Horizontal inequity in the utilization of cataract surgery in Iran: Shahroud Eye Cohort Study, 2009-2014

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Abstract

Background: Since there was no evidence about economic inequity in utilization of cataract surgery in developing countries, such as Iran, this study was designed to measure horizontal inequity in the utilization of cataract surgery and its changes in an Iranian middle-aged population in 2009 and 2014.

Methods: Using data from the first and second phases of Shahroud Eye Cohort Study (2009-2014), the economic inequity in the utilization of cataract surgery in an Iranian middle-aged population aged 40-64 years in 2009 and 2014 was evaluated. The horizontal inequity index (HI) was determined using the indirect standardization method based on a nonlinear (probit) model and the concentration index (C) was decomposed into the contribution of each factor. The analyses were performed using STATA software version 12/SE, and significance level was set at less than 0.05.

Results: The HI in the utilization of cataract surgery increased from 0.080 (95% CI: 0.011-0.098) in 2009 to 0.166 (95% CI: 0.0821-0.228) in 2014. Decomposition of changes in the concentration index showed that among need and non-need variables, older age and economic status (being among the wealthiest 20%) were the greatest contributors, with shares of 67.5% and 57.5%%, respectively, which led to pro-rich inequity during the study periods.

Conclusion: The present study demonstrated that utilization of cataract surgery did not have an equal distribution among economic quintiles, despite considering equal needs based on cataract severity. Results demonstrated that older age and economic status were the greatest contributors to HI increase in 2009 and 2014.

Keywords: Horizontal inequity index, Concentration index, Cataract surgery utilization, Middle-aged population, Iran

Introduction

More than 50% of the visual impairment cases worldwide are caused by cataract, among which 33.4% are blindness and 18.4% a moderate to severe visual impairment. In 2010, cataract was the global cause of blindness for 10.8 million and the cause of visual impairment in 35.1 million individuals (1, 2).

As life expectancy increases and the aged population continues to grow, the number of people with cataracts is expected to increase (3, 4). In low- and middle-income countries, cataract has become a public health priority. It

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↑What is "already known" in this topic:
More than 50% of the visual impairment worldwide is caused by cataract. Also, 90% of blindness in developing countries is related to the socioeconomic status of individuals. Blindness from cataract was focused unequally, such that poorer and less developed countries have higher rates of cataract and worse cataract service indicators.

→What this article adds:
The utilization of cataract surgery did not have an equal distribution among economic quintiles in Iranian middle-aged population in 2009 and 2014. Also, economic status was the greatest contributor in HI increase in 2009 and 2014.

was estimated that between 2010 and 2020, the total cost for the eradication of cataract-related blindness in the world will be 5733 million dollars (5).

The importance of eliminating cataract blindness and reducing preventable blindness is mirrored in the "Universal Eye Health: A Global Action Plan 2014-2019" of the World Health Organization (WHO). This action plan is founded on the achievements of the Vision 2020 Initiative, and one of its priority goals is to reduce the prevalence of preventable blindness and its unequal distribution by 2020 (6). The purpose of the program was to lower the avoidable visual impairments to 25% of its respective value in 2010 by 2020 (5). All the countries are encouraged to implement effective measures to control avoidable blindness at national level (6, 7).

Some studies have suggested that 90% of blindness in developing countries is related to the socioeconomic status of individuals (2, 8, 9). It has also been demonstrated that cataract blindness and its relevant services are unequally distributed among countries and regions. Moreover, the blindness from cataract was focused unequally: impoverished and less developed countries had a higher rate of cataract and worse cataract service indicators (2, 10, 11). A review of the available literature identified inequalities in cataract service indicators, such as cataract surgical rate (CSR) and cataract surgical coverage (CSC) in different countries, including Iran (10, 12, 13).

To the best of the authors' knowledge, no study has investigated inequity in the utilization of cataract surgical services based on the definition of horizontal equity, which is defined as "equal treatment of people with equal medical needs, regardless of economic status, gender, health status, etc." (14, 15). The present study was designed to measure changes in inequity based on the horizontal inequity index in using cataract surgery services in an Iranian middle-aged population in 2009 and 2014 and to decompose the concentration index to determine the contribution of different factors to this inequity.

Methods

Shahroud Eye Cohort Study (SHECS) 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 (16). The first phase of the study (SHECS I) was completed in 2009. Of the 6311 residents of Shahroud aged 40-64 years, who were selected through random cluster sampling, 5190 participated in the study (response rate=82.2%). To collect data, a structured and comprehensive interview was conducted with the study participants. Moreover, all participants underwent visual acuity testing, refraction, and imaging procedures on the examination site. Out of 5190 participants of SHECS I, 453 did not participate in the second phase of the research due to health-related problems (death, n=111), moving to another city (n=126), unwillingness (n=208), and loss to follow-up (n=8), and 4737 of the total participants remained in SHECS II (response rate=91.3%).

In the second phase, all participants had vision tests and ophthalmic examinations. In the next step, all had a slit-

lamp examination by an ophthalmologist as well as an assessment of lens opacities using the WHO Simplified Cataract Grading System (17, 18). All participants signed the informed consent form after the study was explained to them thoroughly. The ethics committee of Shahroud University of Medical Sciences approved the study, which was conducted according to the Declaration of Helsinki.

Definition of Variables

The utilization outcome in this study was determined separately for ShECS I (2009) and II (2014), which was having cataract surgery in at least one eye. Service utilization in ShECS I was based on a binary response variable (yes/no) to the following question: "Have you ever had cataract surgery due to cataracts?" For ShECS II, the question was rephrased to "Have you had surgery for cataract during the past 5 years?" Any individual who have had cataract surgery in at least one eye was counted as a case who received services (yes) compared to those who had not (no).

Since reliable data for the income indicator that can be used to classify the population into different economic groups is not available in developing countries, the principal components analysis (PCA) method was used as a reliable method to build the asset index as recommended by O'Donnell et al (15). PCA was applied to determine the asset index for each phase of the study using data collected in a questionnaire about each individual's possessions, 11 items and 14 items in ShECS I and ShECS II, respectively. In this analysis, the highest levels were associated with having a private bathroom at the residence, a microwave oven, and a dishwasher in 2009, and having access to the internet at home and a computer in 2014. These 3 variables combined represented 51.77% and 56.71% of the observed variance in 2009 and 2014, respectively. Then, an asset index was created based on a weighting for the first PCA factor, and this index was divided into 5 economic quintiles from the poorest to the richest. The details of this process and variables have already been published elsewhere (19, 20).

Several methods are available for cataract grading, and the WHO grading system was used in this study (17). In the first phase of the study, 2 trained raters examined the crystalline lens by reviewing the photos; in cases of disagreement, the final judgment was made by an ophthalmologist. The agreement between the 2 raters in the first phase of the study was 99.6%, 91.5%, and 97.5% for nuclear, cortical, and posterior subcapsular cataracts, respectively.

In ShECS II, grading was done by the ophthalmologist during the slit-lamp exam. Also, a random sample of photos was reviewed by a second ophthalmologist for quality control and for ensuring the agreement between the inter-method and inter-rater. In the WHO grading system, various types of cataracts, including nuclear cataract (NUC), cortical cataract (COR), and posterior subcapsular cataract (PSC), are assessed and graded separately (0, 1, 2, or 3); cases that cannot be graded are assigned a value of 9 (17, 18). In line with previous studies, any case with a grade 2 of NUC, COR, PSC cataract in at least one eye was considered a case of significant cataract requiring surgery (18, 21-23), and this was defined as a binary variable.

Need variables are factors that are biologically related to

the outcome; they indicate a higher need for services and are expected to increase utilization. According to the definition given by O'Donnell et al (15), demographic variables, such as gender, age, health status, and having chronic disease, were considered as need variables. Other factors that according to other studies affect cataract (2, 10, 24, 25) were also considered. In this study, the need variables were as follow: gender; age in 5 groups of 40-44, 45-49, 50-54, 55-59, and 60-64 years in 2009; 5 groups of 45-49, 50-54, 55-59, 60-64, and 65-69 years in 2014; having grade 2 or more of any type of cataract in at least one eye (yes/no); being diabetic (yes/no); having high blood pressure (yes/no); and being a current smoker (yes/no).

Non-need variables are usually determinants of health care utilization and while they do not change the outcome, they are effective on utilization and can affect the inequality of services (15). Non-need variables in this study were having supplementary insurance (yes/no), education level (in 3 groups of illiterate, elementary & middle school, high school & college education), and economic status (in 5 quintiles with quintiles 1 and 5 being the poorest and richest groups, respectively). Basic insurance was excluded due to 94% coverage in 2009 and 98% coverage in 2014. Moreover, age and education variables were considered as a continuous quantitative variable for measuring HI.

Statistical analysis

Statistical analyses were conducted in 4 steps to determine the HI in cataract surgery service utilization: (a) first, utilization of cataract surgery based on actual (unstandardized) need, expected need, and standardized need was estimated based on a nonlinear probit model; (b) inequality in the utilization of cataract surgery was estimated based on the concentration index; (c) the concentration index was decomposed to determine the contribution of various factors to economic inequality, based on need and non-need variables; and (d) the HI index for cataract surgery utilization was calculated.

Measuring inequality, HI, and decomposition analysis

The concentration index, which has been recommended in health economics as a standard tool for measuring health inequity and health service utilization, was used in this study. The covariance between cataract surgery utilization, the fractional rank in the income distribution, and the unstandardized inequity in cataract surgery utilization are formulated in the concentration index. The equation is as follows (14, 15):

$$C = \frac{2}{\mu} \, cor \, (h, r)$$

In the equation, h is surgical service utilization, μ is the mean or ratio of eye care service utilization, and r is the rank of individuals based on their economic status from poorest to richest. The value of the concentration index varies from -1 to +1. A negative (positive) value indicates that the outcome of interest is distributed among individuals with low (high) economic status and a value of zero represents total equality. Since the variable of eye care service utilization in this study was binary, the concentration index ranged from the low limit of μ-1 to the upper limit of 1-μ. Accordingly, the correction for binary variables suggested by Wagstaff et al was applied in the calculation (26).

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 in using cataract surgery. The concentration index was decomposed based on a nonlinear regression model (probit) between the variable of cataract surgery utilization and a set of variables that influence it (15). The concentration index (C) for the variable y_i was obtained by the following formula:

$$C = \sum_j (\beta_j^m \bar{x}_j / \mu) / C_j + \sum_k (y_k^m \bar{Z}_k / \mu) \, C_k + G \, C_\varepsilon / \mu$$

where μ is the mean of cataract surgery service utilization (y_i), C_j and C_k are the concentration index of need variables X_j, and non-need variables Z_k, β_j^m and y_k^m are the minor effects of need (x) and non-need (z) variables, respectively, $\bar{x}_j$ and $\bar{Z}_k$ are the mean of need and non-need variables, respectively, and the products of $(\beta_j^m \bar{x}_j / \mu) / C_j$ and $(y_k^m \bar{Z}_k / \mu) \, C_k$ are, respectively, the contribution of need (j) and non-need (k) variables related to the unstandardized concentration index, and $G \, C_\varepsilon$ is the generalized concentration index of the error term. The HI is a tool widely used to determine whether or not an observed inequality can be considered as a matter of inequity. The HI in cataract surgery service utilization is calculated as the difference in the concentration index for the unstandardized concentration index for service utilization and the contribution of total need variables. Similarly, the interpretation of HI is similar to the concentration index. In other words, a positive (negative) value indicates that HI is in favor of the better off (worse off), and a zero value indicates that there is no inequity (14, 15). Furthermore, the positive or negative amount of the contribution of each variable indicates that the variable is related both to economic status and cataract surgery utilization. A positive or negative impact of each variable shows that it has a positive or negative relationship with increased inequality in the use of cataract surgery. The positive or negative impact of a variable is frequently observed among individuals with a higher or lower economic status (14, 15, 27). In the literature, inequality and inequity are assumed to be similar, but their differences need clarification. Inequality and inequity capture the disproportionate access to health care among certain population groups. Inequity, however, shows unfair access to health care, which should be addressed (28).

To determine the contribution of each factor to the changes in the concentration index during 2009-2014, the decomposition method introduced by Wagstaff et al was used (29):

$$dc = -\frac{c}{\mu} d_\alpha + \sum_k \frac{\bar{x}_k}{\mu}(c_k - c)d\beta_k + \sum_k \frac{\beta_k}{\mu}(c_k - c)d\bar{x}_k + \sum_k \frac{\beta_k}{\mu}\bar{x}_k dc_k + \frac{dGc_\varepsilon}{\mu}$$

In the present study, the effect of cluster sampling was taken into account in descriptive analyses of different variables and the calculation of horizontal inequity index. The STATA software 12/SE was used for analysis.

Results

The characteristics of the study population by need and non-need variables for cataract surgery service utilization in 2009 and 2014 are summarized in Table 1. In general, based on all need and non-need variables, the percentage of people who received cataract surgery increased in 2014 compared to 2009. Among need variables, the percentage of women who had cataract surgery was higher than men in both 2009 and 2014. The other findings demonstrated that the rate of cataract surgery was age-dependent and increased from 0.4% in the 40-44-year age group to 6.9% in the 60-64-year age group. The same pattern was observed in 2014, as the rate of cataract surgery increased from 1.1% in the 45-49-year age group to 12.0% in the 65-69-year age group.

With regards to the non-need variables, such as the economic status, participants in the top quintile were more likely to have undergone a cataract surgery than those in the lowest quintile. In 2019, it was 1.9% within the poorest quintile and 3.3% in the richest. In 2014, the range from the lowest to the highest quintile was from 2.2% to 7.2%.

The determinants of cataract surgery utilization among the 3 economic groups in 2009 and 2014 were compared, and the results are presented in Table 2. The frequency of females with cataract, diabetes, and complementary insurance was significantly higher in those with low economic status compared to those in the high economic group in 2009. People in the low economic group were significantly older and had a lower education compared to those in the high economic group. The same pattern was observed in 2014 with the difference that all variables were significant.

As shown in Figure 1, the concentration curve (CC) of cataract surgery utilization was below the perfect equality line, indicating that the prevalence (%) of utilization was concentrated more among people with higher economic status in the first phase of the study (2009). Figure 2 shows the CC of utilization of cataract surgery for the second phase of the study (2014); the same pattern is shown in the ShECS II. The C for the first phase of the study was 0.069 (95% CI: 0.011, 0.096), while it was equal to 0.092 (95% CI: 0.018, 0.114) in the second phase.

Table 3 shows the decomposition of the concentration index, including need and non-need variables, to determine the contribution of each factor to economic inequality and the HI in 2009 and 2014. 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 0.080 (95% CI:0.0112, 0.098) in the first phase and 0.166 (95% CI: 0.082,0.228) in the second phase, indicating that the utilization of cataract surgery was distributed unequally among different economic quintiles and concentrated more among people with lower economic status. Furthermore, the horizontal inequity between the studied period was increased by 0.086 (95% CI: 0.0121, 0.102), and the increase was statistically significant (p=0.023). In other words, the HI in the utilization of cataract surgery worsened over the 5 years.

The positive (negative) contribution of each factor shows that the variable is concentrated among people with higher (lower) economic status, and if it is distributed among people with different economic equally, then, economic inequality and, consequently, the HI is decreased by (%) in receiving cataract surgery. In 2009, need variables had a positive contribution to increasing the observed economic inequity. Also, among the need variables, the variable of age, with a contribution rate of 10.5%, had the largest share in increasing economic inequality in favor of the rich compared to other variables. Overall, need variables contributed

*Table 1.* The proportion of Cataract surgery in two phases of Shahroud Eye Cohort Study, by different variables

Variables	Category	Cataract surgery in first phase of study in 2009			Cataract surgery in second phase of study in 2014		
		n	proportion (95% CI)	p	n	proportion (95% CI)	p
Gender	Male	2151	2.4 (1.8-2.9)	0.106	1946	5.1 (4.2- 5.9)	0.021
	Female	3039	1.9 (1.3-2.5)		2791	3.7 (2.8-4.5)	
	40-44	966	0.4 (0.0-0.8)	<0.001	-	-	
	45-49	1379	0.8 (0.2- 1.3)		878	1.1 (0.4- 1.8)	<0.001
Age groups	50-54	1288	1.4 (0.7- 2.1)		1277	1.5 (0.8- 2.2)	
	55-59	950	4.1 (2.8- 5.4)		1186	4.0 (2.9- 5.2)	
	60-64	607	6.9 (4.9- 9.0)		859	8.5 (6.5- 10.4)	
	65-69	-	-		537	12.0 (9.1- 14.8)	
Having Cataract	Yes (grade>=2)	137	10.2 (4.7- 15.6)	<0.001	884	7.2 (5.5- 8.9)	<0.001
Diabetes	Yes	646	2.9 (1.7- 4.2)	0.166	1172	8.9 (7.2- 10.6)	<0.001
Hypertension	Yes	1983	1.9 (1.3- 2.6)	0.366	2912	5.6 (4.8- 6.5)	<0.001
Smoking	Yes	635	2.4 (1.3- 3.6)	0.643	674	5.0 (3.1- 7.0)	0.810
Supplementary Insurance*	Yes	2072	2.1 (1.5- 2.8)	0.011	2650	5.2 (4.3- 6.1)	<0.001
	Illiterate	624	2.4 (1.6-2.9)	<0.001	525	4.1 (3.6-5.3)	<0.001
Education	Elementary & Middle school	2408	1.2 (0.9-2.7)		2202	4.3 (3.9-5.7)	
	High school & college	2158	3.2 (2.8-6.1)		1990	5.9 (4.1-5.9)	
	Quintile 1, (low)	1120	1.9 (1.1- 2.7)	<0.001	1012	2.2 (1.0- 2.8)	<0.001
	Quintile 2	965	2.0 (1.1- 2.9)		874	3.2 (2.0- 4.3)	
Economic quintiles	Quintile 3	1975	2.0(1.3- 2.6)		983	4.6 (3.3- 6.0)	
	Quintile 4	561	2.6 (1.2- 4.0)		903	5.8 (4.4- 7.3)	
	Quintile 5, (high)	546	3.3 (1.8- 4.7)		965	7.2 (5.4- 8.9)	

CI: Confidence Intervals, * Data were available for 5087

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Table 2. Characteristics of study population according to different economic groups and study phases, Shahroud, Iran

| | Economic status in first phase of study in 2009 | | | | | | |
| | Low | | Moderate | | High | | p |
Variables	Mean/n	SD/Proportion	Mean/n	SD/Proportion	Mean/n	SD/Proportion	
Gender (Female)	934	68.4	845	59.0	1251	52.7	<0.001[b]
Age (Year)	52.2	6.5	51.5	6.4	49.8	5.7	<0.001[c]
Having cataract (Grade>=2)	52	3.8	46	3.2	39	1.6	<0.001[b]
Diabetes (Yes)	201	14.7	169	11.8	267	11.2	<0.001[b]
Hypertension (Yes)	506	37.0	539	37.6	930	39.2	0.375
Smoking (Yes)	162	11.8	194	13.5	290	12.2	0.347[b]
Supplementary Insurance (Yes)	362	30.0	511	39.4	1194	53.9	<0.001[b]
Education (Year)	4.3	3.8	6.1	3.9	9.5	4.3	<0.001[c]
	Economic status in second phase of study in 2014						
	Low		Moderate		High		
Variables	Mean/n	SD/Proportion	Mean/n	SD/Proportion	Mean/n	SD/Proportion	p
Gender (Female)	1056	67.6	917	59.0	807	50.6	<0.001[a]
Age (Year)	57.7	6.5	55.5	6.0	54.3	5.6	<0.001[b]
Having cataract (Grade>=2)	429	27.4	286	18.3	168	10.5	<0.001[a]
Diabetes (Yes)	416	26.8	370	23.9	332	20.9	<0.001[a]
Hypertension (Yes)	1045	66.8	948	60.9	915	57.2	<0.001
Smoking (Yes)	192	12.2	220	14.1	262	16.4	0.006[a]
Supplementary Insurance (Yes)	755	48.3	877	56.3	1018	63.7	<0.001[a]
Education (Year)	4.4	3.7	7.1	4.0	10.2	4.2	<0.001[b]

SD: Standard Deviation; BMI: Body Mass Index; [a] Chi- squared test, [b] Kruskal Wallis test
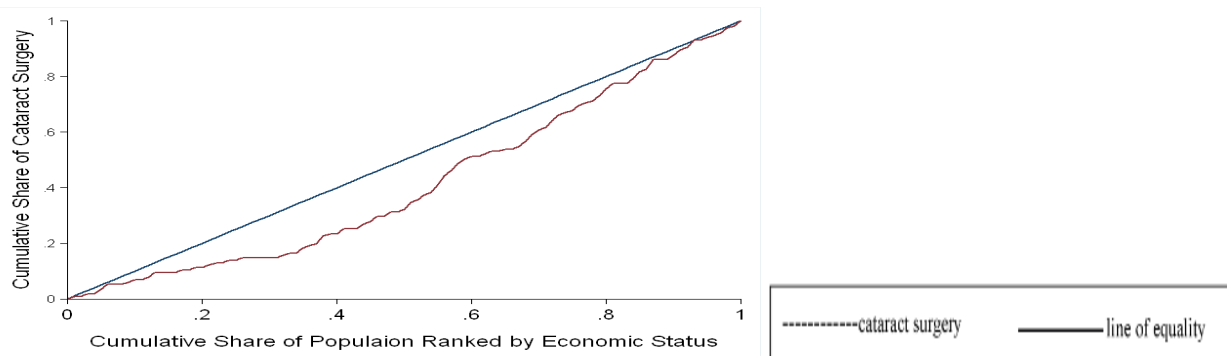
Fig. 1. Concentration curve of utilization of cataract surgery in the SHECS I, year 2009
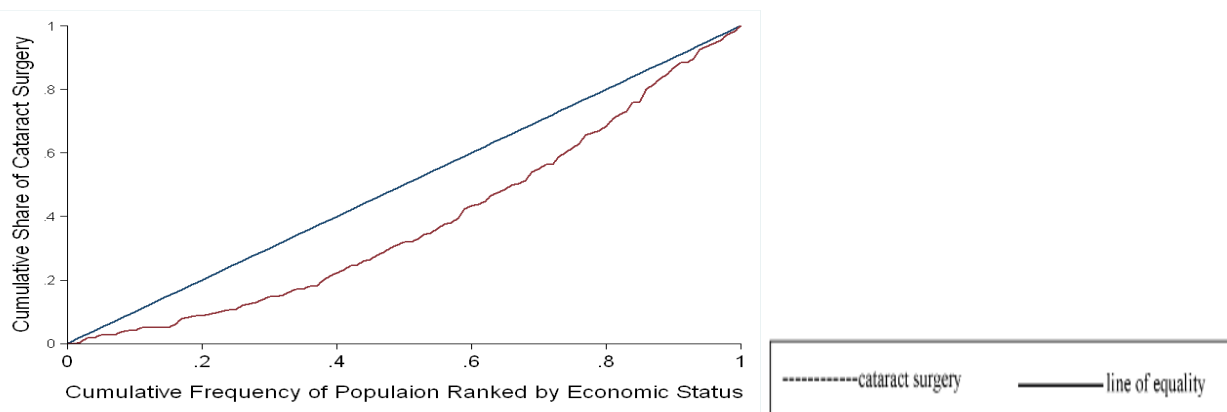
Fig. 2. Concentration curve of utilization of cataract surgery in the SHECS II, year 2014

to 17.7% of the increased economic inequity in a pro-rich direction. Based on non-need variables, the total contribution of economic status made the largest contribution (69.1%) and education (32.6%) was the second contributor to increasing economic inequity in a pro-rich direction. The amount of HI is derived by subtracting the concentration index for service utilization from the unstandardized need and the value of the concentration index for the total need

variables, which was 0.069 in 2009. Its positive value is indicative of a pro-rich pattern in the utilization of cataract surgery services.

In 2014, similar to 2009, the need variables had a positive contribution. The variable of age made the largest contribution (30.1%) to increasing economic inequity in favor of those with a high economic status. The total of the need variables had a contribution of 40.9% to the observed in-

Table 3. Decomposition of concentration indices (C) and changes in concentration index in utilization of cataract surgery, Shahroud, Iran

Variables	First phase of study in 2009		Second phase of study in 2014		Changes in Concentration Index	
	Contribution to overall C	Contribution percent	Contribution to overall C	Contribution Percent	Contribution to change in C	Contribution Percent
Need variables						
Gender (Female)	0.001	1.7	0.010	4.5	0.009	11.2
Age (Year)	0.008	10.5	0.070	30.1	0.054	67.5
Diabetes (Yes)	0.000	0.2	0.011	4.7	0.011	13.7
Having cataract (Yes) (Grade>= 2)	0.002	3.4	0.005	2.3	0.005	6.3
Hypertension (Yes)	0.001	1.4	0.002	1.0	0.001	1.2
Smoking (Yes)	-0.000	0.5	-0.004	-1.7	-0.004	-5.0
Need Total	0.012	17.7	0.094	40.9	0.082	
Non-need variables						
Complementary Insurance (Yes)	0.005	12.6	0.006	6.5	0.001	1.2
Education (Year)	0.022	32.6	0.036	39.1	0.014	17.5
Economic Quintiles						
Quintile 1 (Low)	Reference		Reference		Reference	
Quintile 2	-0.001	-14.0	-0.016	-7.1	-0.017	-21.2
Quintile 3	0.010	12.4	0.002	0.29	-0.008	-10.0
Quintile 4	0.018	20.7	0.041	17.7	0.023	28.7
Quintile 5 (High)	0.044	50.0	0.090	38.6	0.046	57.5
Non-Need Total	0.060	114.3	0.126	95.0	0.066	
Horizontal Inequity Index	0.080		0.166			

crease in economic inequality. Other variables, such as hypertension, smoking, and complementary insurance, had a trivial contribution in both 2009 and 2014.

Among non-need variables, the sum of economic variables made the greatest contribution (49.4%) and years of education (39.1%) was the second factor to increasing economic inequality in favor of the rich compared to other non-need variables. The other result of decomposition of concentration index suggested that the HI in 2014 was 0.166 and remained significant and maintained a pro-rich pattern.

Table 3 demonstrates the contribution of factors that changed horizontal inequality in the utilization of cataract surgery between 2009 and 2014. There is an absolute contribution in changing amount of HI between 2009 and 2014 for each variable, whose absolute value was obtained by subtracting its contribution at the second time (2014) from the first time (2009). Furthermore, its percentage of contribution was obtained by dividing this absolute contribution to the absolute value of the change in the HI (0.08) in using cataract surgery during the study periods. Since the sign of change in HI was positive between 2009 and 2014, each factor whose change of percentage contribution sign was positive (negative), contributed to increasing (decreasing) the amount of HI in using cataract surgery during the study periods. Accordingly, the economic status variable, with a total participation of 55.0%, and the age variable, with a participation rate of 67.5%, contributed to the largest shares in increasing horizontal inequity favored in a pro-rich direction between 2009 and 2014.

Discussion

This study aimed to measure HI in the utilization of cataract surgery by estimating the concentration index. The results provided new evidence about inequity among the middle-aged population and quantified the contribution of each need and non-need variable to the observed economic inequality and HI by decomposing the concentration indices

between 2009 and 2014. The results showed that the HI index for receiving cataract surgery increased from 0.080 in 2009 to 0.166 in 2014. In other words, the utilization of cataract surgery did not have an equal distribution among economic quintiles in Iranian middle-aged population between 2009 and 2014.

In addition, the existence of economic inequality after standardizing cataract surgery utilization based on individual need showed that the observed economic inequality implies a matter of inequity, which was not due to need differences and was avoidable (15). In other words, cataract surgery utilization did not have an equal distribution in the study population based on the definition of the horizontal equity index between 2009 and 2014, and it was more concentrated in people with a high economic status.

The increase in HI in 2014 compared to 2009 can be attributed to the distribution pattern of cataract surgery utilization. The results of this study showed that the wealthiest 20% of the population in 2009 used this service 3.5 times more than their need compared to the poorest 20%. Moreover, in 2014, the wealthiest 20% of the population, compared to the poorest 20%, used cataract surgery about 5 times more than their need, which showed the direct effect of economic status on use of cataract surgery. Furthermore, decomposition of analysis indicated that economic status made the greatest contribution to cataract surgery utilization inequity in both years (2009 and 2014), being responsible for nearly 69.1% of the inequity in 2009 and about 49.4% in 2014. Due to their better financial situation, people in the highest economic quintile could afford supplementary insurance and pay for surgical expenses.

Most studies have examined the relationship between various variables with CSC, CSR, the global burden of cataract, and the economic inequality in these 3 outcomes (13, 25, 30-34). To our knowledge, no study has measured HI in use of cataract surgery. In studies that examined economic inequality in the 3 mentioned outcomes, cataract surgical rate and economic indicators were closely associated

(10, 25, 30, 35, 36). The results of the present study showed that having a better economic status leads to receiving more cataract surgery service. In addition to its indirect effects, economic status can influence health-related problems directly via its effects on using preventive and therapeutic services.

The other result of decomposition of HI and its changes was that shares of years of education and supplementary insurance were the other important factors that increased HI during the study periods. Educated people used cataract surgery more than illiterate or low educated people because of having a better financial status and the ability to pay the surgery cost. It was also found that the mean number of successful education years was significantly higher in the high economic group compared to the low economic group for both years. This can be explained by the fact that educated people have a higher visual needs and awareness of the benefits of periodic medical eye care through timely preventive and therapeutic services (37-39).

Having complementary insurance was the other factor that led to HI increase between 2009 and 2014. A possible explanation of this result can be mentioned to having better economic situation which led to purchasing complementary insurance. This finding, as well as the results of other studies, showed that people with better economic status are able to purchase appropriate insurance coverage, and, as a result, benefit more from health care services, especially specialized services such as surgery (39-41).

Age, as a need variable, made the largest contribution to the increase in economic inequality in the utilization of surgical services. Moreover, age was the second largest contributor among all need and non-need variables; its contribution was 10.5% in 2009 and approximately 30.1% in 2014, its contribution was about 3 times greater in 2014. This increase was due to a larger percentage of older people who needed cataract surgery. In 2009, 6.9% of patients aged 60-64 years had been surgically treated, but 5 years later in 2014, 12% of people aged 65-69 years had cataract surgery (approximately 2-fold increase). Another possible explanation for this increase can be the increase in age of participants, which is an important determinant in the prevalence of cataract and lower economic status in the elderly (28, 30, 35,42). The indirect effect of inequality in age are reduced income after retirement, decreased purchasing power, and costs of eye care services. Thus, older people had the same need for cataract surgery; however, people with high economic status were more likely to receive cataract surgery because of their economic status. No study was found that reported age as a factor in increasing economic inequality in cataract surgery, but some studies have shown that age is a relevant factor in using cataract surgery (30, 35, 42). However, older people in higher socioeconomic groups may have higher visual needs, considering the higher rates of fine visual activities, such as reading, as they are more likely to be active in jobs which do not need physical strength but need fine vision. It seems that special intervention is needed for the elderly to reduce HI in using cataract surgery.

Diabetes is another factor that made a considerable contribution to HI in using cataract surgery in favor of the wealthy in 2014 compared to 2009 (-0.2% compared to 4.7%). This increase in the contribution of diabetes can be attributed to the increase in prevalence of diabetes; approximately 2-fold between the study periods (2009 and 2014), and this increase was observed more in lower economic group. This finding indicated that diabetics had the same need for cataract surgery; however, the group with a high economic status was more likely to use cataract surgery because of their better economic status. Studies have shown that diabetes is one of the determinants of choosing cataract surgery and is a risk factor for cataract (10, 24, 25). However, no study was found on the role of diabetes in economic inequality in using cataract surgery. Therefore, the present study showed that diabetes was a considerable variable in creating and increasing HI in using cataract surgery in favor of the wealthy.

Among the need variables, gender difference was the third factor to make a considerable contribution to increasing HI in receiving cataract surgery in 2014 versus 2009, as it changed from 0.8% to 4.5%. In other words, gender inequity (being female) increased in 2014 compared to 2009 and also in the past 5 years. To elaborate on this finding, the increase in contribution of gender difference can be associated with women's economic status; the percentage of women was remarkably higher in the group with a low economic status than those of the group with a high economic status in both years (2019 and 2014).

Although the analysis approach of this study and the outcome differed from other similar studies, this result is consistent with other studies which found that gender had a significant role in CSC and CSR (31, 42, 43). Another reason for the increase in gender difference was the lower mean of education years among women (about 5 years) compared to men (about 9 years). Also, over 80% of women were housewives in this study; as a result, the percentage of women who had received cataract surgery was lower than men (5.1% vs 2.4%) both in 2009 and 2014. Therefore, special interventions to emphasize the role of regular and periodical ophthalmic examinations are needed to empower women and to improve their health literacy and decrease inequity in receiving cataract surgery.

Clinicians believe that visual needs are difficult to evaluate in epidemiological studies and should be evaluated individually, as other factors than grade of cataract may influence patients and ophthalmologists' decision regarding cataract surgery. These factors include but not limited to literacy and reading trend, type of job, age at the time of retirement, being active or not after retirement, driving trend (eg, at night or not at all), comorbidities- either ocular such as pseudoexfiliation or systemic- and many other factors. Unfortunately, almost of these factors seem to be worse in those with lower socioeconomic status, older ages, and women, which makes it difficult to simply consider it as an inequality in affordability of the surgery procedure or eye care service.

The main strength of this study was that it was the first study to measure the horizontal inequity of using cataract surgery in a prospective cohort study with a large sample size, high participation rate, proper design, and quality control. This study informs health policymakers by providing

evidence of inequity in using cataract surgery in Iran. The Center of Statistics in Iran reports that, on average, the socioeconomic attributes of Shahroud and the urban population of Iran are very similar. Thus, it seems that the present results can be generalized to Iranian urban population aged 40-69 years.

Limitations

First, variables that were based on self-reports in the form of a questionnaire may have been subject to memory bias. Second, the results obtained from this study cannot be used for any causal inference between economic status and horizontal inequity in cataract surgery utilization. Third, no adjustments were made for differences in the quality of cataract surgery, although the study considered inequity in receiving surgical services. Finally, variables, such as the availability of surgical services, affordability of surgical cost, physical disability, and place of residence (urban or rural), were not investigated due to the lack of relevant information. Further studies are recommended to identify other factors involved in receiving cataract surgery.

Conclusion

The present study showed that using cataract surgery did not have an equal distribution among different economic quintiles in both phases of the study, and people with better economic status had the highest proportion of cataract surgery compared to other economic quintiles between 2009 and 2014. To reduce inequity in the utilization of cataract surgery, the government and health care policymakers need to take measures to lower income quintile, to consider middle-aged population, and to lower the prevalence of cataract in older age group to prepare the necessary services. Efforts should be made to cut surgical costs and provide more affordable supplementary insurance coverage for lower income groups to reduce inequality in using cataract surgery. This evidence is also useful in determining barriers to achieve horizontal equity (equal treatment for equal medical needs), which is in agreement with the objectives of the Join Program of the WHO and the International Agency for the Prevention of Blindness in the comprehensive 2014-2019 program.

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Ethical Statement

All the participants signed the informed consent form after the aim of the study was explained to them. The ethics committee of Shahroud University of Medical Sciences approved the study, which was conducted according to the Declaration of Helsinki.

Conflict of Interests

None of the authors had any proprietary interests or conflicts of interest related to this paper. All authors have read and approved the final version of the paper. This study was not published elsewhere and it is not simultaneously being considered for any other publication.

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