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Original research

The reduction of horizontal inequity in unmet refractive error: The Shahroud Eye Cohort Study, 2009–2014

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Abstract

Purpose: To measure Horizontal Inequity Index (HI) of unmet refractive error and its changes between 2009 and 2014 in Iran.
Methods: The data used in this study was taken from population-based study, Shahroud Eye Cohort Study. The number of participants analyzed in first (2009) and second phases of study (2014) were 5190 and 4737, respectively, and individuals between 40 and 64 years were included. The HI was determined by using the Concentration Index (C) based on the nonlinear (Probit) model, and C was decomposed to identify and quantify the contribution of each factor.
Results: After adjusting for need variables, the results demonstrated that the HI in unmet refractive need decreased from −0.288 (95% CI: 0.370, −0.206) in the 2009 to −0.132 (95% CI: 0.290, −0.028) in 2014. Decomposition of the C showed that level of education and economic status were the greatest contributors with shares of 26.2% and 17.9%, respectively, in reducing the amount of HI in unmet refractive error between 2009 and 2014.
Conclusions: The current study demonstrated that unmet refractive error did not have an equal distribution among economic quintiles, despite the same need for correcting refractive errors. Reducing the amount of HI in unmet refractive error between 2009 and 2014 indicated an improvement in the unmet need in the five years period between two phases of study.

Keywords: Horizontal inequity; Concentration Index; Unmet need; Refractive errors; Population-based study

Introduction

Uncorrected refractive errors (UREs) is regarded as one of the most common types of visual impairments (VI) and the main cause of visual impairment, as well as the second cause of blindness.[1,2]

Naidoo et al.[2] reported that global estimate of refractive errors in 2010 included 101.2 million with VI induced by UREs and 6.8 million blind people induced by UREs. Some studies have shown that UREs may reduce educational opportunities, productivity, health status, as well as the life

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quality among people.[3–6] In addition, vision impairment induced by UREs is considered the main cause of disability, which can be often and easily prevented.[7]

Reducing preventable blindness is mirrored in the "Universal eye health: A global action plan: 2014–2019" in the World Health Organization (WHO).[8] This action plan is founded on the achievement of the Vision 2020 and one of its priority goals to reduce the prevalence of avoidable blindness and its unequal distribution such as UREs by 2020. About 90% of people with UREs are living in low- and middle-income countries.[9]

Some studies reported the prevalence of UREs, the percentage of the unmet refractive error, and the use of spectacles in different parts of the world, especially in Asia.[2,10–14] These studies found that the prevalence of unmet refractive error is remarkable, as well as the factors which are effective on them.[6,10,11,15,16] Some also suggested that UREs are distributed unequally especially among the individuals with a low economic status and suburban population.[3,17,18]

Although previous studies demonstrated the relationship between economic status and the prevalence of UREs, the unmet refractive error, and the use of spectacles in different parts of the world,[6,10,16,19] to the best of our knowledge, no study has investigated economic inequity in unmet refractive error. Horizontal equity is defined as "equal treatment for equal medical needs regardless of some characteristics such as economic status, gender, health status, etc".[20,21]

The present study aimed to first, investigate by measuring Horizontal Inequity Index (HI) and its changes between 2009 and 2014 in an Iranian middle-aged population whether the distribution of unmet refractive error is equal, and second, assess the contribution of associated factors to the observed economic inequity which were unavoidable and unfair.

Methods

The Shahroud Eye Cohort Study was designed to longitudinally investigate the prevalence and incidence of visual impairment, major eye problems, and related issues among a middle-aged Iranian population residing in Shahroud. The first phase of the study (ShECS I) was completed in 2009 and among 6311 residents of Shahroud, aged 40–64 years, who were selected through random cluster sampling, 5190 participated in the first phase (response rate = 82.2%). To collect data, a structured and comprehensive interview was conducted with the study participants.[22] Moreover, participants underwent vision tests and ophthalmology examinations. Presenting and best corrected visual acuity (BCVA) was assessed with a logarithm of the minimum angle of resolution (logMAR) chart at a distance of 4 m by trained optometrists. The second phase of the study (ShECS II) was done in 2014, five years after beginning the study. Of the 5190 participants in ShECS I, 4737 participated in SHECS II (response rate = 91.3%). In the second phase, participants had the most ophthalmic examination, performed in the first phase. The details of this study were also published before.[23]

Definition of variables

The outcome determined in ShECS I (2009) and ShECS II (2014), was the unmet refractive error. In the current study, people with an uncorrected visual acuity (UCVA) who were worse than 0.3 logMAR (less than 20/40) in better eye were considered those who needed refractive correction. In this group, the individuals were defined as the unmet need if the difference between their presenting visual acuity (PVA) and BCVA was more than or equal to 0.2 logMAR.[10]

Since reliable income indicators that can be used to classify the population into different economic groups are not available in developing countries, the principal component analysis (PCA) method was used on individual's home assets to build a proxy for economic status.[20] The asset index was then divided into five economic quintiles from the poorest to the richest. The details of this process were already published.[24,25]

Need variables are factors which biologically related to the outcome,[20] such as gender, age, health status, chronic diseases. They indicate a higher need for services and are expected to increase utilization. In current study, like the previous studies,[2,6,10,11] the variables of gender, age groups, being diabetic, having high blood pressure, and being a current smoker were considered as need variables.

Non-need variables are usually determinants of health care utilization, and while they do not change the outcome, they are effective on utilization. As a result, they can affect the inequality of services.[20] In this study, non-need variables included having supplementary insurance, education level, and economic status. Basic insurance was excluded due to its 94.0% coverage in 2009 and 98.0% coverage in 2014. Age and education were considered quantitative variables for measuring HI and decomposition analysis.

This study used the Concentration Index (C) which has been recommended in health economics as a standard tool for measuring economic inequality and horizontal inequity.[20,21] The value of the C varies from -1 to $+1$, but the C ranged from the low limit of μ-*1* to the upper limit of *1*-μ since the outcome variable (unmet refractive error) in the present study was binary. Accordingly, the correction for binary variables suggested by Wagstaff et al. was applied in the calculation.[26,27]

Decomposition of the Concentration Index

Decomposition analysis was used to quantify the contribution of each of the need and non-need variables to the observed inequality and to determine the HI and its changes in unmet refractive error. The C was decomposed based on a non-linear regression model (Probit) between the variable of unmet refractive error and the set of variables that influence it.[20] The details of this process have already been published elsewhere.[25]

The positive (negative) amount of the contribution of each variable indicates that the variable has a positive (negative) relationship with increased inequity in unmet refractive error.[20]

Table 1
The description of unmet refractive error in two phases of Shahroud Eye Cohort Study, by different independent variables.

Independent variables	First phase of study in 2009			Second phase of study in 2014		
	n/N	Proportion (95% CI)	*P* value	n/N	Proportion (95% CI)	*P* value
Sex			0.007			<0.001
Male	99/279	35.5 (28.5–40.0)		88/300	29.3 (24.7–33.9)	
Female	196/429	45.7 (40.5–50.5)		213/485	43.9 (39.4–48.4)	
Age groups						
40–44	30/88	34.1 (24.5–45.1)	<0.001-	–	–	<0.001
45–49	39/138	28.3 (20.5–35.7)		33/113	29.2 (21.1–37.2)	
50–54	74/172	43.0 (35.0–50.8)		50/177	28.2 (21.6–34.8)	
55–59	78/182	42.9 (35.0–49.0)		76/189	40.2 (33.3–47.1)	
60–64	74/128	57.8 (47.0–65.3)		74/179	41.3 (33.7–48.9)	
65–69	–	–		68/127	53.5 (45.5–64.5)	
Diabetes mellitus			0.945			0.093
No	247/592	41.7 (37.4–45.9)		195/538	36.2 (32.1–40.3)	
Yes	48/116	41.4 (33.0–49.7)		103/242	42.5 (36.4–48.6)	
Hypertension			0.421			0.201
No	156/387	40.3 (35.3–45.2)		87/248	35.0 (29.0–41.0)	
Yes	139/321	43.3 (37.6–48.9)		214/537	39.8 (35.7–43.9)	
Smoking			0.967			0.550
No	264/634	41.6 (37.6–45.6)		271/703	38.3 (34.7–41.8)	
Yes	31/74	41.8 (30.6–53.0)		27/77	35.0 (24.5–45.5)	
Supplementary insurance[a]			0.029			0.036
No	178/399	44.6 (39.6–49.6)		128/298	42.9 (37.0–48.8)	
Yes	105/289	36.3 (30.4–42.1)		172/485	35.5 (31.3–39.5)	
Economic quintiles			<0.001			<0.001
Quintile 1 (low)	106/183	57.3 (50.1–65.7)		89/193	46.1 (39.1–53.1)	
Quintile 2	52/122	42.6 (33.4–51.7)		74/165	44.9 (37.1–52.4)	
Quintile 3	102/264	38.6 (32.8–44.4)		57/142	40.1 (32.4–48.3)	
Quintile 4	19/62	30.6 (18.8–42.4)		49/161	30.4 (23.8–37.4)	
Quintile 5 (high)	16/77	20.8 (11.4–30.1)		31/125	24.8 (17.3–32.6)	

n: Number of people who had an unmet need for spectacles; N: People who had an uncorrected visual acuity worse than 0.3 logMAR in the better eye.
[a] Data were available for 5087.

Horizontal Inequity Index

The HI is a tool widely used to determine whether or not an observed inequality can be considered a matter of inequity. In other words, the HI is the existence of any residual amount of inequality after standardization based on the need variables, which is not due to the need differences and is avoidable.[20] The interpretation of HI is similar to the C. A positive (negative) value indicates that HI is concentrated among individuals with higher (lower) economic status and a zero value indicates no inequity.[20,21]

To determine the contribution of each factor to the changes in the C between 2009 and 2014, the decomposition method introduced by Wagstaff et al. was used.[28,29]

In the present study, the effect of cluster sampling was taken into account, descriptive analyses of different variables, and the calculation of HI. All participants in this study signed the informed consent form after the study was well and carefully explained. The present study was confirmed by the Ethics Committee of Shahroud University of Medical Sciences.

Results

Among all participants in both phases of study, 13.7% and 6.1% had a UCVA worse than 0.3 logMAR in the better eye in the year 2009 and 2014, respectively. Among these people, 295 (41.6%) in 2009 and 301 (38.3%) in 2014 had the unmet need for spectacles. In other words, either they did not have spectacles or their spectacles were not appropriate although they needed to wear them.

Table 1 demonstrates the percentage of unmet refractive error based on different variables in the year 2009 and 2014. The percentage of the unmet need was higher and statistically significant among women, low educated individuals, people without supplementary insurance, and people with lower economic status in both phases of study.

The C for the first phase of study was −0.294 (95% CI: 0.376, −0.210) while it was equal to −0.196 (95% CI: 0.295, −0.044) in the second phase. After standardizing the observed economic inequality based on individual needs, any observed residual amount of economic inequality is interpreted as a horizontal inequity. The value of HI was −0.288 (95% CI: 0.370, −0.206) in the first phase, and −0.132 (95% CI: 0.290, −0.028) in the second phase, indicating that the unmet refractive errors were distributed unequally among different economic quantiles and concentrated more among people with low economic status. Furthermore, the horizontal inequity between the studied period was reduced by 0.156 (95% CI: 0.050, 0.260, although the decrease was not statistically significant ($P = 0.179$). In other words, the HI in unmet refractive error has improved over the 5 years, and its amount among people with low economic status has decreased.

Table 2
Decomposition of Concentration indices (C) and changes in C in unmet refractive error, Shahroud, Iran.

Variables	First phase of study in 2009		Second phase of study in 2014		Changes in Concentration Index (C)	
	Contribution to overall C	Contribution percent	Contribution to overall C	Contribution Percent	Contribution to change in C	Contribution Percent
Need variables						
Sex (Female)	0.008	−2.8	−0.020	10.1	−0.029	−17.9
Age (year)	−0.009	3.2	−0.031	16.4	−0.022	−14.1
Diabetes mellitus (Yes)	−0.000	0.00	−0.001	1.2	0.000	0.000
Hypertension (Yes)	0.000	−0.1	0.001	−1.2	0.001	0.006
Smoking (Yes)	0.000	−0.3	0.000	−0.000	0.000	0.000
Total need	0.002	−1.0	−0.049	25.8	−0.051	−32.6
Non-need variables						
Supplementary Insurance (Yes)	0.004	−1.4	−0.006	3.2	−0.010	−6.4
Education (Year)	−0.207	70.4	−0.166	84.3	0.041	26.2
Economic quintiles						
Quintile 1 (low)	Reference		Reference		Reference	
Quintile 2	0.023	−8.0	−0.007	3.6	−0.041	−26.2
Quintile 3	−0.024	8.3	0.003	−1.8	0.016	10.2
Quintile 4	−0.031	10.7	0.009	−4.7	0.023	14.7
Quintile 5 (high)	−0.054	18.3	0.004	−2.0	0.030	19.2
Total non-need	−0.352	98.3	−0.163	82.6	0.059	37.7

C: Concentration Index.

Table 2 shows the decomposition of the C by need and non-need variables in order to determine the absolute contribution and the percentage of contribution of each factor in HI in unmet refractive error in the first and second phases of study and also its changes. Years of education and the economic status had the largest contribution in HI in unmet refractive error in 2009. Other variables such as diabetes, hypertension, and smoking had a trivial contribution.

Other findings show that in 2014, the education, age, and sex had the greatest contribution in C with shares of 84.3%, 16.4%, and 10.1%, respectively.

Table 2 also indicates the contribution of factors that changed horizontal inequity in unmet refractive error between 2009 and 2014. As shown, there is an absolute contribution in changing the amount of HI between the year 2009 and 2014 for each variable, whose absolute value was obtained by subtracting its contribution at the second time from the first time point. Further, its percentage of contribution was obtained by dividing this absolute contribution to the absolute value of the change in the C in unmet refractive error (0.156) during the study periods. Since the sign of the change in HI in unmet refractive error between 2009 and 2014 is positive, it can be said that each factor whose change of percentage contribution sign was positive (negative), contributed in decreasing (increasing) the amount of HI in unmet refractive error between the study periods. Accordingly, the variables of years of education and economic status with the share of 26.2% and 17.9%, respectively, made the largest contribution in reducing the amount of HI in unmet refractive error between 2009 and 2014.

Discussion

The present study attempted to measure HI in unmet refractive errors by estimating the C. The results provide new evidence about economic inequity among the middle-aged population. The results indicated that the HI existed in both years 2009 and 2014, as well during the study period. In other words, the unmet refractive errors was unequally distributed among people with different economic status and concentrated on individuals with lower economic status. This finding is consistent with other studies,[6,10,18,30–32] which indicated that UREs concentrated on people with a lower economic status, although the analysis approach were different.

One of the important findings of current study was the reduction in the amount of HI, which indicated that an improvement of horizontal inequity in unmet refractive error between 2009 and 2014, although this decreasing (0.156) was not statistically significant.

The decomposition of the C and its changes revealed that education had the highest contribution in HI in both years (2009 and 2014), and it made the largest contribution in reducing the amount of HI in unmet refractive error between 2009 and 2014.

With regard to the lack of change in the level of education of the participants in the present study, an increase observed in the contribution of education inequality in the second phase (84.3%) compared to the first phase (70.4%) can be attributed to the improvement of economic status and an increase in mean score of economic status among people with higher education. An additional analysis showed that the percentage of people whose economic status improved during the study periods was 27.2%, 37.3%, 36.6%, 45.0%, and 49.9%, in the groups of illiterate, elementary school, middle school, high school, and college, respectively. This can be explained by the fact that educated people compared to illiterate people or low educated people have a higher awareness of the benefits of periodical medical eye care through timely visits to conduct demanding examinations and ultimately the use of spectacles. This result is consistent with those of other studies, which indicated the importance of education in reducing visual

impairments.[6,15,24,33] Furthermore, the result is in line with the study of Emamian et al.,[10] which suggested that the difference in the prevalence of the unmet need between the two groups of high and low economic status was due to the disparity in the level of education of study participants. Another study also found that lower education is an independent risk factor for visual impairments.[34] Therefore, it can be concluded that one of the most important steps to reduce HI in unmet refractive error is to regulate policies with the aim of increasing literacy in people with a low economic status.

Furthermore, the results of the decomposition analysis showed that education had the greatest contribution (26.2%), in reducing the amount of HI. It could be stated that illiterate or low educated people used these services more than educated people because of the availability of free eye care examinations, which were performed by an optometrist or ophthalmologist. As a result, the percentage of the unmet refractive error decreased significantly among illiterate and low educated participants in 2014 compared to the year 2009. No study was found that reported the effect of education on HI in unmet refractive error over a given time interval, but some studies have shown that level of education is a relevant factor in amount of HI in the utilization of health care services.[25,29,35]

The decomposition analysis and its changes revealed that the economic status with share of 17.9% was the second most important contributor in decreasing the amount of HI in unmet refractive error between 2009 and 2014. Reducing the amount of HI in 2014 compared to 2009 can be attributed to the improvement of economic status of participants between study periods. A possible explanation of this result can be mentioned to the implementation of the targeted subsidies law in Iran. This law was implemented just one year after completing the first phase of the study in 2010.[36] Since measuring the economic status in this study was conducted indirectly by using the data related to the possession of home assets, the economic status of study participants was influenced by targeting subsidies. The results of other study showed that subsidies can increase the financial strength and power of purchasing in Iranian household.[37] The effect of this policy was clearly evident in the ShECS, in such a way that frequency of having many household goods increased in the second phase of the study (2014) compared to the first phase (2009). As a result, those who belonged to the lower economic quantiles in the first phase were transferred to higher economic quintiles. On the other hand, according to another study,[38] the greatest effect of subsidies was primarily related to improving the access to health services and, secondly, was related to the financial strength and purchasing power. Thus, it can be said that the improvement of the economic status of participants, by both reducing the economic inequity and improving the individuals' availability to health care services could contribute to the reduction of the HI in the unmet refractive error between 2009 and 2014. The reduction in unmet need can be confirmed by an improvement of the economic status among people with lower economic status, such that the percentage of the unmet need in the poorest economic quintile in the year 2014 decreased about 11.0%, compared to that of the year 2009. No study was found that indicated economic status as a factor in creating HI in unmet refractive error, but some studies have shown that the relationship between the economic status with visual impairment and also unmet refractive error.[2,6,10,39] Moreover, it seems that the improving the economic status of people in the ShECS II compared to ShECS I, provided both the possibility for purchasing complementary insurance coverage and increasing financial strength to pay spectacle coverage among people with lower economic quintiles.

The other results of decomposition of HI and its changes indicated that the share of age was the first largest contributor among need variables in creating HI in unmet refractive error between 2009 and 2014. Its contribution was 3.2% in 2009 and 16.4% in 2014. This increase in the contribution of age can be due to increase in age of participants, which is an important determinant in the prevalence of refractive errors,[11,12,14,40] and lower economic status in elderly.[41,42] The indirect effect of inequality in age, such as a reducing the level of income following retirement, as well as decreasing purchasing power and payment costs which could be lack of attention to utilizing eye care service,[41] can be controlled by regulating welfare programs for enhancing the economic status of elderly.

Sex difference (being female) was the second factor among need variables that made a considerable contribution to HI in the unmet refractive error, and its share increased from −2.8% in 2009 to 10.1% in 2014. The negative share of sex difference over time (−17.9%) indicated that the women had a worse condition in unmet need, compared to the men, in spite of the same need for correcting refractive errors. In explaining this result, it could be mentioned that the women had higher incidence of visual impairments in some studies.[2,6,10,33,43] In the present study, the percentage of unmet refractive error among women was higher than that of men in 2009 (45.5% vs. 34.3%) and in 2014 (43.9% vs. 29.3%). The share of sex difference in unmet need can be attributed to the lower mean of years of education among women (about 5 years), compared to men (about 9 years). In addition, the effect of cultural norms and social stigma is regarded as another factor, which can be contributed to the increase in the contribution of gender difference (female vs. male) for correcting the refractive errors.[44] In some societies, the use of spectacles for women is associated with embarrassment and social stigma.[6,45] Of course, there was no tool to evaluate and measure this factor directly in the present study. Finally the increase in the contribution of sex difference in amount of HI in unmet need can be related to the woman's economic status. The results of another study[24] and additional analysis indicated that the percentage of women was higher in the group with a low economic status than high economic status group, and the mean of women's economic scores in 2014 was about 2 times lower than the amount in 2009. Thus, women were less likely to meet their need for correcting refractive errors during the study period. Regarding these important findings, it seems that special interventions should be conducted to empower women such as educational programs by emphasizing the role

of regular and periodical ophthalmic examinations and raising the women health literacy in order to reduce the inequity in unmet refractive error.

The main strength of this study is that, to the best of our knowledge, it is considered the first study for measuring HI along with its changes in unmet refractive error, in a prospective cohort study with a large sample size, high participation rate, proper design, and quality control. The present study could provide some evidence about economic inequity monitoring in unmet refractive error for health care policy makers. However, the present study is suffering from some limitations. First, measuring HI in unmet refractive error would be more accurate if the economic status of individuals was based on their income at the national level. Second, some variables such as the availability of eye care services, affordability of service cost, and place of residence (urban or rural) were not investigated in current study due to the lack of relevant information. Further studies are recommended to identify other factors involved in economic inequity in unmet refractive error.

In conclusion, the current study indicated that the unmet refractive error did not have an equal distribution among different economic quintiles, and people with lower economic status had the highest proportion of unmet need compared to other economic quintiles between 2009 and 2014. Although the reduction of HI was observed in unmet refractive error during the study periods, more efforts are needed to decrease economic inequity. To remedy the current situation and reduce economic inequity, screening programs should be designed and implemented for detection of unmet refractive errors, with more attention to the women, elderly, illiterate and low educated people, and individuals with low economic status. The results of present study can be used by policy makers to prevent unavoidable blindness and design appropriate interventions at the national level.

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