Original research

The prevalence of uncorrected refractive errors in underserved rural areas

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Abstract

Purpose: To determine the prevalence of uncorrected refractive errors, need for spectacles, and the determinants of unmet need in underserved rural areas of Iran.

Methods: In a cross-sectional study, multistage cluster sampling was done in 2 underserved rural areas of Iran. Then, all subjects underwent vision testing and ophthalmic examinations including the measurement of uncorrected visual acuity (UCVA), best corrected visual acuity, visual acuity with current spectacles, auto-refraction, retinoscopy, and subjective refraction. Need for spectacles was defined as UCVA worse than 20/40 in the better eye that could be corrected to better than 20/40 with suitable spectacles.

Results: Of the 3851 selected individuals, 3314 participated in the study. Among participants, 18.94% [95% confidence intervals (CI): 13.48—24.39] needed spectacles and 11.23% (95% CI: 7.57—14.89) had an unmet need. The prevalence of need for spectacles was 46.8% and 23.8% in myopic and hyperopic participants, respectively. The prevalence of unmet need was 27% in myopic, 15.8% in hyperopic, and 25.46% in astigmatic participants. Multiple logistic regression showed that education and type of refractive errors were associated with uncorrected refractive errors; the odds of uncorrected refractive errors were highest in illiterate participants, and the odds of unmet need were 12.13, 5.1, and 4.92 times higher in myopic, hyperopic and astigmatic participants as compared with emmetropic individuals.

Conclusion: The prevalence of uncorrected refractive errors was rather high in our study. Since rural areas have less access to health care facilities, special attention to the correction of refractive errors in these areas, especially with inexpensive methods like spectacles, can prevent a major proportion of visual impairment.

Introduction

Refractive errors are the most common visual disorder in children,[1—4] and uncorrected refractive errors have been

identified as the leading cause of visual impairment in many age groups across the world.[1,5,6] A report by Nidoo in 2010 revealed that uncorrected refractive errors were responsible for 101.2 million cases of visual impairment and 6.8 million cases of blindness. A World Health Organization report states that approximately 43% of visual impairment is attributable to uncorrected refractive errors.[7]

Uncorrected refractive errors impair the quality of life of millions of people of different ages, genders, and ethnicities, and they impose heavy burdens on the families of the affected individuals as well as the society as a result of loss of

manpower.[8] Moreover, uncorrected refractive errors at young ages can lead to amblyopia which negatively affects their educational, occupational, and athletic performance.

Over the past decade, different surveys on populations with different ethnic and cultural backgrounds have shown that different factors contribute to the development of refractive errors. These include genetics, environmental factors, and socio-economic status.[8,9] The association between long-term near work and myopia has also been examined in some studies.

Although the effect of uncorrected refractive errors on morbidity and mortality has been well established in previous studies,[10–12] there are limited reports on the prevalence of uncorrected refractive errors in underserved rural areas, especially in Iran.[13–15] A great proportion of the Iranian population lives in rural areas, and they usually have less access to health services, which affects the diagnosis and treatment of refractive errors. The present study was conducted to determine the prevalence of uncorrected refractive errors based on demographic variables and the determinants of the unmet need for correction in the affected population.

Methods

Study type

The present study was conducted cross-sectionally in 2015. The target population of the study was rural-dwellers in underserved regions in Iran. Two underserved rural regions were selected from the north and southwest of Iran.

Sampling approach

Sampling in this study was done using the multistage cluster method. First, two rural districts were randomly selected from the north and southwest of Iran using national data on underserved regions. From the southwest of Iran, Shahyoun District was selected from the Khouzestan province, and from the north of Iran, Kajour District was selected from the Mazandaran Province. Once the target districts were determined, a list of all villages in the districts was prepared, and a number of them were randomly selected. The number of selected villages was proportionate to the total population of each district. Therefore, since Shahyoun has less populated villages, 15 villages were selected in Shahyoun and 5 in Kajour. At this stage, necessary arrangements were made with health authorities and staff, and all over 1 year old rural-dwellers were invited to participate in the study upon signing an informed consent form. For those under 18 years, consents were obtained from the head of the household. Appointments were set for consenting participants to have their examinations at the study site.

Given the main objective of the survey, the sample size was calculated based on the prevalence of visual impairment in a sample Iranian village. Therefore, for a rate of 6.3%, a precision level of 0.01, and a 95% confidence level, the sample size was calculated as 2267. This was corrected to 3400 after

applying a 1.5 design effect, and finally to 3740 after correcting for a 10% non-response rate.

The designated site for study examinations included a room with normal illumination (1300 lux with lights on). For each participant, first demographic data were collected through an interview, and then vision examinations were conducted. All vision tests were performed by two optometrists whose agreement was initially tested in 35 people. According to the intraclass correlation coefficients (ICC), the inter-examiner agreement was 0.897 for manifest refraction and 0.923 for uncorrected visual acuity (UCVA).

Examination

For each participant, first the UCVA was tested with the Snellen E chart at 6 m. Children under 5 years of age who could not respond to this chart were given instructions and tested with Lea Symbols.

In the next stage, autorefraction was done using the Nidek Ref/Keratometer ARK-510A. If autorefraction could not be done for any child, objective refraction was determined by retinoscopy. For all subjects, autorefraction results were checked through retinoscopy (Heine Beta 200 retinoscope, HEINE Optotechnik, Germany) to determine objective refraction. Then all cases with UCVA worse than 20/20 underwent testing for subjective refraction, and their best corrected visual acuity was determined. Finally, all subjects had the slit-lamp exam by an ophthalmologist, and all those under 20 years of age had cycloplegic refraction after instilling cyclopentolate 1%.

Definitions

In individuals under 20 years of age, since cycloplegic refraction was done, myopia and hyperopia were defined as a spherical equivalent of −0.5 diopter (D) or worse and +2.0 D or worse, respectively. For participants older than 20 years of age, myopia and hyperopia were defined as a spherical equivalent of −0.5 D or worse and +0.5 D or worse, respectively. A cylinder power worse than 0.5 D was considered astigmatism. To calculate the met and unmet need for spectacles, the definitions proposed by Bouene et al[8] were used. Need for spectacles was defined as a UCVA worse than 20/40 in the better eye that could be corrected to better than 20/40 with suitable spectacles. Met need was calculated as the proportion of individuals with need who achieved 20/40 vision or better with their current spectacles. Unmet need was calculated as the proportion of individuals with need who did not achieve 20/40 vision or better with their current spectacles or did not have any spectacles at all.

Statistical analysis

The prevalence of uncorrected refractive errors and unmet need for spectacles was summarized as mean and 95% confidence intervals (CI). The effect of cluster sampling was considered in the calculation of CI. Simple and multiple

logistic regression was used to investigate the correlations and odds ratio (OR) were computed.

Ethical issues

This study was approved by the Ethics Committee of Tehran University of Medical Sciences was and conducted in accordance with the tenets of the Helsinki Declaration. All participants signed a written informed consent.

Results

Of the 3851 invitees, 3314 participated in the study (response rate = 86.5%). Examinations were performed on 3255 participants. The mean age of these participants was 21.4 ± 4.37 years (range, 1–93 years) and 43.7% (n = 1421) were female.

The prevalence of need in the total sample was 18.94% (95% CI: 13.48–24.39). The prevalence was higher in women than men, in the elderly (age groups 61–70 years and >70 years) as compared with other age groups, in illiterate participants versus other education groups, and in myopic versus hyperopic individuals (Table 1).

The prevalence of unmet need was 11.23 (95% CI: 7.57–14.89), and it was higher in men than women (Table 1). The results of univariate logistic regression analysis showed that age (above 50 years), level of education, and type of refractive error significantly correlated with the prevalence of unmet need ($P < 0.05$). Nonetheless, as illustrated, the relation between unmet need and age was not linear. After categorizing by age and setting the ≤5 year age group as the reference group, the prevalence of unmet need was found to be significantly higher after the age of 50 years compared to the reference group. In contrast, residence location had no

significant effect on unmet need ($P = 0.082$) and similarly, although the odds of met need was higher in women as compared with men (OR: 1.22 vs. 1.0), their difference was not statistically significant ($P = 0.212$) (Table 2).

The multiple logistic regression model showed that only level of education and type of refractive error were significantly correlated with the unmet need ($P < 0.05$), and the highest odds of unmet need were seen in illiterate participants (OR = 1). In terms of the type of refractive error, the odds of unmet need were 12.13, 5.1, and 4.92 times higher in myopic, hyperopic, and astigmatic participants as compared with emmetropic individuals (Table 3).

Discussion

One of the top five priorities of the Vision 2020 Initiative is refractive errors and the associated vision impairment.[16] Multiple studies have shown that a considerable percentage of visual impairment is related to uncorrected refractive errors.[15,17,18] Uncorrected refractive errors are regarded as serious problems even in developed countries. In Australia for example, 56% of visual impairment and 25% of blindness is attributed to uncorrected refractive errors.[18] Therefore, proper correction of refractive errors can greatly help reduce the prevalence of visual impairment.

The prevalence of unmet need in this study was 11.23%. Another study conducted in Iran reported a prevalence of 9.3%.[15] The prevalence of uncorrected refractive errors and unmet need was 15.1% and 9% in a study in USA, respectively.[19] Inter-study differences may be related to factors such as the target population, sampling method, inclusion criteria, examiner accuracy, and the age of the participants. A higher prevalence of unmet need can be expected if older people or those living in rural areas with less access to health services

Table 1
The prevalence of the need and unmet need for spectacles according to age, gender, level of education, and type of refractive error.

Variables		Need	Met need	Unmet need
		% (95% CI)	% (95% CI)	% (95% CI)
Gender	Male	18.48 (13.92–23.05)	6.13 (4.03–8.23)	12.36 (9.24–15.48)
	Female	19.28 (12.71–25.86)	8.92 (6.44–11.4)	10.36 (5.98–14.74)
Age groups (years)	≤5	7.69 (2.44–12.95)	5.13 (−0.79–11.04)	2.56 (−2.35–7.47)
	6–20	6.37 (4.72–8.02)	4.49 (2.72–6.27)	1.87 (0.76–2.99)
	21–30	18.65 (12.99–24.31)	13.5 (9.73–17.28)	5.14 (1.22–9.07)
	31–40	13.66 (9.21–18.12)	8.72 (4.58–12.86)	4.94 (1.84–8.04)
	41–50	10.77 (7.36–14.19)	6.08 (2.47–9.68)	4.7 (2.15–7.25)
	51–60	21.09 (14.39–27.79)	6.71 (3.39–10.03)	14.38 (10.14–18.62)
	61–70	42.11 (30.6–53.61)	8.55 (2.01–15.1)	33.55 (28.05–39.06)
	>70	67.28 (59.67–74.9)	10.49 (5.78–15.21)	56.79 (50.59–62.99)
Education levels	Illiterate	31.36 (20.43–42.29)	6.51 (4.26–8.76)	24.85 (15.5–34.21)
	Elementary school	12.66 (8.49–16.83)	5.97 (4.15–7.79)	6.7 (3.95–9.44)
	Middle school	6.48 (3.3–9.65)	3.24 (1.19–5.29)	3.24 (1.03–5.45)
	High school	15.44 (10.64–20.24)	11.98 (9.21–14.75)	3.46 (0.48–6.43)
	College	21.84 (15.57–28.11)	14.94 (8.5–21.38)	6.9 (4.04–9.75)
Type of refractive error	Myopia	46.8 (36.29–57.31)	19.8 (15.15–24.45)	27 (20.04–33.96)
	Hyperopia	23.79 (14.79–32.79)	8 (5.02–10.98)	15.79 (9.3–22.28)
	Astigmatism	41.03 (32.4–49.66)	15.57 (11.71–19.43)	25.46 (19.27–31.66)
Total		18.94 (13.48–24.39)	7.71 (5.65–9.77)	11.23 (7.57–14.89)

CI: Confidence intervals.

Table 2
The odds ratio (OR) and *P* value of unmet need using univariate logistic regression analysis.

Variables		OR (95% CI)	*P*-value
Gender	Male	1	
	Female	1.22 (0.88−1.69)	0.212
Age group (years)	≤5	1	
	6−20	0.73 (0.14−3.72)	0.68
	21−30	2.06 (0.51−8.4)	0.288
	31−40	1.98 (0.51−7.66)	0.299
	41−50	1.87 (0.2−17.75)	0.559
	51−60	6.38 (1.14−35.83)	0.037
	61−70	19.19 (3.32−110.88)	0.003
	>70	49.94 (7.93−314.65)	<0.001
Education level	Illiterate	1	
	Elementary school	0.22 (0.14−0.34)	<0.001
	Middle school	0.1 (0.06−0.17)	<0.001
	High school	0.11 (0.07−0.17)	<0.001
	College	0.22 (0.12−0.41)	<0.001
Type of refractive error	Emmetropia	1	
	Myopia	24.39 (15.49−38.42)	<0.001
	Hyperopia	12.36 (8.49−18.01)	<0.001
Astigmatism	No	1	
	Yes	11.55 (6.88−19.38)	<0.001

OR: Odds ratio.
CI: Confidence intervals.

Table 3
The odds ratio (OR) and *P* value of unmet need using multiple logistic regression analysis.

Variables		OR (95% CI)	*P*-value
Education level	Illiterate	1	<0.001
	Elementary school	0.32 (0.2−0.5)	<0.001
	Middle school	0.15 (0.08−0.28)	<0.001
	High school	0.13 (0.09−0.2)	<0.001
	College	0.17 (0.08−0.35)	<0.001
Type of refractive error	Emmetropia	1	<0.001
	Myopia	22.57 (13.93−36.57)	<0.001
	Hyperopia	7.75 (5.17−11.61)	<0.001

OR: Odds ratio.
CI: Confidence intervals.

are included. In the present study, although the prevalence of unmet need was about 2% higher in men than women, the difference was not statistically significant. The Tehran Eye Study found no relationship between gender and unmet need.[15] Studies are inconclusive about the relation between gender and uncorrected refractive errors, although a greater number of studies confirm a higher prevalence of refractive errors in men.[2,20−23] For example, a study on rural individuals aged 30 years and over in Pakistan showed a prevalence of uncorrected refractive about 24% in men and 20% in women.[13] Although the prevalence of some refractive errors has been reported to be higher in women, the prevalence of uncorrected refractive errors is often higher in men than women.[8,13−15,19] Overall, gender seems to have no significant and determining effect on unmet need, and the contradictory results can be due to differences in sampling methods, type of study samples, definitions, and not adjusting for gender-related confounders such as diabetes.

Older age was associated with a higher prevalence of unmet need in this study. In a study in Pakistan,[13] the prevalence of refractive errors increased with age and the highest prevalence was seen in the 50−60-year age group. A study conducted in Mashhad, Iran also reported an increase in the prevalence of refractive errors with age; the prevalence of myopia was 3.64% in those under 15 and 22.36% in participants over 15 years of age.[22] Age has been identified as an important factor in the prevalence of refractive errors and uncorrected refractive errors.[15,19,22] Naturally, with an increase in the prevalence of refractive errors, the prevalence of uncorrected refractive errors increases as well because the sensitivity of the people receiving health services also diminishes at old ages. As a result, it is suggested to re-examine this relationship with including diabetes as a variable in future studies.

One of the important findings of this study was the relationship between the level of education and the prevalence of unmet need. The highest prevalence of unmet need was observed in illiterate participants followed by those with primary school education. Fotouhi et al[15] found relationship between education and unmet need in Tehran Eye Study. In a study by Mashayo et al,[21] a relationship was detected between the level of education and the prevalence of unmet need in patients with visual impairment; the odds of unmet need was 1 in individuals with no formal education and 0.58 in those who had junior high school education or higher. In other words, the odds of unmet need were 42% lower in educated versus non-educated participants [(1−0.58)/1 × 100 = 42%].[8] This finding is logical because educated people have more awareness and knowledge and take better care of their eyes. In addition, low educated people usually do physical jobs that may be associated with more danger to the eye and the risk of refractive errors. An association has been reported between occupation and the prevalence of refractive errors.[21]

In conclusion, the prevalence of uncorrected refractive errors was rather high in our study. Since rural areas have less access to health care facilities, special attention to the correction of refractive errors in these areas, especially with inexpensive methods like spectacles, can prevent a major proportion of visual disorders. Therefore, screening programs should be designed and implemented for the detection of refractive errors, especially in the elderly and illiterate individuals who are among high risk groups.

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