, cataract is the first cause of blindness in almost all developing countries. Poverty is associated with cataract and blindness.[16] A study conducted in Pakistan showed that blindness was markedly more frequent in poor people.[17] The prevalence of blindness in low income countries is five times higher than their high income counterparts in a global level.[18] Cataract is responsible for 51% of the cases of blindness, that is, 20 million blind people.[19] About 82% of the blind people are above 50 years of age; as a result, the global burden of blindness is increasing as the aging population is growing.[15] If immediate measures are not devised and more resources are not allocated to confront blindness, the burden of blindness will double by 2020.[19] In addition to the fact that blindness is more prevalent in poor people, blindness itself results in poverty in the affected person and those who have care for the blind person.[20,21] Therefore, the poverty, cataract, and blindness have complex relationships which require more investigations in a global level. It is estimated that implementation of the Vision 2020 will result in the prevention of blindness in 429 million people and 102 billion dollars of economic benefit.[22]

Refractive errors were the leading cause of visual impairment in our study, both in the younger and the older age groups. This finding is similar to other studies.[23,24] Refractive errors are the first cause of visual impairment (43%) and the second cause of blindness worldwide.[1] According to the estimations of the WHO, there are 153 million low vision and 5 million blind

people in the world.[25] A great proportion of uncorrected refractive errors occur in developing countries.[26] Financial problems are a main barrier to the correction of refractive errors in different societies.[27] A study conducted in European countries showed significant differences in the prevalence and causes of blindness and visual impairment between industrialized *vs* middle income countries.[4] The same difference was observed in the evaluated provinces in our study as the prevalence of blindness and visual impairment and low vision was higher in the north *vs* the south of the country (by about a factor of 2). According to a report published by Statistical Centre of Iran, the villagers residing in the south of Iran have a markedly higher income than their counterparts living in the north of Iran. The effect of economic factors on the prevalence of visual impairment is well established and it seems that in addition to other factors (private insurance, education, level, access to health services) economic variables play a major role in this regard.[5,28] A better economic status allows the population to use the health services provided by the private sector and affects their behavior regarding the utilization of public health services. People with a better economic status use primary health services more than the poor people.[29] Moreover, many eye care services are offered in central and capital cities; as a result, those who can afford the travel costs use more services. Primary health services that are offered in rural areas cannot resolve blindness or visual impairment. These services are similar in the north and south of the country and therefore the difference in the prevalence of visual impairment and blindness between these regions is due to difference in the use of eye care services in other places.

In our study, a great proportion of visual impairment (81%) and blindness (56.41%) were due to uncorrected refractive errors and cataract, which are both preventable and correctable. Using glasses is an inexpensive way of correcting refractive errors in developing countries.[30] Since people in rural areas can provide glasses with difficulty due to financial problems and accessibility issues, effective strategies should be designed to provide the rural population with low-cost corrective glasses.[31] Moreover, offering cataract surgery services in rural areas can also markedly decrease the prevalence of blindness in the society. On the other hand, diabetic retinopathy alone was responsible for 4.52% of the cases of visual impairment and 7.69% of the cases of blindness. The prevalence of diabetes mellitus (both type 1 and type 2) is increasing in the world. Therefore, blindness and visual impairment due to diabetic retinopathy will be more prevalent in the coming years.[32,33] A marked decrease in diabetic retinopathy related visual impairment can be achieved through screening and timely treatment.[34] However, the capacity of the health system to confront the disease should be considered before screening. A study conducted by Hashemi *et al* in rural areas in the north of Iran showed that diagnostic facilities did not improve in rural areas in the past decades and these areas even lacked minimum facilities and equipment for the treatment of ocular problems.[6] Availability of suitable diagnostic and therapeutic services or offering eye care services at least for older age groups are some appropriate measures to decrease the prevalence of visual disorders. These diagnostic and therapeutic procedures can be offered through health insurances.

Summary

What was known before

- Few studies have been performed on people residing in rural areas considering their lower access to health services. A study on the rural population of north of Iran showed a higher prevalence of blindness and visual impairment as compared to the urban population, and it seems to be health facilities like cataract surgery, and availability of glasses in villages can markedly decrease the prevalence of visual impairment With regards to the aforementioned and the necessity of the investigation of these visual problems in underserved rural population, we conducted this study to evaluate the prevalence of blindness and visual impairment and their determinants in underserved villages of Iran.

What this study adds

- Prevalence of visual impairment and blindness was markedly high in this study. Lack of access to health services was the main reason for the high prevalence of visual impairment in this study.

Conflict of interest

The authors declare no conflict of interest.

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