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Manhattan Vision Screening and Follow-Up Study (NYC-SIGHT): Subanalysis of Referral to Ophthalmology

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Abstract

Purpose: The Manhattan Vision Screening and Follow-up Study aims to provide access to eye care for underserved populations, detect native rates of ocular pathology, and refer participants with eye disease to ophthalmology. This subanalysis describes the reasons for referral to ophthalmology and identifies risk factors associated with being referred.

Methods: Enrolled participants were aged ≥40 years, living independently in public housing developments and able to provide consent for eye health screenings. Those with habitual visual acuity 20/40 or worse, intraocular pressure (IOP) 23–29 mmHg, or an unreadable fundus image failed and were scheduled with the on-site optometrist. The optometric exam determined whether further referral to ophthalmology for a clinic exam was warranted. Those with an abnormal image or IOP ≥30 mmHg were referred directly to ophthalmology. Main outcome was factors associated with referral to ophthalmology.

Results: A total of 708 individuals completed the eye health screening over 15 months. A total of 468 participants were referred to ophthalmology (250 had an abnormal image and 218 were

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referred by the optometrist). Those referred were predominantly older adults (mean age 70.0 ±11.4 years), female (66.7%), African American (55.1%) and Hispanic (39.5%). Seventy percent of participants had not had a recent eye exam. Stepwise multivariate logistic regression analysis showed that participants with pre-existing glaucoma (OR 3.14, 95% CI 1.62 to 6.08, $p = 0.001$), an IOP ≥23 mmHg (OR 5.04, 95% 1.91 to 13.28, $p = 0.001$), or vision impairment (mild) (OR 2.51, 95% CI 1.68 to 3.77, $p = 0.001$) had significantly higher odds of being referred to ophthalmology.

Conclusion: This targeted community-based study in Upper Manhattan provided access to eye care and detected a significant amount of ocular pathology requiring referral to ophthalmology in this high-risk population.

Keywords

Community-based; eye health screening; underserved populations; New York City; glaucoma screening

Introduction

As life expectancies continue to increase, preventable eye conditions account for a significant percentage of eye disease and health-care cost burden.[1,2] Large scale vision screenings have helped detect eye diseases such as glaucoma and diabetic retinopathy in early stages.[3,4] Screening for diabetic retinopathy has also improved early detection and has significantly expanded in the past decade.[5–8] While previous studies have shown that screening also increases glaucoma detection, those referred to ophthalmology have low follow-up adherence rates.[9–11] Previous efforts to improve access and utilization of eye care with community- or hospital-based glaucoma screenings in high-risk populations have yielded only marginal results.[9]

Racial/ethnic minority populations, socioeconomically disadvantaged populations, and underserved urban and rural populations frequently have inadequate eye care and poor follow-up, which contributes to eye health disparities.[12–15] Barriers to eye care such as lack of transportation, poor health education, and inability to cover costs of medical services are factors that may contribute to the high rates of undiagnosed ocular pathology in these populations.[11,16–19] Early detection of eye disease may prevent vision-related limitations to physical activity and mobility, as well as psychosocial consequences of low vision. In addition, significant health care savings can be obtained from earlier detection and treatment of eye diseases.[20–22]

To reduce disparities in vision health and eye care experienced by underserved populations, the World Health Organization, American Academy of Ophthalmology Taskforce on Disparities in Eye Care, and *Healthy People 2030* suggest understanding the foundational role that social determinants of health play in health disparities and inequities of eye care.[15,23] Social determinants of health are the conditions into which we are born, grow, live, learn, work, and age and the five domains for targeting interventions include: (i) health and health care access and utilization, (ii) education, (iii) economic stability, (iv) neighborhood and built environment, and (v) social and community context.[15,23] Recent developments

have been made to specifically address social determinants of health that lead to increased risk of untreated eye disease in underserved communities.[15,19]

In 2019, the Vision Health Initiative at the US Centers for Disease Control and Prevention (CDC) funded *Improving Detection and Management of Glaucoma and Other Eye Diseases Among High-Risk Populations (RFA-DP-19–004)*.[24] These studies are investigating innovative strategies to better engage populations most at risk, most vulnerable, and least likely to have access to eye care to detect and manage common eye diseases in community-based settings. In New York City (NYC), Columbia University Department of Ophthalmology researchers designed the Manhattan Vision Screening and Follow-up Study (NYC-SIGHT) to improve early detection and management of glaucoma and other eye diseases in underserved populations living in Upper Manhattan.[25] This paper describes the demographic characteristics, social determinants of health, eye health screening results, and rates of suspected glaucoma and other eye diseases in the study population. We also report the reasons for referral to ophthalmology, and identify factors associated with being referred.

Materials and methods

The overarching study is a 5-year prospective, cluster-randomized clinical trial and the details of the study design and methodology are described in a previous publication.[25] The study was approved by the Columbia University Irving Medical Center Institutional Review Board (IRB) (#AAAR9162) and all aspects of the study were conducted in accordance with the Declaration of Helsinki and were Health Insurance Portability and Accountability Act of 1996 (HIPAA) compliant. Informed consent was obtained from all participants prior to enrollment and the study was registered on ClinicalTrials.gov (NCT04271709).

Target population

By partnering with New York City Housing Authority (NYCHA) and New York City Department for the Aging (DFTA), the study targeted individuals at high risk for undetected eye disease, known to have poor access to eye care.[25] These NYCHA residents fall at or below the NYC.gov poverty measure (zip codes 10027, 10029, 10030, 10031,10032, 10035, 10037, 10039).[26] Ten public housing developments of various sizes were selected by NYCHA near Columbia Ophthalmology and Harlem Hospital Ophthalmology, which provided access to 6640 NYCHA residents (Figure 1, Sample Frame).

Recruitment

Recruitment at the NYCHA developments and DFTA Senior Centers in Harlem and Washington Heights targeted high-risk individuals. For each location, customized IRB-approved advertising materials were distributed to residents' apartments, sent to residents' emails, and posted in common spaces.

Inclusion criteria

Individuals age 40 years and older and willing to consent for a baseline eye health screening were eligible. Those who met the study's inclusion criteria were consented and enrolled over the telephone or in person, in English or Spanish, by the bilingual study coordinators.

Eye Health Screening Protocol

Pre-screening assessment: Demographics and social determinants of health data were captured over the phone or in person for all participants as well as health insurance status, transportation needs to attend the screening, and access to eye care (their own eye doctor, either an ophthalmologist or optometrist). The *Eye Health Screening Protocol* also included a question about the participant's last dilated eye exam and reason for no eye exam in the past 2 years prior to the eye health screening. Participants were asked about their medical and ocular history, ocular medications, eyeglass prescription, and family history of glaucoma and blindness.

In addition, the validated National Eye Institute-Visual Function Questionnaire (NEI-VFQ)-9 was administered at baseline to assess vision-related quality-of-life (VRQOL) prior to the eye health screening. To determine the NEI-VFQ composite score and sub-scale scores, individual responses to each of the eight questions, or items, were first recoded into numerical values of 0 to 100, respectively, with a higher score indicating a better QOL outcome. The sub-scale specific items were then averaged to generate sub-scale scores, with 100 being the highest achievable score per sub-scale. These scores were averaged to compute the overall NEI-VFQ composite score.[27]

Eye health screening: Screenings were conducted by the study staff and community health workers in either the community room at the NYCHA development or the senior center located in the same location or nearby. Visual acuity was measured with a Snellen eye chart at 20 feet with correction. All visual acuity data was converted to the logarithm of the minimum angle of resolution (logMAR) for analysis and those 20/40 or worse in either eye failed the screening. Mild vision impairment (Snellen visual acuity 20/40 to 20/50), moderate vision impairment (Snellen 20/60 to 20/100), and severe vision impairment (Snellen 20/200 or worse) were defined using the WHO classification criteria for vision impairment. The IOP was measured in both eyes using the Ic100 iCare rebound tonometer (iCare, Helsinki, Finland) and those with IOP 23 to 29 mmHg in either eye failed the screening. If IOP was ≥30 mmHg, participants were "fast-tracked" and immediately referred to Columbia Ophthalmology, Harlem Hospital Ophthalmology, or their own eye care provider for an in-office comprehensive dilated eye exam and ocular testing.

Fundus images were taken using the non-mydriatic, auto-focus, hand-held fundus camera (Volk Pictor Prestige; Volk Optical, Mentor, OH) and read and graded by two study ophthalmologists specializing in retina and glaucoma. Grading of each eye included the image quality of the optic nerve (good, fair, poor, or unreadable) based on image features, specifically color, focus, contrast, and illumination. The study retina specialist classified abnormalities as ischemic, retinal vascular/ischemic changes, macular pathology, active retinal disease requiring treatment, non-glaucomatous optic nerve findings, posterior segment hemorrhages and choroidal lesions, and multiple categories could be selected for each eye. Concurrently, the study glaucoma specialist also evaluated the images for glaucomatous findings. Glaucoma findings for each eye may include abnormal cup-to-disc ratio, optic disc asymmetry, disc hemorrhage, peripapillary atrophy, focal nerve notching, and nerve fiber layer bundle defect. Final image reading results were based on the worse eye

as: 1) normal or abnormal with no significant findings, 2) abnormal with significant findings (refer to ophthalmology), or 3) unreadable (refer to study optometrist).

Screening failure criteria for optometric exam: Screening failure criteria consisted of habitual (measured with usual eyeglasses brought to examination) visual acuity 20/40 or worse, IOP 23–29 mmHg, or an unreadable image. These individuals were scheduled to see the on-site study optometrist within 3 weeks in the same location as the screening (Figure 1).

Optometric eye exam protocol: The optometrist conducted a refractive error assessment; anterior segment exam using a portable slit lamp (hand-held) and a non-dilated posterior segment exam using a direct ophthalmoscope (Welch Allyn Panoptic 3.5 V, Skaneateles Falls, NY). According to the *Optometric Exam Protocol* criteria for referral to ophthalmology, participants diagnosed with glaucoma, glaucoma suspect, cataract, retinal abnormalities, or other ocular diagnoses were referred to ophthalmology for a dilated eye exam and further ocular testing, such as visual fields and optical coherence tomography, when deemed necessary. The criteria for referral also included those participants who had not received a dilated eye exam within the last two years, could not remember their last eye exam, or never had an eye exam, which was an *Optometric Exam Protocol* modification recommended by the Data and Safety Monitoring Board.

Referral to ophthalmology: All participants referred to ophthalmology, either, because of an abnormal image finding or by the optometrist, were scheduled for their initial in-office comprehensive ophthalmology appointment.

Statistical methods: Statistical analyses were performed with IBM SPSS version 25 (IBM Corp. Armonk, NY) and R Foundation for Statistical Computing Platform version 4.1.2 (Vienna, Austria).[28] Participant characteristics were summarized for the entire sample using means and standard deviations for continuous variables and frequencies and percentages for categorical variables. Data were collected and managed using Research Electronic Data Capture (REDCap) tools hosted at Columbia University.[29,30] Outcome measures included demographic characteristics, social determinants of health, (ethnicity, race, age, sex, employment, education level, marital status, insurance type), eye health screening results, and rates of suspected glaucoma and other eye diseases in the study population. Factors associated with referral to ophthalmology was the main outcome for this statistical analysis. The analysis did not include adherence to follow-up appointments.

A chi-square test was conducted for each level of a categorical variable between those referred to ophthalmology and not referred to determine statistical significance and then the significant variables were included in the multivariate regression analysis. A two-sample *t*-test was used to compare mean age and the mean NEI-VFQ-9 composite score. A stepwise multivariate logistic regression model was constructed using the significant variables from the chi-square and two-sample t-test to identify possible predictors/factors associated with referral to ophthalmology to determine odds ratios at the 95% confidence intervals. Factors included in the model were demographics, social determinants of health, and clinical characteristics. At each step, variables were added based on the alpha-to-enter significance level of 0.05 and the alpha-to-remove significance level was set at 0.1 to exclude variables in

the final model. For all analyses, p-values of ≤0.05 were considered statistically significant and all tests performed were 2-sided. All variables entered into the stepwise multiple logistic regression were adjusted for other variables that were also significant.

Results

Demographics and social determinants of health

A total of 708 participants completed the eye health screening in the community settings over 15 months from March 1, 2021 to May 31, 2022. Baseline demographic and clinical characteristics of those referred to ophthalmology (n = 468) vs. not referred (n = 240) are shown in Tables 1–3. Mean age (±SD) of participants referred to ophthalmology was 70 (±11.4) years. Females represented 66.7% of referred participants; 55.1% were African American; 39.5% were Hispanic; 97% had health insurance, 61.3% had Medicare, 55.3% had Medicaid, and 28.6% had private or supplemental (Table 1). Most referred participants were single, divorced, separated or widowed (76.3%) and retired (62%). Of those referred to ophthalmology, 29.5% had less than a high school education, 33.8% completed high school, and 36.8% completed some college or college graduate. Only 10% of participants needed transportation to the eye health screening and follow-up appointments. The majority (62.6%) spoke English and 35.3% spoke Spanish as their primary language. Only 32.5% of participants referred to ophthalmology reported that they have their own eye doctor. Age (≥80 years), employment status (retired), needing assistance with transportation, and having Medicare insurance were significantly associated with referral to ophthalmology ($p \leq 0.05$) (Table 1).

Clinical characteristics

Of those referred to ophthalmology, 14.1% self-reported smoking, 151 (32.3%) had diabetes, 307 (65.6%) had hypertension, 71 (15.2%) had glaucoma (confirmed if taking IOP lowering medication), 148 (31.6%) had cataracts, and 113 (24.1%) have a family history of glaucoma. Of the participants who wear prescription eyeglasses and were referred to ophthalmology, 204 (58.7%) were wearing eyeglasses older than two years or could not remember the age of their eyeglasses. A total of 53.2% of those referred to ophthalmology had not had a dilated eye exam in the past 2 years, including participants who could not remember their last exam and those who had never had an eye exam, as reported from the *Eye Screening Protocol*. As shown in Table 2, there were significantly higher rates of self-reported diabetes, hypertension, cataract, and glaucoma in participants referred to ophthalmology ($p \leq 0.05$) (Table 2). Those referred to ophthalmology were significantly more likely to wear prescription eyeglasses and did not attend an eye exam in the past 2 years due to COVID-19 and other reasons. Additionally, the participants who were referred to ophthalmology had a lower VRQOL based on the NEI-VFQ-9 compared to those not referred (p = 0.004) (Table 2).

Eye health screening

Of those referred to ophthalmology, 406 participants (86.8%) failed the screening; 375 (80.1%) had visual acuity 20/40 or worse, 44 (9.4%) had IOP 23–29 mmHg, and 117 (25%) had an unreadable image, with some having multiple reasons for failure (Table

3). Mean visual acuity for those referred to ophthalmology was 0.58 ± 0.53 logMAR with 30.2% having mild vision impairment (Snellen visual acuity 20/40 to 20/50), 31.7% moderate vision impairment (Snellen 20/60 to 20/100), and 18% having severe vision impairment (Snellen 20/200 or worse), as defined by WHO classification criteria for vision impairment.[31] Those referred to ophthalmology were more likely to have mild, moderate and severe vision impairment ($p \leq 0.01$). A total of 7 participants were "fast-tracked" due to IOP ≥30 mmHg.

Based on telemedicine image data from the worse eye of those referred to ophthalmology, 101 (22%) were normal or abnormal with no significant findings, 117 (25%) were unreadable, and 250 (53%) were abnormal (Table 3 and Figure 1).

Optometric eye exam

A total of 365 participants were invited to see the on-site optometrist due to vision 20/40 or worse, IOP 23–29 mmHg, or an unreadable image; 308 attended the eye exam (adherence rate: 83%). Of the 308 participants who had completed the eye exam, 218 were referred to ophthalmology and 257 were diagnosed with refractive error. Reasons for referral included: glaucoma/glaucoma suspect ($n = 51$), cataracts ($n = 74$), retinal abnormalities ($n = 17$), other ocular diagnosis ($n = 22$), and no dilated eye exam in at least 2 years, could not remember their last eye exam, or never had an eye exam ($n = 103$) (Figure 1).

Factors associated with referral to ophthalmology

All odds ratios (OR) listed below were adjusted for other variables that were also significant. Stepwise multivariate logistic regression analysis showed that participants with pre-existing glaucoma (OR 3.14, 95% CI 1.62 to 6.08, $p = 0.001$) or IOP ≥23 mmHg (OR 5.04, 95% 1.91 to 13.28, $p = 0.001$) had significantly higher odds of being referred to ophthalmology. Additionally, participants with mild (OR 2.51, 95% CI 1.68 to 3.77, $p = 0.001$), moderate (OR 4.37, 95% CI 2.81 to 6.81, $p = 0.001$) or severe (OR 8.72, 95% CI 4.36 to 17.46, $p = 0.001$) vision impairment had significantly higher odds of being referred to ophthalmology (Table 4).

Discussion

The Manhattan Vision Screening and Follow-up study is the first community-based eye health screening study in Upper Manhattan to be conducted in NYCHA housing developments and DFTA senior centers. We considered social determinants of health by targeting people where they live (neighborhood and build environment) and focused on providing access to health care, specifically eye care. The incidence of ocular pathology and overdue annual eye exams requiring referred to ophthalmology (66.1%) was surprising high in the study population (Figure 1). We effectively targeted and recruited high-risk, ethnically diverse individuals with poor access to eye care. The stepwise multivariate regression analysis showed that those who had pre-existing glaucoma, an IOP ≥23 mmHg at the eye health screening, or demonstrated vision impairment had higher odds of requiring referral to ophthalmology. However, despite the disease burden of glaucoma and vision impairment in the United States (US), the US Preventive Services Task Force (USPSTF)

concluded in both their 2013 and 2022 recommendations that there is insufficient evidence to assess the balance of benefits and harms of screening for primary open angle glaucoma (POAG) in adults.[32,33] The report also states there is a lack of evidence on ways to help identify persons at increased risk who could benefit from glaucoma screening.[32,33] However, numerous community-based studies conducted over the past 10 years, including our study, have effectively targeted high-risk populations and identified those with both early and later stages of glaucoma and other eye diseases.[22,34–37]

As one of the leading causes of irreversible blindness in the United States, the prevalence of glaucoma is expected to increase from 3 million to 6.3 million people by 2050, proving a need for intervention.[38] Helping individuals make and reschedule eye exam appointments is critical to improve follow-up adherence after eye health screening, as previous vision screening studies have identified poor follow-up as a problem that precludes long-term change in such studies.[10,11,39] The majority of our study participants were considered at high-risk for eye disease; 76% were ≥60 years, 51.8% were African American, and 41.9% were Hispanic. Screening is most cost effective when intended for these high-risk populations.[12] Given that the majority of participants (66.1%) screened in our study exhibited ocular pathology requiring ophthalmology referral, it is clear that targeted eye health screening in high-risk communities is a successful strategy for providing access to eye care and detection of eye disease. Therefore, these data provide strong evidence that it may be time to rethink adult screening recommendations for glaucoma and other eye disease.[40]

This innovative intervention focuses on bringing eye care and eye health education to the neighborhoods where people live to make it convenient, as well as provide access to eye care and utilize follow-up eye care services for those referred to ophthalmology. Our findings further the literature on eye health screening by identifying factors that may improve how we target people at-risk of eye pathology. This study further supports community-based eye health screenings that target underserved populations who have higher rates of inadequate eye care and eye health disparities.[40,41]

Strengths and limitations

The study was conducted during the COVID-19 pandemic and the IRB allowed all consenting and pre-screening questionnaires to be conducted over the telephone, which reduced our time in the community from 90 min to 20 min for each participant, which we believe is an advantage of the study and we will continue as we scale this project. Additionally, we were able to recruit, enroll, and screen a large sample size of diverse, underserved adults and seniors composed of more than 50% African Americans and 42% Hispanic participants, with age range from 40 to 99 years. We acknowledge that this was a self-selected group of participants who may have signed up for the eye health screening because their vision is worsening, adding bias to the sample which may overestimate the rates of vision impairment and eye disease. In addition, while rates of self-reported hypertension and diabetes were higher in those referred for follow-up, the overall rates in the study population of hypertension were 62.7% (n = 444) and diabetes were 29.1% (n = 206). Therefore, the clinical significance of these factors being associated with referral needs further investigation. Lastly, while most participants referred to ophthalmology had

more than one reason for referral, the inclusion of “no recent dilated eye exam” as a reason for referral for only those who saw the optometrist may have increased the perception of the study population’s rate of eye pathology. However, many of these individuals had diabetes and/or hypertension and the Data and Safety Monitoring Board suggested that the optometrist should also refer any participant to ophthalmology for a dilated eye exam if they had not seen an eye doctor in the past 2 years. We did not want the community-based non-dilated optometric exam to be a substitute for an annual dilated eye exam. Future analysis will include adherence to attending the follow-up eye exam appointments for those referred to ophthalmology.

In conclusion, our community-based eye health screening model identified high rates of eye pathology in an underserved population living in Upper Manhattan. About two-thirds of participants who underwent eye health screening were recommended for referral to ophthalmology, with a large portion of referrals made for glaucoma (26.7%), retina (24.6%), cataracts (10.5%), and an overdue comprehensive dilated eye exam (14.5%). This study demonstrates the potential benefit of targeted eye health screening and education.

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Data availability statement

All deidentified participant data, study protocol, statistical plan, and informed consent will be made available by the corresponding author upon email request. The data will be made available with investigator support after approval of a proposal and a signed data access agreement is fully executed. Study materials are available at SIGHTSTUDIES.org.

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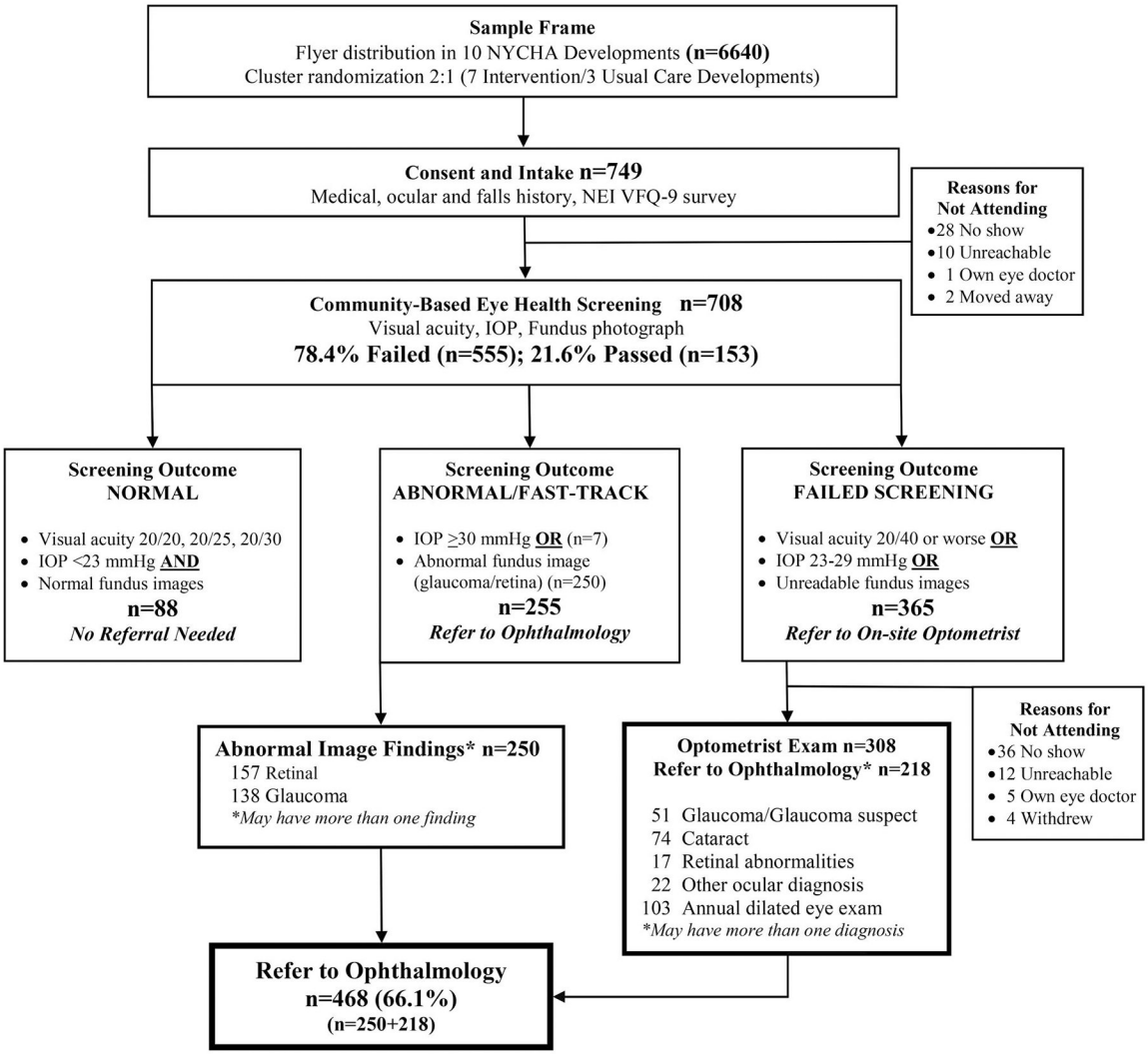

Figure 1.

Consolidated Standards of Reporting Trials (CONSORT) diagram for referral to ophthalmology.

Sample frame of participants recruited by flyer distribution (top center). Informed consent, medical and ocular history, falls risk, and National Eye Institute Vision Function Questionnaire (NEI-VFQ)-9 were assessed by the call center (second row) before the eye health screening. All enrolled participants received the eye health screening including visual acuity, intraocular pressure (IOP) measurement, and fundus photography and the outcome (third row). Reasons for not attending the eye health screening (third row right). Screening outcomes were normal (fourth row left), abnormal image/fast track (refer to ophthalmology) (fourth row center), or failed screening (refer to on-site optometrist) (fourth row right) and each criteria are shown. Reasons for not attending the optometrist eye exam (fifth row right). Participants referred to ophthalmology had either an abnormal retina or glaucoma image finding and (fifth row left). Number of participants seen by the study optometrist and

referred to ophthalmology (fifth row center). Total participants referred to ophthalmology (sixth row left).

Table 1.

Manhattan Vision Screening and Follow-up Study (NYC-SIGHT): demographics and social determinants of health of those referred to ophthalmology.

Variables	Referred to Ophthalmology (*n* = 468)	Not Referred to Ophthalmology (*n* = 240)	*P* Value[a]
Age, Mean (±SD)	70.0 years (±11.4)	65.7 years (+12.3)	**<.001**
Age Category, No. (%)			**0.000**
40–59 years	89 (19.0)	81 (33.8)	
60–79 years	287 (61.3)	129 (53.8)	
≥80 years	92 (19.7)	30 (12.5)	
Sex, No. (%)			.23
Female	312 (66.7)	149 (62.1)	
Male	156 (33.3)	91 (37.9)	
Race, No. (%)			.39
African American, non-Hispanic	258 (55.1)	109 (45.4)	
Other (Multiracial, White, Asian, American Indian)	25 (5.3)	19 (7.9)	
Ethnicity, No. (%)			
Hispanic	185 (39.5)	112 (46.7)	.07
Hispanic Origin[b], No. (%)			.780
Dominican	136 (69.7)	83 (69.7)	
Puerto Rican	32 (16.4)	19 (16.0)	
Mexican	1 (0.5)	2 (1.7)	
Cuban	4 (2.1)	1 (0.8)	
Spanish/South American	22 (11.3)	14 (11.8)	
Education Level, No. (%)			.709
Less than high school	138 (29.5)	76 (31.7)	
High school	158 (33.8)	74 (30.8)	
Some college, college graduate, or graduate degree	172 (36.8)	90 (37.5)	
Employment Status, No. (%)			**<.001**
Employed (full-time, part-time, or self-employed)	81 (17.3)	60 (25.0)	
Unemployed	46 (9.8)	28 (11.7)	
Retired	290 (62.0)	122 (50.8)	
Disabled/Unable to work	51 (10.9)	30 (12.5)	

Variables	Referred to Ophthalmology (*n* = 468)	Not Referred to Ophthalmology (*n* = 240)	*P* Value[a]
Marital Status, No. (%)			.46
Single, divorced, separated, or widowed	357 (76.3)	177 (73.8)	
Married/Domestic partner	111 (23.7)	63 (26.3)	
Need Assistance with Transportation, No. (%)	47 (10.0)	13 (5.4)	**.04**
Has Health Insurance, No. (%)	454 (97.0)	221 (92.1)	**.003**
Insurance Type, No. (%)			
Medicare	287 (61.3)	118 (49.2)	**.002**
Medicaid	259 (55.3)	130 (54.2)	.77
Private or Supplemental	134 (28.6)	75 (31.3)	.47
Primary Language, No. (%)			.180
English	293 (62.6)	134 (55.8)	
Spanish	165 (35.3)	98 (40.8)	
Other (French/Creole/Arabic/Russian)	10 (2.1)	8 (3.3)	
Has Own Eye Doctor, No. (%) (Access to Eye Care)	152 (32.5)	62 (25.8)	.07

Abbreviation: SD, standard deviation.

[a]Bold P *V*alue indicates statistical significance at the $p \leq 0.05$ level.

[b]Hispanic ($n = 297$) + Multiethnic ($n = 17$).

Table 2.

Manhattan Vision Screening and Follow-up Study (NYC-SIGHT): medical and ocular history and telemedicine findings of those referred to ophthalmology.

Variables	Referred to Ophthalmology (*n* = 468)	Not Referred to Ophthalmology (*n* = 240)	*P* Value[a]
Medical Conditions (Self-Reported), No. (%)			
Hypertension	307 (65.6)	137 (57.1)	**.03**
Diabetes	151 (32.3)	55 (22.9)	**.01**
Arthritis/osteoporosis	220 (47.0)	107 (44.6)	.54
Foot problems	160 (34.2)	91 (37.9)	.33
Heart problems	98 (20.9)	41 (17.1)	.22
Depression	85 (18.2)	40 (16.7)	.62
Asthma/COPD	82 (17.5)	36 (15.0)	.39
Cancer	32 (6.8)	15 (6.3)	.77
Other medical conditions	53 (11.3)	27 (11.3)	.98
No medical conditions	43 (9.2)	37 (15.4)	**.01**
Current Smoker, No. (%)	66 (14.1)	37 (15.4)	.64
Ocular Conditions (Self-Reported), No. (%)			
Dry eye	218 (46.6)	113 (47.1)	.90
Blurry vision	175 (37.4)	97 (40.4)	.43
Cataract	148 (31.6)	51 (21.3)	**.004**
Glaucoma	71 (15.2)	12 (5.0)	**<.001**
Floaters	72 (15.4)	39 (16.3)	.76
Double vision	27 (5.8)	24 (10.0)	**.04**
Diabetic retinopathy	9 (1.9)	4 (1.7)	.81
Macular degeneration	7 (1.5)	1 (0.4)	.20
No ocular conditions	94 (20.1)	60 (25.0)	.13
Family History (Self-Reported), No. (%)			
Family history of glaucoma	113 (24.1)	55 (22.9)	.72
Family history of blindness	47 (10.0)	25 (10.4)	.88
Wears Prescription Eyeglasses, No. (%)	347 (74.1)	157 (65.4)	**.02**
Age of Eyeglasses, No. (%)			.092

Variables	Referred to Ophthalmology (*n* = 468)	Not Referred to Ophthalmology (*n* = 240)	*P* Value[a]
Less than 1 year	60 (17.3)	41 (26.1)	
1 to 2 years	83 (23.9)	40 (25.5)	
More than 2 years	174 (50.1)	64 (40.8)	
Can't remember	30 (8.6)	12 (7.6)	
Last Dilated Eye Exam, No. (%) *(Eye Health Screening Protocol)*			.134
Within the past year	114 (24.4)	53 (22.1)	
Within 1 to 2 years	105 (22.4)	58 (24.2)	
More than 2 years	173 (37.0)	77 (32.1)	
Can't remember	53 (11.3)	29 (12.1)	
Never had eye exam	23 (4.9)	23 (9.6)	
Reason No Eye Exam in 2 Years, No. (%)			.075
No reason to go	62 (25.1)	46 (36.2)	
Not thought about it	37 (15.0)	22 (17.3)	
No vision insurance	13 (5.3)	12 (9.4)	
Cost of eye exam	8 (3.2)	2 (1.6)	
Don't have an eye doctor	12 (4.9)	4 (3.1)	
Couldn't get appointment	8 (3.2)	3 (2.4)	
No transportation to office	4 (1.6)	0 (0.0)	
Other, including COVID-19 pandemic	103 (41.7)	38 (29.9)	
NEI-VFQ-9 Mean Composite Score (SD) [b]	76.7 ± 14.9	80.0 ± 14.2	**.004**

Abbreviations: COPD, Chronic Obstructive Pulmonary Disease; NEI-VFQ-9, National Eye Institute Visual Function Questionnaire; SD, standard deviation.

[a] Bold *P* Value indicates statistical significance at the $p \leq 0.05$ level.

[b] NEI-VFQ-9 score is a validated score consisting of 9 questions with 5–6 levels, a higher score being "better" or more visual function.

Table 3.

Manhattan Vision Screening and Follow-up Study (NYC-SIGHT): eye health screening and eye exam results of those referred to ophthalmology.

Variables	Referred to Ophthalmology (*n* = 468)	Not Referred to Ophthalmology (*n* = 240)	*P* Value[a]
Failed Eye Health Screening, No. (%)	406 (86.8)	149 (62.1)	**<.001**
Reason for Failure, No. (%)			
Visual acuity 20/40 or worse	375 (80.1)	122 (50.8)	**0.000**
IOP 23–29 mmHg	44 (9.4)	5 (2.1)	**0.000**
Unreadable image	117 (25.0)	58 (24.2)	0.808
Visual Acuity Based on Worse Eye, Mean (SD), logMAR [b]	0.58 ±0.53	0.32 ± 0.36	**<.001**
Visual Acuity Based on Worse Eye, No. (%)			**<.001**
No vision impairment logMAR 0–0.2 (20/20, 20/25, 20/30)	94 (20.1)	117 (49.0)	
Mild vision impairment logMAR 0.3–0.4 (20/40, 20/50)	141 (30.2)	68 (28.5)	
Moderate vision impairment logMAR 0.5–0.7 (20/60, 20/70, 20/80, 20/100)	148 (31.7)	43 (18.0)	
Severe vision impairment logMAR 1.0–3.0 (20/200, CF, HM, LP, NLP)*	84 (18.0)	11 (4.6)	
IOP (mmHg), Mean (SD)			
Left eye (*n* = 706)	15.0 (4.7)	14.5 (3.5)	.14
Right eye (*n* = 705)	15.0 (4.8)	14.6 (3.4)	.15
Fast-Tracked Participants IOP ≥30 mmHg, No. (%) (n = 7)	7 (1.5)	0 (0.0)	.06
Telemedicine Image Reading Results by Worse Eye,[c] No. (%)			**<.001**
Normal image	91 (19.9)	162 (67.5)	
Abnormal image, no significance	10 (2.1)	16 (6.7)	
Abnormal image	250 (53.0)	0 (0.0)	
Unreadable	117 (25.0)	58 (24.2)	

Abbreviations: IOP, intraocular pressure; SD, standard deviation; logMAR, logarithm of the minimum angle of resolution; CF, count fingers; HM, hand motion; LP, light perception; NLP, no light perception.

[a] Bold *P* Value indicates statistical significance at the $p \leq 0.05$ level.

[b] logMAR converted from Snellen eye chart visual acuity.

[c] n = 704 participants had fundus images taken.

Table 4.

Manhattan Vision Screening and Follow-up Study (NYC-SIGHT): stepwise * multivariate logistic regression model estimating factors associated with referral to ophthalmology.

Variables	Odds Ratio (95% CI)	*P* Value[a]
Glaucoma (Pre-existing)		
No	Ref	**Ref**
Yes	3.14 (1.62–6.08)	**.001**
Reason(s) participant failed eye health screening		
IOP <23 mmHg	Ref	**Ref**
IOP ≥23 mmHg	5.04 (1.91–13.28)	**.001**
Visual Acuity at screening		
No vision impairment	Ref	**Ref**
Mild vision impairment	2.51 (1.68–3.77)	**<.001**
Moderate vision impairment	4.37 (2.81–6.81)	**<.001**
Severe vision impairment	8.72 (4.36–17.46)	**<.001**

Abbreviations: CI, confidence interval; IOP, intraocular pressure; SD, standard deviation; Ref, Reference.

[a] Bold *P* Value indicates statistical significance at the $p \leq 0.05$ level.

* At each step, variables were added based on the alpha-to-enter significance level of 0.05 and the alpha-to-remove significance level was set at 0.1 to exclude variables in the final model.