Original Article

Economic Inequality in Unmet Refractive Error Need in Deprived Rural Population of Iran

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Abstract

Purpose: To determine economic inequality in unmet refractive error (RE) need and its determinants in deprived rural population of Iran.

Methods: In this population-based study, two villages were randomly selected from among underserved villages of Iran. After selecting the participants, optometric examinations, including uncorrected and corrected visual acuity and subjective and manifest refraction, were done for all the participants. Then, unmet need for glasses was determined. Concentration index (C) was used to assess inequality, and Oaxaca–Blinder decomposition method was applied to decompose the gap between the two groups based on the determinants.

Results: Of 3851 samples, 3314 participated in the study (response rate = 86.05%). The data of 3255 participants were used for analysis. The value of C and 95% confidence interval (CI) was −0.088 (−0.157 to −0.020), indicating a pro-poor inequality in unmet need. The prevalence (95% CI) of unmet need was 11.74% (9.25–14.22) in the poor and 6.51% (4.96–8.06) in the rich, with a gap of about 5% in favor of the rich ($P < 0.001$). A marked percentage of the gap was due to the explained portion ($b = 5.73$; $P = 0.031$). In the explained portion, the variable of economic status ($b = 3.48$; $P = 0.004$) and myopia ($b = 0.88$; $P = 0.031$) caused inequality in favor of the rich and against the poor, respectively. In the unexplained portion ($b = −0.51$; $P = 0.372$), the variables of education ($P = 0.002$) and place ($P = 0.001$) had statistically significant effects on inequality.

Conclusions: There is a significant pro-poor economic inequality in the prevalence of unmet need in rural areas of Iran. Although part of this inequality is related to variables such as education and myopia, a major portion (two thirds) of this inequality may be due to the direct effect of economic inequality.

Keywords: Economic inequality, Oaxaca–Blinder decomposition, Rural, Unmet need

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Introduction

Several efforts aiming at vision improvement resulted in a global initiative to eliminate the main causes of avoidable blindness by 2020 (Vision 2020: The right to sight), in which uncorrected refractive errors (REs), as one of the most important causes of visual impairment across the world and the second treatable cause of blindness,[1-3] was one of the main targets.[4] Estimates indicate that more than 2.3 million people suffer from uncorrected RE in the world, while this disorder can be easily diagnosed and treated using optical

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corrective means such as glasses, contact lenses, and refractive surgery.[5,6] However, a very large population is affected by the unmet need for refractive correction. For example, 670 million people are unable to provide corrective spectacles, 517 million have near-vision impairment, and 153 million suffer from distance-vision impairment.[7,8] Moreover, uncorrected RE is associated with several consequences such as decreased educational capabilities, reduced employability and productivity, and impaired quality of life.[3,7]

Due to the marked economic burden of uncorrected RE,[3,8] many researchers made several efforts to estimate the prevalence of unmet and met RE needs.[9-21] Although their results were very controversial, most of them reported a need for identifying the factors affecting the met and unmet needs.[9,12,14,15] For example, some recent studies underlined the role of enabling and predisposing variables, including age, education, living place, and even the type of RE.[9,11-15,17,19,20,22,23]

The relationship between unmet need and predisposing and enabling variables, on the one hand, and the fact that more than 90% of the people with uncorrected RE whose need is not met live in low-income countries and rural areas,[24] on the other hand, indicate a remarkable inequality in uncorrected RE. Several studies showed a gap in unmet RE need between economic groups in the urban population and its determinants,[20] but no study has evaluated economic inequality in unmet need in the rural population, which was the reason why this study was designed and conducted.

Methods

This cross-sectional, population-based study was conducted in the rural areas (villages) of two underserved districts in Iran in 2015. The methodology of the study was explained in detail elsewhere.[25,26] First, the list of all underserved districts in Iran was provided, and then two were randomly selected in the north (Kojur District, Mazandaran Province) and southwest of Iran (Shahyun District, Khuzestan Province) using national data. Then, using the list of all villages in these districts, 15 villages from Shahyun and 5 villages from Kojur were selected randomly. All individuals above 1 year of age living in these villages were invited to participate in the study. Informed consent was obtained from all participants. For individuals under 18 years, informed consent was taken from the head of the household.

A researcher-made questionnaire was applied to collect the demographic data. Then, optometric and ophthalmologic examinations were started in a place with standard illumination in each village. Noncycloplegic refraction was measured with a Nidek auto refractometer (Nidek Co. Ltd, Gammagori, Aichi, Japan). For participants who wore glasses, lensometry was done after measuring their visual acuity with the present spectacles. In the next step, retinoscopy was done to determine manifest refraction, and then subjective visual acuity was measured using a Snellen chart at 6 m. All participants also underwent slit-lamp biomicroscopy. Finally, all participants under 20 years of age underwent cycloplegic autorefraction 35 min after instilling cyclopentolate 1% drops twice at a 5-min interval by an auto refractometer.

Two optometrists who had a high agreement for measuring REs by retinoscopy (intraclass correlation coefficient = 0.897) and uncorrected visual acuity (intraclass correlation coefficient = 0.923) by a Snellen chart performed all the examinations.

In individuals under 20 years of age, as cycloplegic refraction was done, myopia and hyperopia were defined as a spherical equivalent of −0.5 D or worse and 2 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 needs for glasses, the definitions proposed by Bourne *et al*.[27] were used. The need for glasses was defined as uncorrected visual acuity worse than 20/40 in the better eye that could be corrected to more than 20/40 with suitable glasses. The met need was defined as the proportion of the individuals with need for glasses whose visual acuity was 20/40 or better with their current glasses. The unmet need was defined as the proportion of the individuals who needed but did not have glasses or their visual acuity was worse than 20/40 with their current glasses, while suitable glasses improved their visual acuity to 20/40 or better. Amblyopia and structural ocular diseases were considered exclusion criteria.

The data of seven household assets were collected to determine the economic status, and the asset index was generated using principal component analysis according to the weightage of the first component.[28] Concentration index (C) was used as the measure of socioeconomic inequality in unmet need.[29] C is defined based on the concentration curve (CC). In CC, the y-axis shows the cumulative percentage of the health variable, and the x-axis represents the cumulative percentage of the population ranked by the asset index from the poorest to the richest. If every person, irrespective of his or her economic status, has exactly the same value of the health variable, the CC will be a 45° line, known as the line of equality. If, by contrast, the health variable takes a higher (or lower) value among poorer people, the CC will lie above (or below) the line of equality. The farther the curve is from the line of equality, the more inequality exists in the distribution of the health variable between the rich and the poor. C is defined as twice the area between the CC and the line of equality.[29] Therefore, if CC falls on the line of equality, C will be equal to 0, and if CC is above or below the line of equality, it will have a negative or positive value, respectively. CC ranged from −1 to +1.[29]

Then, the participants were divided into three groups of the poor, middle, and rich. The Oaxaca–blinder decomposition method was applied to decompose the factors affecting the gap between the rich and poor. This method is used to present the

mean outcome variable according to the determinant variables in each economic group using the following formula:

1) $\bar{Y}^{poor} = \beta x^{poor} + \varepsilon^{poor}$

2) $\bar{Y}^{rich} = \beta x^{rich} + \varepsilon^{rich}$

Where $\bar{Y}$ is the mean outcome variable, β is the model coefficient including the intercept, ε is the model error, and x is the explanatory variable.

The gap between the two economic groups can be formulated as:

3) $\bar{Y}^{poor} - \bar{Y}^{rich} = \left(\bar{x}^{rich} - \bar{x}^{poor}\right) \beta^{poor} + \left(\beta^{rich} - \beta^{poor}\right) \bar{x}^{rich}$

4) $\bar{Y}^{rich} - \bar{Y}^{poor} = \left(\bar{x}^{rich} - \bar{x}^{poor}\right) \beta^{rich} + \left(\beta^{rich} - \beta^{poor}\right) \bar{x}^{poor}$

The gap between the two economic groups is divided into two portions: 1-explained portion, which is the first part of the right hand side of the above formulas and is due to differences in the mean values of the variables between the two groups, and 2-unexplained portion, which is the second part of the right hand side of the above formulas and is due to differences in the coefficients of these variables.[30,31] As the study outcome was a binary variable, the method developed by Yun for non-linear outcomes was used.[32] Then, to decompose the gap, the percentage of unmet need in the poor and rich was calculated, and finally, the role of the variables of gender, age group, education level, and location in the explained and unexplained portions was evaluated. It should be noted that economic status was also included in the decomposition model as a variable to investigate its direct effects on economic inequality in addition to its indirect effects. The Oaxaca command in the Stata software version 11 (Stata Corporation, College Station, Texas) was used to analyze inequality,[33] and the cluster sampling effect was considered in calculating the confidence intervals (CIs). $P < 0.05$ was considered statistically significant.

Ethical issues

The Ethics Committee of Mashhad University of Medical Sciences approved the study protocol, which was conducted in accordance with the tenets of the Helsinki declaration. All participants signed a written informed consent (grant code = 941722).

Results

Of 3851 samples, 3314 participated in the study (response rate = 86.05%), and the present report is based on the data of 3255 participants. Women comprised 43.7% (n = 1421) of the participants, and the remaining 56.3% (n = 1834) were men. The mean age of the participants was 21.4 ± 4.37 years (range, 1–93 years).

Table 1 presents the prevalence of unmet RE need in all participants according to age, sex, education, living place, and economic group. The prevalence of unmet need (95% CI) was 11.23% (7.57–14.89) in all participants. The highest prevalence of unmet need according to education was seen in illiterate participants (24.85; 95% CI: 15.50–34.21). The highest prevalence of unmet need was seen in participants aged over 70 years (56.79%; 95% CI: 50.59–62.99) according to age group, in participants living in northern villages (14.25%; 95% CI: 11.90–16.61) according to the living place, in the middle economic group (18.37%; 95% CI: 14.54–22.20) according to the economic group, and in men (12.36%; 95% CI: 9.24–15.48) according to sex. Table 1 presents the results of multiple logistic regression analysis between unmet need and the study variables. Accordingly, the odds of unmet need were lower in participants with middle school (odds ratio [OR]: 0.35; P = 0.026) and high school education (OR: 0.35; P = 0.003) compared to illiterate participants. Moreover, the odds of unmet need were higher in the age groups of 61–70 years (OR: 9.99; P = 0.028) and over 70 years (OR: 21.88; P = 0.003) compared to participants aged below 5 years. The OR of unmet need in the rich group was 0.58 compared to the poor group (P = 0.011), indicating that rich people could more easily meet their need for refractive correction. Moreover, there was a direct relationship

Table 1: Result of multiple logistic regression and prevalence of unmet refractive error need in Iranian rural population

	Percentage (95% CI)[#]	Multiple logistic regression	
		OR (95% CI)	*P*
Total	11.23 (7.57-14.89)	1	-
Education			
Illiterate	24.85 (15.50-34.21)	1	-
Elementary school	6.70 (3.95-9.44)	0.73 (0.44-1.21)	0.226
Middle school	3.24 (1.03-5.45)	0.35 (0.14-0.88)	0.026*
High school	3.46 (0.48-6.43)	0.35 (0.18-0.71)	0.003*
College	6.90 (4.04-9.75)	0.46 (0.20-1.05)	0.067
Place			
East	9.06 (7.36-10.77)	1	-
North	14.25 (11.90-16.61)	1.14 (0.79-1.66)	0.471
Age			
≤5	2.56 (1.06-7.47)*	1	-
6-20	1.87 (0.76-2.99)	0.99 (0.11-8.20)	0.994
21-30	5.14 (1.22-9.07)	1.62 (0.19-13.77)	0.657
31-40	4.94 (1.84-8.04)	1.55 (0.18-12.81)	0.681
41-50	4.70 (2.15-7.25)	1.45 (0.17-11.75)	0.725
51-60	14.38 (10.14-18.62)	4.65 (0.60-35.91)	0.140
61-70	33.55 (28.05-39.06)	9.99 (1.29-77.49)	0.028*
>70	56.79 (50.59-62.99)	21.88 (2.84-168.08)	0.003*
Sex			
Female	10.36 (5.98-14.74)	1	-
Male	12.36 (9.24-15.48)	1.26 (0.87-1.82)	0.206
Economic group			
Poor	11.74 (9.25-14.22)	1	-
Middle	18.37 (14.54-22.20)	1.66 (1.08-2.54)	0.020*
Rich	6.51 (4.96-8.06)	0.58 (0.38-0.88)	0.011*
Myopia			
No	5.54 (4.39-6.69)	1	-
Yes	27.27 (23.20-31.30)	5.78 (4.00-8.36)	<0.001*

[#]The CI was calculated by binominal distribution, *Significance.
CI: Confidence interval, OR: Odds ratio

between myopia and unmet need (OR: 5.78; $P < 0.001$) as the prevalence of unmet need was higher in myopic individuals.

The C was −0.088 (95% CI: −0.157 to −0.020), indicating a pro-poor inequality. In other words, unmet need was concentrated in poor people.

There was a significant gap in the prevalence of unmet need between the rich and poor groups. The prevalence of unmet need was 6.51% (4.96–8.06) in the rich and 11.74% (9.25–14.22) in the poor group ($P < 0.001$). Table 2 shows the results of Oaxaca–blinder decomposition for identifying the determinants of inequality in unmet need between the poor and rich groups. Accordingly, economic status ($P = 0.004$) and myopia ($P = 0.031$) in the explained portion and place ($P = 0.001$) and education ($P = 0.002$) in the unexplained portion had a statistically significant effect on inequality.

Discussion

This was the first study of economic inequality in unmet need and its determinants in the Iranian rural population; therefore, the results of this study can be used for health planning. According to the results, the prevalence of unmet need was 11.23% in all participants, indicating that 1 in every 10 rural populations has an unmet need for refractive correction.

Comparison of the prevalence of unmet need between this study and studies conducted in urban areas of Iran underlies the unfavorable condition of the rural population. For example, the prevalence of unmet need was 4.8% in a study by Fotouhi *et al*. in Tehran[9] and 5.7% in a study by Emamian *et al*. in Shahroud.[20] The prevalence of unmet need in our study was even higher than that of other studies conducted in Taiwan (9.5%),[19] Bangladesh (7.2%),[16] and the USA (6.3% and 9.6%),[12,15] indicating lack of optical devices in rural areas, resulting in lack of access to and underutilization of eye-care services. Therefore, priority should be given to developing ophthalmologic services in rural areas through the integration of primary eye-care into primary health care.[16] Some other studies also found the effect of living place on the high prevalence of unmet need.[13,16,17]

In line with other studies,[9,17,19,22,23] the results of this study showed an increase in the prevalence of unmet need with age as 1 in every 5 individuals over 7 years had unmet need. There are different explanations for this relationship. On the one hand, an increase in age is associated with decreased accommodative capacity and increased prevalence of ocular diseases such as cataracts and presbyopia.[16] On the other hand, the idea that "nothing can change the situation" prevents older people from visiting ophthalmologists, resulting in lack of utilization of ophthalmic care, decreased visual acuity, and increased unmet need. Older people with lower education levels have an even worse situation.[19] In line with other studies,[9,11,15,17,19,20,22,23] our results showed an indirect relationship between education and unmet need prevalence; in other words, the prevalence of unmet need was four times higher in illiterate individuals compared to individuals with college education. It seems

Table 2: Result of Oaxaca-blinder decomposition of unmet refractive error need gap between economic groups

Item	Estimation (95% CI)	*P*
General result of decomposition		
Proportion of unmet RE need in poor group	11.74 (9.25 to 14.22)	<0.001*
Proportion of unmet RE need in rich group	6.51 (4.96 to 8.06)	<0.001*
Difference of proportion in the two groups (gap)	5.22 (2.29 to 8.16)	<0.001*
Explained coefficient	5.73 (0.07 to 1.68)	0.031*
Unexplained coefficient	−0.51 (−1.62 to 0.61)	0.372
Determinants	**Coefficient (95% CI)**	***P***
Result of decomposition based on determinants		
Explained portion		
Place	0.38 (−0.13 to 0.91)	0.147
Age	0.74 (−0.15 to 1.65)	0.103
Sex	−0.02 (−0.01 to 0.08)	0.653
Education	0.25 (−0.16 to 0.67)	0.238
Economic status	3.48 (1.09 to 5.88)	0.004*
Myopia	0.88 (0.07 to 1.68)	0.031*
Unexplained portion		
Place	13.17 (5.53 to 20.81)	<0.001*
Age	4.55 (−1.50 to 10.61)	0.140
Sex	0.54 (−1.77 to 2.85)	0.648
Education	−4.38 (−7.19 to −1.56)	0.002*
Economic status	3.41 (−4.01 to 10.84)	0.367
Myopia	0.15 (−1.88 to 2.18)	0.884
Constant	−17.96 (−28.49 to −7.42)	<0.001*

*Significance. CI: Confidence interval, RE: Refractive error

that because people with higher education need good vision, they are more health conscious and undergo regular ocular checkups.[19,20] Moreover, educated people can utilize more eye-care services because of their better economic condition.[21]

The results of our study showed a significant inequality between the poor and rich groups such that there was a gap (or unmet need prevalence difference) of 5.22% between the two groups, indicating 80% more unmet need in the poor group. In other words, this inequality was pro-poor. However, this gap was smaller than the gap reported by Emamian *et al*.,[20] suggesting that the distribution of unmet need is more homogeneous in the rural population. A major part of this difference was due to the explained portion, indicating that the reason for the difference in the prevalence of unmet need between the two groups was the difference in the mean values of the study variables, among which economic status and myopia had a more prominent role. Moreover, 3.48% of the total gap (67% of the gap) was related to the economic status, indicating that after adjusting for education, age, sex, living place, and RE type, the higher prevalence of unmet need in the poor group was due to the direct effect of economic status, and if the economic condition of the poor people improves, more than two-thirds of the inequality between the poor and the rich is removed. Several studies have shown the effect of income on the prevalence of unmet need.[3,14,21]

Fifteen percent (0.88/5.73) of the inequality in the explained portion was due to myopia that was pro-poor. In other words, the prevalence of unmet need was higher in people with a worse economic situation secondary to the higher prevalence of myopia. It seems that near vision is preserved in myopic individuals while their distance vision may be compromised; therefore, there is less interest in myopia correction in poor people, leading to increased prevalence of myopia in this group. The relationship between myopia and unmet need has been investigated in several studies.[9,19]

Overall, the unexplained portion did not have a significant effect on inequality, which may be due to the different effects of study variables on the rich and poor people or the variables that were not included in the model.[30,31] However, some variables in the unexplained portion showed an effective behavior. Contrary to the study by Emamian *et al*. which found that education had a significant effect on inequality in the explained portion,[20] education had a significant effect in the unexplained portion in our study, indicating the different effects of the above variables on the rich and the poor. In other words, the effect of education is in favor of the rich and poor people, who are more vulnerable due to lower education level and are less capable of addressing their need for refractive correction. Therefore, it could be stated that although some studies found a relationship between education level and unmet need,[9,11,15,17,19,20,22,23] this relationship is also affected by the economic status.

One of the variables that could be assessed in the model used in this study was insurance because the coverage of rural insurance (as a governmental insurance) is very high in rural areas (about 100%), and the coverage of private insurance is very low (about 1% of the total population) due to its high costs. Therefore, because there was no variation in this variable, it was not possible to evaluate it in this study. Studies have shown the inverse association of insurance on correctable visual impairment[10,19] because eye-care services are usually expensive and low-income people cannot afford the out-of-pocket costs of ophthalmologic services.

Despite limitations, the results of our study provided evidence that could be helpful in achieving the objectives of Vision 2020: The right to sight, including decreased avoidable blindness and inequality. A large sample size, a high participation rate, a methodologically correct population-based design, and quality control in order to decrease any error during data collection and analysis were the strong points of our study. However, it should be noted that the observed inequality and decomposition results could not show a causal direction between the relationships. On the other hand, the Oaxaca–blinder decomposition method is a deterministic method that decomposes a gap according to the variables present in the model and cannot determine the role of other variables. In general, the results showed a significant pro-poor inequality in the prevalence of unmet need in Iranian rural population. A major part of this inequality was due to differences in the economic situation and prevalence of myopia. In addition to an indirect effect on inequality, economic situation also has a direct effect on it, accounting for 67% of the total gap between the two groups. Myopia also comprised 15% of the explained portions. Therefore, to decrease and eliminate this gap, health policy-makers should direct their efforts on improving the economic status of the rural population and covering the expenses related to easier treatments of myopia (including the costs of spectacles) through increasing the coverage of private insurances.

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Conflicts of interest

There are no conflicts of interest.

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