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Glaucoma

Disparities in Visual Field Testing Frequency Among Subjects With Glaucoma

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Purpose: Prior evidence suggests racial disparities in the utilization of visual field testing (VFT) for the diagnosis and monitoring of glaucoma. In this study, we considered the effect of baseline glaucoma severity and socioeconomic disadvantage along with other potential confounders such as test reliability, ancillary tests, and glaucoma surgeries on racial disparity in the frequency of VFT.

Methods: The records of all subjects with a diagnosis of glaucoma who received VFT at an academic, tertiary care facility from January 2018 to December 2021 were accessed. Analysis was performed to compare VFT frequency, the total number of office visits (DoS), and the ratio of VFT frequency to DoS (VFT/DoS) across self-reported races while controlling for sex, age, socioeconomic disadvantage (Area Deprivation Index), VF reliability indicators and baseline mean deviation, optical coherence tomography frequency, and glaucoma surgeries.

Results: Among the 2654 subjects (1515 White, 782 Black, and 357 Asian) included in this study, Black subjects had the worst socioeconomic status and disease severity at baseline. They also experienced a 3% lower VFT/DoS ratio compared to White subjects ($P = 0.031$). Asian subjects had a 5% lower VFT/DoS ratio compared to White subjects ($P = 0.015$).

Discussion: We identified racial disparity in performing VFT in subjects with glaucoma even when multiple confounders were considered. Further investigation is necessary to identify other race-associated factors to work toward reducing racial disparities in VFT.

Translational Relevance: Black and Asian subjects with glaucoma receive fewer VFT per visit compared to White subjects even when considering socioeconomic disadvantage and disease severity.

Introduction

Glaucoma is the leading cause of vision loss, affecting approximately 80 million people worldwide.[1,2] Diagnosing glaucoma at its earliest stages makes it possible to minimize avoidable vision loss and structural damage to the optic nerve. Recognizable symptoms of glaucoma often present at later stages of disease, making it necessary to routinely perform diagnostic testing on patients to monitor for the onset and progression of disease.

Visual field testing (VFT) is a common method used to assess glaucoma and its progression. The effect of the frequency of VFT on the likelihood of detecting glaucoma progression has been investigated in previous literature. Increasing the frequency of VFT leads to earlier detection of glaucoma progression.[3,4] Additionally, in a computerized simulation, Wu et al.[5] observed that the time required to detect a significant

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progression in mean deviation (MD) in eyes with different true rates of visual field loss decreased as the frequency of VFT increased. The authors recommended performing VFT twice per year based on balancing between the time required to detect progression and the economic burden of increased testing.

Despite the significant role that VFT plays in the early detection and monitoring of glaucoma progression, disparities in VFT frequency and outcomes exist between different racial and socioeconomic groups. Previous research analyzing national data has revealed that Black subjects have a significantly lower annual frequency of VFT than White patients,[6–9] leading to disparities in glaucoma management. Health outcomes related to diagnostic VFT indicate that Black and Asian individuals often present with more severe glaucoma compared to White subjects.[8] A study looking at national data from 2017 to 2019 revealed significantly higher odds of late detection of primary open-angle glaucoma among Blacks compared to other races even after adjusting for other sociodemographic factors.[10] In addition, Black subjects have been reported to have a greater number of inpatient and emergency encounters, as well as a disproportionately higher frequency of surgery for the treatment of glaucoma.[9] A reduction in the frequency of VFT may translate to later detection of disease, worse therapeutic outcomes, and an increased likelihood of invasive treatment being required.

Although prior literature suggests the presence of racial disparities in the utilization of VFT for the diagnosis and monitoring of glaucoma, the underlying causes for this disparity are not clearly understood. Exploring the influence of race on the utilization of VFT for the management of glaucoma may help to identify causes of healthcare disparities.[9,11] A previous study using national Medicare data reported that Blacks have less outpatient follow-up and less glaucoma testing than Whites.[9] These differences persisted even after using a crude identifier to stratify for socioeconomic status.

The referral of patients to VFT may be influenced by multiple factors, including socioeconomic considerations, disease severity, the reliability performance of the test, or the utilization of ancillary tests as alternatives to VFT. Another potential contributor for this healthcare utilization disparity is the occurrence of the COVID-19 pandemic. Despite a rapid increase in diagnostic testing for COVID-19 itself, medical screening overall saw a decline during the pandemic. The implementation of regional lockdowns limited in-person office visits. In addition, the Centers for Medicare and Medicaid Services released recommendations to postpone ambulatory screenings, preventive care visits, and other nonurgent services in April 2020.[12] This policy preceded known testing reductions during the pandemic in screenings for colon, breast, and cervical cancer.[13] It is unknown if VFT for glaucoma experienced similar reductions in testing frequency as a consequence of COVID-19 and, if so, whether the reduction in testing was proportionate between races.

In this study, we aimed to examine real-world racial disparities in the frequency of VFT among subjects with glaucoma within a tertiary academic institute. Our cohort encompasses individuals across a wide age range, and we utilized continuous variables to describe disease severity and socioeconomic status, allowing for a sensitive analysis and evaluation of the effect of potential confounders. In a secondary analysis, we assessed the impact of the COVID-19 pandemic on potential VFT disparities. Altogether, this study aimed to gain a deeper understanding of the racial disparity in VFT frequency.

Methods

Study Design

The study was approved by the Institutional Review Board and ethics committee at NYU Grossman School of Medicine. The study followed the tenets of the Declaration of Helsinki and was conducted in compliance with the Health Insurance Portability and Accountability Act (HIPAA). The records of all glaucoma subjects (open-angle, closed-angle, or secondary glaucoma) 18 year of age or older who had VFT at the Department of Ophthalmology, NYU Langone Health, from January 01, 2018, to December 31, 2021, were accessed. For the secondary analysis, to examine whether the COVID-19 pandemic influenced VFT rates, a second set of analyses was performed, with the duration of the study divided into two time periods: January 1, 2018, to December 31, 2019 (pre-COVID), and January 1, 2020, to December 31, 2021 (mid-COVID). The secondary cohort was derived from the original study population and consisted of subjects who had at least one test performed during both the pre-COVID and mid-COVID time periods.

Recoded Information

Sex, age, self-reported race, and Area Deprivation Index (ADI) were captured for each subject. The self-reported race of each subject was categorized as White, Black, or Asian following guidelines established by the National Institutes of Health. For subjects of mixed races, the first listed race was the one used for categorization. All other subjects who did not identify as a race that could be categorized as White, Black, or Asian (i.e., American Indian, Alaskan Native, Native Hawaiian, and Pacific Islander) were excluded from the study because they constitute only a small fraction of the patient population in our practice. The ADI is a socioeconomic disadvantage indicator constructed from the Neighborhood Atlas dataset, which was made available by the Center for Health Disparities Research at the University of Wisconsin School of Medicine and Public Health.[14] This measure is based on factors including income, education, employment, and housing quality and was derived using neighborhood ZIP Codes as a reference. Each subject was assigned a numerical ADI value from 1 to 10, with 10 being ranked as the highest level of socioeconomic disadvantage. Additionally, baseline Humphrey Field Analyzer (ZEISS, Dublin, CA) MD values were collected as an indicator of disease severity. To determine VFT frequency, the total number of office visits (DoS) and the ratio of VFT frequency to the total number of office visits (VFT/DoS) were recorded. To account for potential confounders associated with the rate of VFT, the frequencies of optical coherence tomography (OCT) imaging visits, selective laser trabeculoplasty (SLT) procedures, and glaucoma surgeries were recorded. In instances of low VFT reliability, clinicians may opt for OCT instead of VFT. SLT and glaucoma surgeries could impact the testing rate, as initial postoperative visits often concentrate on clinical examination without utilizing VFT. We also documented VFT reliability parameters, such as false-positive, false-negative, and fixation loss rates, which could introduce confounding factors into the VFT rate analysis.

Statistical Analysis

One-way analysis of variance (ANOVA), Pearson's χ^2 test, and Kruskal–Wallis rank sum tests were used to identify statistically significant differences for all study parameters as a function of self-reported race. After the identification of significant parameters that may have a confounding effect, analysis of covariance (ANCOVA) was used to compare VFT frequency, DoS, and VFT/DoS ratio as a function of race while adjusting for these variables. For the secondary analyses, the differences in VFT frequency, DoS, and VFT/DoS ratio from pre-COVID to mid-COVID were compared among the races. Tukey's post hoc test was performed for pairwise comparisons between races. $P < 0.05$ was considered statistically significant. R 3.3.2 (R Foundation for Statistical Computing, Vienna, Austria) was used for the statistical analysis.

Results

Racial Differences in VFT

The records of 2654 subjects (1515 White, 782 Black, and 357 Asian) were included for analysis. There were statistically significant differences among the racial groups for all tested variables (Table 1). Black subjects had the highest average level of socioeconomic disadvantage and the worst disease severity at baseline with the highest number of clinical visits per subject; however, when considering the frequency of VFT per the number of visits, Black subjects had the lowest rate. White subjects had the highest proportion of OCTs and SLT, and Black subjects had the highest proportion of glaucoma surgeries. White subjects presented with ADIs and baseline MDs similar to those of the Asian subjects but lower than Black subjects, but White subjects were also observed to have a greater VFT/DoS ratio than Black subjects.

Estimated differences in the VFT/DoS ratio between pairs of races were calculated after controlling for sex, age, ADI, baseline MD, VFT false positives, VFT false negatives, VFT fixation loss, OCT frequency, and SLT and glaucoma surgery frequency (Table 2). When comparing VFT/DoS ratios among the races, there was a significant overall difference ($P = 0.004$). Between race pairs, White subjects had a 3% higher VFT/DoS ratio compared to Black subjects ($P = 0.031$) and a 5% higher VFT/DoS ratio compared to Asian subjects ($P = 0.015$). When examining this change as a percentage reduction from the VFT/DoS ratios in Whites, Blacks showed a 7% decrease (95% confidence interval [CI], 1.5–12.0), and Asians demonstrated an 11% reduction (95% CI, 2.9–16.9). No significant difference was detected between Asian and Black subjects.

Effect of COVID-19 on VFT Disparities

A secondary cohort limited to 1639 subjects who had at least one test performed during both the pre-COVID and mid-COVID time periods (956 White, 479 Black, and 204 Asian) was derived from the original cohort. The baseline characteristics of the secondary cohort showed a decline in VFT frequency, DoS, and VFT/DoS ratios from pre-COVID to mid-COVID across all races (Table 3). When controlling for the effects of sex, age, ADI, VF reliability parameters,

Table 1. Baseline Characteristics and Testing History of Each Racial Group

	White	Black	Asian	*P*
Subjects, *n*	1515	782	357	—
Female, *n* (%)	820 (54.1)	507 (64.8)	204 (57.1)	<0.001[a]
Age (y), mean ± SD	61.7 ± 15.1	58.2 ± 14.4	51.6 ± 16.1	<0.001[b]
ADI, mean ± SD	2.46 ± 1.95	3.64 ± 2.08	2.55 ± 1.77	<0.001[b]
Baseline MD (dB), median (Q1, Q3)	−2.48 (−7.21, −0.49)	−4.11 (−10.72, −1.35)	−2.59 (−6.66, −0.75)	<0.001[c]
Number of visits per subject, mean ± SD	8.90 ± 9.36	9.74 ± 10.03	7.61 ± 7.35	0.001[b]
Frequency of VFT per subject, mean ± SD	2.62 ± 1.90	2.41 ± 1.53	2.27 ± 1.45	< 0.001[b]
VFT false positives, mean ± SD	4.88 ± 6.13	5.55 ± 7.91	5.25 ± 6.43	0.070[b]
VFT false negatives, mean ± SD	4.68 ± 6.45	6.14 ± 7.17	4.13 ± 5.64	<0.001[b]
VFT fixation loss, mean ± SD	26.43 ± 22.13	27.68 ± 22.36	25.08 ± 23.15	0.169[b]
VFT/DoS ratio, mean ± SD	0.46 ± 0.29	0.42 ± 0.29	0.45 ± 0.28	0.007[b]
Frequency of OCT per subject, mean ± SD	2.43 ± 2.09	2.08 ± 1.74	1.86 ± 1.71	<0.001[b]
SLT, *n* (%)	71 (4.69)	25 (3.20)	3 (0.84)	0.002[a]
Glaucoma surgery, *n* (%)	157 (10.36)	98 (12.53)	28 (7.84)	0.050

[a] Pearson's χ^2 test.
[b] ANOVA.
[c] Kruskal–Wallis rank sum test.

Table 2. Estimated Differences in Number of Visits, VFT Frequency, and VFT/DoS Ratio Among Races Using Tukey's Post Hoc Analysis After Adjusting for Sex, Age, ADI, Baseline MD, VF Reliability Parameters, OCT Frequency, and SLT and Glaucoma Surgeries Frequency

	Black/White		Asian/White		Asian/Black		
	Est. (95% CI)	*P*	Est. (95% CI)	*P*	Est. (95% CI)	*P*	Overall *P*
Number of visits per subject	0.81 (0.203 to 1.424)	**0.024**[a]	0.29 (−0.500 to 1.078)	0.750	−0.52 (−1.380 to 0.331)	0.448	**0.033**[a]
Frequency of VFT per subject	0.08 (−0.033 to 0.186)	0.356	0.05 (−0.091 to 0.193)	0.755	−0.03 (−0.179 to 0.129)	0.945	0.372
VFT/DoS ratio	−0.03 (−0.056 to −0.007)	**0.031**[a]	−0.05 (−0.077 to −0.013)	**0.015**[a]	−0.01 (−0.048 to 0.021)	0.724	**0.004**[a]

[a] Statistically significant.

baseline MD, OCT frequency, and SLT and glaucoma surgery frequency on the number of visits and VFT in the secondary analysis, no significant difference among the races was noted in the magnitude of change in VFT frequency, DoS, or VFT/DoS ratio from the pre-COVID 19 to mid-COVID 19 periods (Table 4). Additionally, no significant differences in the magnitude of change in the VFT/DoS ratio between time periods was detected between any race pairs.

Discussion

In this study, we examined racial disparities in VFT, as it is a crucial component in glaucoma management. Blacks and Asians had lower rates of VFT compared to Whites when accounting for potential confounders such as sex, age, socioeconomic disadvantage, baseline glaucoma severity, VF reliability, OCT, SLT, and glaucoma surgery frequency. This dispar-

Table 3. Baseline Characteristics and Testing History of Secondary Cohort

	White	Black	Asian	*P*
Subjects, *n*	956	479	204	
Female, *n* (%)	526 (55)	310 (65)	122 (60)	0.002[a]
Age (y), mean ± SD	62.3 ± 15.4	59.9 ± 14.2	53.0 ± 15.7	<0.001[b]
ADI, mean ± SD	2.45 ± 1.98	3.61 ± 2.12	2.58 ± 1.80	<0.001[b]
Baseline MD (dB), median (Q1, Q3)	−2.62 (−7.82, −0.58)	−4.31 (−10.66, −1.56)	−3.51 (−7.51, −1.01)	<0.001[c]
SLT, *n* (%)	55 (5.6)	20 (4.2)	2 (1.0)	0.011[a]
Glaucoma surgery, *n* (%)	526 (55.0)	310 (64.7)	15 (7.4)	0.319[a]
Visits per subject, mean ± SD				
Total (4 y)	9.03 ± 8.99	9.04 ± 8.23	7.42 ± 6.96	0.042[b]
Pre-COVID (2 y)	4.82 ± 5.06	5.10 ± 5.10	4.29 ± 3.90	0.149
Mid-COVID (2 y)	4.21 ± 6.04	3.94 ± 5.23	3.12 ± 4.75	0.044
Mid-COVID – pre-COVID	−0.61 ± 6.58	−1.16 ± 6.26	−1.17 ± 5.21	0.217
Frequency of OCT per subject, mean ± SD				
Total (4 y)	2.80 ± 2.31	2.38 ± 1.90	2.11 ± 1.91	<0.001[b]
Pre-COVID (2 y)	1.39 ± 1.27	1.21 ± 1.09	1.14 ± 1.03	0.003
Mid-COVID (2 y)	1.42 ± 1.56	1.17 ± 1.29	0.97 ± 1.18	<0.001
Mid-COVID – pre-COVID	0.03 ± 1.65	−0.04 ± 1.46	−0.17 ± 1.12	0.240
Frequency of VFT per subject, mean ± SD				
Total (4 y)	3.07 ± 2.09	2.74 ± 1.65	2.64 ± 1.65	0.001[b]
Pre-COVID (2 y)	1.60 ± 1.11	1.46 ± 0.85	1.48 ± 0.80	0.027
Mid-COVID (2 y)	1.46 ± 1.48	1.28 ± 1.30	1.16 ± 1.19	0.004
Mid-COVID – pre-COVID	−0.14 ± 1.57	−0.19 ± 1.45	−0.31 ± 1.18	0.310
VFT/DoS ratio, mean ± SD				
Total (4 y)	0.50 ± 0.29	0.46 ± 0.28	0.50 ± 0.27	0.047[b]
Pre-COVID (2 y)	0.54 ± 0.32	0.48 ± 0.32	0.51 ± 0.29	0.004
Mid-COVID (2 y)	0.36 ± 0.36	0.31 ± 0.34	0.35 ± (0.36	0.107
Mid-COVID – pre-COVID	−0.18 ± 0.45	−0.16 ± 0.44	−0.16 ± 0.45	0.735

[a]Pearson's χ^2 test.
[b]ANOVA.
[c]Kruskal–Wallis rank sum test.

ity became more pronounced for Black individuals, considering their higher baseline disease severity, which would typically warrant increased test frequency in conventional clinical practice. Awareness of healthcare racial disparity is of utmost importance in order to develop mechanisms to resolve it.

Racial disparities persist across various areas of medicine.[15–18] Our study highlights this disparity in the context of VFT where Blacks and Asians had significantly lower VFT/DoS ratios compared to White individuals. The path to reach this outcome slightly varies among the races. Blacks had the highest number of visits among the three groups, and Asians had the lowest. Nevertheless, both Blacks and Asians had lower VFT/DoS ratios than Whites. Significant race pair differences were present in the VFT/DoS ratios between Blacks and Whites, as well as between Asians and Whites, when accounting for potential confounders. These results partially corroborate with the findings of previous studies that have shown substantially less VFT among Black and Asian patients.[6–9] Our results further strengthen these findings by including a wider age range of subjects and by using continuous variables for sensitive analysis of the effect of disease severity and socioeconomic status.

Although a difference in VFT/DoS ratios ranging between 3% and 5% among races might seem small, from societal and ethical perspectives even this difference raises concerns. Additionally, Black subjects have been found to exhibit increased VF variability, with socioeconomic status playing a significant role in this association.[19] Consequently, this can lead to further

Table 4. Adjusted Estimated Differences in Number of Visits, VFT Frequency, and VFT/DoS Ratio Among Races Within Secondary Cohort After Adjusting for Sex, Age, ADI, Baseline MD, SLT, OCT Frequency, and SLT Glaucoma Surgery Frequency

	Black/White		Asian/White		Asian/Black		
	Est. (95% CI)	*P*	Est. (95% CI)	*P*	Est. (95% CI)	*P*	Overall *P*
Visits per subject							
Total (4 y)	0.73 (0.014 to 1.455)	0.110	0.39 (−0.579 to 1.365)	0.704	−0.34 (−1.392 to 0.708)	0.796	**0.043**[a]
Pre-COVID (2 y)	0.52 (0.044 to 0.995)	0.080	0.25 (−0.389 to 0.895)	0.716	−0.27 (−0.961 to 0.428)	0.729	0.054
Mid-COVID (2 y)	0.25 (−0.236 to 0.741)	0.563	0.20 (−0.463 to 0.858)	0.825	−0.06 (−0.768 to 0.658)	0.987	0.228
Mid-COVID – pre-COVID	−0.35 (−0.991 to 0.295)	0.533	−0.12 (−0.987 to 0.753)	0.962	0.23 (−0.710 to 1.172)	0.878	0.570
Frequency of VFT per subject							
Total (4 y)	−0.01 (−0.152 to 0.141)	0.997	0.08 (−0.118 to 0.278)	0.706	0.08 (−0.129 to 0.299)	0.713	0.589
Pre-COVID (2 y)	−0.02 (−0.102 to 0.067)	0.913	0.02 (−0.093 to 0.135)	0.931	0.04 (−0.085 to 0.161)	0.815	0.572
Mid-COVID (2 y)	0.01 (−0.097 to 0.116)	0.982	0.06 (−0.082 to 0.206)	0.671	0.05 (−0.103 to 0.208)	0.783	0.406
Mid-COVID – pre-COVID	0.00 (−0.125 to 0.128)	>0.999	0.02 (−0.154 to 0.187)	0.980	0.02 (−0.170 to 0.200)	0.986	0.982
VFT/DoS ratio							
Total (4 y)	−0.04 (−0.068 to −0.008)	**0.032**[a]	−0.04 (−0.085 to −0.005)	0.073	−0.01 (−0.050 to 0.037)	0.950	0.289
Pre-COVID (2 y)	−0.06 (−0.096 to −0.027)	**0.001**[a]	−0.07 (−0.113 to −0.019)	**0.016**[a]	−0.00 (−0.055 to 0.046)	0.985	**0.048**[a]
Mid-COVID (2 y)	−0.01 (−0.049 to 0.026)	0.818	0.02 (−0.033 to 0.068)	0.769	0.03 (−0.025 to 0.083)	0.544	0.767
Mid-COVID – pre-COVID	0.03 (−0.019 to 0.080)	0.448	0.06 (−0.003 to 0.131)	0.144	0.03 (−0.039 to 0.106)	0.629	0.132

[a]Statistically significant.

delays in detecting disease progression and hinder timely intervention that might be averted by increasing the frequency of testing in this specific population. A lower frequency of VFT among Black patients may contribute to lower detection and undertreatment of glaucoma, ultimately increasing the risk for disease progression.

When assessing the reliability of VFT performed for each race in our cohort, higher rates of false negatives were seen among Black subjects. False positives and fixation losses were not significantly different between races. These might partially be explained by Black subjects presenting with worse disease severity and larger VF loss, making it difficult to answer reliability challenges in VFT.

OCT tests may serve as an alternative to VFT, particularly in subjects facing challenges in obtaining a reliable test. Within our cohort, Black and Asian subjects exhibited a significantly lower frequency of OCT imaging, dismissing the possibility that the test was utilized as a substitute for the VFT.

Differences in the rates of SLT and glaucoma surgery were observed among races, with White subjects having the greatest proportion of patients that had SLT performed and Black subjects undergoing the greatest proportion of glaucoma surgeries. As Black subjects in our cohort exhibited a more severe baseline disease than Whites, the chosen treatment option aligns with common clinical practice. SLT is typically chosen for subjects with less severe disease, and surgical intervention is reserved for those in more advanced disease stages.

Considering all the potential confounders discussed above (sex, age, socioeconomic disadvantage, baseline glaucoma severity, VF reliability, OCT, SLT, and glaucoma surgery frequency), Black and Asian subjects exhibited 3% and 5% lower VFT/DoS ratios, respectively, compared to Whites (Table 2). This difference became more pronounced when considering the actual rate in Whites, who showed between a 7% and 11% reduction, with the upper limit of the 95% confidence interval reaching as high as 16.9%. These statistically significant and clinically meaningful differences might hinder clinicians' ability to detect changes promptly, potentially leading to delayed treatment adjustments.

In a secondary analysis, we examined the impact of the COVID-19 pandemic, and the associated societal lockdown, on VFT rates. As expected, the pandemic caused a reduction in visits, VFT frequency, and VFT/DoS ratios from pre-pandemic rates. Importantly, the reduction was similar across all races. Therefore, the results of our primary analysis, which included a larger number of subjects, should be considered foremost.

Although our findings suggest that Blacks and Asians are receiving less frequent VFT for glaucoma, it is unclear which specific factors are responsible for this disparity. One possible interpretation is that there may implicit or explicit bias among clinicians in obtaining VFT. This is supported by other studies that have identified racial disparities in vision tests that persist even after controlling for these social factors.[8,9] Although bias in itself is difficult to identify and even more difficult to quantify, the consequences of implicit bias and systemic racism have been explored.[20] The impact of medical necessity on VFT frequency should also be considered. A more severe baseline severity of glaucoma, as is more often seen among Black subjects, may require more frequent follow-up visits for adequate pressure control but without the necessity of additional VFT. This increase in office visits without an increase in testing may cause a disproportionate reduction in VFT/DoS ratios among Black individuals. Another potential interpretation is that there are race-associated factors that influence testing frequency other than disease severity and socioeconomic factors that have not been fully explored. For example, some studies have begun to develop quantitative measures for the concept of medical mistrust, which is defined as distrust of medical personnel and organizations.[21,22] It is unclear whether medical mistrust, which is often more prevalent among minority and disadvantaged communities, plays a role in reducing VFT frequency. Although further investigation into responsible underlying factors is needed, these current findings indicate that there is a continued need to promote health equity initiatives and to discuss the importance of adherence to follow-up for VFT and other examinations when treating patients from minority populations that are at a higher risk for undiagnosed glaucoma.[8,9,23]

Numerous studies have reported reductions in overall access to health care during the COVID pandemic, which was again demonstrated in this study by the reduction of VFT frequency, DoS, and VFT/DoS ratio among all races from pre-COVID to mid-COVID. Surprisingly, despite past studies that have shown exacerbations of health inequity in ambulatory care during the COVID-19 pandemic,[24–26] this trend was not observed in VFT within the population of this study. The onset of COVID-19 resulted in proportionally equivalent reductions in VFT among the races.

The methodology of this study had several limitations that should be considered when interpreting its results. It is conceivable that the prescription of new medication for the treatment of glaucoma during the study duration may have influenced the frequency of

VFT. Adjustments in medications could potentially decrease the need for VFT as the initial visits are primarily focused on measuring intraocular pressure. However, due to the unreliable capture of medication data by our system, prescriptions for glaucoma treatment were not included in the statistical model. Another limitation was also present in the distribution of demographic characteristics of the study population. NYU patients, such as those included in this study, are mostly insured and from neighborhoods of higher socioeconomic status. This is not representative of the makeup of New York City as a whole. The relatively high access to health care observed among all races within this study population may also explain why significant exacerbations in racial disparities were not detected mid-COVID. We observed unbalanced sample numbers among the races, with Whites having the largest representation, followed by Blacks and then Asians. Additionally, the distribution of age across races was not uniform. Asians presented with the lowest mean age compared to Whites and Blacks. This may indirectly have an impact on VFT frequency due to a potentially lower distribution of disease; however, the composition of our population is likely similar to many academic clinical practices in the United States. Future studies investigating the relationship between VFT frequency and race should expand their analyses to multiple healthcare clinics and institutions to acquire a more generalizable study population. Other issues may arise from the fact that the racial categorization of study subjects was based on self-identified race as reported by the participant. The limitations of this most practical race classification method have been thoroughly discussed elsewhere.[27–29]

In conclusion, our study demonstrates that Black and Asian subjects with glaucoma received a lower frequency of VFT per visit than White subjects after controlling for potential confounders. These findings resonate with broader research on racial disparities in health care, where marginalized communities often face barriers that prevent them from receiving timely and appropriate medical care. Concrete efforts should be made to further explore the causes for the disparity and its downstream effect in order to develop mechanisms to resolve it and provide the best possible medical care for individuals of all races.

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