

Gender Disparities in Depression, Stress, and Social Support Among Glaucoma Patients

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Purpose: To understand differences in measures of depression, stress, and social support by gender among those diagnosed with glaucoma.

Methods: We obtained a cohort of glaucoma patients (any type) ages 18 years and over who answered the COVID-19 Participant Experience (COPE) survey of the NIH *All of Us Research Program*. We analyzed several measures of depression, stress, and social support by gender. Logistic regression was used to evaluate the association among reported stress associated with social distancing, depression (using Patient Health Questionnaire-9 [PHQ-9] scores), and measures of social support by self-reported gender, with men as the reference group. Multivariable models were adjusted for age, race and ethnicity, health insurance status, education, and income.

Results: Of 3633 glaucoma patients, 56.8% were women. Many patients had a PHQ-9 score > 4 (33.3%), indicating mild, moderate, or severe depression. In multivariable models, women were significantly more likely to report a PHQ-9 score > 4 (odds ratio [OR] = 1.40; 95% confidence interval [CI], 1.20–1.62; $P < 0.001$) and some or a lot of stress (OR = 1.34; 95% CI, 1.14–1.57; $P < 0.001$) compared with men. Further, women were significantly less likely to report having help all or most of the time if they needed someone to prepare meals (OR = 0.78; 95% CI, 0.67–0.92; $P = 0.002$) or perform daily chores (OR = 0.79; 95% CI, 0.67–0.91; $P = 0.003$) than men.

Conclusions: Women with glaucoma were more likely to experience depression and stress and were less likely to have social support on some measures than men.

Translational Relevance: The disproportionate burden of psychosocial factors among women may complicate glaucoma management.

Introduction

Mental health disorders, such as depression and anxiety, are strongly correlated with a risk of developing a variety of chronic health conditions,^{1,2} including hypertension,³ stroke,⁴ and diabetes.⁵ This association may be demonstrated at many different levels, from the risk of developing disease to issues with management and long-term outcomes.¹ Depression, in particular, is associated with factors that are essential to properly managing a chronic disease such as

glaucoma,⁶ including adherence to medication⁷ and follow-up appointments.⁸ In part, this may be due to the effect of depression on motivation and memory,⁹ which is especially relevant for chronic health conditions that require significant management on the part of patients.

Management of glaucoma requires close monitoring of optic nerve health and may include complicated medical and surgical regimens in order to lower intraocular pressure, the main modifiable risk factor for disease progression.¹⁰ However, similar to many other conditions, depression among glaucoma patients

has been correlated with inferior outcomes, including poor treatment adherence,¹¹ faster visual field loss,¹² and disease severity.¹³ This is especially relevant considering that depression is thought to be more common among glaucoma patients than the general population.¹⁴

There is also evidence that depression is more common in those identifying as women than those identifying as men among glaucoma patients.^{15–17} However, depression rates during the COVID-19 pandemic and disparities in other measures of mental health, such as stress and social support, are not well characterized. In this study, we investigated mental health and social support measures reported by glaucoma patients in nationwide surveys through the National Institutes of Health (NIH) *All of Us Research Program* and compared them by gender. Understanding potential gender disparities is essential for clinicians, hospital administrators, and health policymakers seeking to promote health equity among glaucoma patients.

Methods

Study Population

We obtained data from the NIH *All of Us Research Program*, a nationwide database with an emphasis on diversity.¹⁸ Participants provided written informed consent after receiving an explanation of the nature and possible consequences of the study during enrollment, which was approved by the NIH *All of Us* institutional review board (IRB). *All of Us* collects a wide range of data from participants, including electronic health record (EHR) data, survey data, wearable data, physical measurements, and biospecimen collection.¹⁸ *All of Us* data undergo de-identification processes prior to becoming available to researchers. According to the NIH *All of Us Research Program* Data and Statistics Dissemination Policy, cells with fewer than 20 respondents were suppressed in this study.¹⁸ Secondary analyses of de-identified data, such as those evaluated for our study, are considered non-human subjects research, which was verified by the University of California San Diego IRB. This study adhered to the tenets of the Declaration of Helsinki.

We studied adults ages 18 years and over who participated in the COVID-19 Participant Experience (COPE) survey, a nationwide survey administered by the NIH *All of Us Research Program* seeking to understand how the pandemic affects physical and mental health.¹⁹ The exact survey instrument can be found in Supplementary Material S1. The survey is recur-

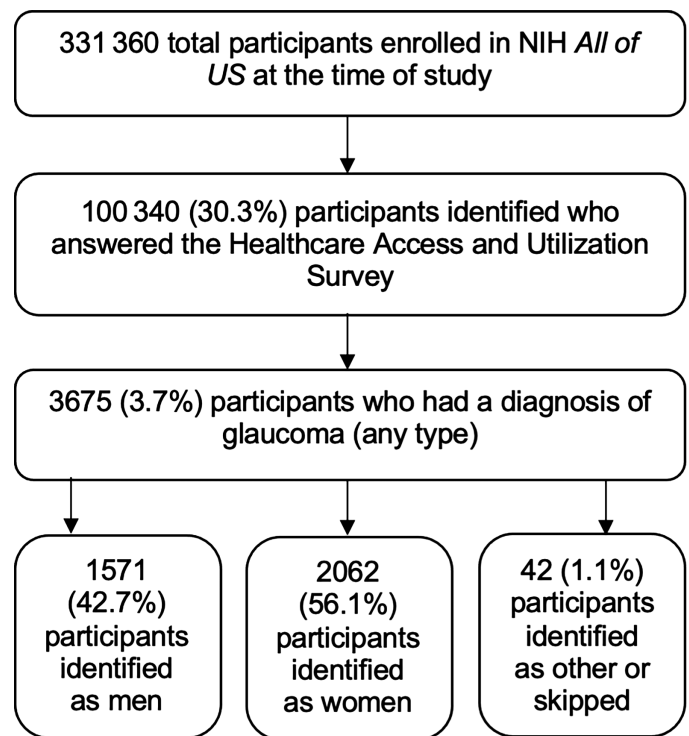


Figure 1. Flowchart of exclusion criteria leading to a final study population of 3633 men and women with glaucoma enrolled in the NIH *All of Us Research Program* who answered at least one version of the COPE survey.

ring, with six versions administered beginning in May 2020. The most recent iteration was February 2021, at the time of this study. Participants answered one or more of these versions, and we obtained answers from each participant's most recent response for analysis. A table of the different survey versions used by gender proportions can be found in Supplementary Material S2. Glaucoma status was based on International Classification of Disease (ICD) diagnosis codes of any glaucoma type, including glaucoma suspect (Supplementary Material S3). At the time of our analysis, 331,360 participants had enrolled in the *All of Us Research Program*. A total of 100,340 individuals were identified who answered at least one version of the COPE survey, of which 3,633 men and women had a diagnosis of glaucoma (Fig. 1).

Variables

We focused our analysis on mental health measures and availability of social support if participants were infected with COVID-19. Demographic information was extracted from participants' survey responses in the *All of Us Basics* survey.²⁰ Gender was categorized as self-identified "man" and "woman," with

the “other/skipped” category dropped due to small numbers, in accordance with data-sharing policies. Age in years was categorized as <40, 40 to 64, 65 to 74, 75 to 84, or ≥ 85 . Racial and ethnic categories were coded as non-Hispanic (NH) white, NH African American, NH Asian, and Hispanic (any race) individuals. Annual household income was categorized as \$0 to \$25k, \$25k to \$50k, \$50k to \$100k, \$100k to \$200k, or $> \$200k$. Education was categorized as no high school diploma, high school diploma/GED, some college, or college and above. Insurance status was categorized as Medicaid, other insured (employer-provided, privately purchased, Medicare, military-provided, Veterans Affairs–provided, or other), or no insurance.

Mental health measures included calculation of Patient Health Questionnaire-9 (PHQ-9) scores, a reliable measure of depression severity²¹; a score of 0 to 4 indicates none or minimal depression, 5 to 9 indicates mild depression, 10 to 14 indicates moderate depression, 15 to 19 indicates moderately severe depression, and ≥ 20 indicates severe depression. We also studied the following question regarding stress: “Have recommendations for socially distancing caused stress for you?” Measures of social support included whether participants had someone available to help if they were confined to bed, to take them to the doctor, to help prepare meals, and to help with daily chores.

Data Analysis

Logistic regression was used to generate odds ratios (ORs) and 95% confidence intervals (CIs) to characterize survey responses coded as binary (PHQ-9: severe/moderate/mild vs. none or minimal depression; stress from social distancing: a lot or some vs. a little or none; social support: always or most of the time vs. some, a little, or none of the time) by gender, with men as the reference group. Univariable and multivariable models were adjusted for race and ethnicity, age category, education category, income category, and health insurance status. Statistical tests were two sided, and P values were considered statistically significant at the $\alpha = 0.05$ level. Analyses were conducted on the NIH *All of Us* Research Workbench using R 4.1.0 (R Foundation for Statistical Computing, Vienna, Austria) and are available in the referenced notebook.²²

Results

Of the 3633 glaucoma patients who responded to the survey items, 2062 (56.8%) identified as women

and 1571 (43.2%) identified as men. Women had a median age of 71 years with an interquartile range (IQR) of 64 to 76 years, and men had a median age of 74 years (IQR, 69–79). The majority of the cohort was NH white (3028, 83.3%), 297 (8.2%) were NH African American, 95 (2.6%) were NH Asian, and 213 (5.9%) were Hispanic (any race). Further, most had at least a college education (2477, 68.2%), and the most common income category was \$50k to \$100k (1231, 33.9%). Nearly all patients had insurance other than Medicaid (3452, 95.0%) (Table 1).

On measures of mental health and social support, one-third of participants (1211, 33.3%) had PHQ-9 scores of > 4 , indicating mild, moderate, or severe depression. Social distancing created either some or a lot of stress for 928 (25.5%) participants. Most participants reported having help all or most of the time if they were confined to bed (2503, 68.9%), if they needed someone to take them to the doctor (2800, 77.1%), if they needed someone to help prepare meals (2519, 69.3%), or if they needed someone to help with daily chores (2429, 66.9%). Women had higher rates than men of endorsing a PHQ-9 score of > 4 (37.9% vs. 28.3%) and some or a lot of stress from social distancing (29.0% vs. 21.8%). Further, women had a lower rate of having help some or all of the time if they were confined to bed (66.0% vs. 75.3%), someone to take them to the doctor (75.6% vs. 81.9%), help preparing meals (65.7% vs. 76.7%), and help with daily chores (63.0% vs. 74.4%) (Table 2).

In unadjusted univariable logistic regression comparing measures of mental health and social support by gender, women were significantly more likely than men to experience depression (OR = 1.62; 95% CI, 1.40–1.87; $P < 0.001$) and stress from social distancing (OR = 1.54; 95% CI, 1.32–1.79; $P < 0.001$). Further, women were significantly less likely than men to have someone help if they were confined to bed (OR = 0.73; 95% CI, 0.63–0.84; $P < 0.001$), to take them to the doctor (OR = 0.82; 95% CI, 0.70–0.96; $P = 0.01$), to help prepare meals (OR = 0.67; 95% CI, 0.58–0.77; $P < 0.001$), and to help with daily chores (OR = 0.67; 95% CI, 0.58–0.77; $P < 0.001$).

Even after adjusting for age, race and ethnicity, education, income, and insurance in multivariable logistic regression models, women were still significantly more likely than men to experience depression (OR = 1.40; 95% CI, 1.20–1.62; $P < 0.001$) or stress from social distancing (OR = 1.34; 95% CI, 1.14–1.57; $P < 0.001$). Further, women were significantly less likely than men to have someone help to prepare meals (OR = 0.78; 95% CI, 0.67–0.92; $P = 0.002$) and to help with daily chores (OR = 0.79; 95% CI, 0.67–0.91; $P = 0.003$). No association was found for having someone

Table 1. Distribution of Selected Characteristics Among Glaucoma Patients Answering the NIH *All of Us* COPE Survey

Characteristics ^a	Men	Women	Total
Total, <i>n</i> (%)	1571 (43.2)	2062 (56.8)	3633 (100.0)
Median age (IQR)	74 (69–79)	71 (64–76)	72 (65–77)
Age category, <i>n</i> (%)			
<65 y	254 (16.7)	518 (25.1)	772 (21.2)
65–74 y	535 (35.3)	819 (39.7)	1354 (37.3)
75–84 y	665 (43.8)	653 (31.7)	1318 (36.3)
≥85 y	117 (7.7)	72 (3.5)	189 (5.2)
Race and ethnicity, <i>n</i> (%)			
NH white	1332 (87.8)	1696 (82.3)	3028 (83.3)
NH African American	92 (6.1)	205 (9.9)	297 (8.2)
NH Asian	47 (3.1)	48 (2.3)	95 (2.6)
Hispanic (any race)	100 (6.6)	113 (5.5)	213 (5.9)
Education, <i>n</i> (%)			
High school diploma/GED or less	104 (6.9)	191 (9.3)	295 (8.1)
Some college	348 (22.9)	513 (24.9)	861 (23.7)
College and above	1119 (73.8)	1358 (65.9)	2477 (68.2)
Income, <i>n</i> (%)			
\$0–\$25k	130 (8.6)	251 (12.2)	381 (10.5)
\$25k–\$50k	214 (14.1)	410 (19.9)	624 (17.2)
\$50k–\$100k	510 (33.6)	721 (35.0)	1231 (33.9)
\$100k–\$200k	497 (32.8)	529 (25.7)	1026 (28.2)
>\$200k	220 (14.5)	151 (7.3)	371 (10.2)
Health insurance, <i>n</i> (%)			
Medicaid/none	54 (3.6)	126 (6.1)	180 (5.0)
Other insured	1517 (96.6)	1936 (93.9)	3453 (95.0)

^aCounts less than 20 (and corresponding percentages) cannot be displayed due to NIH *All of Us* Research Program Data and Statistics Dissemination Policy. In some cases, additional data may be collapsed or obscured to prevent secondary calculation of these values.

help if confined to bed (OR = 0.87; 95% CI, 0.74–1.01; $P = 0.09$) or to take them to the doctor (OR = 1.03; 95% CI, 0.87–1.21; $P = 0.75$) (Fig. 2).

Discussion

In this nationwide study of mental health and social support among glaucoma patients, we found that those identifying as women were more likely to report depression and stress associated with social distancing than those identifying as men. Further, those identifying as women were less likely to report having social support on some measures, such as help with preparing meals and daily chores. To our knowledge, this is the first study to explore gender disparities in mental health among glaucoma patients in the COVID-19 pandemic period. Although prior studies have established gender disparities in mental health—and partic-

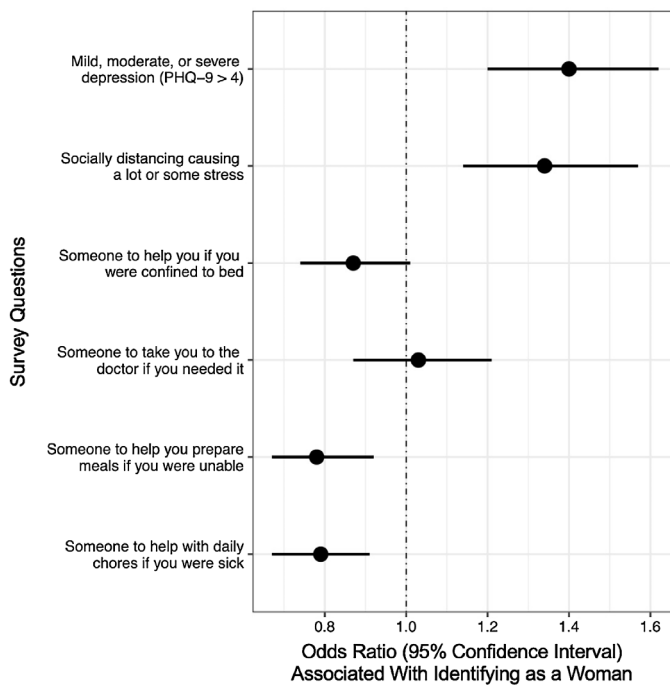
ularly during the COVID-19 pandemic—in general populations²³ and in other chronic disease cohorts,^{24,25} the specific findings in individuals with glaucoma were previously unknown. Our study provides new knowledge in understanding these disparities in glaucoma.

COVID-19 is thought to be more severe when it presents in men, leading to higher death rates from the disease.²⁶ Despite this, women may have experienced more secondary effects.²⁶ One meta-analysis examining mental health among healthcare workers during the pandemic found higher rates of anxiety and depression among women than men.²⁷ Another longitudinal study of the lockdowns from the Netherlands found greater rates of depression among women but greater rates of anxiety among men.²⁸ Women are known to have greater rates of depression at baseline,²⁹ a disparity that begins at puberty and continues into older age.³⁰ This is thought to be at least partially due to social and possible genetic factors that may predispose

Table 2. Distribution of Measures of Mental Health and Social Support Among Glaucoma Patients Answering the NIH *All of Us* COPE Survey

Characteristics ^a	Men, n (%)	Women, n (%)	Total, n (%)
PHQ-9 score			
>4 (mild, moderate, or severe depression)	430 (28.3)	781 (37.9)	1211 (33.3)
≤4 (no depression)	1141 (75.2)	1281 (62.1)	2422 (66.7)
Stress from social distancing?			
A lot or some	330 (21.8)	598 (29.0)	928 (25.5)
A little or none	1241 (81.8)	1464 (71.0)	2705 (74.5)
Someone to help you if you were confined to bed?			
All or most of the time	1142 (75.3)	1361 (66.0)	2503 (68.9)
Some, a little, or none of the time	429 (28.3)	701 (34.0)	1130 (31.1)
Someone to take you to the doctor if you needed it?			
All or most of the time	1242 (81.9)	1558 (75.6)	2800 (77.1)
Some, a little, or none of the time	329 (21.7)	504 (24.4)	833 (22.9)
Someone to prepare your meals if you were unable to do it yourself?			
All or most of the time	1164 (76.7)	1355 (65.7)	2519 (69.3)
Some, a little, or none of the time	407 (26.8)	707 (34.3)	1114 (30.7)
Someone to help with daily chores if you were sick?			
All or most of the time	1129 (74.4)	1300 (63.0)	2429 (66.9)
Some, a little, or none of the time	442 (29.1)	762 (37.0)	1204 (33.1)

^aCounts less than 20 (and corresponding percentages) cannot be displayed due to NIH *All of Us Research Program* Data and Statistics Dissemination Policy. In some cases, additional data may be collapsed or obscured to prevent secondary calculation of these values.

**Figure 2.** Forest plot showing ORs and 95% CIs calculated from multivariable logistic regression (adjusted for age, race and ethnicity, education, income, and insurance) for the association between measures of mental health/social support (including PHQ-9 scores) and gender (with men as the reference group) among glaucoma patients.

women to preferentially internalize negative emotions (e.g., depression and anxiety) and men to externalize negative emotions (e.g., substance use and poor impulse control).³⁰

Women in this study also endorsed greater stress from social distancing. Aside from social distancing causing delays in glaucoma care,³¹ it can lead to feelings of social isolation and a variety of adverse mental health outcomes.^{32,33} It is important for clinicians to be aware of their glaucoma patients' mental health needs, even outside the context of a pandemic. Issues such as depression and anxiety make managing glaucoma difficult by complicating a patient's ability to adhere to medications.¹¹ Depression and anxiety also are postulated to increase the risk of glaucoma progression through faster retinal nerve fiber layer thinning.^{17,29,34} It is notable that mental health has been suggested to directly influence glaucoma progression by affecting the autonomic nervous system, blood flow, and intraocular pressure, among other proposed mechanisms.^{34,35} Mental health issues are an important consideration in comprehensive glaucoma care, as they can have both social and biological ramifications. Moreover, additional study of this subject is needed.

Finally, women in this study had lower levels of social support, as indicated by the help they needed to prepare meals or with daily chores. Though gender

equality has improved gradually in the United States over the past century, disparities in housework are still extensive. Despite comprising the majority of the workforce in pre-pandemic United States,³⁶ in the household, women spend about twice the amount of time cooking and cleaning compared to men.³⁷ Women were also more likely to lose their jobs during shutdowns, as women-dominated sectors such as retail, hospitality, and health care were disproportionately affected.³⁸ Further, women had a greater caregiver burden as a result of school and daycare closures, in both partnered and single-parent households.³⁸ In addition, women are more likely to be single caregivers to their children than are men.³⁹ The pandemic may have also been difficult for elderly women who may not have children at home, as they are nearly twice as likely as men to live alone, largely due to life-expectancy differences by gender.³⁹ Living alone leaves elderly women with less social support in the face of shutdowns or if they get sick and need help with household tasks.

Social support has been found to be positively correlated with quality of life and glaucoma treatment adherence.^{40–42} One study found that low social support among glaucoma patients was significantly associated with increased rates of mental health disorders,⁴³ which can in turn increase vulnerability to vision loss.¹¹ Further, glaucoma patients on the whole have been shown to have issues with transportation, which may make it difficult to obtain groceries⁴⁴ and prepare meals, and is one of the most common reasons why glaucoma surgeries are canceled.^{45,46}

The disproportionate and multifaceted burden that women with glaucoma faced in the early stages of the pandemic highlighted existing disparities that are important for clinicians to be aware of and may indicate particular challenges with glaucoma management. This is especially relevant considering that women carry a disproportionate burden of glaucoma at baseline⁴⁷ and have been shown to have other disparities in eye health, including having a greater overall burden of uncorrected refractive error⁴⁸ and macular degeneration,⁴⁹ being less likely to receive treatment for retinal detachments,⁵⁰ and having lower enrollment in clinical trials.⁵¹ These health disparities must be understood within the context of greater economic gender inequities in the United States, including inequities with wages, the disproportionate burden of childcare and the lack of public investment, and the United States being the only developed nation worldwide without paid maternity leave.⁵²

Our study is not without some limitations. First, as in many survey studies, responses may be influenced

by social desirability bias. This may have led to an underestimation of depression in men in particular, as they have been shown to underreport internalized negative emotions such as depression.⁵³ Second, we did not explore the effect of glaucoma severity, which can increase the likelihood of depression¹³ and may have significantly varied between gender groups. Coding of glaucoma severity using EHR diagnosis codes can be unreliable,⁵⁴ and unfortunately *All of Us* does not currently include clinical notes, visual fields, or imaging that would enable us to directly evaluate disease severity. Third, individuals identifying as “other” gender comprised only about 1% of the overall cohort, and this category also included those who skipped the question, so our study was unable to ascertain potential gender disparities for gender non-binary individuals. Finally, there may have been some selection bias, as most of the *All of Us* participants who elected to participate in the COPE survey identified as white and were well educated (>90% had more than high school education), and nearly all had some form of health insurance. This may have led to an underestimation of social stressors and mental health concerns across the entire cohort, as racial/ethnic minorities such as African Americans and Hispanics have a higher prevalence of open-angle glaucoma (5.6% and 4.7%, respectively) than their NH white counterparts (1.7%) in the general population.⁵⁵ As the *All of Us* cohort grows and more individuals enroll and provide data, we may have opportunity in the future to evaluate other disparities, such as those based on socioeconomic factors or on race and ethnicity.

In conclusion, we found that glaucoma patients identifying as women were more likely to report depression and stress associated with social distancing and were less likely to report having social support than those identifying as men. These findings have served to highlight disparities and reinforce the importance of identifying high-risk populations. Aside from better understanding these associations, ophthalmologists should continue to address the less tangible factors that support eye health and vision outcomes. These social determinants of health include factors such as food, housing, and transportation,⁵⁶ and resources to address these concerns should be integrated into practice.^{42,56,57}

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