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Manhattan Vision Screening and Follow-Up Study (NYC-SIGHT): optometric exam improves access and utilization of eye care services

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Abstract

Purpose—To describe the benefits of optometric evaluation for detection of vision-affecting conditions in the context of community-based eye health screenings and identify factors associated with having a recent dilated eye exam.

Methods—Enrolled participants were age 40 and older, living independently in affordable housing developments in New York City. Eye health screening failure and criteria for seeing the on-site study optometrist were defined as visual acuity 20/40 or worse in either eye, intraocular pressure 23–29 mmHg, or an unreadable fundus image. The optometrist conducted a manifest refraction using loose lenses and used a portable slit lamp and ophthalmoscope to perform a non-dilated anterior and posterior segment ocular health evaluation. Demographics, social determinants of health, eye health screening results, and rates of suspected ophthalmic conditions were recorded. To determine factors associated with having a recent dilated eye exam, which was the main outcome for this statistical analysis, a stepwise multivariate logistic regression was performed.

Results—A total of 708 participants were screened, 308 attended the optometric exam; mean age 70.7 ± 11.7 [standard deviation (SD)] years. Among this subgroup, 70.1% identified as female,

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Ethics approval The study was approved by the Columbia University Institutional Review Board and was conducted in accordance with the Declaration of Helsinki (CUIMCIRB #AAAR9162). The study is registered with ClinicalTrials.gov (NCT04271709).

Informed consent All participants provided informed consent before participating in this study.

54.9% self-identified as African American, 39% as Hispanic/Latino, and 26.6% Dominican ethnicity; 78.2% (241/308) had not undergone a dilated eye exam within the last year, 71.4% reported they did not have an eye care provider. Stepwise multivariate logistic regression analysis indicated that participants who self-reported having cataracts (odds ratio (OR) 2.15; 95% confidence interval (CI) 1.03–4.47; $p = 0.041$), self-reported having glaucoma/glaucoma suspect (OR 5.60; 95% CI 2.02–15.43; $p = 0.001$), or spoke Spanish as their primary language (OR 3.25; 95% CI 1.48–7.11; $p = 0.003$) had higher odds of having a recent dilated eye exam.

Conclusions—This community-based screening initiative demonstrated the effectiveness of optometric exams in detecting vision-affecting conditions and identified factors associated with having a recent dilated eye exam. Optometrists play a vital role in increasing access to eye care for high-risk, underserved populations.

Trial registration—ClinicalTrials.gov (NCT04271709).

Keywords

Vision impairment; Optometric exam; Refraction; Eye health screening; Health-care access; Optometrist; Community-based

Introduction

Vision impairment affects a significant number of individuals worldwide, with at least 771 million people having eye conditions that are preventable or treatable [1]. Refractive error, cataracts, glaucoma, and diabetic retinopathy can be successfully managed if identified, diagnosed, and treated in a timely manner [2], Studies have shown that racial/ethnic minority populations, socioeconomically disadvantaged populations, and underserved urban and rural populations bear the greatest burden of visual impairment and are the least likely to seek out comprehensive eye care [3–9]. Consequently, the challenges lie in the complexity of treatments or incurable ocular conditions, as well as delivering care to communities that need it the most. Therefore, it is crucial to implement innovative interventions that improve access to and utilization of eye care for communities in need.

Community-based screenings are invaluable tools for efficiently assessing the health of a population and they offer a unique opportunity to deliver eye care services beyond traditional clinical settings. School-based vision screenings have proven highly effective in identifying refractive errors and congenital ocular conditions in pediatric populations [10–12], Similarly, adult eye health screenings have been successfully implemented in various locations, including Pennsylvania, Maryland, Nebraska, Michigan, and Alabama [13–16]. Certain ocular conditions, such as glaucoma, may not exhibit noticeable signs or symptoms until advanced stages making it crucial to develop systems for identifying asymptomatic, at-risk individuals in order to prevent blindness [17,18]. Similarly, research has demonstrated the limited effectiveness of primary care practitioner evaluations in detecting ocular conditions among asymptomatic patients, underscoring the need for specialized eye care practitioners to target populations at-risk of vision loss [8]. Recent advancements in ocular imaging and telehealth, however, have facilitated the remote identification of eye health conditions by trained eye care specialists [19]. These technologies enable efficient and accurate assessments of ocular conditions, even in underserved or remote areas, and may improve access to eye care.

In 2019, the Centers for Disease Control and Prevention (CDC) Vision Health Initiative funded three 5-year research grants to develop innovative eye health screening strategies for high-risk populations to investigate how to best provide targeted community-based eye health screenings. The *Screening and Intervention for Glaucoma and Eye Health Through Telemedicine* (SIGHT) studies are taking place in New York City (NYC), Alabama, and Michigan (SIGHTSTUDIES.org) [17]. In NYC, the *Manhattan Vision Screening and Follow-up Study* (NYC-SIGHT) was specifically designed by Columbia University Department of Ophthalmology researchers to improve early detection and management of glaucoma and other eye diseases in underserved populations living in Upper Manhattan. The study targets underserved populations using a community-based approach to improve access to and utilization of eye care services for those who are least likely to seek eye care [20]. The study was conducted in the Harlem and Washington Heights neighborhoods and initiated in 2020 prior to the COVID-19 pandemic. In this paper, we describe a new intervention that starts with an eye health screening followed by an optometric exam. We then analyze its effectiveness in the detection and treatment of vision-affecting conditions in the NYC-SIGHT study. We also identify factors associated with having a recent dilated eye exam in the study population, with the purpose of improving access to eye care by targeted community-based eye health screenings.

Methods

Study design

This study is a subanalysis of results from a 5-year prospective, cluster-randomized clinical trial. The methods have been previously published [20].

Inclusion criteria

Individuals age 40 years and older living in a New York City Housing Authority (NYCHA) development or a Department for the Aging (DFTA) Senior Center member over age 60 and willing to consent to a baseline eye health screening. Those who met the study's inclusion criteria were consented over the telephone (verbal) or in person (written), in English or Spanish, by the bilingual study coordinators. No monetary or other incentive was provided to participants.

The study was approved by the Columbia University Irving Medical Center Institutional Review Board (IRB) (#AAAR9162), and all aspects were conducted in accordance with the Declaration of Helsinki and were HIPAA compliant. Informed consent was obtained from all participants prior to enrollment and the study was registered on ClinicalTrials.gov (NCT04271709).

Target population

The study targeted and recruited high-risk individuals with inadequate eye care who fall at or below the NYC.gov poverty measure living in the zip codes 10027,10029,10030, 10031,10032, 10035, 10037, and 10039 [21]. Ten affordable housing developments were selected by NYCHA near Columbia Ophthalmology and Harlem Hospital, which gave the study team access to a sample frame of 6640 eligible individuals (Fig. 1).

Cluster randomization

A cluster-randomized design was chosen by housing development and in order for more people to benefit from the intervention, a 2:1 randomization scheme was established. Since there are 6640 residents living in 10 housing developments, randomization accounted for size within each development. We first randomly selected the development for the Intervention Arm, which resulted in seven developments for Intervention ($n = 4447$) and three developments for usual care ($n = 2193$). The study was unmasked.

Intervention versus usual care groups

Participants living in developments randomized to the Intervention Group who failed the eye health screening and needed vision correction, received complimentary eyeglasses. If they were referred to ophthalmology, they received enhanced support from patient navigators who assisted with scheduling eye exam appointments over a 1-year period. Participants living in developments randomized to the usual care group who failed the eye health screening and needed vision correction were given an eyeglass prescription only and a list of optical shops. No enhanced support related to in-office eye exam appointments was given to the usual care group. All participants referred to ophthalmology were assisted with making the initial in-office eye exam appointment.

Participant recruitment

Recruitment at the NYCHA developments and DFTA Senior Centers in Harlem and Washington Heights targeted high-risk individuals and used a variety of recruitment methods. English and Spanish IRB-stamped approved flyers were distributed to all residents' apartments, posted in elevators and lobbies, sent via email by NYCHA, and distributed during community and food donation events, COVID-19 vaccinations, and health fairs. Recruitment and enrollment took place from March 1, 2021 to May 31, 2022.

Pre-screening assessment

On the telephone or in-person and prior to the eye health screening, demographics (age, sex, ethnicity, and race) and social determinants of health (employment, education level, marital status, and insurance type) were asked of all participants. To assess access to eye care, participants were asked if they have their own eye doctor, date of their last dilated eye exam, and if the exam was more than 2 years ago, what was the main reason for not having this eye exam. Ocular and medical history, ocular medications, use of prescription eyeglasses, and family history of glaucoma and blindness were also captured during the pre-screening assessment.

Eye health screening

Screenings were conducted in 10 NYCHA developments over 2 days per week for 4 to 12 weeks in either the community room or the senior center located in the same location or nearby. Visual acuity was measured by trained community health workers with a Snellen eye chart at 20 feet with correction. Screening failure was defined as visual acuity 20/40 or worse in either eye. All visual acuity data were converted to the logarithm of the minimum angle of resolution (logMAR) for analysis. Per the World Health Organization and the International Classification of Disease, mild vision impairment was visual acuity based on worse eye: 20/40 to 20/60 (logMAR 0.3–0.48), moderate vision impairment from 20/70 to 20/100 (logMAR 0.54–0.7), and severe vision impairment from 20/200 or worse including count fingers, hand motion, light perception, and no light perception (logMAR 1.0–3.0) [22].

Intraocular pressure (IOP) was obtained by the study ocular technician in both eyes using the IclOO iCare rebound tonometer (iCare, Helsinki, Finland), and those with IOP 23 to 29 mmHg in either eye were referred to the optometrist. If IOP was ≥ 30 mmHg, participants were “fast-tracked” and immediately referred to ophthalmology.

Fundus images were taken by the study ocular photographer using the non-mydriatic (non-dilated), autofocus, hand-held fundus camera (Volk Pictor Prestige; Volk Optical, Mentor, OH) and read and graded remotely by two study ophthalmologists specializing in retina and glaucoma. Final image reading results were based on the worse eye as (1) normal or abnormal with no significant findings, (2) abnormal with significant findings, or (3) unreadable. Participants with visual acuity 20/40 or worse, IOP 23–29 mmHg, or an unreadable image were scheduled to see the on-site study optometrist in the same community location within 3 weeks for their initial appointment.

Optometric exam protocol

The study optometrist obtained baseline uncorrected refractive error using the autorefractor (QuickSee Autorefractor, Plenoptika, Cambridge, MA, USA). To determine the best corrected visual acuity, manifest (non-dilated) refraction was conducted using loose lenses and a trial frame (Goldenwall Adjustable Trial Frame Optical Trial Lens Frame PD 54–70 mm TF-BT). Near acuity was also evaluated by looking at the reading card (Rosenbaum Pocket Vision Card, Amazon), and necessary reading add was determined with additional loose lenses. Best corrected near visual acuity was recorded in both eyes in Jaeger notation, and refractive error was recorded in minus cylinder form.

Participants randomized to the Intervention Arm who needed vision correction received complimentary eyeglasses and a technician measured their pupillary distance and assisted in picking out frames (Warby Parker, New York, NY). Usual care participants who needed vision correction were given an eyeglass prescription only and a list of optical shops within 1 mile from the NYCHA location.

The optometrist used a portable slit lamp [(PSL, 3010-P-2000 1) Keeler USA, Malvern, PA] and ophthalmoscope (Welch Allyn Panoptic 3.5 V, Skaneateles Falls, NY, USA) to perform a non-dilated anterior and posterior segment ocular health evaluation. An ophthalmoscopic exam of the optic nerve was conducted to diagnose glaucoma and glaucoma-suspect based on the American Academy of Ophthalmology *Practice Pattern Guidelines®* [23]. Participants were not dilated because of the limited space and time available at the setting, and the intention of the study was not to have a community-based optometric exam to replace an in-office comprehensive dilated eye exam. The optometrist diagnosed cataracts and other ocular conditions and referred participants for an in-office comprehensive dilated eye exam.

The criteria for referral also included those participants who had not received a dilated eye exam within the last 2 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 Safety and Monitoring Committee. 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.

Satisfaction survey

Upon completion of the optometric exam, participants were asked to rate their level of satisfaction with the exam, the optometrist who conducted it, and their likelihood of attending an in-office dilated eye exam if referred to ophthalmology. Satisfaction levels were evaluated using a 4-point scale, ranging from “very satisfied” to “satisfied,” “dissatisfied,” and “very dissatisfied” and “very likely” to “somewhat likely,” “not very likely,” and “not at all likely.”

Statistical analysis

Study data were collected and managed using Research Electronic Data Capture (REDCap) tools hosted at Columbia University [24,25]. Statistical analyses were performed in IBM SPSS version 25 and R Foundation for Statistical Computing Platform version 4.1.2 [26, 27]. Participant characteristics were summarized for the entire sample using means and standard deviations for continuous variables and frequencies and percentages for categorical variables. Outcome measures included demographic characteristics, social determinants of health, (ethnicity, race, age, sex, employment, education level, marital status, and insurance type), eye health screening results, and rates of suspected glaucoma and other eye diseases in the study population. Factors associated with having a recent dilated eye exam were the main outcome for this statistical analysis.

A chi-square test was conducted for each level of a categorical variable between those who had a dilated eye exam in the past year versus those who did not, could not remember their last eye exam, or never had an eye exam, 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. 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 having a recent dilated eye exam to determine odds ratios (OR) at the 95% confidence intervals (CI). 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

Enrollment and baseline characteristics

Over a 15-month period from March 1, 2021, to May 31, 2022, a total of 708 participants provided consent and successfully completed the eye health screening. Based on the screening criteria of visual acuity of 20/40 or worse, IOP readings of 23–29 mmHg, or an unreadable fundus image, 365 participants were referred to the study optometrist (Fig. 1). Out of these referred participants, 308 (84.3%) attended the optometric eye exam at the community site. Participants who were examined by the optometrist had a mean age of 70.7 ± 11.7 [standard deviation (SD)] years (Table 1). Among this subgroup, 70.1% identified as female, 54.9% identified as African American, and 39% as Hispanic. Notably, the largest Hispanic subgroup within this category was of Dominican ethnicity, accounting for 26.6% of the participants. Nearly all participants who failed the initial eye health screening and saw the optometrist had health insurance (94.8%) with Medicare being the primary form of insurance for 62% of participants, followed by Medicaid (53.6%), and private or supplemental insurance (25.3%). In addition, most of this subgroup of participants reported being single, divorced, separated, or widowed (76.6%), spoke English as their primary language (62.7%), were retired (65.6%), and had some level of college education, ranging from partial college attendance to having attained a college or graduate degree (37.3%). Regarding access to eye care, 71.4% reported that they did not have an eye care provider (Table 1).

Of the participants who failed the initial eye health screening and subsequently saw the on-site study optometrist, 241 (78.2%) had not undergone a dilated eye exam within the past 12 months. Table 1 presents the comparisons between the social determinants of health of those who self-reported having a dilated eye exam in the past year and those who did not. Participants who were seen by the optometrist and self-reported that they did have a dilated eye exam in the past year were more likely to be older (mean age 75.3 vs. 69.5) ($p = 0.000$), of Hispanic/Latino ethnicity ($p = 0.004$), retired ($p = 0.019$), covered by Medicare ($p = 0.016$) or Medicaid ($p = 0.005$) insurance, speak Spanish as their primary language ($p = 0.006$), and had access to their own eye doctor ($p = 0.000$) (Table 1). Conversely, those who had not undergone a dilated eye exam in the past year were more likely to be African American ($p = 0.004$), younger, fall within the age range of 40 to 59 years ($p = 0.008$), employed ($p = 0.019$), speak English as their primary language ($p = 0.006$), and have some level of college education ($p = 0.125$) (Table 1).

Table 2 shows the comparisons between the ocular and medical history of those who self-reported they had a dilated eye exam in the past year and those who did not. The findings indicate that participants who had a dilated eye exam in the past year were more likely to self-report glaucoma ($p = 0.000$), cataracts ($p = 0.002$), and have eyeglasses that were prescribed less than a year ago ($p = 0.000$). Additionally, Table 2 demonstrates that participants who indicated no ocular conditions ($p = 0.041$) and reported wearing eyeglasses that were prescribed more than 2 years ago ($p = 0.000$) were less likely to have had a dilated eye exam in the past year.

Optometrist eye exam findings

A total of 70.5% (*n* = 218) of those who completed the community-based optometric exam were referred to ophthalmology (Table 2 and Fig. 1). Reasons for referral included glaucoma/glaucoma suspect (*n* = 51), cataracts (*n* = 74), retinal abnormalities (*n* = 17), other ocular diagnoses (*n* = 22), and the need for an annual dilated eye exam (*n* = 103), with many participants needing referral for more than one reason (Table 2).

Stepwise multivariate logistic regression analysis

All OR listed in Table 3 were adjusted for other significant variables; 95% confidence intervals (95% CI) are included in parentheses. The results of a stepwise multivariate logistic regression analysis revealed that participants who self-reported having cataracts (OR 2.15; 95% CI 1.03–4.47; $p = 0.041$), self-reported having glaucoma/glaucoma suspect (OR 5.60; 95% CI 2.02–15.43; $p = 0.001$), or spoke Spanish as their primary language (OR 3.25; 95% CI 1.48–7.11; $p = 0.003$) had significantly higher odds of having undergone a recent dilated eye exam (Table 3).

The stepwise multivariate logistic regression analysis indicated that compared to individuals who reported their prescription eyeglasses to be less than 1 year old, those who self-reported their eyeglasses to be less than 2 years old (OR 0.20; 95% CI 0.07−0.58; $p = 0.003$), more than 2 years old (OR 0.19; 95% CI 0.08–0.47; $p = 0.000$), or could not recall the age of their prescription eyeglasses (OR 0.18; 95% CI 0.04–0.94; $p = 0.041$) had lower odds of having undergone a recent dilated eye exam (Table 3).

Satisfaction survey

The optometrist eye exam received highly positive ratings from participants as shown in Fig. 2. A high percentage of the participants reported being “very satisfied” with the convenience of the exam (93%), the optometrist (90%), eye exam (86%), and the duration of the exam (84%). None of the participants expressed dissatisfaction with any aspect of the exam. A total of 95% of participants expressed a high level of willingness (very likely) to attend an appointment with an ophthalmologist if there were referred by the optometrist.

Discussion

Over the past 50 years, legislative changes have expanded the scope of practice for optometrists in the USA, allowing them to assume the role of primary ocular healthcare providers for the majority of Americans [22], In line with this advancement, the NYC-SIGHT Study was conducted to provide community-based eye health screenings and optometric exams to underserved NYC residents living in Upper Manhattan in affordable housing developments. Over half of the participants (51.6%) were referred to the optometrist, and of those, an impressive 83% attended the community-based optometric exam, significantly higher than previously reported [28–30].

The study optometrist provided participants with education regarding the nature of their eye condition(s) and emphasized the importance of regular ocular health evaluations. By evaluating participants with an unreadable image, the optometrist was successfully able to detect ocular diseases that were not visible to the remote study ophthalmologists. The optometric exam also led to the detection of cataracts, glaucoma, and dry eye syndrome, which would have otherwise gone undetected (Fig. 1). Additionally, the optometrist was able to diagnose and treat refractive error conditions in 30% of participants without the need for further follow-up. These findings underscore the importance of optometric evaluations in community-based eye health screenings and highlight the unique benefits optometrists can provide in identifying and addressing a range of potential ocular pathology.

Younger participants and those with a college education were less likely to have undergone a recent dilated eye exam compared to their older or less educated peers, most likely due to the asymptomatic nature of eye diseases. These findings suggest that younger and college-educated populations may perceive a lower urgency in prioritizing their eye health. Thus, the importance of annual dilated eye exams as preventive eye care was stressed, especially for those who had diabetes, hypertension, or a family history of glaucoma or blindness. By raising awareness and promoting education on the significance of regular dilated eye exams, we can better advocate for early detection and intervention in underserved populations.

Previous research has identified various factors contributing to non-adherence to having an annual dilated eye exam, including time constraints, transportation challenges, lack of awareness, or low prioritization of eye care [31, 32], These barriers further emphasize the benefits of community-based screenings. By conducting screenings in the community rooms or senior centers near participants' homes, we can reach those who may otherwise be unlikely to receive eye care and educate participants on the importance of regular comprehensive eye exams.

Participants who identified as African American were less likely to have undergone a recent dilated eye exam compared to those identifying as Hispanic or Latino. This disparity underscores the need for more targeted eye health screening initiatives to address the specific needs of communities. By targeting underserved populations where they live and bringing eye care to these communities, we can work towards reducing disparities and ensuring equal access to eye care for all individuals.

Most participants who were referred for the optometric exam self-reported a concurrent medical condition, with hypertension and diabetes being the most common. If not properly managed, these conditions can cause vision-threatening retinopathy in addition to their host of systemic effects [28, 33]. This further emphasizes the importance of the interaction between the eye care provider and the participants, not only for their ocular health but also for their overall well-being.

Numerous other community-based studies conducted over the past 10 years have effectively targeted high-risk populations and identified those with both early and later stages of glaucoma and other eye diseases [14, 34–37]. The SToP Glaucoma program, for example, included a screening visit in a community setting with a follow-up visit at Wilmer Eye Institute for those who screened positive—of all participants referred, 57% attended the follow-up visit. Our study's high show-rate at the community based optometric exam may suggest the effectiveness of providing ocular evaluations in the community-based setting where the initial screening took place, despite being a non-dilated exam. Previous studies, including the SToP Glaucoma study, have found that a longer distance between the initial screening site and hospital was a risk factor for loss to follow-up. In these studies, free transportation to the site of the follow-up visit was provided for participants to mitigate this risk [34, 38–40]. The implementation of free transportation requires additional financial support. By having the eye exam in the same location as the screening as in this study, we can further reduce one of the many risk factors of loss to follow-up in a cost-efficient manner.

Our ocular screening model was novel in that we aimed to detect a wide range of ocular diseases including glaucoma, cataracts, diabetic retinopathy, and refractive error [14]. Overall, the high detection rates observed in our study and similar community-based initiatives highlight the effectiveness of providing eye care services in the community setting and emphasize the importance of targeting high-risk populations.

Strengths

The study was conducted during the COVID-19 pandemic and as a result, the IRB allowed all consenting and pre-screening questionnaires to be conducted over the telephone. This adaptation reduced the time spent in the community with each participant from 90 to 20 min which allowed us to see more participants and keep wait times down. Another strength of the study was our ability to recruit, enroll, and screen a large and diverse sample size of underserved adults and seniors which included 51.8% African Americans and 42% Hispanic participants, spanning an age range from 40 to 99 years.

Limitations

The targeted population that attended the initial eye health screening and subsequent follow-up exams was self-selected and therefore is a limitation of our study. This self-selection introduces the possibility of sampling bias, as individuals who are asymptomatic or unaware of their vision issues may be less likely to participate. Similarly, those with known vision or ocular health issues may have been more motivated to attend the screening due to their awareness of the importance of their ocular health. It is important to note that ocular health evaluations using a portable slit lamp and ophthalmoscope in a non-dilated setting are not as accurate at diagnosing ocular diseases as an in-office exam with dilation. The use of a trial frame refraction following an autorefractor may not be as effective as using an in-office phoropter for refraction, but the selection of equipment was made to accommodate the volume of exams and expedite the process at these locations. The decision to include “no recent dilated eye exam” as a reason for referral may have increased the study population’s rate of eye pathology, but many of these individuals had diabetes and/or hypertension without any ocular disease, and we did not want the community-based screening to be a substitute for an annual dilated eye exam. These limitations should be taken into account when interpreting the study’s results, and future analysis will include adherence to attending the follow-up eye exam appointments for those referred to ophthalmology.

Conclusion

Doctors of optometry, who are health professionals trained specifically in diagnosing and treating the health of the eye, specialize in refractive error and vision abnormalities, and are uniquely qualified to lead community-based eye health screening programs and studies. The implications are that community-based eye health screenings which included an optometric exam, achieved high detection rates, and were performed in a convenient setting with high satisfaction rates. Eye health screenings can be conducted in senior centers, Federally Qualified Health Centers, primary care settings, and public housing facilities, and these results are generalizable and scalable to a national level. To improve efficiency in future studies, the optometrist can attend on the same day as the eye health screening for future studies. By leveraging the expertise of optometrists, we can make significant progress in reducing eye health disparities and ensuring access to eye care for underserved populations.

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Competing interests

The authors have made the following disclosures: JDH: Member Medical Policy Council of Superior Vision. JML has received research support from National Institutes of Health, Heidelberg Engineering, Novartis, Inc., and is a consultant to Allergan, Inc., Genentech, Inc., Thea Pharmaceuticals, Inc., and Janssen Pharma, Inc. All other authors have no relevant financial or non-financial interests to disclose.

Data availability

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

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Key messages

What is known:

- Vision impairment is a major public health problem that is preventable and treatable.
- Underserved populations have the highest incidence of preventable vision loss and are the least likely to seek out eye care and obtain annual dilated eye exams.
- Vision and eye health disparities are highly prevalent in underserved populations and community-based eye health screenings which include support for follow-up eye care are needed

What is new:

- Community-based eye health screenings that included an optometric exam had high show rates (83%) and detected and diagnosed ocular conditions in a convenient setting with high satisfaction rates.
- A large and diverse sample size of underserved adults and seniors (51.8% African Americans and 42% Hispanic), ranging in age from 40 to 99 years, were recruited, enrolled, and screened in community-based settings in New York City.
- Optometrists can detect and diagnose a range of potential ocular pathology requiring referral to ophthalmology for dilated eye exams, ocular testing, and cataract surgery.

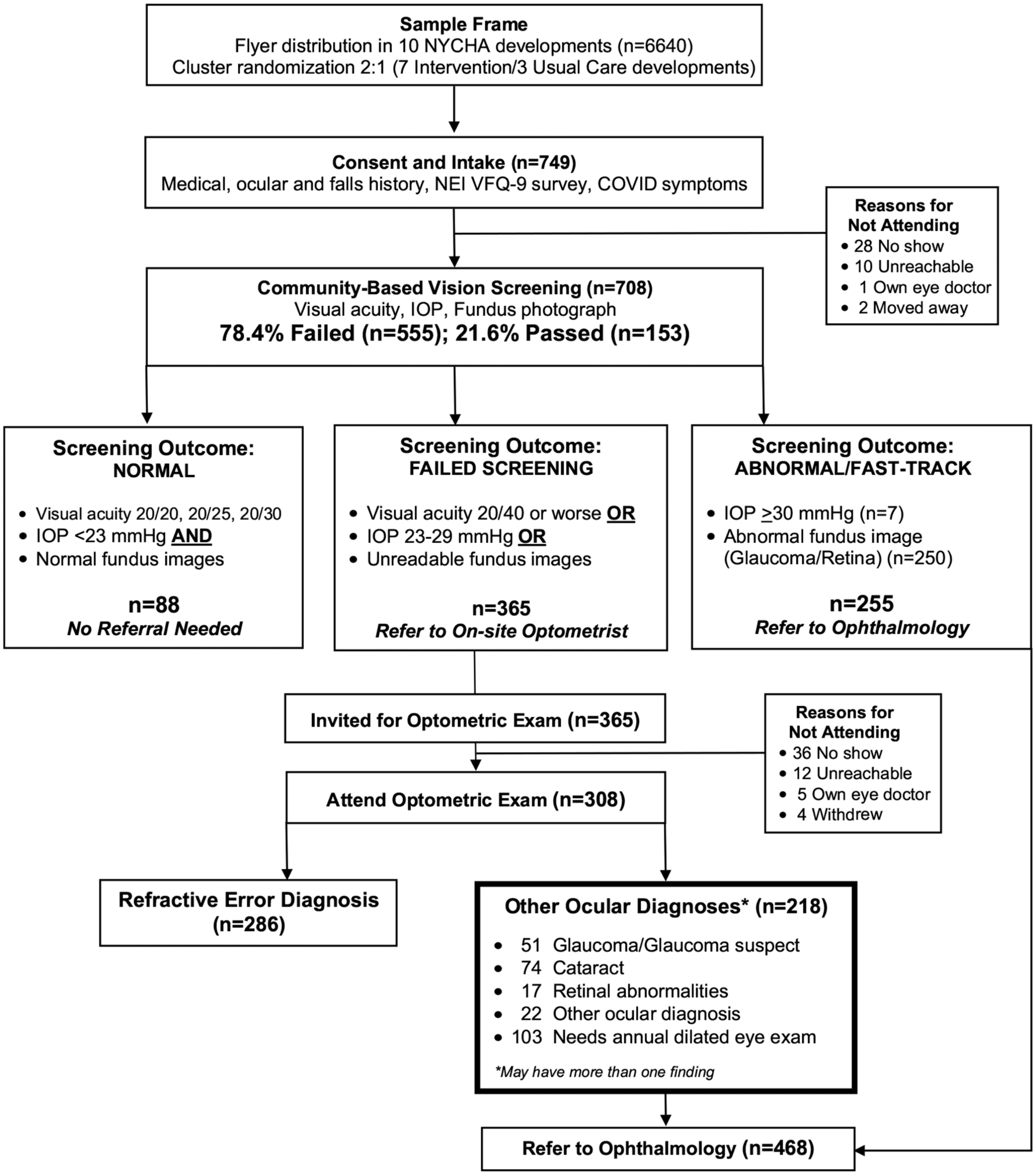

Fig. 1.

Consolidated Standards of Reporting Trials (CONSORT) diagram for optometric exam. Consolidated Standards of Reporting Trials (CONSORT) diagram showing study flowchart. The study recruited participants by distributing flyers (top center). Before the eye health screening, the call center obtained verbal informed consent, intake data, National Eye Institute Visual Function Questionnaire (NEI VFQ-9), and COVID-19 history from the participants (second row). All enrolled participants were then scheduled for eye health screenings at specific locations, namely, the New York City Housing Authority (NYCHA) developments and New York City Department for the Aging (DFTA) Senior Centers (third row). The outcome of the eye health screening was categorized into three groups: normal, failed screening, or abnormal/fast-track (fourth row). Participants who failed the eye health screening were subsequently scheduled to see an on-site optometrist (fifth row). The reasons for some participants not attending the optometrist appointment are indicated (fifth row right). Most of the participants attended the optometrist examination, during which any refractive errors (sixth row left) and other ocular diagnoses (sixth row right) were identified by the optometrist. If necessary, the optometrist referred the participants to ophthalmology, and some were referred based on the abnormal/fast-track screening outcome (seventh row)

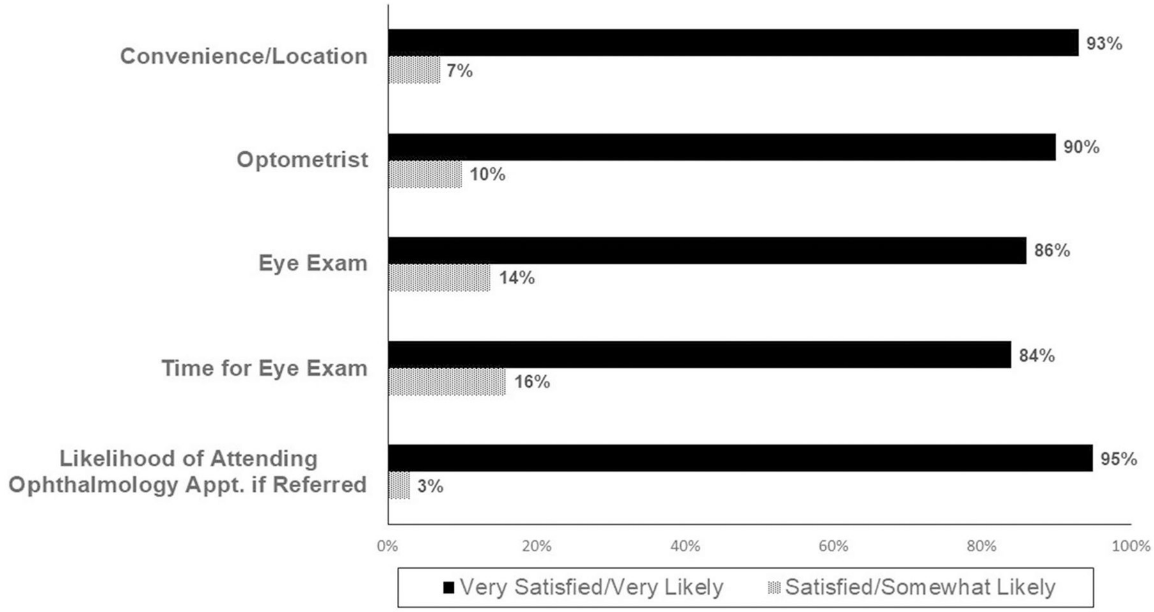

Fig. 2.
Optometric exam satisfaction survey results. The depicted graph illustrates the outcomes of a satisfaction survey that inquired about various aspects of the exam in the following order from top to bottom: convenience/location, optometrist, eye exam, time for eye exam, and the likelihood of attending a follow-up appointment to ophthalmology. Participants' satisfaction levels were gauged using a 4-point scale, encompassing "very satisfied," "satisfied," "dissatisfied," and "very dissatisfied." Similarly, their likelihood of attending a follow-up appointment with ophthalmology was assessed on a scale ranging from "very likely" to "somewhat likely," "not very likely," and "not at all likely." "Very satisfied" and "very likely" are represented by the black solid bar and "satisfied" and "likely" are represented by the gray sold bar

Table 1

Manhattan Vision Screening and Follow-up Study (NYC-SIGHT): baseline demographics and social determinants of health of participants seen by the optometrist

Variable	**Total participants examined by optometrist (*n* = 308)**	**Participants with no dilated eye exam in over a year/never/cannot remember (*n* = 241, 78.2%)**	**Participants who had a dilated eye exam in past year (*n* = 67, 21.8%)**	***p* value**
Mean age ± SD	70.7 years ± 11.7	69.5 years ± 11.5	75.3 years ± 11.2	**0.000** **
Age categories, *n* (%)				**0.008**
40–59 years	55 (17.9)	49 (20.3)	6 (9)	
60–79 years	185 (60.1)	147 (61)	38 (56.7)	
≥80 years	68 (22.1)	45 (18.7)	23 (34.3)	
Sex, *n* (%)				0.226
Female	216 (70.1)	165 (68.5)	51 (76.1)	
Male	92 (29.9)	76 (31.5)	16 (23.9)	
Ethnicity/race, *n* (%)				**0.004**
Hispanic/Latino	120 (39.0)	83 (34.4)	37 (55.2)	
African American (Non-Hispanic)	169 (54.9)	140 (58.1)	29 (43.3)	
Other (multiracial, White, Asian, American Indian)	19 (6.2)	18 (7.5)	1 (1.5)	
Hispanic origin, *n* (%)				0.054
Dominican	82 (26.6)	56 (23.2)	26 (38.8)	
Puerto Rican	22 (7.1)	17 (7.1)	5 (7.5)	
Mexican	1 (0.3)	1 (0.4)	0 (0.0)	
Cuban	4 (1.3)	4 (1.7)	0 (0.0)	
Spanish/South American	18 (5.8)	12 (5)	6 (9)	
Education level, *n* (%)				0.122
Less than high school	97 (31.5)	71 (29.5)	26 (38.8)	
High school graduate	96 (31.2)	73 (30.3)	23 (34.3)	
Some college, college graduate, or graduate degree	115 (37.3)	97 (40.2)	18 (26.9)	
Employment status, *n* (%)				**0.019**
Employed (full-time, part-time, or self-employed)	48 (15.6)	44 (18.3)	4 (6)	
Unemployed	27 (8.8)	24 (10.0)	3 (4.5)	
Retired	202 (65.6)	148 (61.4)	54 (80.6)	

Variable	Total participants examined by optometrist (n = 308)	Participants with no dilated eye exam in over a year/never/cannot remember (n = 241, 78.2%)	Participants who had a dilated eye exam in past year (n = 67, 21.8%)	*p* value
Disabled/unable to work	31 (10.1)	25 (10.4)	6 (9)	
Marital status, *n* (%)				0.276
Single, divorced, separated, or widowed	236 (76.6)	188 (78)	48 (71.6)	
Married/domestic partner	72 (23.4)	53 (22)	19 (28.4)	
Needs assistance with transportation, *n* (%)	21 (6.8)	16 (6.6)	5 (7.5)	0.787 *
Has health insurance, *n* (%)	292 (94.8)	226 (93.8)	66 (98.5)	0.209 *
Health insurance type, *n* (%)				
Medicare	191 (62.0)	141 (58.5)	50 (74.6)	**0.016**
Medicaid	165 (53.6)	119 (49.4)	46 (68.7)	**0.005**
Private or supplemental	78 (25.3)	65 (27)	13 (19.4)	0.208
Primary language, *n* (%)				**0.006** *
English	193 (62.7)	162 (67.2)	31 (46.3)	
Spanish	109 (35.4)	75 (31.1)	34 (50.7)	
Other (French/Creole/Arabic/Bengali/Russian)	6 (1.9)	4 (1.7)	2 (3)	
Has own eye doctor (access to eye care), *n* (%)	88 (28.6)	53 (22)	35 (52.2)	**0.000**

Boldface values indicate statistical significance at $p \leq 0.05$ level

* Fisher's exact test,

** two-sample *t*-test, all other tests: chi-square

SD, standard deviation

Table 2

Manhattan Vision Screening and Follow-up Study (NYC-SIGHT): baseline medical and ocular history, eye health screening, and referral to ophthalmology

Variable	**Total participants examined by optometrist (*n* = 308)**	**Participants with no dilated eye exam in over a year/never/cannot remember (*n* = 241, 78.2%)**	**Participants who had a dilated eye exam in past year (*n* = 67, 21.8%)**	***p* value**
Medical conditions (self-reported), *n* (%)				
Hypertension	204 (66.2)	157 (65.1)	47 (70.1)	0.444
Diabetes	92 (29.9)	71 (29.5)	21 (31.3)	0.766
Arthritis/osteoporosis	154 (50)	118 (49)	36 (53.7)	0.490
Foot problems	114 (37)	84 (34.9)	30 (44.8)	0.137
Heart problems	59 (19.2)	51 (21.2)	8 (11.9)	0.090
Depression	70 (22.7)	50 (20.7)	20 (29.9)	0.116
Asthma/COPD	60 (19.5)	47 (19.5)	13 (19.4)	0.986
Cancer	23 (7.5)	15 (6.2)	8 (11.9)	0.115
Other medical conditions	34 (11)	24 (10)	10 (14.9)	0.251
No medical conditions	26 (8.4)	23 (9.5)	3 (4.5)	0.187
Ocular conditions (self-reported), *n* (%)				
Dry eye	151 (49)	113 (46.9)	38 (56.7)	0.155
Blurry vision	119 (38.6)	96 (39.8)	23 (34.3)	0.413
Cataract	99 (32.1)	67 (27.8)	32 (47.8)	**0.002**
Glaucoma	30 (9.7)	13 (5.4)	17 (25.4)	**0.000**
Floaters	47 (15.3)	38 (15.8)	9 (13.4)	0.638
Double vision	18 (5.8)	13 (5.4)	5 (7.5)	0.557*
Diabetic retinopathy	7 (2.3)	6 (2.5)	1 (1.5)	1.000*
Macular degeneration	1 (0.3)	0 (0.0)	1 (1.5)	0.218*
No ocular conditions	59 (19.2)	52 (21.6)	7 (10.4)	**0.041**
Family history (self-reported), *n* (%)				
Family history of glaucoma	70 (22.7)	53 (22.0)	17 (25.4)	0.559
Family history of blindness	33 (10.7)	22 (9.1)	11 (16.4)	0.088
Wears prescription eyeglasses, *n* (%)	222 (72.1)	170 (70.5)	52 (77.6)	0.254
Age of eyeglasses, *n* (%)				**0.000**

Variable	Total participants examined by optometrist (*n* = 308)	Participants with no dilated eye exam in over a year/never/cannot remember (*n* = 241, 78.2%)	Participants who had a dilated eye exam in past year (*n* = 67, 21.8%)	*p* value
Less than 1 year	40 (18)	20 (11.8)	20 (38.5)	
1 to 2 years	47 (21.2)	36 (21.2)	11 (21.2)	
More than 2 years	114 (51.4)	95 (55.9)	19 (36.5)	
Cannot remember	21 (9.5)	19 (11.2)	2 (3.8)	
Reason for eye health screening failure, *n* (%)				
Visual acuity 20/40 or worse	271 (88)	209 (86.7)	61 (91)	0.341
IOP 23–29 mmHg	20 (6.5)	15 (6.2)	5 (7.5)	0.716
Unreadable image	149 (48.4)	110 (45.6)	39 (58.2)	0.069
IOP (mmHg), mean ± SD				
Left eye (*n* = 307)	14.8 ± 4.2	14.9 ± 4.2	14.7 ± 3.9	0.750**
Right eye (*n* = 307)	14.8 ± 4.2	15.0 ± 4.1	14.4 ± 4.3	0.401**
Optometrist referral to ophthalmology, *n* (%)	218 (70.5)	173 (71.8)	45 (67.2)	0.474
Reason for referral to ophthalmology, *n* (%)				
Glaucoma/glaucoma suspect	51 (16.6)	36 (14.9)	15 (22.4)	0.147
Retinal abnormalities	17 (5.5)	4 (6)	13 (5.4)	1.000*
Cataract	74 (23.7)	59 (24.5)	15 (20.9)	0.542
Other ocular diagnoses	22 (6.8)	14 (5.8)	8 (10.4)	0.180*
Annual dilated eye exam	103 (33.4)	87 (36.1)	16 (23.9)	0.061

Boldface values indicate statistical significance at $p \leq 0.05$ level

* Fisher's exact test,

** two-sample *t*-test, all other tests: chi-square

COPD, chronic obstructive pulmonary disease; *IOP*, intraocular pressure; *SD*, standard deviation

Table 3

Manhattan Vision Screening and Follow-up Study (NYC-SIGHT): stepwise multivariate logistic regression model estimating factors associated with having had a recent dilated eye exam

Variables	Odds ratio (95% CI)	*p* value
Language		0.008
English	Ref	**Ref**
Spanish	3.25 (1.48–7.11)	**0.003**
Cataract		0.041
No	Ref	**Ref**
Yes	2.15 (1.03–4.47)	**0.041**
Glaucoma/glaucoma suspect		0.001
No	Ref	**Ref**
Yes	5.60 (2.02–15.43)	**0.001**
Age of prescription eyeglasses		0.001
Less than 1 year	Ref	**Ref**
Less than 2 years	0.20 (0.07–0.58)	**0.003**
More than 2 years	0.19 (0.08–0.47)	**0.000**
Cannot remember	0.18 (0.04–0.94)	**0.041**

Bold values indicate statistical significance at the $p \leq 0.05$ level

CI, confidence interval; *Ref*, reference

[*] 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