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Research Article

**ASSOCIATION BETWEEN GLAUCOMA AND HEALTH-RELATED
QUALITY OF LIFE: A POPULATION-BASED STUDY OF DATA FROM
THE UNITED STATES**Ayman M. Baabdullah¹, Mohammed H. Aldebasi², Hind M. Alhodaly¹, Hend M. Alsawadi¹, Abrar F. Aljohani¹, Suliman Alghanam³, Eman Alhussain⁴¹Faculty of Medicine, King Abdulaziz University, Jeddah, Saudi Arabia., ²Faculty of Medicine, Al Imam Mohammad Ibn Saud Islamic University, Riyadh, Saudi Arabia., ³Population Health, King Abdullah International Medical Research Center, King Abdulaziz Medical City, Riyadh, Saudi Arabia., ⁴Glaucoma consultant, Department of Ophthalmology, King Abdulaziz University Hospital, Jeddah, Saudi Arabia.**Abstract:**

Introduction: In the United States (US), glaucoma is the leading cause of irreversible blindness, accounting for 11% all cases. Limited visual abilities may extremely affect individual's quality of life by restricting daily activities. Little is known about the impact of glaucoma on self-reported health; thus, this study aimed to investigate the association between glaucoma and Health Related Quality of Life (HRQOL) among the US population

Methods: This study used the Medical Expenditure Panel Survey (MEPS), a nationally representative household survey of the US population. Participants aged 40 years or above with and without glaucoma diagnosis were included. The study population were then divided into two age groups (40-64) and (65 and above). Outcomes were the mental and physical components of short form-12 (SF-12). The association between glaucoma and SF-12 was evaluated using a weighted multivariable linear regression model adjusting for gender, race, poverty status, insurance, smoking and diabetes

Results: The weighted sample represents 148,007,416, of which (2.85%) had glaucoma. Glaucoma patients were more likely to be insured than those without glaucoma (98.4% vs. 91.8%, $P < 0.01$). Younger individuals (40-64 years) with glaucoma reported physical component scores that were 2.1 lower than older individuals with glaucoma ($P < 0.01$)

Conclusion: We found that glaucoma significantly affects the physical components of HRQOL. Younger individuals with glaucoma may find it difficult to use aids or other strategies to overcome their limited visual abilities. Thus, early support for younger individuals newly diagnosed with glaucoma may promote and improve their quality of life.

Keywords: glaucoma, quality of life, blindness, age, diabetes mellitus, ethnicity.

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INTRODUCTION:

Glaucoma is the leading cause of irreversible blindness globally [1]; moreover, it is the second most common cause in the United States (US), affecting more than 11% of the population ≥ 40 years of age in 2010 [2, 3]. It was estimated to affect 64.3 million people worldwide in 2013, and the number of affected individuals is expected to increase to 111.8 million by the year 2040 [4]. In the US alone, there are approximately 1.5 million patients with glaucoma, of whom 120,000 have lost their vision due to the disease [5]. Moreover, the economic burden of glaucoma treatment, both direct and indirect, is estimated to be \$2.5 billion per year [6]. Blindness and visual impairment caused by glaucoma impact patient quality of life (QOL) in many respects, including vision-dependent mobility, risks of car accidents and falls, ability to read, and ability to perform other daily activities [7, 8]. In addition, physical and social functioning, somatic pain, and mental health are affected [9]. However, QOL perception differs considerably among individuals, due to multiple factors (e.g., cultural beliefs, social environment, and personal expectations) [8]. Therefore, recent studies have explored the association between glaucoma and QOL by using different questionnaires, as well as in different communities [9, 10].

A cross-sectional study performed by Freeman et al., which assessed QOL using the Activities of Daily Vision Scale, found that patients with glaucoma had higher odds for reporting increased difficulty with different visual activities [11]. Another similar study by Park et al., performed in Korea, evaluated health-related QOL (HRQOL) of patients with glaucoma through the EuroQol five-dimension descriptive system (EQ-5D) and the EuroQol visual analog scale. That study revealed lower HRQOL scores, as well as a significantly greater prevalence of impaired health conditions, among patients with glaucoma, compared to healthy participants [12].

Assessment and maintenance of QOL in patients with glaucoma are becoming increasingly important in treatment of glaucoma, aiding physicians in corresponding improvement or adjustment of treatment [13]. As little is known about the impact of glaucoma on self-reported health, we performed this study to investigate the association between glaucoma and HRQOL among the US population.

MATERIAL AND METHODS:

This study was conducted using data from the Medical Expenditure Panel Survey (MEPS), which is a nationwide representative survey of the US population conducted and coordinated by the Agency

for Healthcare Research and Quality. MEPS was launched in 1996 with the aims of assessing health care facility utilization, health care expenditure, and health insurance coverage. Annually, a new sample of households is chosen and followed for approximately 2 years; throughout this period, participants are interviewed five times. MEPS for 2014 was used to conduct this study. The survey consisted of numerous datasets covering areas such as demographics, expenditures, medical status, and health condition. Three datasets were used: population characteristics, prescriptions, and medical conditions. This study used publicly available deidentified data; therefore, it was granted a waiver of approval by the institutional review board.

HRQOL was assessed by using mental and physical components of the Short-Form 12-Item Health Survey Version 2® (SF-12) [14]. SF-12 scores of both mental and physical components were compared between patients with glaucoma and healthy participants. This study included participants who were ≥ 40 years of age; they were allocated into two groups according to age (40 to 65 years, and ≥ 65 years). The exposure was glaucoma, while the outcome of interest was QOL. Other variables included were sex, race, poverty status, insurance, smoking, and diabetes. STATA version 14 for Mac (STATA Corp., College Station, TX, USA) was used for all statistical analyses. MEPS constitutes a weighted sample to provide nationally representative data regarding non-institutionalized individuals living in the US. [15]. Descriptive statistics were performed regarding age, sex, insurance status, smoking, race, and poverty status. A chi-squared test was used to compare categorical variables. Odds ratios (OR) with 95% confidence intervals (CIs) were reported. A P-value of < 0.05 was regarded as the threshold for statistical significance. A multiple linear logistic regression model was used to assess the association between glaucoma and QOL. The model was adjusted for age (younger as reference), poverty (poor as reference), sex (male as reference), diabetes mellitus (DM), and ethnicity (white as reference).

RESULTS:

Table 1 summarizes the characteristics of the participants. Compared to the non-glaucoma participants, a significantly higher percentage of patients with glaucoma were older (61.2% vs. 27.3%; $p < 0.001$), had public insurance (38.1% vs. 23.8%; $p < 0.001$) and had black ethnicity (18.2% vs. 11.2%; $p < 0.001$). Moreover, a lower percentage of patients with glaucoma was uninsured (1.7% vs. 8.2%; $p <$

0.001) and had white ethnicity (73.2% vs. 81.1%; $p < 0.001$). There was no significant statistical

association between the presence of glaucoma and current smoking ($p = 0.098$).

Table 1. Participant characteristics (total n = 13,620, which represents 148,007,416 of the US population)

	Glaucoma (n = 4,212,880)	Non-glaucoma (n = 143,794,536)	p-value
Older	61.2	27.3	<0.001*
Younger	38.8	72.7	
Private insurance	60.3	68.0	<0.001*
Public insurance	38.1	23.8	
Uninsured	1.7	8.2	
Smoking	9.4	12.2	0.098
Non-smoking	90.6	87.8	
White ethnicity	73.2	81.1	<0.001*
Black ethnicity	18.2	11.2	
Other ethnicity	8.6	7.7	

*significant at $p < 0.05$.

Table 2 shows the results of linear regression analysis that was conducted to assess the association between glaucoma and the physical component of QOL. When the linear regression model was adjusted for age, poverty, sex, DM, and ethnicity, the presence of glaucoma was significantly associated ($p < 0.001$) with reduced scores. Furthermore, the analysis

revealed that increased scores in the physical component were significantly associated with older age ($p < 0.001$). Reduced scores were significantly associated with a diagnosis of glaucoma ($p < 0.001$), older age without glaucoma ($p < 0.001$), and DM with glaucoma ($p < 0.001$).

Table 2. Multiple linear regression to assess associations between glaucoma and the physical component of quality of life

	Regression coefficient	Confidence interval	p-value
Older non-glaucoma	-3.87	-4.64 to -3.10	<0.001*
Diagnosis of glaucoma	-4.86	-7.19 to -2.54	<0.001*
Older with glaucoma	6.94	4.11 to 9.76	<0.001*
DM with glaucoma	-6.68	-7.38 to -5.97	<0.001*

DM: diabetes mellitus; *significant at $p < 0.05$.

Table 3 shows the results of linear regression analysis that was conducted to assess the association between glaucoma and the mental component of QOL. When the linear regression model was adjusted for age, poverty, sex, DM, and ethnicity, the presence of glaucoma was not significantly associated ($p = 0.795$ in younger and $p = 0.606$ in older patients) with the scores. The regression model also showed that increased scores in the mental component were

significantly associated with older age ($p < 0.001$), male sex ($p < 0.001$), middle and high incomes ($p < 0.001$), and non-white ethnicities (black, $p < 0.001$; other, $p = 0.005$). Lower scores were significantly associated with DM ($p < 0.001$) and use of public insurance ($p < 0.001$). There were no significant associations with poverty ($p = 0.275$) or being uninsured ($p = 0.724$).

Table 3. Multiple linear regression to assess associations between glaucoma and the mental component of quality of life

	Regression coefficient	Confidence interval	p-value
Older	2.52	1.97 – 3.06	< 0.001*
Younger glaucoma patient	-0.27	-2.33 – 1.79	0.795
Older glaucoma patient	0.64	-1.81 – 3.10	0.606
Sex	1.20	0.83 – 1.58	< 0.001*
Poverty	0.98	-0.79 – 2.74	0.275
Middle income	4.41	3.40 – 5.41	< 0.001*
High income	5.65	4.59 – 6.72	< 0.001*
Diabetes	-1.98	-2.62 – -1.35	< 0.001*
Black ethnicity	1.06	0.50 – 1.63	< 0.001*
Other ethnicity	1.17	0.36 – 1.99	0.005*
Public insurance	-2.52	-3.19 – -1.85	< 0.001*
Uninsured	-0.156	-1.02 – 0.72	0.724

*significant at $p < 0.05$.

DISCUSSION:

This study aimed to measure and compare QOL in patients with glaucoma and individuals without glaucoma, using the HRQOL survey among the US population. Our study found that Old non-glaucoma individuals have three times less quality of life comparing to young non-glaucoma individuals. It also concludes that among glaucoma patients old individuals have two times better quality of life when we compare them to young individuals.

In our study, we found a significantly greater percentage of older patients with glaucoma (61.2% vs. 27.3%; $p < 0.001$), compared to non-glaucoma participants. A similar result was demonstrated in a study performed in Sydney, Australia between May 2004 and October 2004 [16]. Our study showed that the presence of glaucoma was significantly associated ($p < 0.001$) with poor QOL, when the linear regression model was adjusted for age, poverty, sex, DM, and ethnicity. Our findings are also similar to prior research at the University of California San

Diego, regarding optic nerve structure and visual function in glaucoma; notably, changes in binocular visual field sensitivity (as assessed by standard perimetry) were significantly associated with time-dependent changes in patient-reported QOL outcomes among patients with glaucoma [17]. Furthermore, the findings are consistent with those of a study involving patients with glaucoma in the Shanghai Eye and Ear, Nose, Throat Hospital from January to August 2012, which concluded that Chinese patients with glaucoma had a moderate vision-related QOL, compared to QOL in cohorts from other countries [18].

Another previous study was conducted to assess the social impact of eye diseases in a developing population in Andhra Pradesh, in southern India; it revealed that patients with glaucoma had lower mean scores than individuals without visual impairment (62.6 vs. 84.1 for patients with glaucoma and healthy subjects, respectively) and patients with other eye diseases (78.1, 74.4, and 72.7 for refractive errors, cataract, and retinal diseases, respectively) [19]. In a separate study, Wilson et al. administered the SF-36 questionnaire to three groups: 121 patients with primary open-angle glaucoma, 42 patients with suspected glaucoma, and 135 patients with no diagnosis of ocular disease except cataract (control group). The study showed that controls had higher mean scores than patients with primary open-angle glaucoma or patients with suspected glaucoma on all SF-36 domains ($p < 0.001$); notably, the “general mental” domain showed no difference among groups ($p = 0.148$) [20].

Satisfaction of patients with glaucoma is affected by many factors, including disease progression with loss of vision, as well as topical and systemic side effects, difficulties in administration of medication, and complexity involved in medication regimens. The Salisbury Eye Evaluation Study, which was performed among patients with glaucoma to identify the task most affected by glaucoma, found that patients with bilateral glaucoma were nearly five times more likely than individuals without glaucoma to report severe difficulty with near activities [21].

The present analysis revealed significantly increased scores in the physical component of QOL among older patients with glaucoma ($p < 0.001$), compared to younger patients with glaucoma; this aspect has not been discussed in similar studies. This finding may arise in relation to several factors. First, there are likely to be greater daily demands for younger individuals (e.g., familial, social, and occupational responsibilities). Second, older individuals may encounter less difficulty in using

accommodations provided for disabled persons, compared to younger individuals, because older individuals may have become accustomed to such adaptations. Decreased scores were also significantly associated with older age among non-glaucoma participants ($p < 0.001$), which may be due to the normal process of aging. Furthermore, decreased QOL was significantly associated with DM ($p < 0.001$), which is consistent with the increased complications experienced by many patients with DM.

This study should be regarded as an initial assessment of QOL and its associated factors in patients with glaucoma who are ≥ 40 years of age in the US. However, caution should be exercised when interpreting the study findings due to a number of limitations. First, reliance on self-reported answers to the survey may have been influenced by recall bias and personality factors. Second, there are multiple factors that might affect overall QOL, including other comorbidities (e.g., cardiovascular diseases or central nervous system pathologies) that were not identified in the analysis; thus, the regression was not adjusted for these factors. Third, social and familial support information were not available; this environmental aspect could affect the results of the mental component of the questionnaire. Despite these limitations, the strengths of this study are that it included a large and homogeneous sample, and that it included participants in a random manner, which may have reduced bias.

In our study, we have identified factors suggestive of a need for increased care among patients with glaucoma who have poor economic status and depression; our study revealed that lower scores were significantly associated with the use of public insurance ($p < 0.001$). In conclusion, our study found increased scores of the physical component among patients with middle and high incomes ($p < 0.001$). So, we recommend that government and public service departments provide increased assistance, such as psychological care for depressed patients and financial aid to those with heavier economic burdens; these changes may improve QOL among patients with glaucoma.

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