

Socioeconomic Factors and Disease Severity at Glaucoma Presentation

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Abstract

Purpose: To investigate the impact of socioeconomic factors on presenting severity of glaucoma

Methods: In a cross-sectional study at Farabi Eye Hospital, and during 12 months study period, 258 patients with newly diagnosed glaucoma were enrolled and socioeconomic status of the patients were evaluated.

Results: Lower socioeconomic score was associated with higher intraocular pressure ($r=-0.307$, $P<0.0001$), poorer best corrected visual acuity (BCVA) ($r=-0.280$, $P\leq 0.0001$), and higher cup/disc ratio ($r=-0.351$, $P\leq 0.0001$). Expressed income was also negatively correlated with cup/disc ratio ($r=-0.258$, $P<0.0001$).

Conclusion: Advanced glaucoma at presentation is directly related to the low socioeconomic status of patients.

Keywords: Advanced Glaucoma, Cup/Disc Ratio, Socioeconomic Status

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Introduction

Blindness is one of the major causes of disability in both developed and developing countries. In the United States, it is shown that 3.2% of disabilities are caused primarily by visual impairment, ranking as the 9th main cause of disability.^{1,2} Glaucoma is the most common cause of irreversible blindness in the world and it is the second cause of visual loss, only secondary to cataract. A survey by the World Health Organization (WHO) in 2002 demonstrated the presence of 37 million blind peoples worldwide and 12.3% of them are attributable to glaucoma.³ It is estimated that 8.4 million people are blinded by the glaucoma and this would be risen to 11.1 million patients by 2020.⁴ Approximately 70 million peoples are affected by primary glaucoma and it is estimated to rise by an additional 20 million people within the subsequent decade.⁴ This would be specially relevant considering the aging of population and the age related nature of glaucoma.⁵ In Tehran Eye Study, glaucoma was responsible for 2.7% cases of visual impairments; however, the study had limited power in detecting true disease burden in Iran.⁶ Unfortunately, it is estimated that only half of glaucoma sufferers are diagnosed and treated at present time⁷⁻⁹ and the number of undiagnosed glaucoma patient could be much higher in developing or undeveloped countries, reaching more than 90% in rural India.¹⁰ Many of glaucoma patients are diagnosed only in the advanced stages of disease and it is demonstrated that late presentation, when visual field loss threatens central vision, is an important risk factor for blindness.¹¹⁻¹³

Improvements in glaucoma care have been limited by suboptimal screening and diagnosis, low use of eye care services, and poor adherence to treatment and follow-up, and this is specially relevant to the developing countries.¹⁰ Regarding the lack of single adequate screening tool for glaucoma, early detection of glaucoma is problematic and is not cost-effective in many countries, so it is desirable to identify those with higher risk of glaucoma and glaucoma blindness and to target the screening and treatment programs to this subgroup of patients.¹⁴

Among various high risk population for development of glaucoma, socioeconomically

deprived groups are specially focused on. Poverty and undereducation have a known adverse effect on health in general¹⁵ and specifically on several chronic diseases¹⁶⁻¹⁸ including glaucoma. Several studies demonstrated a correlation between socioeconomic status (SES) and both presence and severity of glaucoma.¹⁹⁻²²

In developing countries, lower income and education could predispose a greater fraction of society to suboptimal disease diagnosis and management. This could be particularly true for chronic diseases such as glaucoma. However, scarce studies are present on the possible association of SES and glaucoma incidence and severity in these communities.

The aim of current study was to investigate the impact of socioeconomic factors on presenting severity of glaucoma.

Methods

A cross-sectional study was designed at Farabi Eye Hospital. This is a subspecialty, eye hospital in capital city of Tehran, serving both primary patients of Tehran and, as a tertiary hospital, patients referred from all around the country. All patients with newly diagnosed glaucoma between April 2008 and March 2009 entered the study. All of the participants provided a written informed consent and the research was done with adherence to the Declaration of Helsinki. The study protocol was approved by the Ethical Committee of Tehran University of Medical Sciences.

Patients with secondary glaucoma, glaucoma suspect and ocular hypertension, history of ocular surgery, ocular comorbidity, history of long term topical ocular medications, acute angle closure glaucoma, and systemic diseases with potential ocular involvement were excluded from the study. In addition patients with ocular media opacity, preventing accurate determination of cup/disc ratio were excluded. In a subset of newly diagnosed glaucoma cases, the patients were referred to the hospital with a diagnosis of glaucoma and antiglaucoma medications were started just prior to referral and enrollment in the study. In this subgroup of patients, intraocular pressure (IOP) was not entered in the data analysis; however, because of impossibility of short-term and significant effect of IOP reduction on

cup/disc ratio and severity of damage, other data of these patients were considered valid and these patients were included in our analysis pool.

All enrolled patients had a definite diagnosis of glaucoma, made by a glaucoma expert at glaucoma subspecialty clinic. A social worker filled a standardized questionnaire on SES of the patient. The questionnaire, used previously in similar studies in Iran and locally validated, focused on 4 main areas and each of them are weighted to provide a final score between 7 and 31 with lower score indicating worse socioeconomic condition (Table 1).

A full set of ophthalmic examination was done for each patient by a glaucoma subspecialist, unaware of patient's socioeconomic score. Best corrected visual

acuity (logMAR) was determined for all patients. IOP was determined with Goldmann applanation tonometry for all subjects and mean of 3 readings was recorded. Cup/disc ratio was determined by glaucoma expert, using a 90 diopter lens to have a magnified fundus view at slit-lamp. Disease severity was determined based on cup/disc ration, using both a linear and stratified model. Three different stratification schemas were tried for cup/ disc ratio (Table 2). In bilateral cases, data of the eye with more severe damage was considered in data analysis.

Data analysis was performed with χ^2 test, student T-test, and Pearson correlation, using SPSS version 15.0 (SPSS Inc., Chicago, Illinois). All tests were two tailed and the significance level was set at $P < 0.05$ level.

Table 1. Socioeconomic scoring for Iranian glaucoma patients

| Variable | Variable weight | Subgroups | Scores |
|--------------------|-----------------|---|----------------------------|
| Education | 12 of 31 | Illiterate | 2 |
| | | Primary School | 4 |
| | | Secondary School | 6 |
| | | BSc | 9 |
| | | MSc and Higher | 12 |
| Job | 8 of 31 | Farmer; Simple Worker | 2 |
| | | Shopkeeper, Housekeeper | 4 |
| | | Simple Governmental employer | 6 |
| | | Higher governmental employer; Engineer; Physician | 8 |
| Residency | 8 of 31 | Tehran | 4 to 8 (8 for downtown) |
| | | Province capital city | 6 |
| | | City | 4 |
| | | Village | 2 |
| Number of children | 3 of 31 | 1-2 | 3 |
| | | 3-4 | 2 |
| | | More than 5 | 1 |

Table 2. Cup/disc ratio classification schema and number of patients in each level

| Grading | Cup/disc ratio | Presumed severity | Number (%) |
|----------|----------------|-------------------|------------|
| Method 1 | 0.3-0.6 | Mild | 74 (28.7) |
| | 0.7-0.8 | Moderate | 78 (30.2) |
| | 0.9 to 1.0 | Severe | 106 (41.1) |
| Method 2 | 0.3 to 0.5 | Mild | 50 (19.4) |
| | 0.6 to 0.7 | Moderate | 47 (18.2) |
| | 0.8 to 1.0 | Severe | 161 (62.4) |
| Method 3 | 0.3 to 0.5 | Mild | 50 (19.4) |
| | 0.6 to 0.8 | Moderate | 102 (30.5) |
| | 0.9 to 1.0 | Severe | 106 (41.1) |

Results

During the 12 months study period, 258 patients with newly diagnosed glaucoma were eligible for enrollment in the study. There were 158 male patients, representing 61.2% of study population. Mean age of patients was 63.6 ± 13.9 years, ranging from 10 to 90 years.

SES score, as defined in Table 1, had a mean of 12.24 ± 3.4 in our glaucoma patients. The lowest score was 7 and the highest socioeconomic score in newly diagnosed patient was 23 which is significantly lower than maximum score of 31.

One-hundred fifty-eight patients (61.2%) expressed monthly income data. Mean monthly income was equal to 352.28 ± 135.09 US\$ (range: 73.11-1044.49). According to the Central Bank of Iran, the official exchange rate was 1US\$= 9574.0 IR RIs at the study period. The income data was not independently validated and could be imprecise.

Best corrected visual acuity (BCVA) ranged between logMAR acuity of 0 to 3 with a mean of 1.04 ± 0.89 . IOP reading was reliable in 191 patients (74.03%). In 67 patients (25.96%) antiglaucoma medications were started just before referral to the hospital and the damaging pressure could not be precisely determinate; hence, the IOP was regarded as unreliable. Mean IOP was 34.01 ± 11.91 mmHg and ranged from 13 to 72 mmHg. Mean cup/disc ratio was 0.75 ± 0.22 and ranged between 0.3 and 1.0.

There was no significant difference between genders considering the study variables, except for lower age of female patients (60.47 vs. 66.57 years, $P=0.004$). Socioeconomic score had a significant correlation with patients age and decreased with increasing age ($r=-0.30$, $P<0.0001$). Obviously, socioeconomic score was positively correlated with express income ($r=0.604$, $P<0.0001$).

Noticeably, lower socioeconomic score was associated with higher IOP ($r=-0.307$, $P<0.0001$), poorer BCVA ($r=-0.280$, $P<0.0001$), and higher cup/disc ratio ($r=-0.351$, $P<0.0001$). Expressed income was also negatively correlated with cup/disc ratio ($r=-0.258$, $P<0.0001$).

In stratifying glaucoma severity according to cup/disc ratio, there was a significant difference between socioeconomic factors of patients with mild, moderate and severe disease ($P<0.0001$ for all). The frequency of patients according to disease severity is shown in Table 2.

Discussion

In a cross-sectional study on newly diagnosed glaucoma patient, we found that patient with lower SES, presented more advanced glaucoma. This could be interpreted as more blindness, more disability and a vicious cycle of increasing poverty. Several similar reports

published previously from other countries with different economical and health systems.

A correlation between lower SES and increased morbidity and mortality of different causes has been demonstrated.^{23,24} For example, cardiovascular diseases,^{16,17} colorectal,²⁵ breast,²⁶ hepatocellular,²⁷ and skin cancers,²⁸ and diabetes¹⁷ were associated with SES, among many other causes. Considering visual system, again socioeconomic differences were observed in several conditions including amblyopia,²⁹ cataract,³⁰ age-related macular degeneration (ARMD),³¹ and visual impairment of any cause.³²

Several studies published about the effect of SES on the incidence and severity of glaucoma. These reports came from both developed and developing countries. Investigating risk factors for late presentation of chronic glaucoma, Fraser and associates compared 110 patients suffering advanced glaucoma with 110 patients with mild to moderate glaucomatous damage in the United Kingdom.²⁰ The author reported a strong association between socioeconomic deprivation and late presentation of the disease. SES was mainly determined based on the occupational group of patients. Other determinants for late attendance in the study were initial IOP, family history of glaucoma, method of referral and time interval since last optometric visit. In a later report, Fraser and colleague evaluated the same cohort of glaucomatous patients and added care access, housing tenure, education, ethnic origin and use of general medical services beside the occupational category for the evaluation of SES.¹⁹ Again, the author reported a significant association between socioeconomic deprivation and late presentation of glaucoma.

Sukumar and associates used patients' postcode for evaluation of SES and reported an association between late presentation of glaucoma and poor SES.²² Noticeably, these patients had less educational attainment and were less aware of glaucoma in family which could cause difficulties in treatment, follow-up and case-finding. The authors stressed on the importance of focusing in low SES subgroups of society for future case-finding programs on the field of glaucoma. This is in accordance to our

findings and would be specially relevant for the screening programs in developing countries as well as developed countries.

Ng and associates evaluated the effect of socioeconomic deprivation on severity of glaucoma at presentation in 122 new cases of glaucoma in the UK.²¹ They found that age and socioeconomic deprivation were positively correlated with glaucoma presentation at more advanced stages. Interestingly, residents of socioeconomic deprived area for frequently presented severe glaucoma. In their study, the disease severity was determined based on mean deviation in the Humphrey's visual field test. Unfortunately, a large proportion of our patients perform field test sub-optimally, even on repeated testing of visual field and so, the visual fields were unreliable as a global index for determining disease severity for all glaucoma patients. With this in mind, we found cup/disc ratio, as determined by a glaucoma expert with more than 15 years experience on the field of both medical and surgical glaucoma, a more objective and reliable index.

Several mechanisms have been proposed to explain the effect of SES on health, including endocrine responses, exposure to carcinogens and pathogens, health related attitudes, and resources, psychological and environmental influences.¹⁵ Some of these are especially relevant for glaucoma; namely an endocrine response with increased intrinsic cortisone level due to stress^{19,33,34} and patients attitude regarding the nature of the disease.^{33,35}

Yip and coworkers in the Tanjong Pagar Study were pioneer in demonstrating a socioeconomic gradient in distribution of IOP.³³ Interestingly, higher IOP was strongly associated with worse SES, even after adjustment for age and central corneal thickness. This could propose a pathophysiological explanation for higher prevalence of glaucoma and presentation with more advanced disease in patients with poorer socioeconomic condition; however, possible association between glaucoma and SES was not evaluated in their study. We found a significant relationship between low SES and higher IOP; in addition, we demonstrated a strong association between glaucoma severity at presentation and SES.

Presentation with advanced glaucoma has established adverse effects on patient's health and welfare, health system and economic system. These adverse effects would be more devastating in patients with poor SES. Late presentation of glaucoma is an established risk factor for blindness.^{11-13,13,36} Impaired vision has serious consequences such as unemployment³⁷ and decreased quality of life^{38,39}; these could form a vicious cycle. In our study, we relied on educational level as one major determinant of SES. As most of education take place in early life, it is unlikely that SES based on education be affected by glaucoma itself and we could conclude that the patients had poorer SES before developing advanced glaucoma.

In a study on known glaucoma patients in Egypt, Eldaly and associates showed that glaucoma patients expend approximately 30% of their monthly income for anti-glaucoma medications.⁴⁰ In addition they demonstrated that 40% of glaucoma patients are unaware of the blinding nature of glaucoma. As a conclusion, economic burden of glaucoma treatment and lack of knowledge about the disease was proposed as main barriers to glaucoma control. Intuitively, this could result in poorer glaucoma management in patients with worse SES, whom present with more advanced disease. Educational programs to increase knowledge about glaucoma in the general population could improve disease control. It seems that the role of media as a source of knowledge should be stressed in the developing countries; this is neglected in many developing countries.^{35,40}

Lee and associates investigated risk factors for poor follow-up among 300 glaucoma patients in India.¹⁰ Lack of formal education was a significant predictor of poor follow-up with an odds ratio of 4.13. Considering the late presentation of this subgroup of patients, lack of proper follow-up and poor adherence to treatment could be translated into more blindness in patients with low SES. Ramalho and colleague reported a

similar poor compliance for medical therapy in glaucoma patients with low SES in Brazil.⁴¹

Blindness has significant adverse effect on economy. Globally, blindness and low vision resulted in an estimated \$19 223 million and \$22 764 million loss in gross domestic product in year 2000.⁴² Poverty and blindness are, therefore, inter-related.⁴³

The current evidences highlight a correlation between low SES and glaucoma in the term of incidence, severity, poor management, less regular follow-up and more blindness. This would be important for health policy makers to target the screening and treatment programs to low SES subgroups of society, specially in area with limited resources and manpower. However, despite the three- to four-fold higher prevalence of blindness in low income countries than in industrialized countries,⁴⁴ studies on association between SES and glaucoma are quite scarce in developing countries.^{10,41,43} Our study adds to the current evidences concerning SES and glaucoma relationship.

Conclusion

Our studies had some limitation, most importantly the lack of reliable visual fields in a substantial proportion of our patients with established glaucoma. In addition, there was no reliable data about patients' income. Moreover, our results is limited to the subset of patients referring to Farabi Eye Hospital and may be not truly representative of Iranian society; however, as this is the largest eye hospital in Iran, serving both as a referral and primary hospital with a diverse group of patients, the sample should be in close approximation to the society. Despite these limitations, we could demonstrate a statistically significant correlation between SES and glaucoma severity at presentation. Further study with more detailed SES evaluation in a larger cohort of glaucoma patients and follow-up of the current cohort would reveal more evidence on the relationship between glaucoma and socioeconomic condition.

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