The Gap of Visual Impairment Between Economic Groups in Shahroud, Iran: A Blinder-Oaxaca Decomposition

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The authors assessed the role of economic inequality in visual impairment and decomposed the gap between high and low income groups. Study data were extracted from the first phase of the Shahroud Eye Cohort Study, performed in 2009, with 5,190 participants aged between 40 and 64 years. The participants were divided into low, medium, and high economic groups according to their assets by using a principal component analysis. The gap between low and high economic groups was decomposed to its determinants by using the Blinder-Oaxaca method. The prevalence of visual impairment, a presenting vision worse than 20/40 in the better eye, was 3.57% and 11.07% in the high and low economic groups, respectively. Age and education were the major factors in the decomposition model, contributing to 41.38% of the gap. Insurance status, gender, and education of the head of the household had no effect on this gap. Economic inequality in visual impairment was noteworthy. Although part of the gap between low and high economic groups was explained by differences in age and education, the greater part (58.62%) could be due to differences in health-care access and utilization.

health status disparities; Iran; socioeconomic factors; visual acuity

Abbreviation: ShECS, Shahroud Eye Cohort Study.

Health status disparities and the role of poverty in health have received global attention in recent years (1). Health authorities need to know how their current or future policies may cause inequality so that they can make corrections (2).

After investigators measure inequality in a community, the next step is its interpretation. This can be done through decomposition of inequality into its contributing factors (3).

In the decomposition method first implemented by Blinder (4) and Oaxaca (5) in 1973 to assess labor market discrimination, the outcome gap between 2 groups is divided into 2 components: one component due to differences in magnitudes of the determinants of the outcome between groups (the explained or endowment component) and a second component attributable to group differences in the effects of these determinant(s) (the unexplained or coefficient component) (3). In recent years, the Oaxaca method has been increasingly implemented in health research (6–11). To our knowledge, this is the first article using this method in a study on visual impairment and eye disease.

Studies on disparity in visual impairment are limited to some reports about gender inequality in eye care services (12–14) and blindness in poor communities (15). In the Eastern Mediterranean Region, the only study about gender inequality was conducted in Oman, where Khandekar and Mohammed (16) investigated gender disparities in blindness and eye diseases that lead to blindness.

In Iran, the prevalence of visual impairment by presenting vision was reported to be 2.5% in Tehran, 33.6% of which was due to refractive errors (17). Overall, published reports have described visual impairment in Iran to some extent (18), but similar to other countries, the issue of inequality has been left out.

The Shahroud Eye Cohort Study (ShECS) started in 2008, and the first phase was completed in 2009. In this report, we
try to explore inequality in visual impairment using ShECS data and the Blinder-Oaxaca decomposition method.

**MATERIALS AND METHODS**

The studied sample comprised participants of the first phase of ShECS, where 6,311 residents aged 40–64 years and living in Shahroud were randomly selected and 5,190 individuals (82.2%) were studied.

Shahroud represents a typical Iranian urban population whose socioeconomic status is average. The literacy rate in the population over 6 years of age is 84.5%, which is slightly higher than the national average of 79.5% (19).

Sample selection was done through multistage cluster sampling in 300 clusters of 20 people each, distributed proportionately to the size of the population covered by the 9 health-care centers throughout Shahroud. During the interview, we inquired about the possession or lack of 11 household items in the form of a binary variable. We also recorded the years of education of the participant and the head of the household as continuous variables.

The outcome measure in this study was visual impairment as determined by the presenting (habitual) vision of the participant in daily life situations, whether corrected or uncorrected (20). Presenting vision was measured by trained staff and optometrists using standard logarithm of the minimum angle of resolution (referred to as “LogMAR”) charts. Visual impairment was defined as a presenting vision greater than 0.3 LogMAR (worse than 20/40) in the better eye.

The studied sample was grouped according to their economic status. For this purpose, a principal component analysis was done first on home assets, as described by O’Donnell et al. (3). Then, we constructed the assets index variable based on the weighting of the first component and divided it into tertiles. To assess inequalities, we compared only the high (n = 2,376) and the low (n = 1,373) economic groups.

We assessed the role of age, gender, insurance status, and education years of the participant and the head of the household on the observed difference between the 2 groups. The outcome measure was a dichotomous variable indicating the presence or absence of visual impairment.

In the Blinder-Oaxaca model (Appendix), we aimed at entering the most influential variables and blocked those with collinearity. Therefore, first, a multiple logistic regression model was constructed by entering all mentioned variables (full model). Then, less influential variables were excluded from the model in a backward stepwise approach, and more compact models were created. The final model was built on the basis of likelihood ratio test results. A significance level of 0.1 was considered for maintaining variables in the model.

The ShECS project was approved by the Ethics Committee of Shahroud University of Medical Sciences, and all participants signed informed consents after the nature and methods of the study were explained to them.

**RESULTS**

Optometry tests were conducted on 5,182 participants. Visual impairment was detected in 344 people (6.64%). The rate was significantly lower in men (5.48%) than in women (7.50%) (P = 0.004). The prevalence of visual impairment in high, middle, and low socioeconomic groups was 3.57%, 7.47%, and 11.07%, respectively (P < 0.001). The prevalence of visual impairment increased from 3.44% in the group aged 40–44 years to 13.83% in the group aged 60–64 years. On the basis of the multiple logistic regression results, of the 5 independent variables (age, gender, insurance status, and education years of the participant and the head of the household), the participant’s age and years of education were entered into the decomposition model.

The main causes of visual impairment were uncorrected refractive errors (66.3%), amblyopia (11.4%), and cataract (7.6%). Table 1 describes these causes in the low and high economic groups.

The gap between the low and high economic groups was decomposed into major components (Table 2). The intergroup difference in terms of the prevalence of visual impairment was 7.49%, of which 3.10% (i.e., 41% of the intergroup gap) was due to the entered variables (endowments) and in favor of the high economic group. On the other hand, 4.38% (i.e., 59%) of the gap was the difference in coefficients or the unexplained component. Participants’ age and education were the major contributing factors to this gap in the explained component. However, in the unexplained component, the coefficients of these variables did not differ significantly between groups.

**DISCUSSION**

We found a 3.10-fold higher prevalence of visual impairment in the low economic group. This demonstrates the important role of economic factors and poverty in vision health and implies that vision health indices cannot be improved equally and fairly without addressing issues in the low economic group. We believe that eliminating poverty can be the most important intervention to diminish the economic inequality in vision impairment in this region.

Decomposition of the gap between these 2 groups showed that differences in age and education contributed to 41.38% of the gap. The remaining 58.62% is associated with other factors that have made the low economic group susceptible to changes in factors that contribute to inequality.
Decomposition of the Economic Gap in Visual Impairment

Differences in the level of education can explain only 33.5% of the intergroup gap. Other studies have also demonstrated increased prevalence of visual impairment with lower levels of education (21–28), although myopia is a visual impairment that shows increased prevalence rates at higher levels of education (29, 30). A new finding of this study is the contribution of education to the gap between 2 groups, which can be very helpful in designing effective interventions to eliminate inequality. However, it must be noted that the relation between education and the intergroup gap is not necessarily a causal one, and further studies are warranted.

In terms of economic status, the distribution of samples in the low economic group in relation to age groups implied that younger people are better off. Therefore, support programs for the poor should pay special attention to older age groups.

Because more than half of the intergroup gap is associated with the unexplained component, there should be other important factors that need to be investigated so that we can understand their effect on this economic inequality. Healthcare access and utilization patterns are 2 important factors that we did not assess. Insurance status showed no significant role as an independent variable in the decomposition model. This is probably because, although more than 94% of the participants were insured, basic medical insurance plans do not provide coverage for certain needs, such as prescription glasses and some eye-care procedures. Moreover, some surgical procedures are performed only in the capital, so higher socioeconomic groups have the means to travel and receive such services, while others are deprived of them. People’s behavior and perception toward receiving eye care need to be assessed for a better understanding of these issues.

According to Table 1, the causes of visual impairment that are costlier and need regular visits, such as cataracts, corneal opacities, or those associated with low education such as amblyopia and diabetic retinopathy, are more prevalent in the low economic group. The lower prevalence of these causes in the high economic group has made uncorrected refractive errors to be the major cause of visual impairment in this group and more prevalent than in other groups.

The impressive response rate (82.2%) and the large sample size of 5,190 participants are strengths of this study. Other strengths include the measuring of corrected and uncorrected visual acuity by trained staff, under close and daily supervision, as well as using presenting visual acuity as the outcome, which is important in population-based studies and is influenced by socioeconomic status.

In terms of limitations, as with many populations, especially in developing countries, the income is not clear, and because we did not collect consumption data, there was no comprehensive index with which we could divide the population into economic groups. Nonetheless, there is less measurement error in collecting information on home assets, and using these variables with proper statistical methods is a good substitute, especially for developing nations (3). Principal component analysis on such variables is a robust tool for measuring living standards (31).

The first phase of ShECS was a cross-sectional study, and considering its main objectives, it could not provide us with all the required variables, such as access to services, nor did it consider comparing rural and urban populations. On the other hand, we cannot tell if the observed association among variables is a causal one or merely a description of the existing situation. Obviously, the next phases of this cohort and studying changes over time will provide us with valuable information.

The decomposition method used in the present study has been implemented in health-related investigations, in both developed and developing countries (6, 11). Using their results can help to reduce the gap between different population groups. Although there are no similar studies concerning inequality in visual impairment among different economic groups, a case-control study in Kenya, the Philippines, and Bangladesh showed that participants who were visually impaired because of cataracts are poorer than those who enjoy better vision (13). Another population-based study in Pakistan found that blindness was significantly more prevalent among the poor (15). In addition, the Vision 2020 initiative report points out the high prevalence of blindness in poor communities (32). However, it must be noted that visual impairment can be both the effect and the cause of poverty (Appendix).

In conclusion, education was the most important factor whose change in magnitude contributed to inequality in visual impairment between the high and low economic groups. In fact, 2.51% of the 7.49% gap between these 2 groups (33.5% of the gap) was attributed to intergroup differences in education. Other issues that need more attention include improving the economic status and eliminating poverty, especially in older age groups.

Although the observed relation between visual impairment and the variables of age and education is not necessarily a causal one, health authorities can use the results of this study to develop interventions to reduce inequality. In addition to targeting the known factors in this study, they

Table 2. Decomposition of the Gap Between the Low and High Economic Groups in Terms of Visual Impairment and Description of the Contribution of Each Variable in Creating This Gap in the Explained and Unexplained Components, Shahroud, Iran, 2009

<table>
<thead>
<tr>
<th>Visual Impairment</th>
<th>Prediction, %</th>
<th>95% CI</th>
<th>P Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prevalence in high economic group</td>
<td>3.57</td>
<td>2.84, 4.31</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Prevalence in low economic group</td>
<td>11.07</td>
<td>9.35, 12.79</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Differences</td>
<td>−7.49</td>
<td>−9.36, −5.62</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Due to endowments (explained)</td>
<td>−3.10</td>
<td>−4.34, −1.87</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Due to coefficients (unexplained)</td>
<td>−4.38</td>
<td>−6.79, −1.97</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Abbreviation: CI, confidence interval.
should pay attention to other factors such as level of access to services.

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The principal idea behind decomposition is to explain the distribution of the outcome variable through a set of factors that vary systematically with the socioeconomic status. For instance, changes in health can be interpreted with changes in income, level of education, insurance status, and so on (3).

Blinder and Oaxaca, in 1973, divided the wage gap between the black groups and the white groups into 2 components: 1) one related to intergroup differences in the level of education, work experience, and other factors affecting income as one component and 2) the other related to discrimination.

This technique decomposes the gap between the average outcome variable in 2 population groups into 2 components. One component is due to differences in the magnitudes of the determinants of the outcome between populations (the explained or endowment component), such as differences in education or work experience between the 2 races, and a second component is attributable to group differences in the effects of these determinant(s) (the unexplained or coefficient component) (3). In the example above, the unexplained component denotes the part of the wage gap that exists even in the absence of differences in education and work experience; this component is due to discrimination. Decomposition of intergroup differences into 2 components is exclusive to the Oaxaca method and is not seen in other decomposition methods (3).

The common Blinder-Oaxaca decomposition method is based on 2 linear regression models that fit separately for the 2 population groups (in this case, high and low economic groups) (6).

\[ Y_H = \beta X_H + \epsilon_H \]  

\[ Y_L = \beta X_L + \epsilon_L \]

in which \( Y \) is the outcome variable (presenting vision), \( \beta \) is the coefficient including the intercept, \( X \) is the explanatory variable, and \( \epsilon \) is the error.

Considering the 2 linear regression models, one finds that the gap between the 2 groups in terms of the outcome variable (in this case, presenting vision) is the following:

\[ \bar{y}_H - \bar{y}_L = (X_H - X_L)\beta_H + X_L(\beta_H - \beta_L) \]  

(A3)

and

\[ \bar{y}_L - \bar{y}_H = (X_H - X_L)\beta_L + X_H(\beta_H - \beta_L). \]  

(A4)

In equations A3 and A4, the first part of the right side of the equations is the observable difference in the variables in the 2 groups (the endowment or explained component). This component is associated with the magnitude of the determinants of the studied outcome in the 2 groups. The second part on the right side of the equation is differences in the variable coefficients in the 2 groups (the coefficient or unexplained component). This component is associated with intergroup differences in the effect of the determinants of the studied outcome.

For decomposition, first, the regression coefficient \( \beta \) as the main effect and its interaction with other independent variables were derived from a logistic regression model containing the independent variables of age, education years, and the dummy variable of economic status. Then, differences in the \( \beta \) variables in the 2 low and high economic groups were assessed.

Considering the nonlinearity of the assessed variables in this study and the type of the outcome measure, we used the method introduced by Yun (33) in 2004 for decomposing nonlinear binary dependent variables.

The Blinder-Oaxaca command in STATA software, version 10 (StataCorp LP, College Station, Texas), was then used following the method described by Jann (34) in 2008. Considering the type of the outcome measure, we used the logit option. To calculate confidence intervals with the Blinder-Oaxaca command accurately, we included household members in the cluster to take intracluster correlations into consideration.

More discussion about the results

If poverty is defined as deprivation from basic capabilities and not just as low income, one would conclude that real poverty is far more severe than income poverty, and that there is a 2-way association between low income and different handicaps (35). In fact, income-wise division of the population into the poor and the nonpoor is not the best approach, because in light of new concepts, equity exists when people have equal opportunity in receiving services (in this case, eye care services), and any deviation from this situation can be a measure for dividing the population into 2 groups (35, 36). Therefore, should the population be grouped well and the data for major variables be available, implementing this decomposition model can be useful in designing interventions to reduce the intergroup gap.