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Manhattan Vision Screening and Follow-up Study (NYC-SIGHT): Baseline Results and Costs of a Cluster-Randomized Trial

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Abstract

- **PURPOSE:** To describe the 15-month baseline results and costs of the Manhattan Vision Screening and Follow-up Study, which aims to investigate whether innovative community-based eye health screening can improve early detection and management of glaucoma and other eye diseases among high-risk populations.
- **DESIGN:** Five-year prospective, cluster-randomized controlled trial.
- **METHODS:** Individuals aged 40+ years were recruited from public housing buildings in New York City for an eye health screening (visual acuity (VA) with correction, intraocular pressure measurements (IOP), and fundus photography). Participants with VA 20/40 or worse, IOP 23–29 mm Hg, or an unreadable fundus image failed the screening and were scheduled for an optometric examination at the same location; those with an abnormal image were referred to ophthalmology. A cost analysis was conducted alongside the study.
- **RESULTS:** A total of 708 participants were screened; mean age 68.6 ± 11.9 years, female (65.1%), African American (51.8%) and Hispanic (42%). 78.4% (n = 555) failed the eye health screening; 35% (n = 250) had an abnormal image and were also referred to ophthalmology. 308 participants attended the optometric exam; 218 were referred to ophthalmology. Overall, 66.1%

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were referred to ophthalmology. The cost per participant to deliver the eye health screening and optometric examination was $180.88. The cost per case of eye disease detected was $273.64.

- **CONCLUSIONS:** This innovative study in public housing developments targeted high-risk populations, provided access to eye-care, and improved early detection of ocular diseases in New York City. The study has identified strategies to overcoming barriers to eye care to reduce eye health disparities.

The prevalence of blindness in the United States is projected to double by 2050, and racial/ethnic minority populations, socioeconomically disadvantaged populations, and underserved urban and rural populations continue to experience a disproportionate burden of eye disease, especially glaucoma.[1–5] According to the US Centers for Disease Control and Prevention (CDC), glaucoma is one of the leading causes of irreversible blindness in the United States, and the prevalence will increase from 3 million to 6.3 million people by 2050.[6] Diabetic retinopathy (DR) is also a leading cause of blindness, and the number of people with DR is estimated to increase worldwide from 126.6 million in 2010 to 191.0 million by 2030.[7] According to the Lancet Global Health's Commission on Global Eye Health, an estimated 596 million people had distance vision impairment worldwide in 2020, and 43 million were blind.[8] Communities with a high proportion of people living in poverty, older adults, and those who identify as Black or Hispanic have higher rates of DR, vision impairment, and glaucoma and approximately 50% of glaucoma cases are undiagnosed.[2,7–10]

The report "Making Eye Health a Population Health Imperative: Vision for Tomorrow" proposes a new population-centered framework to reduce health disparities related to eye disease, and a model for action that highlights different levels of prevention activities across a range of stake-holders.[11] The National Eye Institute (NEI) has created the Office of Vision Health and Population Sciences and is working to reduce vision health disparities that negatively affect quality of life.[12] *Healthy People 2030* also includes objectives aimed at reducing blindness due to glaucoma, diabetic retinopathy, age-related macular degeneration, cataracts, and refractive error.[13] Innovative eye health screening methods and early detection strategies to address the rising trend of avoidable vision loss are needed to reduce health inequity and eye health disparities in high-risk populations.[11] Community-based eye health interventions that consider social determinants of health (SDOH) have the potential to identify and target those at highest risk for blindness.[14] Key areas for consideration are as follows: (1) neighborhood and built environment, (2) health and health care, (3) social and community context, (4) education, and (5) economic stability.[14,15]

In 2019, the Centers for Disease Control and Prevention (CDC) Vision Health Initiative funded three 5-year research grants to develop innovative screening strategies for high-risk populations to generate evidence that would address how best to identify high-risk individuals and to provide targeted eye health screening.[6] The Screening and Intervention for Glaucoma and Eye Health Through Telemedicine (SIGHT) studies are taking place in New York, Alabama, and Michigan (SIGHTSTUDIES.org).[15] In New York City (NYC), researchers at Columbia University designed the Manhattan Vision Screening and Follow-up Study (NYC-SIGHT) to investigate whether community-based eye health screenings can improve early detection and management of glaucoma, vision impairment, cataract, and

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other eye diseases among people living in New York City Housing Authority (NYCHA) public housing developments in upper Manhattan. This cluster-randomized clinical trial was initiated during the COVID-19 pandemic, and is testing whether significant visual impairment can be identified through community-based eye health screenings and whether patient navigators can improve access to ophthalmologic care in these high-risk populations. This paper describes the baseline results by randomization group and implementation costs for the NYC-SIGHT study, which began in 2020.

METHODS

- **STUDY DESIGN:**

  This study is a 5-year prospective, cluster-randomized controlled trial, and the methods have been previously described in detail.[16] The NYCHA development (location) was chosen as the unit of randomization, which was designed by the study biostatistician. In order for more people to benefit from the intervention of eyeglasses and patient navigation, a 2:1 randomization scheme was established (7 intervention developments: 3 Usual Care developments). Columbia University Irving Medical Center Institutional Review Board (IRB)/Ethics Committee (#AAAR9162) approval was obtained, and all aspects of the study were conducted in accordance with the Declaration of Helsinki and in compliance with the Health Insurance Portability and Accountability Act (HIPAA). Informed consent was obtained from all participants prior to enrollment, and the study was registered on ClinicalTrials.gov (NCT04271709, New York, NY).

- **TARGET POPULATION:**

  The eye health screening was conducted in either the community room at the NYCHA development or the Department for the Aging (DFTA) Senior Center located at the NYCHA housing development or nearby; target enrollment was 1500 participants. Recruitment in Harlem and Washington Heights neighborhoods targeted high-risk individuals living at or below the NYC.gov poverty measure (zip codes 10027, 10029, 10030, 10031, 10032, 10035, 10037, 10039) and focused on SDOH Neighborhood and Built Environment and Access to Health and Health Care.[14,16,17]

- **INCLUSION CRITERIA:**

  Inclusion criteria were individuals aged 40 years and older living in an NYCHA housing development or member of a DFTA Senior Center aged 60 years and older and willing to consent for a baseline eye health screening and 12-month follow-up.[16] Those who met the study's inclusion criteria provided consent over the telephone or in person, in English or Spanish, by the bilingual study coordinators.

- **PRE-SCREENING ASSESSMENT:**

  Demographics and social determinants of health—Participants were asked about their date of birth, sex, race/ethnicity, education level, employment, and marital status. Health insurance status and transportation needs to attend the vision screening were captured. Access to eye care was also assessed by asking whether participants had their

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own eye doctor, when they had had their last dilated eye examination, and reasons for not having an eye examination within the past 2 years.

- **CLINICAL CHARACTERISTICS:**

  Participants were asked about their medical and ocular history, ocular medications, prescription eyeglasses, and family history of glaucoma and blindness. Participants were asked about feelings of unsteadiness when standing or walking, occurrences of falling in the past year, and subsequent emergency department visits or hospital admissions related to falling. The validated National Eye Institute Visual Function Questionnaire (NEI-VFQ) −9 was administered at baseline. All participants were asked whether they had ever tested positive for COVID-19 and were asked about their current vaccination status, including first, second, and booster shots if these were available.

- **EYE HEALTH SCREENING:**

  Visual acuity (VA) was measured with a Snellen eye chart at 20 feet with correction, with failure being VA 20/40 or worse in either eye. The VA was converted to the logarithm of the minimum angle of resolution (logMAR) for analysis. Intraocular pressure (IOP) was obtained in both eyes using the Ic100 iCare rebound tonometer (iCare), with an IOP of 23 to 29 mm Hg in either eye considered abnormal. Those with an IOP ≥30 mm Hg were "fast-tracked," and these participants were immediately scheduled with ophthalmology. In addition, at least 2 undilated fundus images of the disc and macula of each eye were taken by a trained ocular photographer in a dark environment using an autofocus, hand-held fundus camera (Volk Pictor Prestige; Volk Optical). Images were read and graded by one study ophthalmologist specializing in retina and one specializing in glaucoma. Both IOP and disc photographs were taken to improve the accuracy of detecting glaucoma suspects, as neither IOP nor disc photographs alone are good screening tools.[9] Final reading results were based on the worse eye as follows: (1) normal or abnormal with no significant findings, (2) abnormal with significant findings, or (3) unreadable. Those with a VA 20/40 or worse, IOP 23 to 29 mm Hg, or an unreadable image were scheduled to see the on-site optometrist within 3 weeks. Those with a readable abnormal image or who were fast-tracked (IOP ≥30 mm Hg) were scheduled with ophthalmology.[16]

- **ASSESSING FALLS RISK:**

  Participants identified during pre-screening as at-risk for falling were administered the Stopping Elderly Accidents, Deaths, and Injuries (STEADI) tests during the eye health screening.[18] The Timed Get Up and Go Test, 30-Second Chair Stand Test, and 4-Stage Balance Test were administered by community health workers and study coordinators; based on the STEADI algorithm, participants were classified as at low, medium, or high risk for falling. All participants were provided with a CDC Falls Risk Prevention Handout after STEADI tests were administered.[19]

- **OPTOMETRIC EYE EXAMINATION:**

  Participants who failed the eye health screening and had a normal or unreadable fundus image were scheduled within 3 weeks for a non-dilated comprehensive eye examination by

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an optometrist at the same location (synchronous). Refractive error was obtained using an autorefractor (QuickSee Autorefractor, Plenoptika) to guide the optometrist in prescribing eyeglasses using a Trial Lens kit. Participants randomized to the intervention group who failed the eye health screening received complementary eyeglasses. Participants randomized to the Usual Care group with refractive error were given an eyeglass prescription and a list of nearby optical shops.

The optometrist performed an anterior segment examination using a portable slitlamp and a posterior segment examination using a direct ophthalmoscope (Welch Allyn Panoptic 3.5V) to detect ocular abnormalities. The optometrist used an ophthalmoscopic examination of the optic nerve to diagnose glaucoma and glaucoma suspect based on the *American Academy of Ophthalmology (AAO) Preferred Practice Pattern Guidelines*.[20,21] Participants diagnosed with cataracts, retinal abnormalities, or other ocular conditions were referred to ophthalmology for a dilated eye examination and further ocular testing, if necessary.

- **REFERRAL TO OPHTHALMOLOGY:**

  All participants referred to ophthalmology were scheduled for their first eye examination appointment by patient navigators. Participants in the intervention group received additional support from patient navigators to assist with all aspects of follow-up eye care over the course of 1 year, specifically scheduling, rescheduling, and reminding participants of ophthalmology appointments. Navigators reviewed EPIC electronic medical records to document appointment adherence. Participants in the Usual Care Group did not received support from patient navigators after the initial follow-up eye examination appointment was scheduled. Participants who had their own eye doctor provided their contact information and were asked to sign a medical release form for the study staff to track follow-up adherence.

- **STATISTICAL ANALYSIS:**

  Study data were collected and managed using Research Electronic Data Capture (REDCap) tools hosted at Columbia University, and are summarized using means and SDs for continuous variables and frequencies, and percentages for categorical variables.[22,23] Ocular data collected included VA converted to logMAR, IOP, last dilated eye examination, and whether a participant was referred by the optometrist to ophthalmology. Clinical data included self-reported diabetes or hypertension, falls risk, and smoking history. χ^2 Tests were performed in IBM SPSS Version 25.[24] The NEI-VFQ-9 composite score was computed according to the published standard scoring algorithm.[25] Composite scores were summarized by means and SDs among the study population by randomization group, and question 6 (driving) was removed from the NEI-VFQ analysis because so few people drive in Manhattan.

- **COST ANALYSIS:**

  A cost analysis was conducted alongside the study to identify staff time and resources required to deliver the eye health screening and optometric examination. The cost per case for any detected eye disease was reported as the number of participants who were referred to ophthalmology. Cost measures included staff time costs for the on-site eye health screening, equipment, supplies, optometrist eye examinations, personal protective equipment, and

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travel costs to the sites. Staff time costs were calculated using the Activity-Based Costing method, a micro-costing approach that quantifies the monetary value of personnel required to deliver the screening based on the time and resources required.[26]

During the study, staff logged time spent on implementation tasks in minutes. Because this recorded time did not include time spent managing the program and overhead (indirect costs), we multiplied their recorded time by a factor of 3 to arrive at a more realistic estimate.

All time costs were converted to dollars by multiplying time spent performing each task by hourly wage rates, obtained from 2021 US Bureau of Labor Statistics (BLS) data for the specific types of staff involved (ophthalmic medical technician $19.77/h, optometrist $60.31/h, and ophthalmologist $129.85/h).[27] The ophthalmologist time was required for image reading only, as they were not otherwise involved in delivering the intervention. All staff time costs were then inflated by 30.4% to account for fringe benefits. Costs for equipment (without depreciation value), travel, and supplies were obtained from financial accounting records. There were no rental costs for any of the spaces; therefore, rental costs and depreciation were not included in the cost analysis. Because the goal of the cost analysis was to estimate the costs of delivering the program in a real-world community setting, we excluded all costs associated with research including but not limited to institutional review board approval and maintenance, research training, research data collection, investigator meetings, research consultants, research-related travel, and principal investigator time spent on study oversight.

- **SATISFACTION SURVEYS:**

  Surveys were administered to participants to determine their satisfaction with the screening (duration, convenience, screening staff), and the likelihood of attending the optometric examination if referred. Participants who completed the examination were also asked to rate their satisfaction and the likelihood of attending a follow-up eye examination if referred to ophthalmology.

RESULTS

- **DEMOGRAPHICS/SOCIAL DETERMINANTS OF HEALTH:**

  A total of 708 participants completed the eye health screening in the community settings from March 1, 2021, to May 31, 2022. Baseline demographic and clinical characteristics by randomization group are shown in Tables 1 and 2. Mean (SD) age was 68.6 SD ± 11.9 years (range 40–99 years). In all, 65.1% of participants were female. A total of 51.8% of participants were African American and 42% Hispanic (69.7% Dominican). Of the participants, 95.3% reported that they had health insurance, 57.2% Medicare, and 54.9% Medicaid (Table 1). Most participants were single, divorced, separated, or widowed (75.4%) and retired (58.2%). A total of 30.2% of participants had less than high school education, 32.8% had completed high school, and 37% had completed some college. Only 8.5% of participants needed transportation to the screening. The majority (60.3%) spoke English as

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their primary language, and 37.1% spoke Spanish as their first language. Only 30.2% of participants reported that they had their own eye doctor.

- **CLINICAL CHARACTERISTICS/FALLS RISK:**

  A total of 103 participants (14.5%) self-reported smoking, diabetes (29.1%), hypertension (62.7%), family history of glaucoma (23.7%), glaucoma (11.7%), and diabetic retinopathy (1.8%). Pre-existing glaucoma was confirmed if participants were taking IOP-lowering medications. Of the 708 participants, 351 (49.6%) were invited to complete the STEADI test during screening (Table 2).

- **NEI-VFQ-9:**

  Of the 708 participants screened, the mean NEI-VFQ-9 score was 68.3 ± 11.6; those in the intervention group had a significantly lower score and will be adjusted for in future analysis (Table 2).

- **EYE HEALTH SCREENING:**

  A total of 555 participants (78.4%) failed the screening; 497 had VA 20/40 or worse, 49 had IOP ≥23 mm Hg, and 175 had an unreadable image, with some having multiple reasons for failure. Study ophthalmologists' telemedicine image reading based on the worse eye found 281 (39.7%) were normal or abnormal with no significant findings, 175 (24.7%) were unreadable, and 248 (35%) were abnormal. Those with glaucoma/suspect (n = 138) and retina (n = 157) abnormalities seen on fundus images were referred to ophthalmology (Table 3). Seven subjects had an IOP ≥30 mm Hg and were "fast-tracked." As 5 of the "fast-tracked" participants also had an abnormal image, a total of 250 were referred to ophthalmology (Figure 1). Of those with an abnormal fundus image, 62 participants passed the screening and would have been missed without this imaging.

- **ON-SITE OPTOMETRIC EXAMINATION:**

  Within 3 weeks of the eye health screening, 365 participants were scheduled to see the on-site optometrist (synchronous examination) due to VA 20/40 or worse, IOP 23 to 29 mm Hg, or an unreadable image; 308 attended the eye examination (adherence rate: 86% intervention vs 80% Usual Care). Of the 308 participants who had completed the eye examination, 218 (30.8%) were referred to ophthalmology and 257 were diagnosed with refractive error. A total of 168 intervention participants received complimentary eyeglasses and 89 Usual Care participants received an eyeglass prescription and a list of optical shops (Figure 1).

- **COST ANALYSIS:**

  The mean total staff time required to deliver the eye health screening and optometric examination was 40.12 minutes ± 16.04 per participant. The largest contributors to total time were the eye health screening (12.28 minutes ± 4.01) and appointment management/scheduling (13.92 minutes ± 11.86). Optometrist time was 5.53 minutes ± 6.59 for the total number of participants. For the 308 of 708 participants (43.5%) who received this optometric examination, the mean optometrist time was 11.44 minutes ± 4.71. Total mean

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staff time cost, including all components, was $76.29 ± $33.27 per participant; total cost of equipment, travel, and supplies was $103.96 per participant. The total cost per participant was $180.88. The cost per case of eye disease detected was $273.64, based on the costs of delivering the program divided by the number of participants referred to ophthalmology (n = 468).

- **SATISFACTION SURVEYS:**

  Of the 708 screened participants, 93% reported being very satisfied with the convenience and location of the screening, 85% were very satisfied with the screening time, 82% were very satisfied with the screening team, and 85% were very satisfied with the overall vision screening. Most participants (88%) stated that they were very likely to recommend this eye health screening to their family and friends. Of those referred to the on-site optometrist, 97% stated that they were very likely to attend this appointment, and 80% of the Usual Care group and 86% of the intervention group actually attended this appointment. Of the 308 participants who attended the on-site optometric examination in the community, 86% were very satisfied with the eye examination, 90% were very satisfied with the optometrist, 84% were very satisfied with the time for the eye examination, and 93% were very satisfied with the convenience and location, which are extraordinarily high follow-up attendance rates.

DISCUSSION

The Manhattan Vision Screening and Follow-up study is the first community-based study in New York City targeting residents living in public housing to detect glaucoma and other eye diseases in a predominately older, African American and Hispanic population. Overall, 468 of the 708 screened participants (66.1%) required referral to ophthalmology, with 26.6% diagnosed with glaucoma suspect (including 11.7% with pre-existing glaucoma). This rate of glaucoma suspect is significantly higher than in most previously reported population-based studies, which we believe is due to the targeted recruitment and self-selected enrollment in this underserved population with poor access to eye care as well as the inclusion of glaucoma suspects.[28–35]

Currently, New York State is reported to have one of the highest rates of glaucoma in the United States, and vision-health disparities exist in Washington Heights and Harlem where the study is being conducted.[36–37] According to the New York State Department of Health population-based surveillance studies, 5.3% of New Yorkers (1 in 20) have glaucoma, and 2.9% have diabetic retinopathy.[36] The prevalence of both eye conditions rises steadily with age, and Hispanics, non-Hispanic Blacks, those with high school educations or less, and those with annual household incomes less than $50,000 are at increased risk.[37] Public housing developments offer unique opportunities to reach socioeconomically disadvantaged and underserved adults and seniors as a strategy to improve access to eye care.[38] Our study partner, NYCHA, selected 10 developments that were in close proximity to Columbia University Harkness Eye Institute and Harlem Hospital Ophthalmology, which gave us access to about 6000 residents, and our population included 51.8% African American and 42% Hispanic.[39] Currently, NYCHA owns and operates 355 housing developments for

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300,000 adult and senior residents in 5 boroughs (Manhattan, Bronx, Brooklyn, Queens, and Staten Island) through the federal public housing program (Section 9).[39]

In addition, community-based interventions that require the team to bring eye care to the neighborhood may minimize the carbon footprint of eye care as well as improve access to eye care and participant satisfaction.[40] Satisfaction rates were highest for the convenience and location of the eye health screening and the on-site community optometrist eye examinations (93% of participants were very satisfied). These data are in line with previous research that shows that individuals prefer a short distance to travel for eye examination appointments.[40,41]

According to the AAO's *Primary Open-Angle Glaucoma Preferred Practice Pattern Guidelines*, screening is most cost-effective when it is intended for these high-risk populations.[20,21] Despite the disease burden of glaucoma in the United States, the 2022 *US Preventive Services Task Force (USPSTF)* concluded that insufficient evidence exists to assess the balance of risks and benefits of screening for primary open-angle glaucoma in adults.[42,43] 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, yet numerous studies in different settings have been published that effectively identified those at increased risk by targeting screenings to high-risk population.[42,43]

This innovative study provides important evidence of the tremendous need for early detection of glaucoma and other eye diseases in African American and Hispanic populations, with 78.4% failing the screening, 66.1% referred to ophthalmology for follow-up, and 26.6% rates of glaucoma, including 83 pre-existing glaucoma cases. In addition, more than 50% of participants had not had a dilated eye examination in the past 2 years, consistent with previously reported community-based studies yet higher than data reported by New York State Department of Health Report on Vision Impairment and Access to Eye Care.[28,44–47] It is important to note that 95.3% of participants had health insurance (57.2% Medicare, 54.9% Medicaid) and only 8.5% of participants needed transportation to the screening and follow-up eye examinaton appointments. Importantly, we also identified the costs associated with implementing this community-based eye health screening program, which revealed that most of the costs are related to staff time. Understanding the costs is critical as we attempt to gain funding to expand the study. Although recruitment was challenging during the COVID-19 pandemic (target enrollment was 1500), we were able to successfully enroll and screen 708 individuals, and 93% reported they were very satisfied with the convenience and location of the screening, higher than previously reported patient responses in similar screenings.[44,45] The current screening included visual acuity, IOP measurements, fundus photography, and an on-site optometrist, and was conducted where people live and the senior centers that they attend. Senior centers provide meals, socialization, and activities for many people, such as exercise classes, computer and phone training, and game playing and contributed to our recruitment success during the COVID-19 pandemic from 2020 to 2022.[48] Our community partner, the New York City DFTA, currently funds more than 300 older adult centers (for adults age 60+ years) in the 5 boroughs, which are also important future opportunities to reach socioeconomically disadvantaged and underserved seniors as a strategy to improve access to eye care.[48]

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The on-site optometrist provided eyeglass prescriptions and referral to ophthalmology for cataracts, glaucoma, glaucoma suspect, and retinal abnormalities (Figure 1). A total of 103 participants were also referred by the optometrist for an annual dilated eye examinations because they had never had an eye examination or had not seen an eye doctor within the past 2 years. Both the intervention (free eyeglasses) and Usual Care groups (eyeglass prescription only) had a high show rate for on-site optometric examination appointments (86% and 80%, respectively), which suggests that this on-site eye examination was an important service. The study optometrist educated participants on ocular disease and the importance of attending annual eye examination appointments, especially participants with diabetes and existing glaucoma or those who need cataract surgery. The patient navigators also scheduled all initial appointments for both the Usual Care and intervention groups who are referred to ophthalmology.

- **PANDEMIC CHALLENGES:**

  During the COVID-19 pandemic, the institutional review board approved a modification to the study design to account for social distancing and the safety of the research team and study. A pre-screening telephone call and a call center were implemented to allow research staff to assess eligibility and to obtain verbal informed consent, intake and demographics, medical and ocular history, NEI-VFQ-9 survey, and assessment of falls risk over the telephone. These pre-screening telephone calls began 5 months prior to screening and reduced on-site time from 2 hours to 30 minutes per participant. Environmental factors, such as neighborhood crime, added challenges to the present study. We hired a bilingual (Spanish-speaking) security guard for the community screenings and eye examinations, which benefited recruitment by increasing our visibility.

- **LIMITATIONS:**

  Although the recruitment was cluster-randomized by housing development, the proportion of people who self-selected to participate varied between the type of NYCHA development, which may be a limitation as well as a source of bias and therefore may overestimate rates of eye disease. Overall, senior-only buildings, where a DFTA senior center was located, were more effective than larger adult housing developments for recruiting and conducting the eye health screenings. For example, 24% (67 of 275) of the residents living at 99 Fort Washington (seniors only age 60+ years) completed the eye health screening compared to 7% (156 of 2286) of the residents at Polo Grounds/Rangel Houses (adults 40+ and seniors 60+ years). The larger developments with adults and seniors were more difficult to enroll. However, targeting both adults (40+ years) and senior developments (60+ years) is important for early detection of glaucoma and other eye diseases and to improve follow-up adherence for those referred for follow-up eye care.[16] Overall, we recruited 11% of the sample frame (708 of 6640), which is lower than originally projected; however, more participants failed the screening (78.4%) and were referred to ophthalmology (66.1%) than originally estimated (Figure 1). In addition, studies show poor interobserver agreement on disc reading by the ophthalmologist; therefore, all images were ready by both a glaucoma specialist (Q.W.) and a retina specialist (J.D.H.). It is also important to consider that there may be some false-positive cases, which can be expensive, can result in unnecessary visits, and can take participants and those accompanying them away from their usual activities. Future

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analysis of appointment adherence and ocular diagnoses confirmation of those referred to ophthalmology will be conducted.

To conclude, the Manhattan Vision Screening and Follow-up study detected 468 participants who required follow-up with ophthalmology at a cost of $180.88 per participant and $273.64 per case of eye disease detected. By leveraging community partners, we identified and engaged racial/ethnic minority groups, socioeconomically disadvantaged populations, and underserved populations most at risk for glaucoma and other eye diseases and improved their access to eye care. Those in the intervention group continue to receive additional support from patient navigators to assist with all aspects of follow-up eye care over 1 year that may provide additional evidence that high-risk individuals can benefit from patient navigator support. These results are generalizable and scalable to a national level, and the eye health screening can be conducted in senior centers, public housing facilities, primary care settings, community centers, and Federally Qualified Health Centers. These results provide important evidence that persons at increased risk could be identified and could benefit from community-based eye health screenings. The influences of sociocultural, environmental, economic, and demographic factors in urban settings must be considered to reduce health inequity and eye health disparities in at-risk populations.[49]

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Data Sharing 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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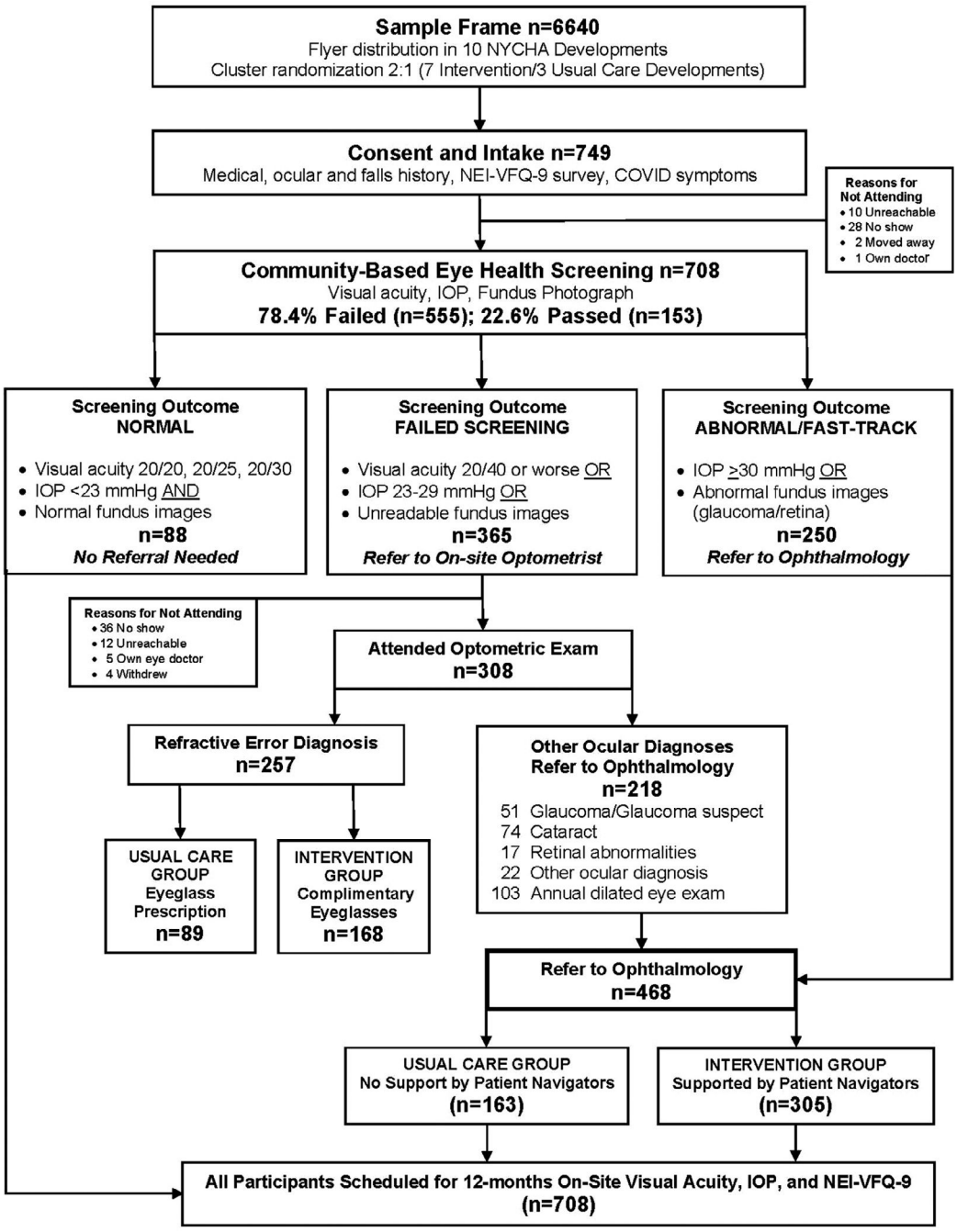

FIGURE 1.

Consolidated Standards of Reporting Trials (CONSORT) diagram showing study flowchart. Participants were recruited via flyer distribution (top center). Verbal informed consent, intake data, and COVID-19 history were obtained via the call center prior to eye health screening (second row). All enrolled participants were scheduled for eye health screenings at the New York City Housing Authority (NYCHA) Developments and New York City Department for the Aging (DFTA) Senior Centers (third row). Reasons for not attending eye health screening (third row right). Eye health screening outcome of normal, failed

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screening or abnormal/fast-track (fourth row). All participants who failed the eye health screening were scheduled with the on-site optometrist (fifth row). Optometrist diagnoses including refractive error (sixth row, left). Usual Care group received eyeglass prescription only, intervention group received complimentary eyeglasses (seventh row, left). Total participants referred to ophthalmology (eighth row, right). Intervention participants referred to ophthalmology were assisted by patient navigators whereas Usual Care group participants were not supported (ninth row). All enrolled participants are invited and scheduled for a 12-month on-site visual acuity (VA), intraocular pressure (IOP), and National Eye Institute Vision Function Questionnaire–9 (NEI-VFQ-9) survey (last row).

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TABLE 1.

Manhattan Vision Screening and Follow-up Study: (NYC-SIGHT) Demographics and Social Determinants of Health

Variable	Total Participants (n = 708)	Intervention Group (n = 454)	Usual Care Group (n = 254)	*P* Value
Age, y, mean ± SD (range)	68.6 ± 11.9 (40-99)	68.3 ± 11.9 (40-99)	69.0 ± 11.9 (40-98)	.486
Age Category, y, n (%)				
40–59	170 (24.0)	116 (25.6)	54 (21.3)	.200
60–79	416 (58.8)	260 (57.3)	156 (61.4)	.282
≥80	122 (17.2)	78 (17.2)	44 (17.3)	.962
Sex, n (%)				
Female	461 (65.1)	295 (65.0)	166 (65.4)	.920
Ethnicity/Race, n (%)				
Hispanic/Latino	297 (42.0)	218 (48.0)	79 (31.1)	.000[a]
Black, non-Hispanic	367 (51.8)	203 (44.7)	164 (64.6)	.000[a]
Other (multiracial, White, Asian, American Indian)	44 (6.2)	33 (7.3)	11 (4.3)	.120
Hispanic Origin, n (%) (n = 314)				
Dominican	219 (69.7)	168 (771)	51 (64.6)	.000[a]
Puerto Rican	51 (17.2)	38 (17.4)	13 (16.5)	.108
Mexican	3 (1.0)	0 (0.0)	3 (3.8)	.020[a]
Cuban	5 (1.7)	2 (0.9)	3 (3.8)	.259
Spanish/South American	36 (12.1)	24 (11.0)	12 (15.2)	.744
Education Level, n (%)				
Less than high school	214 (30.2)	148 (32.6)	66 (26.0)	.066
High school	232 (32.8)	164 (36.1)	68 (26.8)	.011[a]
Some college, college graduate, or graduate degree	262 (37.0)	142 (31.3)	120 (47.2)	.000[a]
Employment Status, n (%)				
Employed (full-time, part-time, or self-employed)	141 (19.9)	82 (18.1)	59 (23.2)	.099
Unemployed	74 (10.5)	54 (11.9)	20 (7.9)	.094
Retired	412 (58.2)	257 (56.6)	155 (61.0)	.253
Disabled/Unable to work	81 (11.4)	61 (13.4)	20 (7.9)	.026[a]
Marital Status, n (%)				

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Variable	Total Participants (n = 708)	Intervention Group (n = 454)	Usual Care Group (n = 254)	*P* Value
Single, divorced, separated, or widowed	534 (75.4)	338 (74.4)	196 (772)	.421
Married/domestic partner	174 (24.6)	116 (25.6)	58 (22.8)	.421
Needs Assistance with Transportation, n (%)	60 (8.5)	43 (9.5)	17 (6.7)	.203
Has Health Insurance, n (%)	675 (95.3)	432 (95.2)	243 (95.7)	.755
Health Insurance Type, n (%)				
Medicare	405 (57.2)	259 (57.0)	146 (575)	.911
Medicaid	389 (54.9)	262 (57.7)	127 (50.0)	.048[a]
Private or supplemental	209 (29.5)	135 (29.7)	74 (29.1)	.866
Primary Language, n (%)				
English	427 (60.3)	243 (53.5)	184 (72.4)	.000[a]
Spanish	263 (371)	199 (43.8)	64 (25.2)	.000[a]
Other (French/Creole/Arabic/Bengali/Russian)	18 (2.5)	12 (2.6)	6 (2.4)	.820
Has Own Eye Doctor (Access to Eye Care), n (%)	214 (30.2)	132 (29.1)	82 (32.3)	.373

NYC-SIGHT = New York City–Screening and Intervention for Glaucoma and Eye Health Through Telemedicine.

[a]Statistically significant at $P < .05$ level.

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TABLE 2.

Manhattan Vision Screening and Follow-up Study (NYC-SIGHT): Baseline Medical and Ocular History and Falls Risk

Variable	Total Participants (n = 708)	Intervention Group (n = 454)	Usual Care Group (n = 254)	*P* Value
Medical Conditions (Self-Reported), n (%)				
Hypertension	444 (62.7)	286 (63.0)	158 (62.2)	.835
Diabetes	206 (29.1)	130 (28.6)	76 (29.9)	.718
Arthritis/osteoporosis	327 (46.2)	220 (48.5)	107 (42.1)	.105
Foot problems	251 (35.5)	167 (36.8)	84 (33.1)	.322
Heart problems	139 (19.6)	87 (19.2)	52 (20.5)	.674
Depression	125 (177)	81 (178)	44 (17.3)	.862
Asthma/COPD	118 (16.7)	88 (19.4)	30 (11.8)	.010[a]
Cancer	47 (6.6)	31 (6.8)	16 (6.3)	.786
Other medical conditions	80 (11.3)	51 (11.2)	29 (11.4)	.941
No medical conditions	80 (11.3)	53 (11.7)	27 (10.6)	.674
Current Smoker, n (%)	103 (14.5)	70 (15.4)	33 (13.0)	.380
COVID-19 Vaccination Status (Self-Reported), n (%)				
Vaccinated (at least 2 shots)	565 (79.8)	345 (76.0)	220 (86.6)	.001[a]
Not vaccinated for COVID-19	123 (17.4)	98 (21.6)	25 (9.8)	.000[a]
Ocular Conditions (Self-Reported), n (%)				
Dry eye	331 (46.8)	221 (48.7)	110 (43.3)	.169
Blurry vision	272 (38.4)	185 (40.7)	87 (34.3)	.088
Cataract	199 (28.1)	122 (26.9)	77 (30.3)	.328
Glaucoma	83 (11.7)	55 (12.1)	28 (11.0)	.665
Floaters	111 (15.7)	60 (13.2)	51 (20.1)	.016[a]
Double vision	51 (7.2)	38 (8.4)	13 (5.1)	.108
Diabetic retinopathy	13 (1.8)	10 (2.2)	3 (1.2)	.332
Macular degeneration	8 (1.1)	7 (1.5)	1 (0.4)	.166
No ocular conditions	154 (21.8)	95 (20.9)	59 (23.2)	.476
Family History (Self-Reported), n (%)				
Family history of glaucoma	168 (23.7)	100 (22.0)	68 (26.8)	.155

Am J Ophthalmol. Author manuscript; available in PMC 2023 July 01.

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Variable	Total Participants (n = 708)	Intervention Group (n = 454)	Usual Care Group (n = 254)	*P* Value
Family history of blindness	72 (10.2)	44 (9.7)	28 (11.0)	.574
Wears Prescription Eyeglasses, n (%)	504 (71.2)	331 (72.9)	173 (68.1)	.176
Age of Eyeglasses, n (%)				
<1 y	101 (20.0)	66 (19.9)	35 (20.2)	.938
1–2 y	123 (24.4)	80 (24.2)	43 (24.9)	.865
>2 y	238 (47.2)	158 (477)	80 (46.2)	.750
Can't remember	42 (8.3)	27 (8.2)	15 (8.7)	.843
Last Dilated Eye Examination, n (%)				
Within the past year	167 (23.6)	107 (23.6)	60 (23.6)	.987
Within 1–2 y	163 (23.0)	107 (23.6)	56 (22.0)	.645
>2 y	250 (35.3)	162 (35.7)	88 (34.6)	.782
Can't remember	82 (11.6)	47 (10.4)	35 (13.8)	.172
Never had eye examination	46 (6.5)	31 (6.8)	15 (5.9)	.633
Reason for No Eye Examination in Past 2 y, n (%)				
No reason to go	108 (28.9)	76 (32.1)	32 (23.4)	.073
Not thought about it	59 (15.8)	42 (177)	17 (12.4)	.174
No vision insurance	25 (6.7)	16 (6.8)	9 (6.6)	.946
Cost of eye examination	10 (2.7)	6 (2.5)	4 (2.9)	.823
Don't have an eye doctor	16 (4.3)	11 (4.6)	5 (3.6)	.648
Couldn't get appointment	11 (2.9)	5 (2.1)	6 (4.4)	.211
No transportation to office	4 (1.1)	2 (0.8)	2 (1.5)	.577
Other, including COVID	141 (37.7)	79 (33.3)	62 (45.3)	.022[a]
NEI-VFQ-8 Mean Composite Score ± SD	68.3 ± 11.6	673 ± 11.5	70.0 ± 11.8	.003[a]
Falls History, n (%) (Pre-screening)				
Worries about falling and feels unsteady when standing or walking	296 (41.8)	177 (39.0)	119 (46.9)	.042[a]
Fell in the past year 1–5 times	176 (24.9)	108 (23.8)	68 (26.8)	.378
Visited emergency room due to falling	59 (8.3)	32 (7.0)	27 (10.6)	.098
Hospitalized due to falling	23 (3.2)	12 (2.6)	11 (4.3)	.224
Conduct STEADI in the Field	351 (49.6)	210 (46.3)	141 (55.5)	.018[a]

COPD = chronic obstructive pulmonary disease; NEI-VFQ-9 = National Eye Institute Vision Function Questionnaire–9; NYC-SIGHT = New York City–Screening and Intervention for Glaucoma and Eye Health Through Telemedicine; STEADI = Stopping Elderly Accidents, Deaths, and Injuries.

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[a] Statistically significant at $P < .05$ level.

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TABLE 3.

Manhattan Vision Screening and Follow-up Study (NYC-SIGHT): Baseline Eye Health Screening, Eye Exam, and Referral to Ophthalmology

Variable	Total Participants (n = 708)	Intervention Group (n = 454)	Usual Care Group (n = 254)	*P* Value
Failed Eye Health Screening, n (%)	555 (78.4)	364 (80.2)	191 (75.2)	.123
Reason for Failure, n (%)				
Visual acuity 20/40 or worse	497 (70.2)	338 (74.4)	159 (62.6)	.001[a]
IOP ≥23 mm Hg	49 (6.9)	33 (7.3)	16 (6.3)	.626
Unreadable image	175 (24.7)	95 (20.9)	80 (31.5)	.002[a]
Visual Acuity Based on Worse Eye (Snellen), mean logMAR ± SD IOP (mm Hg), Mean ± SD	0.49 ± 0.50	0.51 ± 0.50	0.45 ± 0.49	.094
Left eye (n = 706)	14.8 ± 4.3	14.8 ± 4.4	14.9 ± 4.2	.673
Right eye (n = 705)	14.9 ± 4.4	15.0 ± 4.6	14.7 ± 4.1	.296
Fast-tracked participants IOP ≥30 mm Hg, n (%)	7 (1.0)	5 (1.1)	2 (0.8)	.686
Telemedicine Image Reading Results by Worse Eye, n (%) (n = 704)				
Normal image	255 (36.0)	172 (379)	83 (32.7)	.166
Abnormal image, no significance	26 (3.7)	14 (3.1)	12 (4.7)	0.266
Abnormal image	248 (35.0)	169 (372)	79 (31.1)	.101
Unreadable	175 (24.7)	95 (20.9)	80 (31.5)	.002[a]
Reasons for Abnormal Image, n (%)				
Glaucoma findings	138 (19.5)	94 (20.7)	44 (173)	.276
Retinal findings	157 (22.2)	110 (24.2)	47 (18.5)	.079
Optometrist Referral to Ophthalmology, n (%)	218 (30.8)	135 (29.7)	83 (32.7)	.181
Optometrist Eye Examination Findings (Refer to Ophthalmology), n (%)				
Glaucoma/suspect	51 (7.2)	39 (8.6)	12 (4.7)	.056
Retinal abnormalities	17 (2.4)	12 (2.6)	5 (2.0)	.574
Cataract	74 (10.5)	48 (10.6)	26 (10.2)	.888
Other ocular diagnoses	22 (3.1)	17 (3.7)	5 (2.0)	.191
Refraction	7 (1.0)	5 (1.1)	2 (0.8)	.686
Annual dilated eye examination	103 (14.5)	54 (11.9)	49 (19.3)	.007[a]
All Referrals to Ophthalmology, n (%)	468 (66.1)	305 (67.2)	163 (64.2)	.417

IOP = intraocular pressure; logMAR = logarithm of the minimum angle of resolution; NYC-SIGHT = New York City–Screening and Interven- tion for Glaucoma and Eye Health Through Telemedicine.

[a] Statistically significant at $P < .05$ level.

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