Title

Social and Health Care Utilization Factors Associated With Ophthalmic Visit Nonadherence in Glaucoma: An All of Us Study

Journal

Journal of Glaucoma, 32(12)

ISSN

1057-0829

Authors

Wu, Jo-Hsuan

Varkhedi, Varsha

Saseendrakumar, Bharanidharan Radha

et al.

Publication Date

2023-12-01

DOI

10.1097/ijg.0000000000002300

Peer reviewed

HHS Public Access

Author manuscript

J Glaucoma. Author manuscript; available in PMC 2024 December 01.

Published in final edited form as:

J Glaucoma. 2023 December 01; 32(12): 1029–1037. doi:10.1097/IJG.0000000000002300.

Social and healthcare utilization factors associated with ophthalmic visit non-adherence in glaucoma: an *All of Us* study

Jo-Hsuan Wu, MD[1,2,3], **Varsha Varkhedi**[1,2], **Bharanidharan Radha Saseendrakumar, MS**[1,2], **Kaela Acuff**[1,2], **Robert N. Weinreb, MD**[1,3], **Sally L. Baxter, MD, MSc**[1,2,3]

[1]Division of Ophthalmology Informatics and Data Science, Viterbi Family Department of Ophthalmology and Shiley Eye Institute, University of California San Diego, La Jolla, California

[2]Health Department of Biomedical Informatics, University of California San Diego, La Jolla, California

[3]Hamilton Glaucoma Center, Shiley Eye Institute, Viterbi Family Department of Ophthalmology, University of California, San Diego, La Jolla, CA, United States.

Abstract

Purpose: To characterize social and healthcare utilization factors associated with non-adherence with ophthalmic visits among patients with glaucoma.

Methods: Glaucoma patients in the *All of Us* database who completed the Healthcare Access and Utilization Survey were included and categorized into “visit” and “non-visit” groups based on visit adherence, defined by self-reported past-year encounters with eyecare providers (yes/no). Data regarding potential factors affecting ophthalmic visit adherence, including past-year medical visits, inabilities to afford healthcare, and self-reported reasons for delayed care, were extracted. Chi-Square tests and logistic regression were used to compare the two groups. Odds ratios (ORs) of visit adherence were analyzed for potential risk factors.

Results: Of 5739 glaucoma patients, 861(15%) were in the non-visit group. More participants in the visit group reported past-year general doctor/specialist visits (94%/65%; vs. non-visit group:89%/49.3%; P<0.05). The non-visit group reported greater difficulty in affording medical care and learning about medical conditions, and higher rates of delayed/missed healthcare access for various concerns (P<0.05). Older age (OR=1.02[1.01–1.03]), higher education (OR=1.25[1.13–1.40]) and income level (OR=1.06[1.01–1.11]), not employed for wages (OR=1.28[1.08–1.53]), and higher healthcare utilization in general medical/specialist visits (ORs range:1.08–1.90) were associated with visit adherence (P<0.05). Visit non-adherence was associated with cost saving on medication (OR=0.62[0.40–0.97]) and delaying/avoiding seeing healthcare providers because of dissimilarity (OR=0.84[0.71–0.99]) (P<0.05).

Conclusions: This study builds on prior literature by identifying potentially modifiable factors associated with visit non-adherence and under-utilization of eyecare in glaucoma. These may

Corresponding Author/Address for Reprints: Sally L. Baxter, MD, MSc, Shiley Eye Institute and Viterbi Family Department of Ophthalmology, University of California, San Diego, 9415 Campus Point Dr, MC 0946, La Jolla, CA 92093 (s1baxter@health.ucsd.edu).

inform strategies to improve real-world ophthalmic visit adherence and identify patients who might benefit from additional support.

Precis

In a diverse nationwide cohort, lower education and income levels, cost saving on medications, fewer past-year medical/specialist visits, and concerns regarding dissimilarity with healthcare providers were risk factors for ophthalmic visit non-adherence among glaucoma patients.

Keywords

All of Us program; Healthcare access and utilization; Socioeconomic factors; Visit adherence; Glaucoma; Healthcare barriers

INTRODUCTION

Successful management of glaucoma relies heavily on patient adherence with medical instructions, including medication use and regular ophthalmic assessment.[1] As vision loss is irreversible and often accelerates as glaucoma worsens,[2] more frequent ophthalmic assessment is warranted as disease progresses. Depending on glaucoma severity, the suggested interval between visits can range from one year to as short as 1–2 months.[3, 4] While periodic evaluation is crucial in monitoring glaucoma progression, such a visit schedule can be inconvenient, time-consuming, and difficult to adhere to, particularly since patients with glaucoma may be elderly with impaired visual function.

Some prior studies have focused on medication adherence of patients with glaucoma,[5–7] while visit adherence and its barriers have not been explored to as great of detail. Regular visits to clinic are extremely relevant to patient outcomes,[8, 9] as they provide opportunities for disease re-evaluation, patient-physician communication, and treatment modification. A recent study found that around 75% of glaucoma patients in the United States, regardless of disease severity, received less than 1 visual field (VF) test per year, which is far below expert recommendations on follow-up frequency.[10] Considering the progressive course of glaucoma and the impact of vision loss on patients' daily lives, it is critically important to assess potential barriers or risk factors affecting visit adherence in this patient group.

In this study, we examined the social and healthcare utilization factors associated with ophthalmic visit non-adherence in glaucoma via the nationwide *All of Us* database. Specifically, to characterize the healthcare utilization barriers to ophthalmic visit adherence, we utilized data from the *All of Us* Healthcare Access and Utilization Survey (HCAUS). The HCAUS provides patient-reported data on healthcare utilization status (e.g., frequency of past-year medical visits) and covers a full spectrum of potentially modifiable and/or intervenable causes of underutilization of medical resources (e.g., reasons for delaying or missing medical care, subjective concerns when seeking healthcare, inabilities to afford certain healthcare services, etc.).[11–13] Exploration of these barriers may help to clarify the more direct causes of low eyecare utilization, predict patients with visit non-adherence, as well as inform individual- or system-level pragmatic strategies that may improve real-world visit adherence among glaucoma patients.

MATERIALS AND METHODS

This study adhered to the tenets of the Declaration of Helsinki. All data used in the current study were obtained from the version 6 dataset of the National Institutes of Health (NIH) *All of Us* Research Program, which included a wide range of data from electronic health records (EHR), surveys, physical measurements, and biospecimen collection that can be accessed and analyzed using the cloud-based *All of Us* Researcher Workbench. To protect participant privacy, data in *All of Us* underwent de-identification and transformation prior to release in the database. Secondary analyses of the de-identified *All of Us* data are considered non-human subjects research, which has been confirmed by the University of California San Diego Institutional Review Board (IRB).

Study population

This study included *All of Us* participants aged ≥18 years with a diagnosis of glaucoma who participated in the *All of Us* HCAUS survey, a voluntary survey offered to all *All of Us* participants. Participants of *All of Us* provided written informed consent at enrollment, which was approved by the *All of Us* IRB. The diagnosis of glaucoma was determined based on *All of Us* EHR condition codes (SNOMED-23986001). Ophthalmic visit adherence was defined based on answers to the HCAUS question about whether the participants have seen any eyecare provider in the prior year ("During the past 12 months, have you seen or talked to an optometrist, ophthalmologist, or eye doctor?"). Only participants providing an answer of "yes" or "no" were included. The participants were then categorized into a "visit group" and a "non-visit group" based on the answer being "yes" and "no", respectively. The flowchart of participants' inclusion and categorization is shown in Figure 1.

Data collection

Demographic, socioeconomic, and healthcare utilization and access data regarding factors potentially relevant to ophthalmic visits were collected from the *All of Us* database. Data from the whole *All of Us* demographic package was included. Based on our prior studies,[14] socioeconomic data collected included: (1) education level, (2) income level, (3) employment status, (4) housing and living situations, (5) marital status, and (6) health insurance status (see Table, Supplemental Digital Content 1). As aforementioned, we included data from the *All of Us* HCAUS, which is a nationwide survey originally derived from the National Health Interview Survey.[15] In addition to the HCAUS, some additional survey items in the *All of Us* Social Determinants of Health Survey (SDHS) relevant to the analysis were also included. From these surveys, data in the following dimensions were included: (1) past-year medical visits, (2) inabilities to afford healthcare, (3) physical or functional disabilities, (4) reasons for delayed healthcare access, (5) language barriers, (6) subjective experience, and (7) social support. Details of HCAUS and SDHS data inclusion are provided supplementarily (see Table, Supplemental Digital Content 2). We analyzed only data items with a response rate higher than 30%, and imputation was performed for all variables with missingness.

Statistical analysis

All statistical analyses were performed in a Python notebook within the Jupyter environment on the *All of Us* Research Workbench.

For comparison of characteristics between visit and non-visit groups, Chi-square testing was performed for categorical variables and two-sample T-tests were performed for continuous variables after verifying assumptions involved in parametric hypothesis testing. Per *All of Us* data sharing policies, any counts < 20 were censored and reported as "< 20" in the results, and the percentage was recoded as "<*x*%", where *x* represents the percentage corresponding to 20 as the numerator.

Logistic regression modeling was performed to identify factors associated with visit adherence. In univariable models, bivariate analyses were performed to calculate the bivariate/unadjusted odds ratios (ORs), 95% confidence intervals (CIs), and P-values of the potential factors associated with better visit adherence (OR > 1) or worse visit adherence (OR < 1; i.e. non-adherence), defined based on past-year encounters with eyecare providers. For the multivariable analysis, bidirectional stepwise feature selection with Akaike information criterion was performed to build the best-performing multivariable model. The potential presence of multicollinearity was checked before the analysis, and no considerable collinearity (coefficient >0.8) was found among the variables. The adjusted ORs (95% CIs, and P-values) were then reported for variables included in the final multivariable model. Statistical significance was defined as a P-value <0.05.

RESULTS

Demographic and socioeconomic characteristics

A total of 5739 glaucoma patients were identified, of which 861 (15%) were categorized into the non-visit group based on reporting not having seen an eyecare provider in the last 12 months. Table 1 shows the demographic and socioeconomic characteristics of the two groups. Participants in the visit group were generally older than the non-visit group (mean [SD] age 69.1 [11.8] vs. 64.8 [12.8] years), with White race (visit vs. non-visit: 74.1% vs. 64.6%) and non-Hispanic/Latino ethnicity (visit vs. non-visit: 91.0% vs. 81.6%) better represented (P< 0.05 for all). More participants in the visit group had an above-college level education (87.7% vs. 80.1%; P<0.05). More visit group participants were also homeowners (70.4% vs. non-visit group: 64.3%). In contrast, the non-visit group reported a higher rate of stable home concern (i.e., housing insecurity) (9.9%, vs. visit-group: 6.8%) and lower income levels (35.3% with income <50k, vs. visit group: 27.9%, see Figure, Supplemental Digital Content 3) (P< 0.05 for both). No difference in insurance status was found between the two groups (P=0.54).

Healthcare access and utilization characteristics

Table 2 shows the healthcare access and utilization characteristics that were significantly different between the two groups. Due to space constraints, most data items that did not reach statistical significance were not shown. Eye care visits/utilization followed overall medical visit utilization patterns: more participants in the visit group reported past-year

visits to either a general doctor (94%) or a specialist (65%), as compared to the non-visit group (89% and 49.3%) (P < 0.05 for both). The non-visit group reported greater difficulty in affording healthcare services, including follow-up care, specialist visit, and medication, in all questions (6.4–13.4%, vs. visit group: 4.2–9.0%) (P < 0.05 for all). Overall, there were no significant differences between the two groups regarding the presence of physical or functional inconvenience, except for the frequency of having problems learning about medical conditions. The non-visit group tended to report greater difficulty in understanding written information about their medical condition (P=0.04; Table 2). The non-visit group also reported higher rates of delayed healthcare access due to not being able to get time off work (6.7%, vs. visit group: 4.4%), not having transportation (7.8%, vs. visit group: 5.7%), not being able to afford co-pays (8.0%, vs. visit group: 4.0%) or deductibles (9.3%, vs. visit group: 4.4%), and being nervous about seeing a healthcare provider (8.8%, vs. visit group: 6.7%) (P< 0.05 for all). For questions regarding language barriers, subjective experiences, and social support, most answers did not differ between the two groups. However, more participants in the non-visit group expressed that it was at least somewhat important that the healthcare providers understand or are similar to them in race/ethnicity, gender, religion/beliefs, or native language (57.4% vs. visit group: 53.0%) (P< 0.05).

Factors associated with ophthalmic visit non-adherence

Table 3 summarizes the potential factors associated with better or worse ophthalmic visit adherence in glaucoma based on multivariable modeling. In the best-performing multivariable model, older age (adjusted OR [95%CI] 1.02 [1.01, 1.03]), higher education (OR 1.25 [1.13, 1.40]), higher income level (OR 1.06 [1.01, 1.11]), and not employed for wages (OR 1.28 [1.08, 1.53]) were associated with greater odds of eye care visit adherence (P < 0.05 for all). Visit adherence was also positively associated with having any past-year general visit (OR 1.90 [1.46, 2.46]) or specialist visit (OR 1.68 [1.43, 1.97]) and an increased number of past-year general (OR 1.08 [1.02, 1.14]) or specialist visits (OR 1.14 [1.06, 1.24]) (P < 0.05 for all). On the other hand, visit non-adherence was associated with reporting taking less medication to save money (OR 0.62 [0.40, 0.97]) and delaying/avoiding seeing healthcare providers because of dissimilarity (OR 0.84 [0.71, 0.99]) (P<0.05 for both). Figure 2 summarizes the mean (95% CI) ORs of factors showing significant association with ophthalmic visit adherence in the multivariable model.

DISCUSSION

Using a nationwide dataset, this study examined social and healthcare utilization factors associated with ophthalmic visit non-adherence among glaucoma patients. One strength of our study was the diverse enrollment of the *All of Us* database,[16] which included populations that are often less represented in biomedical research. Additionally, the HCAUS data include patient responses to various questions spanning across dimensions such as healthcare affordability, subjective perception of healthcare services and self-reported reasons impeding healthcare access. This enabled a comprehensive investigation of the more direct and potentially modifiable/intervenable causes of barriers to ophthalmic visits, rather than simply demographic characteristics alone. Our study may not only complement prior studies on other aspects of patient adherence in glaucoma,[5–7] but may also provide insights

into future measures by physicians or policy makers to improve ophthalmic visit adherence and overall eyecare utilization.

In this study, the definition for visit adherence was self-reporting having at least one visit with eyecare providers in the prior 12 months. This corresponds to the minimum follow-up frequency advised for stable glaucoma by the practice guidelines.[4] For patients with progressive or more advanced glaucoma, more frequent monitoring was recommended. In the study by Stagg et al.,[10] as high as 75% of glaucoma patients received <1 VF per year. While the observed rate of visit non-adherence was lower in our study (approximately 15%), the number was still concerning. Notably, we cannot rule out the possibility of an underestimated non-adherence rate due to selection bias, considering the *All of Us* participants might be more involved in healthcare, and response bias, since some participants might provide false positive response.[17] Most importantly, such high prevalence of visit non-adherence, even when assessed using a relatively loose criterion, indicates this is a critical issue in glaucoma care deserving of more attention.

Using the HCAUS data, we were able to investigate prior behaviors of the patients that are potentially predictive of lower healthcare access and utilization, including visit non-adherence. As expected, ophthalmic visit adherence in glaucoma generally follows patterns of past-year general doctors and other specialist visits, given patients who are more adherent to ophthalmic visits are also more likely to face less barriers to healthcare in general. Amongst all variables, having past-year general medical visit was most predictive of a better ophthalmic visit adherence. Clinically, this indicates information about the patients' past visit history or treatment adherence, not limited to that in ophthalmology, may help to assess the risk of visit non-compliance in glaucoma. Moreover, recommendation of further ophthalmic examination by primary care physicians may help to improve ophthalmic visit adherence and encourage access and utilization of eyecare.

The HCAUS also enabled an in-depth investigation of self-reported reasons and the more direct causes of low healthcare utility and medical non-adherence, which distinguishes this study from other works.[18–20] While our findings also support the general correlation between a higher socioeconomic status and better patient adherence, using the HCAUS data, we further showed that, in the specific context of glaucoma follow-up, financial concerns were prominent and directly related to poor ophthalmic visit adherence. Significantly higher rates of patients in the non-visit group reported having difficulty in affording healthcare services, as well as having voluntarily delayed or missed healthcare to save money. Notably, the behavior of cost saving on medication was most predictive of visit non-adherence. While prior studies have suggested the cost of medication as an existing healthcare barrier in various diseases,[21–23] this finding is of particular concern in the management of glaucoma, given topical medication is the mainstay of treatment. Furthermore, the non-visit group expressed greater difficulties in getting time off work or arranging transportation to access healthcare, suggesting the inconvenience and lack of support from the patients' work or living environment may be another issue impeding visit adherence. Although these factors are potentially modifiable, whether they are partially financially driven (e.g. cannot get time off work due to possible salary decrease and/or fear of job loss) remains to be examined.

The aforementioned results add to the existing evidence suggesting a disparity in eyecare utilization associated with the patients' financial ability,[24–26] and that a worse affordability (higher cost) of eyecare may further increase this disparity by constituting barriers to medical adherence.[27–29] In a study by Greig et al., disparity in income was a risk factor driving appointment no-shows in patients with chronic eye disease.[25] Of note, a relatively high rate of our patient cohort was medically insured and had above-average income and education, suggesting the proportion of patients from more vulnerable backgrounds might be limited in this study. Thus, the ophthalmic visit non-adherence and eyecare barriers among a broader population may be even more pronounced, which underlines the importance of our analysis. To improve visit adherence and eyecare utilization in glaucoma, efforts to mitigate such financial barriers should be explored on both individual and systemic levels.[30] Although our results indicate the need for policy makers to review eyecare affordability, a more personalized, multi-targeted approach that help alleviate the financial burden and incentivize eyecare access should also be considered. For instance, the arrangement of free transportation and the option of flexible payment plans. Alternatively, the integration of telemedicine, which allows a more flexible appointment scheduling without geographic barriers, may also promote eyecare access in patients having difficulties attending clinic in person or during working hours, especially in the COVID era.[31–33]

Although often neglected, some patient-oriented and subjective factors that may affect visit adherence were also examined in our study. Interestingly, more participants in the non-visit group found the demographic or cultural background of their healthcare providers to be important, and a noticeable rate of glaucoma patients reported delaying or avoiding seeing healthcare provides due to background dissimilarity. While studies on ophthalmic patients were limited,[34] it is increasingly recognized that race and religion discordance between healthcare providers and patients may contribute to barriers of care, posing challenges for the clinicians to provide competent care and establish patient-health professional rapport.[35–37] A good patient-physician relationship is often beneficial for patient outcome,[38, 39] including in glaucoma.[40] Although increasing representation in ophthalmology remains a systemic problem requiring efforts by governmental or professional organizations,[41–45] there are other means to mitigate such barriers. These include offering alternative language options or interpreter assistance in the clinic and providing training on cultural competence of care to the clinical staffs. Similarly, there are various approaches to address other subjective concerns more prevalent in the non-visit group, including nervousness seeing healthcare providers or inabilities in understanding medical information. Using lay-man terms or visual aids in explaining ophthalmic conditions, offering printed information in alternative language options, and providing counseling on at-home eyecare can be practiced to achieve this goal.

This study has a few limitations. Potential biases of the HCAUS and of our study cohort have been mentioned above,[17] both of which suggest more prominent healthcare barriers and disparity in general US glaucoma population. Moreover, as the current definition for ophthalmic visit adherence did not consider the higher visit frequency required in more severe glaucoma, a worse real-world adherence should be anticipated. Additionally, we could not analyze the potential impact of patient history of ophthalmic surgery. Surgical history was not available in the HCAUS, and survey responses regarding eye care visits

could not be linked to procedure codes in EHR data due to date-shifting procedures in the de-identification and data transformation processes conducted by *All of Us*. Some other common problems encountered in big data studies based on questionnaires include missing data and non-response, selection, and sampling biases.[17, 46] Nonetheless, the *All of Us* program has tried to minimize them by ensuring the confidentiality of survey responses and a diverse enrollment, and a good survey response rates were observed for most questions included in this study.

In conclusion, lower education and income levels, cost saving on medications, fewer past-year medical/specialist visits, and concerns regarding dissimilarity with healthcare providers were risk factors for ophthalmic visit non-adherence among glaucoma patients in this diverse nationwide cohort. These results provide insights into direct causes of under-utilization of eyecare, as well as strategies to improve real-world ophthalmic visit adherence. Furthermore, they may help to identify glaucoma patients who might benefit from outreach or additional counseling.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

ACKNOWLEDGEMENT

The *All of Us* Research Program is supported by the National Institutes of Health, Office of the Director: Regional Medical Centers: 1 OT2 OD026549; 1 OT2 OD026554; 1 OT2 OD026557; 1 OT2 OD026556; 1 OT2 OD026550; 1 OT2 OD026552; 1 OT2 OD026553; 1 OT2 OD026548; 1 OT2 OD026551; 1 OT2 OD026555; IAA #: AOD 16037; Federally Qualified Health Centers: HHSN 263201600085U; Data and Research Center: 5 U2C OD023196; Biobank: 1 U24 OD023121; The Participant Center: U24 OD023176; Participant Technology Systems Center: 1 U24 OD023163; Communications and Engagement: 3 OT2 OD023205; 3 OT2 OD023206; and Community Partners: 1 OT2 OD025277; 3 OT2 OD025315; 1 OT2 OD025337; 1 OT2 OD025276. In addition, the *All of Us* Research Program would not be possible without the partnership of its participants.

Funding sources:

This work is supported by National Institutes of Health/National Eye Institute Grants (P30EY022589, UL1TR001442, DP5OD029610, R01MD014850), University of California Tobacco Related Disease Research Program (T31IP1511), and an unrestricted grant from Research to Prevent Blindness (New York, NY). The sponsor or funding organization had no role in the design or conduct of this research.

Financial Disclosure:

Robert N. Weinreb is a consultant of Abbvie, Aerie Pharmaceuticals, Alson, Allergan, Amydis, Equinox, Eyenovia, Iantrek, IOPtic, Implandata, Nicox, Santen and Topcon. Robert N. Weinreb reported instrujents for research from Heidelberg Engineering, Carl Zeiss Meditec, Centervue, and Topcon; grants from the National Eye Institute and National Institute of Minority Health Disparities and Research ro Prevent Blindness: patents from Toromedes, Carl Zeiss Meditec to UCSD; founder of Toromedes; all outside the submitted work. No other disclosures were reported. Sally L. Baxter reported grants from the National Institutes of Health during the study conduction, grants from Research to Prevent Blindness and the University of California; personal fees from VoxelCloud and iVista Medical Education; equipment from Optomed and Topcon; and nonfinancial support from the University of California Office of the President Grant outside the submitted work. No other disclosures were reported.

REFERENCES

1. Weinreb RN, Aung T, Medeiros FA. The pathophysiology and treatment of glaucoma: a review. Jama. May 14 2014;311(18):1901–11. doi:10.1001/jama.2014.3192 [PubMed: 24825645]

2. Rao HL, Kumar AU, Babu JG, et al. Relationship between severity of visual field loss at presentation and rate of visual field progression in glaucoma. Ophthalmology. Feb 2011;118(2):249–53. doi:10.1016/j.ophtha.2010.05.027 [PubMed: 20728941]

3. Parikh RS, Parikh SR, Navin S, et al. Practical approach to medical management of glaucoma. Indian J Ophthalmol. May-Jun 2008;56(3):223–30. doi:10.4103/0301-4738.40362 [PubMed: 18417824]

4. Prum BE Jr., Rosenberg LF, Gedde SJ, et al. Primary Open-Angle Glaucoma Preferred Practice Pattern(®) Guidelines. Ophthalmology. Jan 2016;123(1):P41–p111. doi:10.1016/j.ophtha.2015.10.053 [PubMed: 26581556]

5. Muir KW, Lee PP. Glaucoma medication adherence: room for improvement in both performance and measurement. Arch Ophthalmol. Feb 2011;129(2):243–5. doi:10.1001/archophthalmol.2010.351 [PubMed: 21320975]

6. Newman-Casey PA, Robin AL, Blachley T, et al. The Most Common Barriers to Glaucoma Medication Adherence: A Cross-Sectional Survey. Ophthalmology. Jul 2015;122(7):1308–16. doi:10.1016/j.ophtha.2015.03.026 [PubMed: 25912144]

7. Robin A, Grover DS. Compliance and adherence in glaucoma management. Indian J Ophthalmol. Jan 2011;59 Suppl(Suppl1):S93–6. doi:10.4103/0301-4738.73693 [PubMed: 21150041]

8. Ramakrishnan MS, Yu Y, VanderBeek BL. Association of Visit Adherence and Visual Acuity in Patients With Neovascular Age-Related Macular Degeneration: Secondary Analysis of the Comparison of Age-Related Macular Degeneration Treatment Trial. JAMA Ophthalmology. 2020;138(3):237–242. doi:10.1001/jamaophthalmol.2019.4577 [PubMed: 32027349]

9. Rose AJ, Timbie JW, Setodji C, et al. Primary Care Visit Regularity and Patient Outcomes: an Observational Study. J Gen Intern Med. Jan 2019;34(1):82–89. doi:10.1007/s11606-018-4718-x

10. Stagg BC, Stein JD, Medeiros FA, et al. The Frequency of Visual Field Testing in a US Nationwide Cohort of Individuals with Open-Angle Glaucoma. Ophthalmology Glaucoma. 2022/05/20/ 2022;doi:10.1016/j.ogla.2022.05.002

11. Carrillo JE, Carrillo VA, Perez HR, et al. Defining and targeting health care access barriers. J Health Care Poor Underserved. May 2011;22(2):562–75. doi:10.1353/hpu.2011.0037 [PubMed: 21551934]

12. Jacobs B, Ir P, Bigdeli M, et al. Addressing access barriers to health services: an analytical framework for selecting appropriate interventions in low-income Asian countries. Health Policy and Planning. 2011;27(4):288–300. doi:10.1093/heapol/czr038 [PubMed: 21565939]

13. Kullgren JT, McLaughlin CG, Mitra N, et al. Nonfinancial barriers and access to care for U.S. adults. Health Serv Res. Feb 2012;47(1 Pt 2):462–85. doi:10.1111/j.1475-6773.2011.01308.x [PubMed: 22092449]

14. Acuff KD A; Radha-Saseendrakumar B; Wu J-H; Weinreb RN; Baxter SL Associations between socioeconomic factors and visit adherence among patients with glaucoma in nationwide All of Us Research Program. Ophthlamology Glaucoma.

15. Statistics NCfH. National Health Interview Survey, 2021. 2021;

16. The “All of Us” Research Program. New England Journal of Medicine. 2019;381(7):668–676. doi:10.1056/NEJMsr1809937 [PubMed: 31412182]

17. Sedgwick P Questionnaire surveys: sources of bias. Bmj. 2013;347

18. Dreer LE, Girkin C, Mansberger SL. Determinants of medication adherence to topical glaucoma therapy. J Glaucoma. Apr-May 2012;21(4):234–40. doi:10.1097/IJG.0b013e31821dac86 [PubMed: 21623223]

19. Musa I, Bansal S, Kaleem MA. Barriers to Care in the Treatment of Glaucoma: Socioeconomic Elements That Impact the Diagnosis, Treatment, and Outcomes in Glaucoma Patients. Current Ophthalmology Reports. 2022/09/01 2022;10(3):85–90. doi:10.1007/s40135-022-00292-6 [PubMed: 35911786]

20. Acuff K, Delavar A, Saseendrakumar BR, et al. Associations between socioeconomic factors and visit adherence among patients with glaucoma in the nationwide All of Us Research Program. Ophthalmology Glaucoma. 2023/02/04/ 2023;doi:10.1016/j.ogla.2023.01.008

21. Delavar A, Radha Saseendrakumar B, Weinreb RN, et al. Racial and Ethnic Disparities in Cost-Related Barriers to Medication Adherence Among Patients With Glaucoma Enrolled

in the National Institutes of Health All of Us Research Program. JAMA Ophthalmology. 2022;140(4):354–361. doi:10.1001/jamaophthalmol.2022.0055 [PubMed: 35238904]

22. Iuga AO, McGuire MJ. Adherence and health care costs. Risk Manag Healthc Policy. 2014;7:35–44. doi:10.2147/rmhp.S19801 [PubMed: 24591853]
23. Gupta D, Ehrlich JR, Newman-Casey PA, et al. Cost-Related Medication Nonadherence in a Nationally Representative US Population with Self-Reported Glaucoma. Ophthalmol Glaucoma. Mar-Apr 2021;4(2):126–130. doi:10.1016/j.ogla.2020.08.010 [PubMed: 32841767]
24. Zhang X, Beckles GL, Chou C-F, et al. Socioeconomic disparity in use of eye care services among US adults with age-related eye diseases: National Health Interview Survey, 2002 and 2008. JAMA ophthalmology. 2013;131(9):1198–1206. [PubMed: 23868137]
25. Greig EC, Gonzalez-Colaso R, Nwanyanwu K. Racial, Ethnic, and Socioeconomic Disparities Drive Appointment No-Show in Patients with Chronic Eye Disease. Journal of Racial and Ethnic Health Disparities. 2022/07/21 2022;doi:10.1007/s40615-022-01363-x
26. Wu J-H, Lin S, Moghimi S. Big data to guide glaucoma treatment. Taiwan Journal of Ophthalmology. July 28, 2023. doi:10.4103/tjo.TJO-D-23-00068
27. Rim TH, Choi M, Yoon JS, et al. Sociodemographic and health behavioural factors associated with access to and utilisation of eye care in Korea: Korea Health and Nutrition Examination Survey 2008–2012. BMJ Open. 2015;5(7):e007614. doi:10.1136/bmjopen-2015-007614
28. Gupta P, Majithia S, Fenwick EK, et al. Rates and Determinants of Eyecare Utilization and Eyeglass Affordability Among Individuals With Visual Impairment in a Multi-Ethnic Population-Based Study in Singapore. Translational Vision Science & Technology. 2020;9(5):11–11. doi:10.1167/tvst.9.5.11
29. Varadaraj V, Frick KD, Saaddine JB, et al. Trends in Eye Care Use and Eyeglasses Affordability: The US National Health Interview Survey, 2008–2016. JAMA Ophthalmol. Apr 1 2019;137(4):391–398. doi:10.1001/jamaophthalmol.2018.6799 [PubMed: 30676634]
30. Sommers BD, Maylone B, Blendon RJ, et al. Three-year impacts of the Affordable Care Act: improved medical care and health among low-income adults. Health Affairs. 2017;36(6):1119–1128. [PubMed: 28515140]
31. Lam PY, Chow SC, Lai JSM, et al. A review on the use of telemedicine in glaucoma and possible roles in COVID-19 outbreak. Surv Ophthalmol. Nov-Dec 2021;66(6):999–1008. doi:10.1016/j.survophthal.2021.03.008 [PubMed: 33811912]
32. Gan K, Liu Y, Stagg B, et al. Telemedicine for Glaucoma: Guidelines and Recommendations. Telemed J E Health. Apr 2020;26(4):551–555. doi:10.1089/tmj.2020.0009 [PubMed: 32209001]
33. Maa AY, Medert CM, Lu X, et al. Diagnostic Accuracy of Technology-based Eye Care Services: The Technology-based Eye Care Services Compare Trial Part I. Ophthalmology. Jan 2020;127(1):38–44. doi:10.1016/j.ophtha.2019.07.026 [PubMed: 31522900]
34. Chan AX, McDermott Iv JJ, Lee TC, et al. Associations between healthcare utilization and access and diabetic retinopathy complications using All of Us nationwide survey data. PLoS One. 2022;17(6):e0269231. doi:10.1371/journal.pone.0269231 [PubMed: 35704625]
35. Swihart DL, Yarrarapu SNS, Martin RL. Cultural Religious Competence In Clinical Practice. StatPearls. StatPearls Publishing
36. Chipidza FE, Wallwork RS, Stern TA. Impact of the Doctor-Patient Relationship. Prim Care Companion CNS Disord. 2015;17(5)doi:10.4088/PCC.15f01840
37. Flores G and Culture the patient-physician relationship: achieving cultural competency in health care. The Journal of pediatrics. 2000;136(1):14–23. [PubMed: 10636968]
38. Olaisen RH, Schluchter MD, Flocke SA, et al. Assessing the Longitudinal Impact of Physician-Patient Relationship on Functional Health. The Annals of Family Medicine. 2020;18(5):422–429. doi:10.1370/afm.2554 [PubMed: 32928758]
39. Farin E, Gramm L, Schmidt E. The patient–physician relationship in patients with chronic low back pain as a predictor of outcomes after rehabilitation. Journal of behavioral medicine. 2013;36(3):246–258. [PubMed: 22476813]
40. RIFFENBURGH RS. Doctor-Patient Relationship in Glaucoma Therapy. Archives of Ophthalmology. 1966;75(2):204–206. doi:10.1001/archopht.1966.00970050206011 [PubMed: 5903806]

41. Salsberg E, Richwine C, Westergaard S, et al. Estimation and Comparison of Current and Future Racial/Ethnic Representation in the US Health Care Workforce. JAMA Network Open. 2021;4(3):e213789–e213789. doi:10.1001/jamanetworkopen.2021.3789 [PubMed: 33787910]

42. Aguwa UT, Srikumaran D, Brown N, et al. Improving Racial Diversity in the Ophthalmology Workforce: A Call to Action for Leaders in Ophthalmology. Am J Ophthalmol. Mar 2021;223:306–307. doi:10.1016/j.ajo.2020.10.007 [PubMed: 33393483]

43. Yashadhana A, Clarke NA, Zhang JH, et al. Gender and ethnic diversity in global ophthalmology and optometry association leadership: a time for change. Ophthalmic and Physiological Optics. 2021;41(3):623–629. [PubMed: 33650712]

44. Olivier MMG, Forster S, Carter KD, et al. Lighting a Pathway: The Minority Ophthalmology Mentoring Program. Ophthalmology. 2020;127(7):848–851. doi:10.1016/j.ophtha.2020.02.021 [PubMed: 32564810]

45. Valantine HA, Lund PK, Gammie AE. From the NIH: A systems approach to increasing the diversity of the biomedical research workforce. CBE—Life Sciences Education. 2016;15(3):fe4. [PubMed: 27587850]

46. Kaplan RM, Chambers DA, Glasgow RE. Big data and large sample size: a cautionary note on the potential for bias. Clinical and translational science. 2014;7(4):342–346. [PubMed: 25043853]

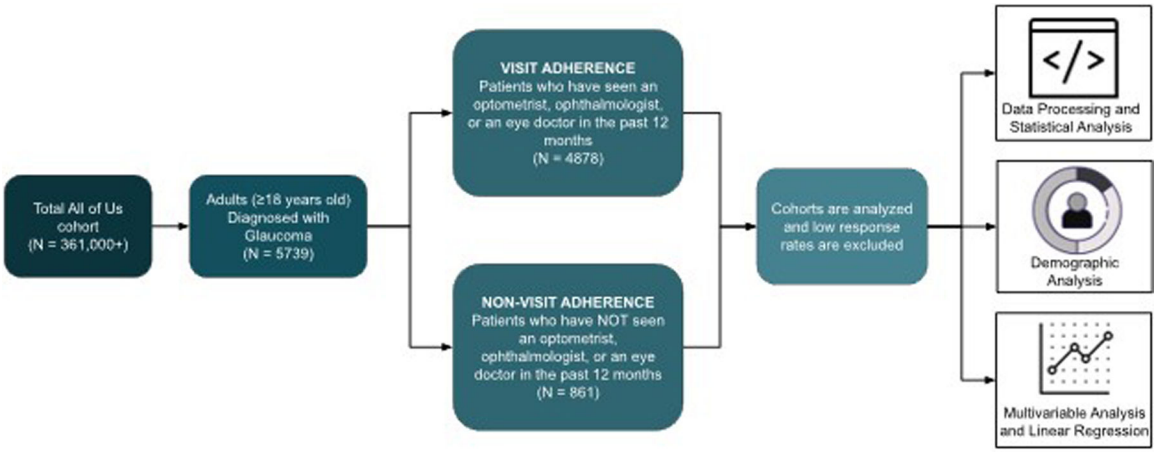

Figure 1.

Flowchart summarizing the process of participants' inclusion, cohort categorization and data analysis

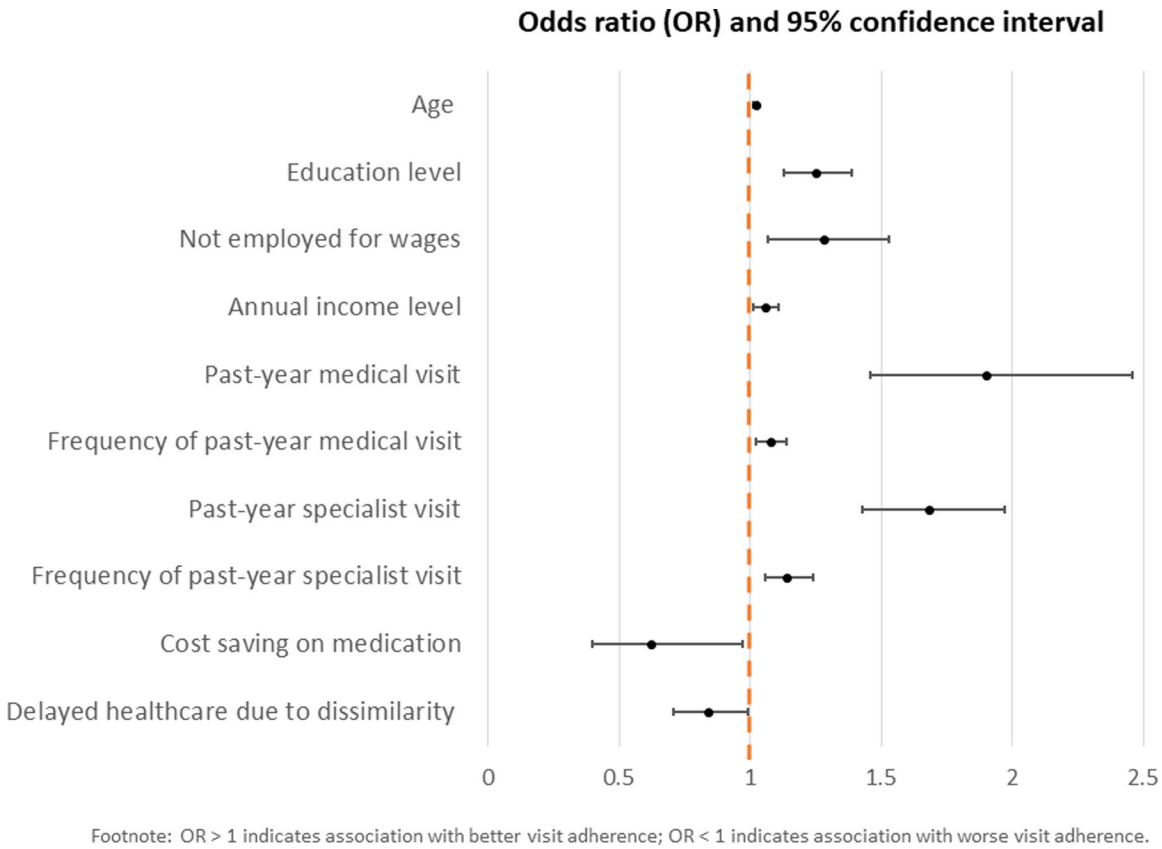

Figure 2.

Forest plot showing the mean (95% confidence interval) odds ratio of factors demonstrating significant association with ophthalmic visit adherence in the multivariable model

Table 1.

Demographic and socioeconomic characteristics of *All of Us* participants with glaucoma based on self-reported eyecare visits in the prior year

	Glaucoma participants (N = 5739)		
	Visit group, N = 4878 (85 %)	**Non-visit group, N = 861 (15 %)**	**P-value**
Age (Mean, SD), years	69.1 (11.8)	64.8 (12.8)	**<0.001**
Gender (n, %)			0.23
Male	1978 (40.5%)	330 (38.3%)	
Female	2900 (59.5%)	531 (61.7%)	
Self-Reported Race (n, %)			**<0.001**
Black or African American	606 (12.4%)	137 (15.9%)	
White	3616 (74.1%)	556 (64.6%)	
Asian	158 (3.2%)	38 (4.4%)	
Other	498 (10.2%)	130 (15.1%)	
Self-Reported Ethnicity (n, %)			**<0.001**
Not Hispanic or Latino	4446 (91.1%)	746 (86.6%)	
Hispanic or Latino	432 (8.9%)	115 (13.4%)	
Education level (n, %)			**<0.001**
College graduate or advanced degree	3107 (63.7%)	461 (53.5%)	
Highest grade: College year 1–3	1173 (24.0%)	229 (26.6%)	
Highest grade: 12 or GED	426 (8.7%)	115 (13.4%)	
Less than a high school degree/equivalence or NA	139 (3.5%)	56 (6.5%)	
Marital status (n, %)			**0.002**
Divorced	749 (15.4%)	134 (15.6%)	
Living with partner	164 (3.4%)	38 (4.4%)	
Married	2784 (57.1%)	442 (51.3%)	
Never married	658 (13.5%)	158 (18.4%)	
Separated	78 (1.6%)	<20 (<2.3%)	
Widowed	398 (8.2%)	66 (7.7%)	
NA	47 (1.0%)	<20 (<2.3%)	
Housing situations (n, %)			**0.003**
Home owner	3433 (70.4%)	554 (64.3%)	
Home renter	1165 (23.9%)	249 (28.9%)	
Other arrangement or NA	280 (5.7%)	58 (6.7%)	
Stable home concern over past 6 months (n, %)			**0.002**
Yes	334 (6.8%)	85 (9.9%)	
No or NA	4544 (93.2%)	776 (90.2%)	
Employment status (n, %)			**<0.001**
Not currently employed for wages	3192 (65.4%)	481 (55.9%)	

	Glaucoma participants (N = 5739)		
	Visit group, N = 4878 (85 %)	**Non-visit group, N = 861 (15 %)**	**P-value**
Employed for wages/self-employed or NA	1686 (34.6%)	381 (44.1%)	
Annual income (n, %) in USD			**<0.001**
> 200k	491 (10.1%)	64 (7.4%)	
100k-200k	1032 (21.2%)	178 (20.7%)	
50k-100k	1349 (27.6%)	199 (23.2%)	
25k-50k	737 (15.1%)	142 (16.5%)	
Less than 25k	622 (12.8%)	162 (18.8%)	
NA	647 (13.3%)	116 (13.5%)	
Health insurance (n, %)			0.54
Any health insurance	4777 (98.0%)	842 (97.8%)	
Not insured	58 (1.2%)	<20 (<2.3%)	
NA	43 (0.9%)	<20 (<2.3%)	

Footnote: Per *All of Us* data statistics and dissemination policy, data collapse has been performed across cells for variables initially containing a single cell with a count of <20, in order to prevent data triangulation and deduction.

Table 2.

Healthcare access and utility characteristics of visit and non-visit groups

	Visit group, N = 4878 (85 %)	**Non-visit group, N = 861 (15 %)**	**P-value**
Past-year medical visit			**<0.001**
Past-year general doctor visit (N, %)			
Yes	4584 (94.0%)	767 (89.0%)	
No or NA	294 (6.0%)	94 (10.9%)	
Total number of past-year general doctor visit (N, %)			**0.005**
1–3	2452 (49.7%)	459 (53.3%)	
4–7	1364 (27.9%)	195 (22.7%)	
8–12	421 (8.7%)	64 (7.4%)	
13 or more	295 (6.0%)	32 (3.7%)	
NA	373 (7.7%)	111 (12.9%)	
Past-year specialist visit (N, %)			**<0.001**
Yes	3172 (65.0%)	424 (49.3%)	
No	1399 (28.7%)	382 (44.4%)	
NA	307 (6.3%)	55 (6.4%)	
Total number of past-year specialist visit (N, %)			0.26
1–3	1864 (38.2%)	270 (31.4%)	
4–7	884 (18.1%)	100 (11.6%)	
8 or more	354 (7.3%)	41 (4.7%)	
NA	1776 (36.4%)	450 (52.3%)	
Inabilities to afford healthcare			
Prescription medicines (N, %)			**<0.001**
Yes	441 (9.0%)	113 (13.1%)	
No or NA	4437 (91.0%)	748 (86.9%)	
Eyeglasses (N, %)			**<0.001**
Yes	396 (8.1%)	115 (13.4%)	
No	4097 (84.0%)	687 (79.8%)	
NA	385 (7.9%)	59 (6.9%)	
Follow-up care (N, %)			**<0.001**
Yes	204 (4.2%)	62 (7.2%)	
No	4242 (87.0%)	733 (85.1%)	
NA	432 (8.9%)	66 (7.7%)	
Specialist (N, %)			**<0.001**
Yes	261 (5.4%)	80 (9.3%)	
No	4198 (86.1%)	717 (83.3%)	
NA	419 (8.6%)	64 (7.4%)	
Delayed filling a prescription to save money (N, %)			**<0.001**

	Visit group, N = 4878 (85 %)	Non-visit group, N = 861 (15 %)	P-value
Yes	375 (7.7%)	105 (12.2%)	
No	4400 (90.2%)	732 (85.0%)	
NA	103 (2.1%)	24 (2.8%)	
Skipped medication doses to save money (N, %)			**<0.001**
Yes	265 (5.4%)	76 (8.8%)	
No or NA	4613 (94.6%)	785 (91.2%)	
Took less medication to save money (N, %)			**<0.001**
Yes	270 (5.5%)	87 (10.1%)	
No or NA	460558 (93.4%)	774 (89.9%)	
Used alternative therapies to save money (N, %)			**0.008**
Yes	207 (4.2%)	55 (6.4%)	
No	4354 (89.3%)	755 (87.7%)	
NA	317 (6.5%)	51 (5.9%)	
Physical or functional inconvenience			
How often do you have problems learning about your medical condition because of difficulty understanding written information? (N, %)			**0.037**
Never	3728 (76.4%)	612 (71.1%)	
Occasionally	741 (15.2%)	155 (18.0%)	
Sometimes	270 (5.5%)	62 (7.2%)	
Often	44 (0.9%)	<20 (<2.3%)	
Always	41 (0.8%)	<20 (<2.3%)	
NA	54 (1.1%)	<20 (<2.3%)	
Reasons for delayed healthcare access			
Couldn’t get time off work (N, %)			**0.003**
Yes	213 (4.4%)	58 (6.7%)	
No	4430 (90.8%)	757 (87.9%)	
NA	235 (4.8%)	46 (5.3%)	
Didn’t have transportation (N, %)			**0.015**
Yes	278 (5.7%)	67 (7.8%)	
No	4516 (92.6%)	765 (88.7%)	
NA	84 (1.7%)	30 (3.5%)	
Couldn’t afford the co-pay (N, %)			**<0.001**
Yes	196 (4.0%)	69 (8.0%)	
No	4274 (87.6v)	714 (82.9%)	
NA	408 (8.4%)	78 (9.1%)	
Had to pay out of pocket for some or all of the procedure (N, %)			**<0.001**
Yes	481 (9.9%)	122 (14.2%)	
No	3945 (80.9%)	652 (75.7%)	
NA	452 (9.3%)	87 (10.1%)	

	Visit group, N = 4878 (85 %)	**Non-visit group, N = 861 (15 %)**	**P-value**
Deductible was too high/or could not afford the deductible (N, %)			**<0.001**
Yes	214 (4.4%)	80 (9.3%)	
No	4202 (86.1%)	697 (81.0%)	
NA	462 (9.5%)	84 (9.8%)	
Were nervous about seeing a health care provider (N, %)			**0.022**
Yes	326 (6.7%)	76 (8.8%)	
No	4392 (90.0%)	747 (86.8%)	
NA	160 (3.3%)	38 (4.4%)	
Subjective experience			
How important is it to you that your health care providers understand or are similar to you in any of these ways? (N, %)			**0.038**
Not important	1351 (27.7%)	206 (23.9v)	
Slightly important	797 (16.3%)	132 (15.3%)	
Somewhat important	1220 (25.0%)	220 (25.5%)	
Very important	13685 (28.0%)	275 (31.9%)	
NA	145 (3.0%)	28 (3.3%)	
How often have you either delayed or not gone to see health care providers because they were different from you in any of these ways? (N, %)			**<0.001**
None of the time	4380 (89.8%)	719 (83.5%)	
Some of the time	248 (5.1%)	81 (9.4%)	
Most of the time	42 (0.9%)	<20 (<2.3%)	
Always	35 (0.7%)	<20 (<2.3%)	
NA	173 (3.5%)	38 (4.4%)	

Footnote: Per *All of Us* data statistics and dissemination policy, data collapse has been performed across cells for variables initially containing a single cell with a count of <20, in order to prevent data triangulation and deduction.

Table 3.

Potential factors associated with eye care visit adherence among participants with glaucoma in *All of Us*

	Bivariate (Unadjusted) Odds Ratio (95% Confidence Interval)	P-Value*	Multivariable (Adjusted) Odds Ratio (95% Confidence Interval)	P-Value*
Demographic factors				
Age	1.03 (1.02, 1.03)	**<0.001**	1.02 (1.01, 1.03)	**<0.001**
Male gender	1.10 (0.95, 1.27)	0.22	0.88 (0.75, 1.04)	0.13
Race: Black or African American	0.68 (0.56, 0.84)	**<0.001**	1.02 (0.81, 1.30)	0.87
Race: Asian	0.64 (0.45, 0.93)	**0.016**	0.86 (0.59, 1.28)	0.45
Race: Others	0.59 (0.48, 0.73)	**<0.001**	0.83 (0.57, 1.23)	0.34
Ethnicity: Hispanic or Latino	0.63 (0.51, 0.79)	**< 0.001**	1.08 (0.72, 1.62)	0.70
Socioeconomic factors				
Increased education level	1.35 (1.25, 1.47)	**<0.001**	1.25 (1.13, 1.39)	**<0.001**
Marital status: living with partner	0.77 (0.52, 1.16)	0.20	0.88 (0.58, 1.36)	0.55
Marital status: married	1.13 (0.91, 1.38)	0.27	1.05 (0.83, 1.32)	0.71
Marital status: never married	0.75 (0.58, 0.96)	**0.023**	0.87 (0.67, 1.15)	0.33
Marital status: separated	0.93 (0.53, 1.73)	0.81	1.22 (0.68, 2.31)	0.53
Marital status: widowed	1.08 (0.79, 1.49)	0.64	0.93 (0.67, 1.29)	0.64
Home owner	1.12 (0.78, 1.57)	0.53	0.75 (0.50, 1.09)	0.15
Home renter	0.86 (0.59, 1.23)	0.41	0.91 (0.61, 1.32)	0.62
Stable house concern: yes	0.67 (0.53, 0.87)	**0.002**	0.93 (0.70, 1.24)	0.62
Not currently employed for wages	1.50 (1.30, 1.74)	**<0.001**	1.28 (1.07, 1.53)	**0.006**
Increased annual income level	1.09 (1.06, 1.13)	**<0.001**	1.06 (1.01, 1.11)	**0.013**
Healthcare access and utility factors				
Past-year medical visit: yes	2.13 (1.65, 2.72)	**<0.001**	1.90 (1.46, 2.46)	**<0.001**
Increased number of past-year medical visit	1.10 (1.06, 1.16)	**<0.001**	1.08 (1.02, 1.14)	**0.007**
Past-year specialist visit: yes	1.98 (1.71, 2.30)	**<0.001**	1.68 (1.43, 1.97)	**<0.001**
Increased number of past-year specialist visit	1.13 (1.06, 1.21)	**<0.001**	1.14 (1.06, 1.24)	**0.001**
Inability to afford: prescription medicine	0.66 (0.53, 0.82)	**<0.001**	1.03 (0.76, 1.41)	0.83
Inability to afford: eyeglasses	0.57 (0.46, 0.72)	**<0.001**	0.80 (0.61, 1.06)	0.11

J Glaucoma. Author manuscript; available in PMC 2024 December 01.

	Bivariate (Unadjusted) Odds Ratio (95% Confidence Interval)	P-Value*	Multivariable (Adjusted) Odds Ratio (95% Confidence Interval)	P-Value*
Inability to afford: follow-up care	0.56 (0.42, 0.76)	**<0.001**	1.00 (0.67, 1.52)	0.99
Inability to afford: specialist	0.55 (0.43, 0.72)	**<0.001**	0.96 (0.61, 1.42)	0.85
To save money: delayed prescription filling	0.60 (0.48, 0.76)	**<0.001**	0.86 (0.61, 1.24)	0.42
To save money: skipped medication doses	0.59 (0.46, 0.78)	**<0.001**	1.23 (0.79, 1.94)	0.37
To save money: took less medication	0.52 (0.41, 0.68)	**<0.001**	0.62 (0.40, 0.97)	**0.035**
To save money: used alternative therapies	0.65 (0.48, 0.89)	**0.006**	1.12 (0.79, 1.61)	0.55
Have problem learning about medical condition	0.87 (0.80, 0.96)	**0.005**	1.01 (0.91, 1.13)	0.86
Delayed access: time off work	0.63 (0.47, 0.86)	**0.003**	1.07 (0.77, 1.51)	0.70
Delayed access: transportation	0.72 (0.55, 0.95)	**0.018**	0.98 (0.72, 1.35)	0.92
Delayed access: co-pay	0.48 (0.36,0.64)	**<0.001**	0.90 (0.60, 1.35)	0.59
Delayed access: out of pocket fee	0.66 (0.54, 0.82)	**<0.001**	1.05 (0.80, 1.40)	0.73
Delayed access: high deductible	0.45 (0.34, 0.59)	**<0.001**	0.72 (0.49, 1.07)	0.10
Delayed access: nervousness	0.74 (0.57, 0.97)	**0.024**	1.00 (0.76, 1.34)	1.00
Importance of similarity with healthcare provider	0.91 (0.85, 0.97)	**0.003**	1.02 (0.95, 1.09)	0.59
Delayed/Avoid seeking healthcare due to dissimilarity	0.68 (0.59, 0.79)	**<0.001**	0.84 (0.71, 0.99)	**0.035**

*P values of statistically significant variables were shown in bold.