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Vision-Related Quality of Life Among Glaucoma Patients in Saudi Arabia

A cross-sectional study

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Abstract

Objectives: This study aims to examine the impact of glaucoma severity and socioeconomic factors on perceived VRQoL among patients diagnosed with glaucoma in Saudi Arabia. ***Methods:*** This cross-sectional study was conducted on adult glaucoma patients attending the ophthalmology outpatient clinics at King Fahad Medical City (KFMC), and King Saud University Medical City (KSUMC), Riyadh, Saudi Arabia, over the period from May 2022 to May 2023. The validated Arabic translation of the 39-item National Eye Institute Visual Function Questionnaire (NEI VFQ-39) was used to measure VRQoL. Multivariate linear regression are performed to examine the associated factors of VRQoL. ***Results:*** A total of 454 adult patients with glaucoma were included in this study. Mean age of patients was 60.8± 15.0 years. Most patients had severe glaucoma (42.5%), were female (54.2%), married (67.8%), unemployed (55.3%), with an income level of less than SAR 10,000 per month (35.9%), and about one-third had lower secondary education (32.8%). About 24.4% of them reported that they required care assistant and 31.9% of them live with care assistants. The mean of the overall

composite score (OCS) of NEI VEQ-39 was 71.0 ± 21.3. Severity of glaucoma, education, employment status, needing care assistance, and having care assistance from others were significant factors of VRQoL in patients with glaucoma in Saudi Arabia. ***Conclusion:*** Perceived VRQoL among Saudi adult glaucoma patients is influenced by glaucoma severity, education, employment, and care needs. The study informs healthcare providers to enhance patient care and thereby improve patient QoL.

Keywords: Glaucoma; Quality of Life; Sociodemographic Factors; Saudi Arabia.

Advances in Knowledge:

- Reduced perceived levels of VRQoL and its all aspects are evident among adult patients with glaucoma in Saudi Arabia.
- The study showed that glaucoma severity, the need for care assistant, and having care assistants negatively impacted the overall levels of VRQoL and most of its subscales.
- The study revealed a positive impact of employment status and education on the overall VRQoL among glaucoma patients, whereas age, sex, income levels, and marital status did not show any significant effect.

Application to Patient Care:

- The current study highlights the importance of incorporating regular VRQoL assessments into patient care for creating personalized treatment plans tailored to individual patient needs.
- There is a need for targeted, comprehensive, and patient-centred care approaches that address glaucoma severity, socioeconomic factors, and individual patient needs to improve the overall VRQoL for individuals living with glaucoma in Saudi Arabia.
- Further research focusing on longitudinal assessments of VRQoL and its evolution with glaucoma progression could inform the development of cost-effective treatment and support programs, empowering glaucoma patients and enhancing their care in Saudi Arabia.

Introduction

Visual-Related Quality of Life (VRQoL) is crucial in managing glaucoma, as it directly reflects the disease's impact on patients' daily functioning and overall well-being. Glaucoma is a significant cause of irreversible blindness globally, primarily due to its progressive damage to the optic nerve and visual field loss, which leads to a decline in visual function.[1,2] This deterioration has a profound impact on patients' VRQoL, which is defined as a measure of how visual impairments affect daily living activities and overall well-being.[3,4] The progression of glaucoma can restrict patients' ability to perform routine activities like driving, navigating spaces, participating in social events, and reading, ultimately diminishing their independence.[5,6] Monitoring VRQoL enables early detection of functional decline, even before significant changes are evident in clinical measures like intraocular pressure or visual field tests.[7]

Furthermore, assessing VRQoL in glaucoma is seen as a method that can offer more in-depth insights into patients' needs and challenges than standard clinical measures, which may not fully capture the abilities and limitations individuals with glaucoma face in their daily living activities.[8,9] Therefore, VRQoL assessments have become progressively important in glaucoma treatment since they help clinicians develop personalized strategies to slow disease progression while ensuring the highest possible quality of life for each patient.

Research has shown a dose-response relationship between the severity of visual field loss and the decline in VRQoL in patients with various eye diseases, including glaucoma.[10,11] This relationship highlights the critical need for early and effective management to mitigate the progression of visual impairments and maintain VRQoL. Previous research also highlighted that non-adherence to medications contributes significantly to vision loss among glaucoma patients.[12,13]

Investigating the factors associated with VRQoL among patients with glaucoma is crucial for ensuring better management and targeted treatment strategies. Previous studies showed that many factors can influence VRQoL in patients with glaucoma, including disease severity, stage, and type,[14-17], sociodemographic factors (e.g., age, sex, education, marital status, etc.), and clinical factors (e.g., contracts, intraocular pressure, visual acuity, etc.).[8,18-21] The main gap

identified in the literature is that most studies assessing the factors influencing VRQoL in glaucoma patients have produced mixed results. Additionally, research conducted in Saudi Arabia on VRQoL and its contributing factors has predominantly focused on children with glaucoma,[22] with limited studies available on adult patients. The levels of VRQoL may vary significantly between children and adults, potentially indicating different associated factors. Therefore, the current study aimed to assess the impact of glaucoma severity and socioeconomic factors on perceived VRQoL among patients diagnosed with glaucoma in Saudi Arabia.

Methods

This is a cross-sectional study conducted on glaucoma patients attending the ophthalmology outpatient clinics at KFMC and KSUMC, Riyadh, Saudi Arabia, over the period from May 2022 to May 2023.

Inclusion criteria were all Saudi adults aged 18 years and above and diagnosed and managed for primary or secondary glaucoma at KFMC and KSUMC, and able to provide consent to participate in this study. The diagnosis of glaucoma was confirmed through clinical assessment by the ophthalmologist, and records were documented in the electronic medical record system at both study sites based on the glaucomatous cup to disc ratio (CDR). However, patients who are unwilling to participate or unable to understand the questionnaire due to major systemic illness or physical disabilities that could affect the questionnaire's completion were excluded from the study. Individuals with clinically significant impairment of visual function for reasons other than glaucoma, such as cataract and age-related macular degeneration, diabetic retinopathy, history of retinal reattachment surgery, intraocular surgery, or laser treatment, or thought to have an optic neuropathy were also excluded.

The sample size was calculated using the OpenEpi programme (Emory University, Atlanta, Georgia, USA). With a 95% confidence interval, a type I error (α) of 0.05, and a margin of error of 0.05 to achieve an 80% power level, the minimum required sample size was 375. After accounting for a 20% non-response rate and incomplete patient responses, the minimum required sample size was adjusted to 450.

Eligible patients were approached by a research assistant who explained the study in detail to the patients. Informed consent was sought from the patients before participation. Patients who agreed to participate were enrolled in the study and the questionnaire was administered by trained interviewers.

The instrument used in this study comprises two parts. The first part contains the sociodemographic and clinical information of study participants, including age, gender, educational level, occupation, monthly income, marital status, availability of caregiver, and type of glaucoma. The type of glaucoma variable is classified into three categories (i.e., mild, moderate, and severe) based on the CDR. That is, a CDR of less than 0.50 indicates mild glaucoma, moderate glaucoma has a CDR between 0.5 and 0.7, and severe glaucoma is defined by a CDR greater than 0.70. These details were collected from the patients and cross-verified with their respective medical records. In cases of inconsistencies, patient-reported information was considered. The second part involves measuring VRQoL using the validated Arabic version of the NEI VFQ-39.[23] The NEI VFQ-39 questionnaire has been widely used for assessing the correlations between VRQoL and glaucoma visual function damage.[4,24] The questionnaire comprises of 12 subscales: general health (GH), general vision (GV), ocular pain (OP), near activities (NA), distance activities (DA), social functioning (SF), mental health (MH), role difficulties (RD), dependency (DP), driving, colour vision (CV), and peripheral vision (PV).[24] The GH subscale contains two items: one rated on a five-point scale and the other on a 10-point scale. Similarly, the GV subscale includes two items, with one rated on a six-point scale and the other on a 10-point scale. The OP subscale consists of two items, both rated on a five-point scale. The NA and DA subscales each contain six items, all rated on a six-point scale. The SF subscale comprises three items, also rated on a six-point scale. The MH subscale includes five items, rated on a five-point scale. Both the RD and DP subscales consist of four items, each rated on a five-point scale. The driving subscale contains three items: one rated on a five-point scale and the other two on a six-point scale. Lastly, the CV and PV subscales each consist of one item, rated on a six-point scale.[25]

Following the scoring system reported in the literature,[25] the overall composite score (OCS) of VRQoL using the NEI VFQ-39 questionnaire is calculated by first transforming each response

onto a 100-point scale, where scores range from 0 to 100. Then, the items within each subscale are averaged to obtain a subscale score. These subscale scores are then averaged together to derive the OCS of VRQoL, except the GH subscale. This composite score serves as the main outcome variable of this study, offering a summary measure of the patient's VRQoL, with higher composite scores indicating better VRQoL.[25]

The Statistical Package for Social Sciences (SPSS) version 26.0 (IBM Software Group, Chicago, IL, USA) was used to conduct the statistical analysis. Categorical variables were described using counts and percentages while continuous variables were described using mean and standard deviations (SD). Multivariate linear regressions were performed to examine the significant factors of the OCS of the NEI VFQ-39 questionnaire and its subscales. The dependent variables were the natural logarithmic transformation of OCS and subscales of NEI VFQ-39. Statistical significance was sought at values lower than 0.05.

The current study was applied according to the Declaration of Helsinki and was approved by the institutional review board (IRB) at KFMC in Riyadh, Saudi Arabia. After an explanation of the risks and benefits of taking part in this study by the questionnaire panel of collectors to participants, all of them provided written informed consent. The identity of study participants was kept anonymous and confidential.

Results

The response rate for the study is 97.6%, with 454 out of 465 distributed questionnaires being returned and validated for analysis. Table 1 shows the basic summary statistics of the study variables. The results reveal that 82 (18.1%) participants had mild glaucoma, 179 (39.4%) had moderate glaucoma, and 193 (42.5%) had severe glaucoma. The average age of all patients was 60.8 ± 15.0 years such that 43.2% of them aged 45 to 65 years (n = 169). Female proportion was slightly higher represented in the sample in comparison to males (54.2% versus 45.8%). About one-third of them had lower secondary education (n = 149, 32.8%) and most of them were married (n = 308, 67.8%). The distribution of the sample by employment status shows that more than half of participants were unemployed (n = 251, 55.3%). About 35.9% of participants had an

income level of less than SAR 10,000 (n = 163). Approximately 24.4% of the participants needs reported that they need care assistants and 31.9% of them reported that they had care assistants.

Table 2 displays the average scores of NEI VFQ-39 questionnaire for each subscale and the overall composite score (OCS). The results revealed the NEI VFQ-39 average scores indicate varying levels of VRQoL across different visual-related subscales among glaucoma patients. The highest mean scores were observed in the CV (77.3 $\pm$ 25.5) and SF (77.1 $\pm$ 23.7) subscales, suggesting relatively better outcomes in these areas. In contrast, NA (58.4 $\pm$ 26.5) and RD (59.1 $\pm$ 28.7) subscales exhibited lower mean scores, reflecting greater challenges in these domains. The average OCS of NEI VFQ-39 is 71.0 $\pm$ 21.3, indicating a reduced overall visual function and VRQoL among the patients assessed.

To investigate the significant factors of VRQoL among glaucoma patients, multivariate linear regression models were estimated and the results are shown in Table 3. The results revealed that the statistically significant predictors of the OCS of VRQoL were educational levels, severity of glaucoma, employment status, requiring care assistance, and having care assistants. However, age, sex, income levels, and marital status were not statistically significant. The overall model was statistically significant and explained about 28.8% of the variations in the mean OCS of NEI VFQ-39 (Adjusted R-Squared = 0.288). More specifically, the results of this model revealed that higher level of education was significantly associated with better VRQoL for the OSC of NEI VFQ-39 (b = 0.261, p-value = 0.001). Moreover, increased severity of glaucoma was significantly associated with lower VRQoL (b = - 0.251, p-value = 0.001). As for employment status, students (b = 0.343, p-value = 0.043), employed (b = 0.250, p-value = 0.002), and retired (b = 0.177, p-value = 0.012) had an average score of 0.41, 0.28, and 0.19, respectively, higher than unemployed patients holding other factors constant. Patients who reported that they required care assistance scored an average OCS of NEI VFQ-39 of 0.22 lower than those who did not (b = - 0.251, p-value = 0.002), holding the other variables constant. The average OCS of NEI VFQ-39 among patients who reported that they have care assistants was 0.24 lower than those who did not (b = - 0.275, p-value < 0.001), assuming that the other factors remained constant.

The current study also examined the significant factors of each subscale of NEI VFQ-39 questionnaire using multiple linear regression models. The results revealed that educational level positively affected GH (b = 0.052, p-value = 0.009), NA (b = 0.108, p-value = 0.003), DA (b = 0.053, p-value = 0.036), DP (b = 0.090, p-value = 0.001), CV (b = 0.050, p-value = 0.005), and PV (b = 0.048, p-value = 0.025) subscales. The severity of Glaucoma significantly decreases multiple subscales including GH (b = -0.117, p-value = 0.002), NA (b = -0.130, p-value = 0.035), SF (b = -0.099, p-value = 0.007), and DP (b = -0.149, p-value = 0.001). Furthermore, employment status significantly influenced several subscales with mixed effects. Students significantly increased the average scores of the GH (b = 0.434, p = 0.008), NA (b = 0.474, p = 0.024), and DP (b = 0.411, p = 0.029) subscales compared to unemployed patients. Employment significantly increased the mean scores of various subscales, including GV (b = 0.159, p = 0.013), SF (b = 0.188, p = 0.006), MH (b = 0.224, p = 0.024), RD (b = 0.171, p = 0.042), and DP (b = 0.201, p = 0.028) compared to unemployed participants. Retirement positively influenced only the SF subscale (b = 0.115, p = 0.047) compared to unemployed patients. Furthermore, statistically significant and negative impact of requiring care assistance on all subscales of the NEI VFQ-39 except OP. Having care assistance also significantly decreases the average scores of all NEI VFQ-39 subscales except GH.

In contrast, age, sex, income level, and marital status did not show any significant impacts across all subscales of the NEI VFQ-39 as well as the OCS of VRQoL, indicating that these variables are not robust predictors of VRQoL dimensions among the studied patients with glaucoma in Saudi Arabia.

Discussion

This cross-sectional study investigated the levels of VRQoL and determined specific sociodemographic factors and glaucoma severity that may influence VRQoL among glaucoma patients in Saudi Arabia. The current study emphasizes several areas that could enhance the well-being of individuals living with glaucoma. While the literature suggests that glaucoma patients experience diminished VRQoL influenced by various factors, no studies have specifically investigated perceived levels of VRQoL and its contributing factors among adult glaucoma

patients in Saudi Arabia. Most existing research on VRQoL in Saudi Arabia has focused on children with glaucoma, consistently reporting reduced VRQoL levels in this group.[22]

To provide a more comprehensive discussion, we summarize the findings of the current study and those reported in the literature in Table 4. The findings of this study revealed diminished levels of VRQoL among adult glaucoma patients in Saudi Arabia. This finding was consistent with several previous findings.[5,6,15,16,18,26,27] For example, a study conducted by Jordan and Mowatt[15] reported an average composite score on the NEI VFQ-25 among Jamaican glaucoma patients that is comparable to our findings. This finding highlights the need for targeted strategies to enhance VRQoL in adult glaucoma patients in Saudi Arabia. Incorporating VRQoL assessments into regular patient care could enable clinicians to customize treatment plans to address individual challenges more effectively, thereby enhancing the quality of patient care and improving overall patient well-being. Nonetheless, the low average scores stem from the fact that the questionnaire was developed to assess the quality of life among patients with visual impairment and suffering from eye diseases that adversely impact their QoL.[28]

The study also indicated higher mean scores of VRQoL in the CV and SF dimensions, while lower mean scores were observed in the NA and RD subscales. Riva *et al*.[18] showed that among Italian glaucoma patients, the highest mean scores were in the CV and SF dimensions of the NEI VFQ-25 instrument, aligning with our results. However, they showed that the lowest mean scores were in the GH and GV subscales, which contrasts with our current findings. In agreement with our findings, Onakoya *et al*.[27] indicated that the highest mean scores were observed in CV and Sf subscales of the NEI VFQ-25 instrument. Nevertheless, they found the lowest mean scores in GH, GV, and driving subscales, which is not congruent with our findings. A study conducted by Guchi *et al*.[26] reported that the highest mean scores of VRQoL among glaucoma patients in Ethiopia were found in the glare and dark adaptation dimensions, followed by central and near vision, while the lowest mean scores were observed in the PV dimension measured using the Glaucoma Quality of Life-15 (GQL-15). The current study highlights the multidimensional impact on different aspects of daily living activities among patients with glaucoma that could significantly change patients' way of living. The current study also emphasizes the significance of VRQoL components in guiding personalized care by addressing patients' specific needs.[8,9] However, the cross-sectional design captures VRQoL at a single point

in time, which may change with disease progression. Thus, longitudinal studies are recommended to explore how VRQoL evolves as glaucoma progresses among Saudi patients.

The results of multivariate linear regression revealed that the severity of glaucoma significantly impacts the OCS of NEI VFQ-39. The increased disease severity was associated with reduced levels of VRQoL among study participants, which is congruent with various previous findings.[8,16,17,21,27,29,30] A study conducted by Sencanic *et al*.[8] showed a decline in VRQoL as glaucoma progressed to more advanced stages among Serbian people with glaucoma. Szegedi *et al*.[17] found that patients with advanced glaucoma in Germany reported lower NEI VFQ-39 subscales and composite scores compared to those with early and moderate glaucoma. The findings of this study also demonstrated that the severity of glaucoma has a significant negative impact on all subscales of the NEI VFQ-39 instrument, except for the OP and CV subscales. A study conducted by Guchi *et al*.[26] revealed that glaucoma severity was negatively associated with all subscales of GQL-15. Similar results were also reported by Ayele *et al*.[30] and Dhawan *et al*.[31] among patients with glaucoma in Ethiopia and India, respectively. Onakoya *et al*.[27] indicated that the VRQoL was significantly reduced in patients with glaucoma with the increasing severity of the disease. They also demonstrated significant differences in average scores of all NEI VFQ-25 subscales between mild, moderate, and severe glaucoma patients, except for the OP subscale, which is congruent with our findings. A study in Slovakia indicated that VRQoL for patients with POAG who have visual impairments is notably diminished when contrasted with those who do not experience visual impairments except for driving subscale.[32] Therefore, the findings of this study suggest that healthcare providers should prioritize regular screenings and comprehensive monitoring of glaucoma progression.

The current study also revealed that education was a statistically significant predictor of the OCS of NEI VFQ-39. Higher levels of education were significantly associated with better VRQoL among glaucoma patients in Saudi Arabia and this result is in accordance with several previous studies.[8,26,27,33-35] Patients with advanced education are likely to be more informed about their illness and better understand the limitations caused by glaucoma.[8,34,35] In contrast, those with lower education levels often face barriers to accessing appropriate medical care and adhering to treatment, as lower education is frequently linked with lower socioeconomic status.[36] The results

of this study also showed that lower educational levels were significantly associated with lower mean scores of GH, NA, DA, RD, DP, CV, and PV subscales. A study in Italy found that education was significantly associated with GH, MH, and GV subscales but not with the OCS.[18] Therefore, the study underscores the critical need for interventions that provide tailored patient education and support programs to help patients understand the impact of the disease on their daily lives, especially among patients with lower education.

In agreement with several previous findings, the current study showed that being unemployed was significantly associated with poorer overall VRQoL as compared to students, employed, and retired patients with glaucoma in Saudi Arabia.[8,15,18,26,35] Sencanic *et al*.[8] showed that unemployed or retired patients experienced poorer VRQoL as measured by GQL-15 instrument but this effect was not evident using NEI VFQ-39. This study also showed different effects of employment status on the subscales of NEI VFQ-39. Being employed was associated with higher mean scores of GV, SF, MH, RD, and DP while students had higher mean scores in GH, NA, and DP subscales as compared to unemployed patients. However, being retired was only associated with higher mean score of SF subscale in comparison to unemployed. Riva *et al*.[18] showed that being employed or student was only associated with better overall VRQoL, GH, and MH as compared to retired and unemployed patients in Italy. Our findings suggest that limited resources can hinder patients' access to and treatment adherence, ultimately affecting their overall well-being. Therefore, addressing these resource limitations is essential for enhancing patients' health outcomes. Hence, the government and healthcare providers must reinforce treatment policies and make healthcare services more accessible to those with limited resources.

In our study, we identified two factors not previously discussed in the literature: the need for assistance and the presence of care assistants. Our findings revealed that a need for assistance was significantly associated with a reduced overall VRQoL, affecting all subscales of the NEI VFQ-39, except for the OP subscale. Similarly, patients with care assistants reported poorer overall VRQoL and lower mean scores across most subscales of the NEI VFQ-39, except for the GH subscale. These findings reflect the potential challenges in managing daily activities among patients with glaucoma. Therefore, this study highlights the need to develop personalized care plans, provide additional resources for daily living, and offer training for caregivers to improve

patient independence and well-being, ultimately creating a more supportive environment for glaucoma patients.

Nonetheless, this study did not reveal any significant effect of age, sex, marital status, and income level on overall VRQoL and its all aspects. Our findings were confirmed with some previous studies while it contradicted others. A recent study conducted in Serbia indicated that age, sex, and marital status were not significantly associated with VRQoL in patients with glaucoma, which is consistent with our findings.[8] Meanwhile, a study by Jordan and Mowatt[15] revealed that a lower overall composite score of VFQ-25 was significantly associated males, and living in rural areas whereas it was not significantly associated with marital status, employment status, history of laser trabeculoplasty, and history of cataract surgery or trabeculectom. Evidence from Nigeria indicated that age and ethnicity were significantly associated with the OCS of NEI VFQ-25 while sex and marital status were not significantly associated with NEI VFQ-25 OCS.[27] Riva *et al*.[18] showed that employment status, marital status, and sex were significantly associated with the total score of NEI VFQ-25 while age, profession, and housing were not significantly associated with the total score of NEI VFQ-25. A study by Alqudah *et al*.[19] found that age was negatively associated with the transformed composite score of NEI VFQ-25 among patients with glaucoma, which is not consistent with our findings. However, they showed that there were no significant associations between the transformed composite score and sex, which is in line with our results. Sesar *et al*.[21] indicated that females, older age, unmarried status, lower education, economic status, and living in an urban area adversely impacted the QoL for patients with POAG. In contrast to our findings, a case control study conducted in Ethiopia indicated that older age, rural residence, low monthly income, longer disease duration, and severe visual impairment were significant factors of poorer QoL.[30] The insignificant effect of certain sociodemographic variables in this study may reflect cultural, social, or healthcare system differences in Saudi Arabia. However, these variables are still crucial in patient care, as they can influence access to resources, support systems, and overall well-being. Future research should further explore these relationships to better understand their implications for improving VRQoL in glaucoma patients.

The findings of this study carry important implications for glaucoma specialists, general ophthalmologists, and public health personnel involved in blindness prevention. Incorporating regular VRQoL assessments into patient care is essential, as it allows for more personalized treatment plans tailored to the specific needs of patients. Patient counsellors and educators should emphasize the importance of education and employment in improving VRQoL and provide targeted support for those with lower education levels or limited resources. For patients with glaucoma, particularly those requiring assistance or with care assistants, personalized care plans and additional resources for daily living are crucial to maintaining independence and enhancing well-being. These insights underscore the need for comprehensive, patient-centred care approaches to improve the overall QoL for individuals living with glaucoma in Saudi Arabia.

While the current study provided valuable insights regarding VRQoL in Saudi Arabia among patients with glaucoma, it was subject to various limitations. The lack of complete information about certain crucial parameters such as the fellow eye, the severity of the field of vision damage, the status of the cataract, and diabetes posed a challenge to our investigation. Indeed, several previous research highlighted these parameters were significant contributing factors of reduced VRQoL.[15,17,19,27] Therefore, there is a need to make such clinical parameters available to enable a more in-depth examination of such factors impacting VRQoL. Moreover, the cross-sectional design and the lack of a control group of a healthy population are considered further limitations of this study, which limited the generalizability of our findings to the overall glaucoma population. However, the literature, NEI VFQ-39 was developed for patients with eye diseases, not for a healthy population resulting in a celling impact.[28] Furthermore, an important component of NEI VFQ-39 is the 'Driving' subscale, which measures the self-reported perceived driving difficulties by glaucoma patients. It is also important to note that about 35.0% of participants were regular drivers at the time of administering the NEI VFQ-39 questionnaire, which may be attributed to the recent legislation in Saudi Arabia allowing women to drive. Consequently, the percentage of female drivers is limited, considering that more than half of the participants are females (i.e., 54.2%) and hence limited investigating its associated factors. Finally, relying on self-reported data for measuring VRQoL could introduce recall bias, and utilizing only single instrument may not capture the full spectrum of participants' experiences.

Conclusion

This study is among the few that have assessed the levels of VRQoL and its associated factors in adult patients with glaucoma in Saudi Arabia. The findings revealed that Saudi adult glaucoma patients experience reduced levels of VRQoL. Key factors contributing to VRQoL include the severity of glaucoma, education level, employment status, the need for care assistance, and living with caregivers. By targeting these significant factors, healthcare providers can improve patient care and enhance VRQoL for individuals with glaucoma.

Authors' Contribution

All authors contributed to the study conception and design. Funding acquisition was sought by Amani Abu-Shaheen (AA) and Isamme AlFayyad (IA). Material preparation and data collection were performed by Essam A Osman (EAO), Doaa Dahan (DD), and Sadique Zameer (SZ). Data analysis was conducted by Mohsen Ayyash (MA). The first draft of the manuscript sections were written by Amani Abu-Shaheen (AA), Humariya Heena (HH), Abdusalam Torjoman (AT), and Mohsen Ayyash (MA). All authors commented on reviewing and editing previous versions of the manuscript. All authors read and approved the final manuscript.

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Conflict of Interest

The authors declare no conflict of interests.

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547 **Table 1:** Demographic characteristics of study participants

Characteristics		
Categorical variables	**N**	**%**
Glaucoma type		
Mild	82	18.1
Moderate	179	39.4
Severe	193	42.5
Sex		
Male	208	45.8
Female	246	54.2
Age group		
Less than 45 years	63	13.9
45 – 65 years	196	43.2
Above 65 years	195	42.9
Educational level		
Illiterate	107	23.6
Lower secondary	149	32.8
Secondary	83	18.3
University degree	94	20.7
Graduate studies	21	4.6
Marital Status		
Single	43	9.5
Married	308	67.8
Widowed	84	18.5
Divorced	19	4.2
Employment Status		
Student	7	1.5
Employed	65	14.3
Retired	131	28.9
Unemployed	251	55.3
Level of Income		

No source	113	24.9
Less than SAR 10,000	163	35.9
From SAR 10,000 to 20,000	156	34.4
More than SAR 20,000	22	4.8
Needs Care Assistance, yes	111	24.4
Has Care Assistant, yes	145	31.9
Quantitative variables	**Mean**	**SD**
Age, years	60.8	15.0

SAR: Saudi Riyals; SD: Standard deviations.

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550 **Table 2:** NEI VFQ-39 average scores

Subscale	**Mean ± SD**
General Health	65.4 ± 20.7
General Vision	61.9± 19.4
Ocular Pain	65.7± 27.2
Near Activities	58.4 ± 26.5
Distance Activities	74.7 ± 25.1
Social Functioning	77.1 ± 23.7
Mental Health	60.2 ± 29.3
Role Difficulties	59.1 ± 28.7
Dependency	61.9 ± 31.5
Driving	66.5 ± 32.5
Colour Vision	77.3 ± 25.5
Peripheral Vision	67.0 ± 28.5
Total NEI VFQ-39 score	71.0 ± 21.3

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Table 3: Results of the multiple linear regression for OCS and subscales of NEI VFQ-39.

	OCS	**GH**	**GV**	**OP**	**NA**	**DA**	**SF**	**MH**	**RD**	**DP**	**CV**	**PV**
Variables												
Intercept	4.771*	4.773*	4.484*	4.657*	4.550*	4.716*	4.727*	4.588*	4.899*	4.892*	4.824*	4.663*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Age	-0.016	- 0.004	- 0.002	0.000	0.000	- 0.001	0.000	0.001	- 0.002	- 0.002	- 0.002	- 0.001
	(0.091)	(0.081)	(0.298)	(0.964)	(0.949)	(0.598)	(0.848)	(0.591)	(0.298)	(0.410)	(0.116)	(0.628)
Female sex	0.038	- 0.070	0.056	- 0.114	0.044	0.089	0.060	- 0.065	0.030	- 0.092	0.034	- 0.031
	(0.453)	(0.128)	(0.213)	(0.086)	(0.589)	0.118	(0.223)	(0.356)	(0.617)	(0.155)	(0.431)	(0.554)
Marital status												
Single	- 0.147	- 0.227	- 0.105	- 0.008	- 0.134	- 0.171	- 0.107	- 0.196	- 0.235	- 0.158	- 0.121	- 0.104
	(0.149)	(0.098)	(0.164)	(0.944)	(0.330)	(0.072)	(0.226)	(0.101)	(0.101)	(0.149)	(0.095)	(0.238)
Widowed	0.065	- 0.025	0.013	- 0.092	0.010	0.024	- 0.018	- 0.037	- 0.082	- 0.152	- 0.026	- 0.058
	(0.412)	(0.659)	(0.796)	(0.216)	(0.922)	(0.744)	(0.751)	(0.637)	(0.219)	(0.134)	(0.580)	(0.315)
Divorced	- 0.103	- 0.162	- 0.086	- 0.098	- 0.233	- 0.096	- 0.117	- 0.184	- 0.200	- 0.142	- 0.214	- 0.115
	(0.375)	(0.084)	(0.295)	(0.421)	(0.120)	(0.382)	(0.211)	(0.158)	(0.080)	(0.236)	(0.095)	(0.218)
Educational level	**0.261***	**0.052***	0.022	0.002	**0.108***	**0.053***	0.024	0.027	**0.061***	**0.090***	**0.050***	**0.048***
	(0.001)	**(0.009)**	(0.217)	(0.928)	**(0.003)**	**(0.036)**	(0.236)	(0.348)	**(0.015)**	**(0.001)**	**(0.005)**	**(0.025)**
Employment status												
Student	**0.343***	**0.434***	0.206	**0.474***	0.221	0.235	0.287	0.406	**0.411***	0.330	0.166	0.304
	(0.043)	**(0.008)**	(0.148)	**(0.024)**	(0.354)	(0.137)	(0.064)	(0.070)	**(0.029)**	(0.103)	(0.212)	(0.060)
Employed	**0.250***	0.147	**0.159***	0.076	0.158	0.145	**0.188***	**0.224***	**0.171***	**0.201***	0.069	0.004
	(0.002)	(0.041)	**(0.013)**	(0.413)	(0.151)	(0.062)	**(0.006)**	**(0.024)**	**(0.042)**	**(0.028)**	(0.250)	(0.960)
Retired	**0.177***	0.032	0.071	0.016	- 0.050	0.104	**0.115***	0.107	0.108	0.080	0.042	- 0.002
	(0.012)	(0.588)	0.183	(0.835)	(0.597)	(0.126)	**(0.047)**	(0.194)	(0.124)	(0.297)	(0.407)	(0.975)
Income level	0.006	0.021	0.039	0.050	- 0.045	0.003	- 0.010	0.050	- 0.003	0.041	- 0.011	0.008

	(0.865)	(0.472)	(0.111)	(0.194)	(0.363)	(0.936)	(0.726)	(0.223)	(0.935)	(0.278)	(0.646)	(0.779)
Assistance needs	**- 0.251***	**- 0.235***	**- 0.135***	- 0.102	**- 0.227***	**- 0.262***	**- 0.171***	**- 0.200***	**- 0.287***	**- 0.217***	**- 0.133***	**- 0.122***
	(0.002)	**(0.000)**	**(0.006)**	(0.164)	**(0.023)**	**(0.000)**	**(0.002)**	**(0.011)**	**(0.000)**	**(0.002)**	**(0.004)**	**(0.035)**
Has an assistant	**- 0.275***	- 0.066	**- 0.129***	**- 0.220***	**- 0.337***	**- 0.228***	**- 0.199***	**- 0.261***	**- 0.318***	**- 0.347***	**- 0.226***	**- 0.193***
	(0.000)	(0.222)	**(0.007)**	**(0.002)**	**(0.000)**	**(0.001)**	**(0.000)**	**(0.001)**	**(0.000)**	**(0.000)**	**(0.000)**	**(0.000)**
Severity of glaucoma	**- 0.251***	**- 0.117***	**- 0.105***	- 0.066	**- 0.130***	**- 0.104***	**- 0.099***	**- 0.167***	**- 0.149***	**- 0.158***	- 0.040	**- 0.076***
	(0.001)	**(0.002)**	**(0.002)**	(0.176)	**(0.035)**	**(0.014)**	**(0.007)**	**(0.002)**	**(0.001)**	**(0.001)**	(0.202)	**(0.045)**
Adjusted R^2	0.288	0.221	0.143	0.133	0.167	0.227	0.196	0.217	0.327	0.391	0.248	0.161

Note: The coefficients estimated in log-linear models can be transformed using the formula: $(e^{\beta} - 1) \times 100\%$. When dealing with very small values of the estimated coefficients, e^{β} is approximately equivalent to β.

Table 4: Summary of the findings of the current study and recent literature

Authors	Country	Design	Instrument of VRQoL	Main Findings
Current Study	Saudi Arabia	Cross-sectional study	NEI VFQ-39	• Diminished levels of VRQoL among adult glaucoma patients in Saudi Arabia (71.0 ± 21.3). • Higher mean scores in CV (77.3 ± 25.5) and SF (77.1 ± 23.7) dimensions, lower in NA (58.4 ± 26.5) and RD (59.1 ± 28.7). • Glaucoma severity significantly impacts VRQoL, particularly reducing scores across various NEI VFQ-39 subscales. • Education and employment status positively influence VRQoL, while age, sex, marital status, and income levels do not. • The need for assistance and the presence of care assistants negatively impact VRQoL.
Sencanic *et al*.[8]	Serbia	Cross-sectional study	GQL-15, NEI VFQ-25	• Education, employment status, and still driving positively influenced the overall score of VRQoL. • History of glaucoma interventions, severity of glaucoma, and visual acuity negatively impacted VRQoL.
Jordan and Mowatt[15]	Jamaica	Cross-sectional study	NEI VFQ-25	• The mean QoL using NEI VFQ-25 was 71.2 (95% CI. [66.8-75.7]). • The highest mean score in the CV subscale (89.8), while the

Authors	Country	Design	Instrument of VRQoL	Main Findings
				lowest mean score in the driving subscale (34.0). • Lower overall composite scores were significantly associated with a higher number of medications, longer disease duration, male sex, rural living, and worse visual acuity, but not with marital or employment status.
Szegedi *et al*.[17]	Germany	Cross-sectional study	NEI VFQ-39	• Patients with advanced glaucoma reported lower NEI VFQ-39 subscales and composite scores compared to early/moderate glaucoma. • Age and visual acuity were not significantly correlated with the overall score of NEI VFQ-39.
Riva *et al*.[18]	Italy	Multicenter, cross-sectional	NEI VFQ-25	• The mean QoL using NEI VFQ-25 was 56.7 $\pm$ 17.9. • The highest scores were in CV and SF dimensions of NEI VFQ-25, while the lowest scores were in GH and GV. • Employment status, marital status, and sex were significantly associated with the total NEI VFQ-25 score. However, age, education, housing status, and profession were not.
Alqudah *et al*.[19]	Jordan	Cross-sectional study	NEI VFQ-25	• Higher levels of VRQoL such that the mean score of NEI VFQ-25 was 91.6 $\pm$ 6.7 • Age negatively associated with OCS as well as CV, DA, and driving subscales.

Authors	Country	Design	Instrument of VRQoL	Main Findings
				• Female sex was negatively associated with DA, driving, and PV subscales, but not associated with the OCS and other subscales.
Guchi *et al*.[26]	Ethiopia	Cross-sectional study	GQL-15	• The mean score of VRQol measured by GQL-15 was 47.85 ± 15.41. • Significant factors of VRQoL were education, glaucoma severity, and visual acuity. However, place of residence was not significant.
Onakoya *et al*.[27]	Nigeria	A hospital-based cross-sectional	GQL-15, NEI VFQ-25	• The mean QoL using NEI VFQ-25 was 85.2 ± 16.07. • Highest VRQoL scores in CV and SF dimensions, while lowest scores in GH, GV, and driving subscales of NEI VFQ-25. • VRQoL significantly reduced with increasing glaucoma severity, males, and lower educational levels. • Negative effect of age on the total score of NEI VFQ-25 and its all subscales, except for OP, MH, CV, and RD. Negative effect of age on the mean total score of GQL-15. • No significant effects of ethnicity, religion, marital status, and living situation on VRQoL.

Authors	Country	Design	Instrument of VRQoL	Main Findings
Tripathi *et al*.[29]	North India	Cross-sectional study	GQL-15	• Mean GQL-15 total score among glaucoma patients was significantly higher than non-glaucoma people, indicating poorer QoL. • Severity of glaucoma, sex, literacy, visual field, and visual acuity were significantly associated with QoL, while age, place of residence, employment, and marital status were not.
Ayele *et al*.[30]	Ethiopia	Case control study	GQL-15	• Mean GQL-15 total score among glaucoma patients was significantly higher than controls, indicating poorer QoL. • Poorer QoL was significantly associated with advanced glaucoma, living in rural areas, longer disease duration, lower monthly income, severe visual impairment, and older age.
Dhawan *et al*.[31]	India	Case control study	GQL-15	• The average score of GQL of glaucoma patients was significantly greater than healthy individuals, indicating poorer QoL. • Glaucoma severity was significantly associated with reduced VRQoL across various subscales of GQL-15.
Majerníková *et al*.[32]	Slovakia	Cross-sectional study	NEI VFQ-25; WHOQOL-BREF	• VRQoL for patients with POAG who have visual impairments is significantly decreased in comparison to those who do not experience visual impairments except for driving

Authors	Country	Design	Instrument of VRQoL	Main Findings
				subscale.
Sung *et al*.[33]	Korea	Cross-sectional study	NEI VFQ-25	• The reduced overall QoL scores were significantly linked to additional eye diseases, lower education levels, an anxious personality, the number of glaucoma medications, worse visual acuity in the affected eye, and visual field mean deviation. • Female sex and other ocular diseases were significantly associated with lower scores of OP and driving subscales, while age negatively affected NA. • Higher educational levels were significantly associated with OP, NA, DA, SF, MH, RD, dependence, and driving subscales.
Chun *et al*.[34]	Korea	Cross-sectional study	NEI VFQ-25	• Mean deviation of visual field was significantly associated with lower scores of OCS of NEI VFQ-25 and its all subscales, except for OP. • Age, sex, education, and income levels were not significantly associated with OCS of NEI VFQ-25 and DA, SF, MH, RD, dependency, and driving subscales. However, age negatively affected mean scores of DA and OP subscales.
Kim et al.[35]	Korea	Cross-sectional	EQ-5D-3L; EQ-VAS	• Male sex sand higher educational levels showed direct and

Authors	Country	Design	Instrument of VRQoL	Main Findings
		study		indirect effects mediated by treatment satisfaction on EQ-5D-3L. • Higher educational levels directly and indirectly through global satisfaction affected the overall score of EQ-VAS, while male sex indirectly impacted EQ-VAS through global satisfaction.
Zhou et al.[36]	China	Cross-sectional study	GQL-15	• Poorer VRQoL was more pronounced in glare and dark adaptation and central and near vision. • Significant factors of the total score of GQL-15 were age, education, type of glaucoma, presence of depression, economic burden, monthly income, disease duration, habitual-corrected visual acuity, mean defect, number of glaucoma surgeries, and treatment history.