

# Emotional and Caregiver Burden in Adults with Glaucoma-Related Blindness at a Chinese Tertiary Center

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**Purpose:** To investigate the psychological and functional burden of glaucoma-related blindness in adult patients and their primary caregivers, and to examine the interrelationships within the patient-caregiver dyad.

**Patients and Methods:** A cross-sectional study enrolled 110 adult patients with glaucoma-related blindness and their caregivers. Depressive symptoms, vision-related quality of life, and caregiver burden were assessed using the Patient Health Questionnaire-9 (PHQ-9), the National Eye Institute Visual Function Questionnaire-25 (NEI-VFQ-25), and the 22-item Zarit Burden Interview (ZBI-22), respectively. Logistic regression analyses were performed to identify factors associated with caregiver burden. A mediation analysis examined whether patients' depressive symptoms mediated the association between visual impairment (VI) and caregiver burden.

**Results:** As the severity of VI increased, patient PHQ-9 scores rose, while NEI-VFQ-25 scores declined correspondingly (all  $P < 0.05$ ). Similarly, caregivers demonstrated higher PHQ-9 and ZBI-22 scores with rising levels of patient VI (all  $P < 0.05$ ). Notably, patient and caregiver PHQ-9 scores were positively correlated ( $r = 0.336$ ;  $P = 0.040$ ). In multivariable logistic regression, higher caregivers' depressive symptom scores (adjusted OR = 1.28; 95% CI: 1.09–1.49;  $P = 0.002$ ) and higher patient intraocular pressure (adjusted OR = 1.04; 95% CI: 1.01–1.07;  $P = 0.044$ ) remained independently associated with higher odds of caregiver burden. The indirect effect of VI on caregiver burden through the patients' depressive symptoms was significant ( $P < 0.05$ ).

**Conclusion:** Glaucoma-related blindness imposes significant psychological and functional burdens on patients and caregivers, with evidence of emotional contagion. Effective control of intraocular pressure and mental health support for caregivers are critical to reducing caregiver burden.

**Keywords:** glaucoma, blindness, adult patients, emotional contagion, caregiver burden

## Introduction

Glaucoma is a leading cause of irreversible blindness worldwide, currently affecting an estimated 80 million individuals, with prevalence projected to reach 112 million by 2040.<sup>1</sup> The World Health Organization estimates that glaucoma accounts for approximately 8% of global blindness.<sup>2</sup> In China, a national multicenter hospital-based study found that 42.7% of patients with primary angle-closure glaucoma at initial hospitalization had blindness in at least one eye, and 5.33% had bilateral blindness.<sup>3</sup> As the world is experiencing population aging, the prevalence of glaucoma is expected to rise, consequently increasing the number of individuals suffering from glaucoma-related blindness. This growing and vulnerable population warrants increased clinical and public health attention to mitigate the broader impact of glaucoma-related disability.

Glaucoma-related blindness affects not only visual function but also has a profound impact on patients' mental health and daily functioning.<sup>4–6</sup> Patients afflicted with glaucoma-related blindness frequently suffer from depression and face substantial challenges in essential tasks required for independent living, such as mobility, self-care, and household management.<sup>7,8</sup> These difficulties often place a considerable burden on caregivers, who provide patients with critical unpaid support for activities of daily living (ADL), medical management, and emotional care.<sup>9</sup> Caregiver burden has been widely recognized in other chronic neurodegenerative disorders, particularly Alzheimer's disease and Parkinson's disease, in which informal caregivers often experience substantial emotional, physical, and financial strain.<sup>10,11</sup> Previous studies have shown that primary congenital glaucoma significantly impacts caregivers' quality of life (QoL), particularly their psychosocial well-being, contributing to substantial caregiver burden.<sup>12–14</sup> However, the interrelationships among visual function, depressive symptoms, and caregiver burden in the patient-caregiver dyad remain incompletely understood in adults with glaucoma-related blindness.

Therefore, this study aimed to explore the psychological and functional burden experienced by adults with glaucoma-related blindness and their primary caregivers, as well as the interrelationships within the patient-caregiver dyad, with a focus on visual function, depressive symptoms, and caregiver burden. By addressing this gap, the present study may provide evidence to inform more targeted interventions and comprehensive support strategies for patients with glaucoma-related blindness and their caregivers.

## Materials and Methods

### Data Sources and Study Population

The cross-sectional study was conducted at Zhongshan Ophthalmic Center (ZOC), Sun Yat-sen University, China, from February 2023 to February 2025. The study protocol adhered to the Declaration of Helsinki and received approval from the Institutional Review Committee of ZOC (2022KYPJ252). Written and oral informed consents were obtained from all participants and their caregivers. Participants were recruited from the inpatient wards and outpatient clinics of the Glaucoma Department at a tertiary eye hospital (ZOC).

Patients aged  $\geq 18$  years with glaucoma-related blindness and their primary caregivers were recruited. Eligible patients met the following criteria: (1) diagnosed with glaucoma; (2) best-corrected visual acuity (BCVA)  $< 20/400$  or visual field constriction to less than  $10^\circ$  from fixation in at least one eye for  $> 3$  months; (3) absence of non-glaucomatous ocular comorbidities; (4) no concurrent medical conditions requiring regular caregiver assistance (eg, physical disabilities, neuropsychiatric disorders).<sup>14,15</sup> Caregivers were eligible if they: (1) most frequently provided care; (2) had provided informal care for at least 3 months; (3) received no financial compensation.<sup>12</sup> Patients and caregivers were excluded if they had experienced major traumatic events within the preceding 6 months, were unable to complete the study questionnaires, or declined to participate.

### Variable Definitions

Three Chinese-language questionnaires with satisfactory reliability and validity were used in this study, including the National Eye Institute Visual Function Questionnaire-25 (NEI-VFQ-25), the Patient Health Questionnaire-9 (PHQ-9), and the 22-item Zarit Burden Interview (ZBI-22). The NEI-VFQ-25 assesses the impact of VI on daily activities and emotional health, with scores ranging from 0 to 100, with higher scores indicating better vision-related QoL.<sup>16,17</sup> The PHQ-9, a 9-item tool, assesses depression severity scored 0–27 (0 = none, 1 = several days, 2 = over half the days, 3 = nearly daily).<sup>18</sup> Scores classify depression severity: 0–4 (minimal), 5–9 (mild), 10–14 (moderate), 15–19 (moderately severe), and 20–27 (severe).<sup>19</sup> Caregiver burden is assessed using the ZBI-22, which has five ordered frequency-related response categories, scored 0 (never) to 4 (nearly always).<sup>20,21</sup>

Patient-related variables included socio-demographic characteristics, namely age, gender, employment status, marital status, annual household income, education level, and health status. Ocular and clinical characteristics were collected, such as BCVA, intraocular pressure (IOP, recorded as the mean of the three most recent measurements documented before study enrollment), cup-to-disc (C/D) ratio, frequency of ocular symptoms (pain, redness, itching, tearing), number

of glaucoma medications, history of ocular surgery, and duration of blindness. Patient-reported outcomes included depressive symptoms assessed using the PHQ-9 and vision-related QoL assessed using the NEI-VFQ-25.

Furthermore, caregiver-related variables included sociodemographic characteristics such as age, gender, employment status, marital status, annual household income, education level, and health status. Caregiving-related characteristics included relationship to patient, duration of caregiving, involvement of additional relatives or friends in caregiving, use of supportive services (eg, respite care, training in assisting older adults, support group participation), and the total number of assistance with three domain health-related tasks (ADL and instrumental activities of daily living [IADL]-related activities, health systems logistics, and health management).<sup>22,23</sup> Caregiver-reported outcomes included depressive symptoms assessed using the PHQ-9 and caregiver burden assessed using the ZBI-22.

Patients were classified into three groups of VI based on the better-seeing eye: no VI ( $BCVA \geq 20/40$ ), mild-moderate VI ( $20/200 \leq BCVA < 20/40$ ), and severe VI-blindness ( $BCVA < 20/200$ ).<sup>24</sup> For caregivers, a total ZBI-22 score of 20 or higher was considered indicative of significant caregiver burden.<sup>25,26</sup>

## Statistical Analysis

All analyses were performed using R statistical software (version 4.2.2; R Foundation for Statistical Computing, Vienna, Austria). Data were expressed as mean  $\pm$  standard deviation (SD) or median (interquartile range, IQR) for continuous variables and frequency (percentage) for categorical variables. Analyses of ocular parameters were conducted using data from the better-seeing eye. For baseline characteristic comparisons, normally distributed continuous variables were analyzed using Student's *t*-test or one-way analysis of variance (ANOVA), skewed continuous variables using the Mann–Whitney *U*-test or Kruskal–Wallis test, and categorical variables using the chi-square test or Fisher's exact test, as appropriate. A *P*-value  $< 0.05$  was considered statistically significant. Logistic regression models were used to assess factors associated with caregiver burden. Variables with a *P*-value  $< 0.10$  in the univariable analysis were included in the multivariable regression model. Results are reported as crude and adjusted odds ratios with 95% confidence intervals and *P* values. Spearman correlation coefficients were calculated between patients' NEI-VFQ-25 and PHQ-9 scores, and between PHQ-9 scores of patients and their caregivers. Mediation analysis was performed to evaluate whether patients' depressive symptoms mediated the association between VI and caregiver burden. The mediation model was adjusted for potential confounders selected a priori based on clinical relevance, including patient age, gender, marital status, general health, employment status, and IOP.

Sample size estimation was based on the primary outcome of caregiver burden (ZBI-22 score  $\geq 20$ ). The expected proportion of caregivers meeting this prespecified threshold was conservatively set at 40%, informed by prior evidence that approximately 48% of caregivers of legally blind patients experience at least mild caregiver burden.<sup>27</sup> To achieve a two-sided 95% confidence level and a precision of  $\pm 10\%$  for the prevalence estimate, a minimum of 93 patient-caregiver pairs was required.<sup>28</sup> Allowing for a potential 15% rate of incomplete data or nonresponse, 110 patient-caregiver pairs were targeted and ultimately enrolled.

## Results

A total of 145 patients with glaucoma-related blindness and their primary caregivers were initially screened. Thirty-five patient-caregiver pairs were excluded due to uncooperative behavior during the interview ( $n = 17$ ), communication barriers ( $n = 8$ ), or incomplete data ( $n = 10$ ). Ultimately, 110 pairs were enrolled in the study. The baseline characteristics of patients stratified by VI severity are presented in Table 1. The patients were 44.6% elderly, 30.0% middle-aged, and 25.4% young, with 55.4% male. Among the patients, 38.2% were classified as severe VI or blindness, 39.1% had mild to moderate VI, and 22.7% had no VI in the better-seeing eye. The C/D ratio increased with VI severity, whereas no significant group differences were found in IOP, glaucoma medication use, ocular surface symptoms, general health, or VI duration, which may influence patient QoL and caregiver burden (Table 1). In contrast, patients with severe VI or blindness were significantly younger and more likely to be not married (all  $P < 0.001$ ). The caregivers were 21.8% elderly, 30.9% middle-aged, and 47.3% young, with 45.5% male. Most were spouses or children of the patient (88.2%), providing an average of  $7.34 \pm 7.89$  years of care (Table 2). While no significant differences were observed in caregiver demographics across patient VI groups, caregivers of patients with severe VI or blindness were less likely to have a university education or above ( $P = 0.056$ ).

**Table 1** Baseline Characteristics of Patients by Visual Impairment Severity

Patient Characteristic	Grouped by Patient Visual Impairment Severity				P value
	All (n = 110, 100%)	Severe VI-Blindness (n = 42, 38.2%)	Mild-Moderate VI (n = 43, 39.1%)	No VI (n = 25, 22.7%)	
Age <sup>a</sup>					< 0.001
Young	28 (25.4%)	18 (42.8%)	5 (11.6%)	5 (20.0%)	
Middle	33 (30.0%)	17 (40.5%)	10 (23.3%)	6 (24.0%)	
Elderly	49 (44.6%)	7 (16.7%)	28 (65.1%)	14 (56.0%)	
Gender					0.563
Male	61 (55.4%)	26 (61.9%)	22 (51.2%)	13 (52.0%)	
Female	49 (44.6%)	16 (38.1%)	21 (48.8%)	12 (48.0%)	
Employment status					0.159
Employed	67 (60.9%)	30 (71.4%)	22 (51.2%)	15 (60.0%)	
Unemployed	43 (39.1%)	12 (28.6%)	21 (48.8%)	10 (40.0%)	
Marital status					< 0.001
Married	92 (83.6%)	28 (66.7%)	40 (93.0%)	24 (96.0%)	
Not married	18 (16.4%)	14 (33.3%)	3 (7.0%)	1 (4.0%)	
Annual household income, yuan					0.899
< 10 k	59 (53.6%)	23 (54.8%)	23 (53.5%)	13 (52.0%)	
10–100 k	34 (30.9%)	13 (30.9%)	13 (30.2%)	8 (32.0%)	
> 100 k	17 (15.5%)	6 (14.3%)	7 (16.3%)	4 (16.0%)	
Education level					0.105
Primary	34 (30.9%)	10 (23.8%)	19 (44.2%)	5 (20.0%)	
Secondary	52 (47.3%)	20 (47.6%)	19 (44.2%)	13 (52.0%)	
University or above	24 (21.8%)	12 (28.6%)	5 (11.6%)	7 (28.0%)	
Health status					0.197
Good	51 (46.4%)	15 (35.7%)	22 (51.2%)	14 (56.0%)	
Fair or poor	59 (53.6%)	27 (64.3%)	21 (48.8%)	11 (44.0%)	
Better-seeing eye					0.018
Right eye (OD)	47 (42.7%)	11 (26.2%)	24 (55.8%)	12 (48.0%)	
Left eye (OS)	63 (57.3%)	31 (73.8%)	19 (44.2%)	13 (52.0%)	
Duration of blindness, y	4.12 (7.20)	3.66 (5.88)	3.99 (5.27)	5.12 (11.23)	0.717
IOP, mmHg	21.60 (11.21)	23.56 (12.95)	21.33 (11.13)	18.77 (7.24)	0.236
C/D ratio	0.77 (0.25)	0.89 (0.18)	0.80 (0.21)	0.57 (0.26)	< 0.001
BCVA, LogMAR	0.80 (0.80)	1.57 (0.79)	0.46 (0.21)	0.09 (0.11)	< 0.001
Glaucoma medication, n	3.00 (2.00)	3.00 (2.00)	3.00 (2.00)	3.00 (1.00)	0.464
Ocular surface symptom, n	1.00 (1.00)	0.00 (1.00)	1.00 (1.00)	1.00 (1.00)	0.311
Ocular surgery, n	1.00 (3.00)	1.50 (3.00)	1.00 (2.50)	1.00 (2.00)	0.486

**Notes:** <sup>a</sup>Age was categorized according to the World Health Organization classification: young (18–44 years), middle (45–59 years), and elderly (≥ 60 years). Data are presented as n (%), mean (SD), or median (IQR), as appropriate. P values were calculated using the chi-square test, Fisher's exact test, one-way ANOVA, or Kruskal–Wallis test, as appropriate.

**Abbreviations:** VI, visual impairment; IOP, intraocular pressure; C/D, cup-to-disc; BCVA, best-corrected visual acuity; SD, standard deviation; IQR, interquartile range; ANOVA, analysis of variance.

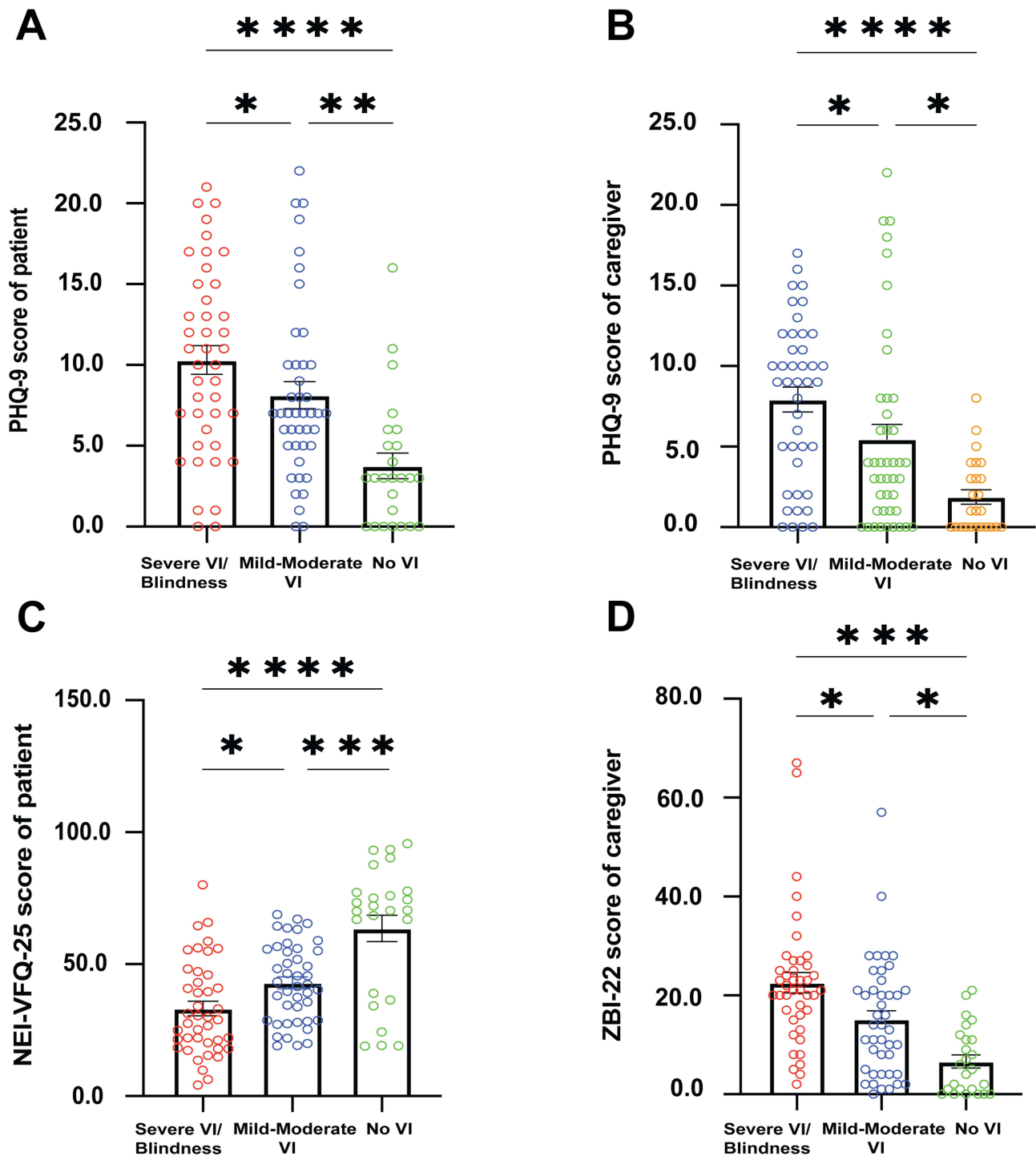
Figure 1 illustrates that both patients and their caregivers experienced significantly greater psychological and functional burden with increasing severity of VI. Patients with more severe visual loss had higher PHQ-9 scores and lower NEI-VFQ-25 scores (all  $P < 0.05$ ), indicating increased depressive symptoms and poorer vision-related QoL. Similarly, caregivers of these patients reported higher PHQ-9 and ZBI-22 scores (all  $P < 0.05$ ), reflecting greater emotional distress and caregiving burden. As shown in Figure 2A, higher levels of depressive symptoms (PHQ-9) were significantly associated with poorer vision-related QoL (NEI-VFQ-25) in patients with glaucoma-related blindness (Spearman  $r = -0.505$ ;  $P < 0.001$ ). Moreover, patient and caregiver PHQ-9 scores were significantly positively correlated, suggesting emotional interdependence within the caregiving dyad (Spearman  $r = 0.336$ ;  $P = 0.040$ ; Figure 2B).

**Table 2** Baseline Characteristics of Caregivers by Patient Visual Impairment Severity

Caregiver Characteristic	Grouped by Patient Visual Impairment Severity				P value
	All (n = 110, 100%)	Severe VI-Blindness (n = 42, 38.2%)	Mild-Moderate VI (n = 43, 39.1%)	No VI (n = 25, 22.7%)	
Age <sup>a</sup>					0.117
Young	52 (47.3%)	23 (54.8%)	17 (39.5%)	12 (48.0%)	
Middle	34 (30.9%)	14 (33.3%)	11 (25.6%)	9 (36.0%)	
Elderly	24 (21.8%)	5 (11.9%)	15 (34.9%)	4 (16.0%)	
Gender					0.846
Male	50 (45.5%)	18 (42.9%)	21 (48.8%)	11 (44.0%)	
Female	60 (54.5%)	24 (57.1%)	22 (51.2%)	14 (56.0%)	
Employment status					0.333
Employed	81 (73.6%)	29 (69.1%)	35 (81.4%)	17 (68.0%)	
Unemployed	29 (26.4%)	13 (30.9%)	8 (18.6%)	8 (32.0%)	
Marital status					0.972
Married	94 (85.5%)	36 (85.7%)	37 (86.1%)	21 (84.0%)	
Not married	16 (14.5%)	6 (14.3%)	6 (13.9%)	4 (16.0%)	
Annual household income, yuan					0.133
< 10 K	46 (41.8%)	15 (35.7%)	22 (51.1%)	9 (36.0%)	
10–100 K	41 (37.3%)	21 (50.0%)	10 (23.3%)	10 (40.0%)	
> 100 K	23 (20.9%)	6 (14.3%)	11 (25.6%)	6 (24.0%)	
Education level					0.056
Primary	19 (17.3%)	6 (14.3%)	10 (23.3%)	3 (12.0%)	
Secondary	54 (49.1%)	27 (64.3%)	18 (41.9%)	9 (36.0%)	
University or above	37 (33.6%)	9 (21.4%)	15 (34.8%)	13 (52.0%)	
Health status					0.631
Good	78 (70.9%)	32 (76.2%)	29 (67.4%)	17 (68.0%)	
Fair or poor	32 (29.1%)	10 (23.8%)	14 (32.6%)	8 (32.0%)	
Relationship to patient					0.359
Spouse	50 (45.5%)	17 (40.5%)	22 (51.2%)	11 (44.0%)	
Children	47 (42.7%)	17 (40.5%)	19 (44.2%)	11 (44.0%)	
Other	13 (11.8%)	8 (19.0%)	2 (4.6%)	3 (12.0%)	
Duration of caregiving, y	7.34 (7.89)	7.62 (6.54)	7.78 (9.32)	6.12 (7.45)	0.680
ADL/IADL-related activity, n	3.00 (3.00)	3.00 (4.00)	3.00 (2.00)	3.00 (4.00)	0.907
Health management, n	1.00 (1.00)	1.00 (1.00)	2.00 (1.00)	2.00 (1.00)	0.131
Health systems logistics, n	4.00 (3.00)	3.50 (3.00)	4.00 (3.00)	4.00 (3.00)	0.373
Total caregiving tasks <sup>b</sup> , n	8.00 (6.00)	7.50 (8.00)	9.00 (5.00)	8.00 (7.00)	0.647
Additional informal caregiver <sup>c</sup>					0.705
Yes	67 (60.9%)	25 (59.5%)	25 (58.1%)	17 (68.0%)	
No	43 (39.1%)	17 (40.5%)	18 (41.9%)	8 (32.0%)	
Supportive services <sup>d</sup>					0.059
Yes	40 (36.4%)	14 (33.3%)	12 (27.9%)	14 (56.0%)	
No	70 (63.6%)	28 (66.7%)	31 (72.1%)	11 (44.0%)	

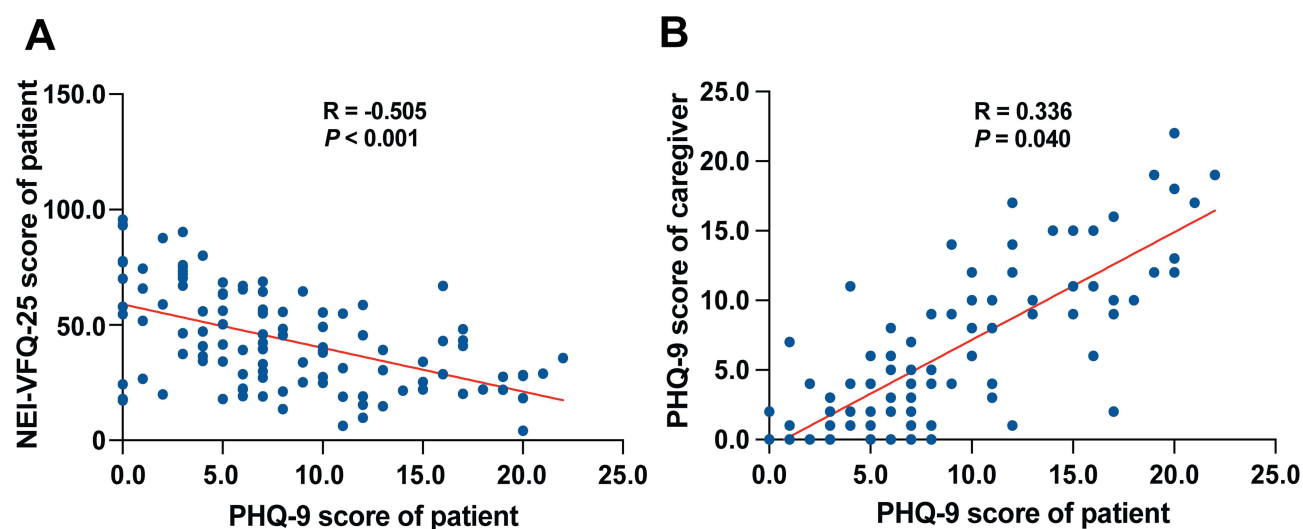
**Notes:** <sup>a</sup>Age was categorized according to the World Health Organization classification: young (18–44 years), middle (45–59 years), and elderly ( $\geq 60$  years). <sup>b</sup>The total number of caregiving tasks across three health-related domains (activities of daily living and instrumental activities of daily living-related activities, health systems logistics, and health management). <sup>c</sup>Participation of non-primary informal caregivers, including other relatives, friends, or community members, in caregiving activities. <sup>d</sup>Supportive services include respite care, caregiver training for assisting patients, participation in support groups, psychological services, social management, assistive device guidance, and community outreach. Data are presented as n (%), mean (SD), or median (IQR), as appropriate. P values were calculated using the chi-square test, Fisher's exact test, one-way ANOVA, or Kruskal–Wallis test, as appropriate.

**Abbreviations:** VI, visual impairment; ADL, activities of daily living; IADL, instrumental activities of daily living; SD, standard deviation; IQR, interquartile range; ANOVA, analysis of variance.



**Figure 1** Quantification of Burden by Patient Visual Impairment Severity. Quantification of PHQ-9 scores across patients (A) and caregivers (B), NEI-VFQ-25 scores across patients (C), and ZBI-22 scores across caregivers (D). The data are reported as mean ± SEM, based on one-way ANOVA. \**p* < 0.05, \*\**p* < 0.01, \*\*\**p* < 0.001, and \*\*\*\**p* < 0.0001. **Abbreviations:** PHQ-9, Patient Health Questionnaire-9; NEI-VFQ-25, National Eye Institute Visual Function Questionnaire-25; ZBI-22, 22-item Zarit Burden Interview; SEM, standard error of the mean; ANOVA, analysis of variance.

Among all caregivers, 47 (42.7%) met the threshold for significant burden (ZBI-22 score ≥ 20; Table 3). Compared to caregivers without burden, those with burden had significantly higher PHQ-9 scores (9.21 ± 5.66 vs. 2.89 ± 3.39; *P* < 0.001) and were less likely to utilize supportive services (25.5% vs. 44.4%; *P* = 0.041). In the caregiver burden group, patients were younger (*P* = 0.008), more likely to be employed (*P* = 0.034), not married (*P* = 0.006), in poor general health (*P* = 0.003), with



**Figure 2** Correlation Analysis. **(A)** Spearman correlation analysis of PHQ-9 scores and NEI-VFQ-25 scores in patients with glaucoma-related blindness. **(B)** Spearman correlation analysis of PHQ-9 scores between patients with glaucoma-related blindness and their caregivers.

**Abbreviations:** NEI-VFQ-25, National Eye Institute Visual Function Questionnaire-25; PHQ-9, Patient Health Questionnaire-9.

elevated IOP ( $P = 0.012$ ), a larger C/D ratio ( $P = 0.040$ ), worse BCVA ( $P < 0.001$ ), higher PHQ-9 scores ( $P < 0.001$ ) and lower NEI-VFQ-25 scores ( $P < 0.001$ ).

To evaluate the demographic, clinical, and socioeconomic factors associated with caregiver burden among adults with glaucoma-related blindness, univariable and multivariable logistic regression analyses were performed (Figure 3 and Table S1).

**Table 3** Comparison of Caregiver and Patient Characteristics by Caregiver Burden Status

Characteristic	No Caregiver Burden (n = 63, 57.3%)	Caregiver Burden (n = 47, 42.7%)	P value
<b>Caregiver</b>			
Age <sup>a</sup>			0.766
Young	30 (47.6%)	22 (46.8%)	
Middle	18 (28.6%)	16 (34.0%)	
Elderly	15 (23.8%)	9 (19.2%)	
Gender			0.526
Male	27 (42.9%)	23 (48.9%)	
Female	36 (57.1%)	24 (51.1%)	
Employment status			0.864
Employed	46 (73.1%)	35 (74.5%)	
Unemployed	17 (26.9%)	12 (25.5%)	
Marital status			0.237
Married	56 (88.9%)	38 (80.8%)	
Not married	7 (11.1%)	9 (19.2%)	
Annual household income, yuan			0.678
< 10 k	25 (39.7%)	21 (44.7%)	
10–100 k	23 (36.5%)	18 (38.3%)	
> 100 k	15 (23.8%)	8 (17.0%)	
Education level			0.143
Primary	10 (15.9%)	9 (19.1%)	
Secondary	27 (42.9%)	27 (57.5%)	
University or above	26 (41.2%)	11 (23.4%)	

(Continued)

**Table 3** (Continued).

Characteristic	No Caregiver Burden (n = 63, 57.3%)	Caregiver Burden (n = 47, 42.7%)	P value
Health status			0.890
Good	45 (71.4%)	33 (70.2%)	
Fair or poor	18 (28.6%)	14 (29.8%)	
Relationship to patient			0.906
Spouse	28 (44.4%)	22 (46.8%)	
Children	28 (44.4%)	19 (40.4%)	
Other	7 (11.2%)	6 (12.8%)	
Duration of caregiving, y	6.25 (7.19)	8.81 (8.60)	0.092
ADL/IADL-related activity, n	2.50 (3.00)	3.00 (3.00)	0.160
Health management, n	1.00 (1.00)	2.00 (1.00)	0.485
Health systems logistics, n	4.00 (3.00)	4.00 (3.00)	0.291
Total caregiving tasks <sup>b</sup> , n	7.00 (6.00)	8.00 (9.00)	0.323
Additional informal caregiver <sup>c</sup>			0.520
Yes	40 (63.5%)	27 (57.5%)	
No	23 (36.5%)	20 (42.5%)	
Supportive services <sup>d</sup>			0.041
Yes	28 (44.4%)	12 (25.5%)	
No	35 (55.6%)	35 (74.5%)	
PHQ-9 total score	2.89 (3.39)	9.21 (5.66)	< 0.001
<b>Patient</b>			
Age <sup>a</sup>			0.008
Young	13 (20.6%)	15 (31.9%)	
Middle	14 (22.2%)	19 (40.4%)	
Elderly	36 (57.2%)	13 (27.7%)	
Gender			0.424
Male	37 (58.7%)	24 (51.1%)	
Female	26 (41.3%)	23 (48.9%)	
Employment status			0.034
Employed	33 (52.4%)	34 (72.3%)	
Unemployed	30 (47.6%)	13 (27.7%)	
Marital status			0.006
Married	58 (92.1%)	34 (72.3%)	
Not married	5 (7.9%)	13 (27.7%)	
Annual household income, yuan			0.339
< 10 k	31 (49.2%)	28 (59.6%)	
10–100 k	23 (36.5%)	11 (23.4%)	
> 100 k	9 (14.3%)	8 (17.0%)	
Education level			0.056
Primary	16 (25.4%)	18 (38.3%)	
Secondary	36 (57.1%)	16 (34.0%)	
University or above	11 (17.5%)	13 (27.7%)	
Health status			0.003
Good	37 (58.7%)	14 (29.8%)	
Fair or poor	26 (41.3%)	33 (70.2%)	
Better-seeing eye			0.417
Right eye (OD)	29 (46.1%)	18 (38.3%)	
Left eye (OS)	34 (53.9%)	29 (61.7%)	
Duration of blindness, y	3.97 (7.92)	4.31 (6.19)	0.813
IOP, mmHg	19.19 (9.48)	24.83 (12.58)	0.012

(Continued)

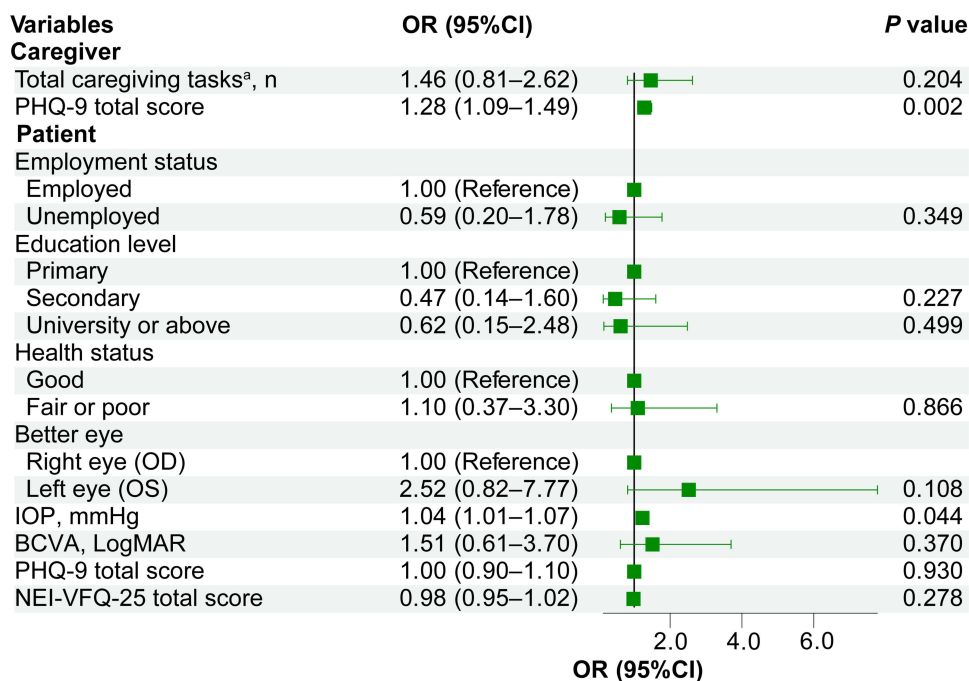
**Table 3** (Continued).

Characteristic	No Caregiver Burden (n = 63, 57.3%)	Caregiver Burden (n = 47, 42.7%)	P value
C/D ratio	0.73 (0.26)	0.81 (0.19)	0.040
BCVA, LogMAR	0.72 (0.66)	1.40 (0.83)	< 0.001
Glaucoma medication, n	3.00 (2.00)	3.00 (2.00)	0.320
Ocular surface symptom, n	1.00 (1.00)	0.50 (1.00)	0.065
Ocular surgery, n	1.00 (3.00)	1.00 (3.00)	0.332
PHQ-9 total score	4.81 (3.61)	12.21 (5.50)	< 0.001
NEI-VFQ-25 total score	52.34 (22.63)	32.61 (14.20)	< 0.001

**Notes:** <sup>a</sup> Age was categorized according to the World Health Organization classification: young (18–44 years), middle (45–59 years), and elderly ( $\geq 60$  years). <sup>b</sup> The total number of caregiving tasks across three health-related domains (activities of daily living and instrumental activities of daily living-related activities, health systems logistics, and health management). <sup>c</sup> Participation of non-primary informal caregivers, including other relatives, friends, or community members, in caregiving activities. <sup>d</sup> Supportive services include respite care, caregiver training for assisting patients, participation in support groups, psychological services, social management, assistive device guidance, and community outreach. Data are presented as n (%), mean (SD), or median (IQR), as appropriate. P values were calculated using the chi-square test, Fisher's exact test, Student's t-test, or Mann-Whitney U-test, as appropriate.

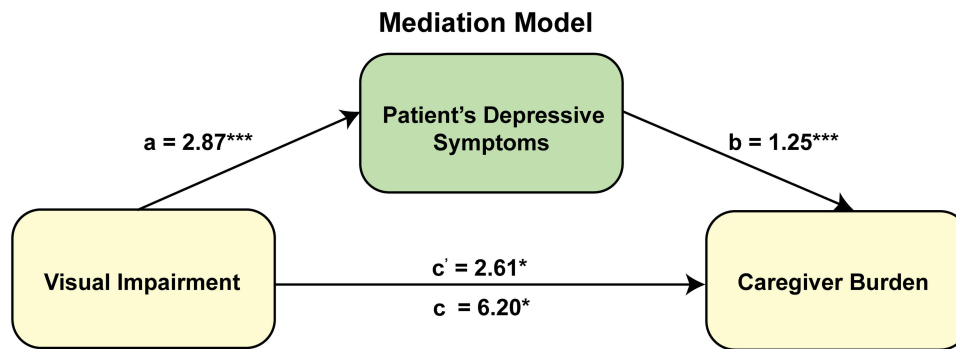
**Abbreviations:** ADL, activities of daily living; IADL, instrumental activities of daily living; PHQ-9, Patient Health Questionnaire-9; IOP, intraocular pressure; C/D, cup-to-disc; BCVA, best-corrected visual acuity; NEI-VFQ-25, National Eye Institute Visual Function Questionnaire-25; SD, standard deviation; IQR, interquartile range.

In univariable analysis, a higher total number of caregiving tasks and higher caregiver PHQ-9 scores were associated with increased caregiver burden. Among patient-related factors, poorer general health, higher IOP, worse BCVA, higher PHQ-9 scores, and lower NEI-VFQ-25 scores were also associated with caregiver burden. In the multivariable model, only higher caregiver PHQ-9 scores (adjusted OR = 1.28; 95% CI: 1.09–1.49;  $P = 0.002$ ) and higher patient IOP (adjusted OR = 1.04; 95% CI: 1.01–1.07;  $P = 0.044$ ) remained independently associated with caregiver burden.



**Figure 3** Forest plot of multivariable logistic regression analysis for caregiver burden. Caregivers' depressive symptoms (PHQ-9 score) and IOP remained independently associated with caregiver burden. <sup>a</sup> The total number of caregiving tasks across three health-related domains (activities of daily living and instrumental activities of daily living-related activities, health systems logistics, and health management).

**Abbreviations:** OR, odds ratio; CI, confidence interval; PHQ-9, Patient Health Questionnaire-9; IOP, intraocular pressure; BCVA, best-corrected visual acuity; NEI-VFQ-25, National Eye Institute Visual Function Questionnaire-25.



**Figure 4** Path diagram illustrating the mediation analysis of patients' depressive symptoms (total PHQ-9 scores) in the association between visual impairment (BCVA, logMAR) and caregiver burden (total ZBI-22 scores). Path a indicates the effect of VI on patients' depressive symptoms, path b the effect of patients' depressive symptoms on caregiver burden, path c the total effect of VI on caregiver burden, and path c' the direct effect after adjustment for the mediator. Unstandardized effects are presented. \* $P < 0.05$ , \*\*\* $P < 0.001$ . **Abbreviations:** PHQ-9, Patient Health Questionnaire-9; BCVA, best-corrected visual acuity; ZBI-22, 22-item Zarit Burden Interview; VI, visual impairment.

Mediation analysis was performed to determine whether patients' depressive symptoms accounted for the association between VI severity and caregiver burden (Figure 4). The indirect effect of VI on caregiver burden through PHQ-9 was significant (bootstrap indirect effect = 3.59; 95% CI: 1.61–5.99), indicating that poorer vision contributed to greater caregiver burden in part by increasing patients' depressive symptoms. The direct effect of VI severity on caregiver burden remained significant after inclusion of the mediator ( $B = 2.61$ ;  $P = 0.047$ ), supporting a partial mediation model.

## Discussion

This cross-sectional study, conducted in a Chinese tertiary eye care center, revealed a significant association between the psychological and functional burdens of adults with glaucoma-related blindness and their primary caregivers. The patient-caregiver dyad in glaucoma-related blindness has seldom been examined as an integrated unit to explore their interrelated psychological and functional burdens.<sup>29,30</sup> Our study demonstrated that greater patient VI severity was linked to more psychological distress and lower daily functioning, with emotional contagion of depressive symptoms between patients and caregivers. Notably, caregivers' depressive symptoms and elevated IOP indicating uncontrolled glaucoma were independent predictors of caregiver burden. These findings highlight the need for glaucoma care that includes not only disease control but also routine assessment of depressive symptoms, early identification of caregiver burden, and targeted supportive services for both patients and their caregivers.

In the current study, we found that the impact of visual functions on QoL varied at different stages of glaucoma-related blindness, which was in line with the earlier findings.<sup>31</sup> Moreover, our findings further demonstrated that patients with reduced vision-related QoL are more prone to depressive symptoms. Glaucoma-related VI limits mobility, independence, and the ability to perform daily tasks such as reading, self-care, and medication use.<sup>32,33</sup> This loss of autonomy may lead to social withdrawal and depression. Addressing these challenges is essential to providing comprehensive care in the context of glaucoma-related blindness.

The results of this study showed that caregiver psychological burden was associated with the VI severity of the adult patient with glaucoma-related blindness. Similarly, a previous study showed that caregiver depression increased as VI worsened in legally blind patients.<sup>34</sup> Interestingly, we also found that the increased depressive symptoms in caregivers were closely associated with those in their patients. The close association between depressive symptoms in patients and their caregivers likely reflects emotional interdependence. As caregivers provide prolonged and intimate support, they may internalize the emotional distress of the patient, particularly in the setting of progressive disease. This phenomenon, often described as emotional contagion, has been reported in other chronic disease contexts and contributes to a reciprocal cycle of psychological burden.<sup>35,36</sup> Recognizing and addressing this dyadic interaction is essential for improving mental health outcomes in both patients and caregivers.

Furthermore, multivariable analysis identified two independent predictors of caregiver burden: uncontrolled glaucoma manifested as elevated IOP and caregivers' depressive symptoms. Worse BCVA was not independently associated with

caregiver burden after adjustment, partially differing from the previous report.<sup>37</sup> This may reflect the limited ability of BCVA alone to capture the functional and caregiving burden of glaucoma, in which central visual acuity is often preserved until advanced stages. However, elevated IOP may serve as a marker of insufficient disease control and a higher perceived risk of further visual deterioration, which may increase uncertainty and emotional stress among caregivers. In addition, higher IOP may be accompanied by more frequent follow-up visits, closer medication supervision, and possible anticipation of surgical intervention, all of which may increase practical caregiving demands. These results suggest that achieving better IOP control may be relevant not only to preserving patients' vision but also to reducing caregiver burden.

In this study of adults with glaucoma-related blindness, caregivers' depressive symptoms appear to be a stronger driver of caregiver burden. Previous studies on primary congenital glaucoma have demonstrated that caregiver burden stems not only from disease severity but also from emotional burden, specifically depression.<sup>12,14</sup> However, unlike caregivers of children, those caring for adults with glaucoma-related blindness often face added challenges of aging, comorbid illness, and long-term dependency, which contribute to the development of depressive symptoms. Caregiver depression remains a critical but overlooked component of adult glaucoma management and merits focused clinical attention. Integrating caregiver psychological supportive intervention into routine glaucoma management plays a role in alleviating caregiver distress and enhancing overall care outcomes.

In addition to these findings, our mediation analysis showed that patients' depressive symptoms may partly mediate the relationship between VI and caregiver burden. Although patients' depressive symptoms did not remain independently associated with caregiver burden after multivariable adjustment, the results still support a potential pathway through which worsening vision contributes to caregiver burden via its adverse psychological impact on patients. This finding highlights the clinical necessity of identifying and addressing depressive symptoms in patients with glaucoma-related blindness.

The present study has several limitations. First, the cross-sectional design limits causal inference and precludes assessment of longitudinal changes in burden. Second, all participants were recruited from a tertiary care center, which may introduce selection bias and limit the generalizability of the findings to community-based settings. Third, caregiver burden was assessed using self-report scales, which are subject to potential recall or reporting bias. Fourth, IOP was calculated as the mean of the three most recent pre-enrollment measurements, with non-standardized timing and intervals, which may affect reproducibility. Finally, unmeasured factors, including caregivers' understanding of glaucoma and other sociocultural influences on caregiving, may also have affected perceived burden.

## Conclusion

Glaucoma-related blindness exerts significant psychological and functional burdens on both patients and their primary caregivers, and an emotional contagion of depressive symptoms between these dyads is observed. Patients' depressive symptoms may partly mediate the relationship between VI and caregiver burden. This underscores the critical need for a holistic approach to care, where effective IOP control in glaucoma, proactive attention to patients' mental health, and strengthened support for caregivers are paramount in alleviating the burden. These findings underscore the need to incorporate mental health screening and caregiver support into routine glaucoma care to enhance well-being for both patients and caregivers. Future research should explore the implementation and long-term efficacy of such integrated care models in glaucoma-related blindness.

## Abbreviations

PHQ-9, Patient Health Questionnaire-9; NEI-VFQ-25, National Eye Institute Visual Function Questionnaire-25; ZBI-22, 22-item Zarit Burden Interview; VI, visual impairment; ADL, activities of daily living; QoL, quality of life; ZOC, Zhongshan Ophthalmic Center; BCVA, best-corrected visual acuity; IOP, intraocular pressure; C/D, cup-to-disc; IADL, instrumental activities of daily living; SD, standard deviation; IQR, interquartile range; ANOVA, analysis of variance; OR, odds ratio; CI, confidence interval.

## Data Sharing Statement

The data that support the findings of this study are available from the corresponding author upon reasonable request.

## Ethics Approval

This study included human subjects. The human ethics committees at Zhongshan Ophthalmic Center (Sun Yat-sen University, China) approved the study (No. 2022KYPJ252). All research adhered to the tenets of the Declaration of Helsinki. All participants provided informed consent.

## Consent to Participate

All participants provided written permission before their inclusion in the study.

## Consent for Publication

All participants gave written consent for the publication of anonymized data.

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## Disclosure

The author(s) report no conflicts of interest in this work.

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