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Michigan Screening & Intervention for Glaucoma and Eye Health through Telemedicine Program: First Year Outcomes and Implementation Costs

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Abstract

Purpose: The Michigan Screening and Intervention for Glaucoma and Eye Health through Telemedicine (MI-SIGHT) program aims to engage people at high risk of glaucoma; we assess first year outcomes and costs.

Design: Clinical cohort study.

Methods: Participants ≥18 years were recruited from a free clinic and a federally qualified health center in Michigan. Ophthalmic technicians in the clinics collected demographic information, visual function, ocular health history, measured visual acuity, refraction, intraocular pressure, pachymetry, pupils, and took mydriatic fundus photographs and retinal nerve fiber layer optical coherence tomography. Data were interpreted by remote ophthalmologists. During a follow-up visit, technicians shared ophthalmologist recommendations, dispensed low-cost glasses and collected participant satisfaction. Main outcome measures were prevalence of eye disease, visual function, program satisfaction and costs. Observed prevalence was compared to national disease prevalence rates using z-tests of proportions.

Results: Among 1171 participants enrolled, average age was 55 years (SD=14.5), 38% were male, 54% identified as Black, 34% as White, 10% as Hispanic, 33% had ≤ high school education, and 70% had income <$30k. The prevalence of visual impairment was 10.3% (national average 2.2%), glaucoma and suspected glaucoma 24% (national average 9%), macular degeneration 2.0%

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(national average 1.5%), and diabetic retinopathy 7.3% (national average 3.4%) (p<0.0001). 71% of participants received low-cost glasses, 41% were referred for ophthalmology follow-up, and 99% were satisfied or very satisfied with the program. Startup costs were $103,185; recurrent costs were $248,103 per clinic.

Conclusions: Telemedicine eye disease detection programs in low-income community clinics effectively identify high rates of pathology.

Table of Contents – Precis

The Michigan Screening and Intervention for Glaucoma and Eye Health through Telemedicine (MI-SIGHT) program's aim was to engage people at high risk of glaucoma in screening; it met this aim with a glaucoma/suspected glaucoma rate of 24%, three times the national average. Demographic characteristics, participant satisfaction, prevalence of eye disease and program costs are described for the first-year cohort.

Introduction

In 2016, the National Academy of Science, Engineering, and Medicine (NASEM) issued a call to action to make "eye health a population health imperative."[1] On July 23, 2021, the United Nations adopted the "Vision for Everyone" resolution, calling on member countries to ensure full access to eye care services to improve individual and population health and development.[2,3] Glaucoma and diabetic retinopathy remain the leading causes of irreversible blindness among Black and Hispanic Americans and the second and third leading causes of blindness among White Americans after macular degeneration.[3–7] Hispanic Americans alongside Americans living with lower socio-economic status, when compared to non-Hispanic White Americans, are more likely to report not wearing eyeglasses because they are unable to afford them.[4] Unaffordable eyeglasses contributes to the reality that refractive error is a leading cause of vision loss in the United States (US) even though it is an easily reversible cause.[8]

Currently, the majority of eye care is delivered in clinics that are separate from trusted community-based health care settings. These community-based health care organizations serve people with lower incomes who are disproportionately comprised of Black and Hispanic Americans, but these community clinics are most often unable to offer eye care services due to the high cost associated with specialty care. As identified by NASEM and the United Nations, improving population-health requires novel programmatic methods to screen and to provide definitive eye care for the growing number of people living in the U.S. with diabetes, with undiagnosed glaucoma,[3] and with uncorrected refractive error.[4]

The Michigan Screening and Intervention for Glaucoma and Eye Health through Telemedicine (MI-SIGHT) program is a telemedicine-based glaucoma and eye disease detection initiative.[9] It is funded by the Centers for Disease Control and Prevention as one of three demonstration projects to evaluate novel ways of detecting eye disease and connecting people with appropriate treatment in populations at high risk of blinding eye disease. The MI-SIGHT program used community-engaged research to implement a telemedicine program in two primary care clinics. The MI-SIGHT Community Advisory

Board is comprised of clinicians, administrators, patients, and researchers from the two clinics and researchers at the University of Michigan (UM). The group meets quarterly to evaluate and refine the program.

In the MI-SIGHT program, ophthalmic technicians at the community clinics obtain an eye health history, visual acuity, refraction, intraocular pressure, central corneal thickness, fundus photographs and a retinal nerve fiber layer optical coherence tomograph (OCT). This data is then transmitted through the electronic health record (EHR) to UM eye physicians for review and interpretation. Screening for all five leading causes of visual impairment (refractive error, cataract, glaucoma, diabetic retinopathy, and macular degeneration) is performed, alongside screening for other less common causes of visual impairment detectable on fundus imaging. If pathology is detected, eye clinician relationships have been established to offer affordable treatment. Low-cost glasses are offered to participants through an on-line retailer. This manuscript serves to detail the socio-demographic characteristics, clinical findings, self-reported visual functioning, and program satisfaction from the first year of implementation of this community-based telemedicine program. The start-up costs are detailed to inform future implementation efforts. Future work will quantify the proportion of participants who attended recommended follow-up with the ophthalmologist.

Methods

The study was approved by the Institutional Review Board at the University of Michigan and adhered to all Tenets of the Declaration of Helsinki. The clinical trial component of the study is registered at clinicaltrials.gov (NCT04274764). The MI-SIGHT program is being conducted in two clinics serving low-income communities with large proportions of Black and Hispanic residents: a free clinic in Ypsilanti, Michigan (MI) and a federally qualified health center (FQHC) in Flint, MI. Due to different times to initiate each site, the first-year cohort consists of participants recruited from June 28, 2020 until June 27, 2021 for the free clinic, and from January 27, 2021 until January 26, 2022 for the FQHC. Participants were recruited by various methods including directly calling patients referred by clinicians at the free clinic, calling patients with diabetes who were overdue for their annual eye exam at the FQHC, and advertising within the communities.

Community residents ≥ 18 years of age were eligible to participate. We excluded patients with: 1. significant eye pain; 2. sudden decrease in vision within one week; 3. binocular diplopia; 4. cognitive impairment (assessed as inability to answer screening questions); 5. pregnancy; 6. incarceration; or 7. moving outside of driving distance to the clinic within 6 months.

Following confirmation of study eligibility, enrollment began with obtaining written informed consent. Consents were obtained in multiple languages as the free clinic serves a population where approximately 20% of patients do not speak English and there is no majority second language spoken. Full consent forms were provided in English, Spanish, and Arabic, and short form consents were provided in Albanian, Chinese, French, Hindi, Korean, Igbo and Tagalog.

After obtaining informed consent, an ophthalmic technician completed a health history and surveys with the patient. This included the 9-item National Eye Institute Visual Function Questionnaire (VFQ9) to assess visual function and vision-related quality of life.[10] This shortened version of the original questionnaire[11] assesses visual function across 7 domains (general vision, near and distance activities, mental health, role difficulties, driving, and peripheral vision). Each question is asked on a 5- or 6-point Likert scale, coded from 0 to 100 with larger values indicating better visual function. The questionnaire is scored overall and for the 7 subscale domains as a mean of items included.

Following completion of the history and surveys, the ophthalmic technician completed the following activities with the patient: 1. Presenting visual acuity (VA) assessment at distance and near (Snellen acuity with current correction, if any); 2. Refraction measurements (ARK- Autorefractor & Keratometer, Marco Ophthalmic, Jacksonville, FL) and refinement with subjective refraction with a table-clamped phoropter;[12]5. Eyeglass measurement including inter-pupillary distance (Essilor Digital Pupilometer, Essilor, Chicago, IL); 6. Eye examination including pupillary response, anterior chamber angle assessment by penlight, extraocular motility and alignment, and intraocular pressure (IOP) measurement (iCare tonometer, Raleigh, NC); 7. Dilation with 0.5% tropicamide only[13] for those participants without a narrow angle on penlight exam[14] and IOP less than 30 mmHg to mitigate the potential risk of acute angle closure; 8. Mydriatic imaging of the posterior pole by fundus photography (three images focused on the disc, the macula, and the superotemporal arcade[15] and Retinal Nerve Fiber Layer Optical Coherence Tomography (RNFL OCT) (Topcon, Oakland, NJ). The ophthalmic technician entered the examination data into the participant's UM EHR (EPIC, Verona, WI) and the images were uploaded into the UM ophthalmic imaging system (CONTINUUM PACS, Integrated Ophthalmic Systems Inc., Woburn, MA). If urgent or emergent conditions such as severely elevated IOP were identified, a UM ophthalmologist and either the ophthalmologist at the FQHC or the Medical Director at the free clinic were paged and ensure that the participant was offered timely, appropriate care. After the examination, the ophthalmic technicians helped participants with refractive error select low-cost eyeglasses (single vision lenses start at $12, bifocals start at $35, ZenniOptical.com), and placed the order after the prescription was confirmed by the ophthalmologist.

Remote ophthalmologists at UM reviewed the MI-SIGHT participant data. The remote ophthalmologists designated whether fundus photographs and OCT images were gradable or ungradable. The remote ophthalmologists assessed whether the following vision and eye diseases were present or absent using a template in the EHR: visual impairment (BCVA ≤20/40 in the better seeing eye), refractive error, cataract, glaucoma, macular degeneration, and diabetic retinopathy, alongside any other incidental findings. The ophthalmologists assessed any signs of cataract as requiring or not requiring referral for surgical consultation based on level of visual acuity. The ophthalmologists assessed for the presence and stage of diabetic retinopathy with/without macular edema according to the NHS criteria.[16] The ophthalmologists assessed for macular degeneration using Age-Related Eye Disease Study (AREDS) criteria.[17]Glaucoma or suspected glaucoma was assessed by the grading ophthalmologist using the following criteria:[15] 1. Patient previously treated for glaucoma (e.g. already taking glaucoma medications or previous glaucoma surgery); 2. Narrow angle

on penlight exam; 3. Cup-to-disc ratio ≥ 0.7;[18] 4. Asymmetry of the cup-to-disc by ≥0.2 where the larger cup is ≥0.6;[15] 5. Abnormal high quality OCT (overall RNFL thickness <80 microns or thinning at <1% certainty (RED-damaged tissue) in the inferior or superior quadrants);[15,19] 6. IOP > 21 mmHg (median of the 3 measures taken), interpreted according to the following criteria: if the IOP is 22–24 mmHg and the c/d ratio is <0.35 with no other risk factors, there is no referral but if the c/d is ≥0.35, refer within 6 months; IOP 25–29 mmHg, refer within 1 month; IOP 30–40 mmHg, refer within one week; IOP >40, refer within 24 hours or immediately. Each ophthalmologist used clinical judgment to determine whether the participant's diagnosis was glaucoma or glaucoma suspect. Each of the six ophthalmologists on the team met with the study PI individually to go over diagnostic criteria prior to beginning to interpret examinations and group meetings were held quarterly to address issues and inconsistencies. The grading ophthalmologist designated the appropriate follow-up interval and type of ophthalmic care needed and sent a templated letter to the primary care physician with the assessment and plan.

All MI-SIGHT program costs were tracked through grant budget report forms and credit card statements. Although this manuscript reports on the first-year cohort of participants, the start-up costs were incurred in an approximately 6-month period prior to patient recruitment at each clinic. Line items from each budget report or credit card statement were categorized as costs associated with either start-up or those that would be expected to recur annually, and then further grouped into subcategories such as medical supplies, moving expenses, etc.

Statistical Methods

The first-year cohort of MI-SIGHT participant data was summarized with descriptive statistics (mean, standard deviation [SD], median, frequency, and percentage) for sociodemographic characteristics, self-reported medical history, and ophthalmic disease screening results. Descriptive statistics are provided for the overall sample and stratified by clinic with clinic differences tested by 2-sample t-tests and Chi-square tests. Snellen visual acuity (VA) was converted to LogMAR equivalent for the descriptive analysis. For conversion, values of count fingers, hand motion, light perception, and no light perception were approximated by Snellen VAs of 20/4000, 20/40000, 20/400000, and 20/4000000000, respectively. Values >20/20 were trimmed to 20/20. The ungradable rates for fundus photographs and OCTs were tallied. The observed prevalence of disease found during screening was compared for differences from national prevalence rates using 1-sample, 2-sided z-tests of proportions; screening disease rates were compared between clinics with chi-square or Fisher exact tests. The distribution of self-reported visual function from the VFQ9 is displayed with boxplots showing the mean, median, and interquartile range for the composite score and subscales, overall and stratified by clinic. Self-reported visual function was compared between clinics and between participants with and without pathology using 2-sample Wilcoxon tests. Program satisfaction was summarized with descriptive statistics, overall and stratified by clinic. Satisfaction was compared between clinics for the proportion of subjects reporting the two highest responses with Fisher's exact tests. Multiple comparison adjustment was performed using Holm's procedure. Program implementation costs were categorized as start-up or yearly recurrent costs each with subcategories and

summed to report totals. All analysis was performed with SAS version 9.4 (SAS Institute, Cary, NC).

Results

A total of 1,171 community residents participated in the first year of the MI-SIGHT program, including 397 from the free clinic (34%) and 774 from the FQHC (66%). Overall, participants were on average 55 years old (SD=14.5), 38% were male, 54% identified as Black, 34% as White, 10% as Hispanic or Latino, 33% reported a high school education or less, and 70% reported income <$30k (Table 1). Self-reported medical history showed 38% of participants with diabetes, 53% with hypertension, 50% being a current or former smoker, 5% with glaucoma, and 27% with a family history of glaucoma. Eighty percent of the cohort (n=932) remembered the date of their last dilated eye exam. Of those 932 participants, 44% had not had a dilated eye exam in the last two years. Presenting VA for the better eye was on average 0.12 LogMAR units (SD=0.19; Snellen equivalent=20/26±1.9 lines). Descriptive statistics of the cohort are also provided stratified by clinic in Table 2. The mean presenting LogMAR VA was 0.08 at the free clinic and 0.13 at the FQHC with significantly worse presenting VA at the FQHC ($p<0.0001$). Those at the FQHC were more likely to identify as Black (64.7% versus 33.8%; $p<0.0001$), were more likely to have comorbidities such as diabetes or hypertension, and had lower rates of college education (college degree: 7.7% versus 20.7% $p<0.0001$).

Of the 1,171 participants, 1,165 (99.5%) completed the entire technician screening examination and photography, which were then graded remotely by ophthalmologists. The ungradable rate for fundus photographs was 1.4% and the ungradable rate for OCT imaging was 2.6%. Follow-up with a comprehensive ophthalmologist within one year was recommended for 41% of participants. Table 2 presents the results of the screening. Uncorrected or under-corrected refractive error (presenting VA ≤20/50 corrected to ≥20/40 in the better seeing eye) was observed in 8.2% of participants, significantly larger than the reported national rate of 5.3% ($p<0.0001$).[8] Visual impairment (better eye VA <20/40) was found in 10.3% of participants, which is also significantly larger than the national prevalence rate of 2.2% ($p<0.0001$).[20] However, rates of uncorrected or under-corrected refractive error and visual impairment were higher when taking into account either eye of a participant rather than just the better eye (18.7% and 24.6%, respectively). Most patients (71.0%) ordered glasses to correct their vision, spending an average of $37 (SD=$25, range=$7-$207, median=$33). Cataract was observed in 21.5% of participants, which is significantly larger than the national prevalence rate of 17% ($p<0.0001$).[21] Visually significant cataract(s) were observed in 5.2% of the cohort. There were 24.0% of participants who were positive for glaucoma or glaucoma suspect in at least one eye, significantly larger than current national prevalence rates of 6–9% ($p<0.0001$).[22] Of the 284 subjects who screened positive for glaucoma, 37 (13.0%) self-reported a previous diagnosis of glaucoma, 193 (68.0%) reported no prior diagnosis of glaucoma, and 54 (19.0%) reported they were unsure of their glaucoma diagnosis status. The observed rate of incident glaucoma was estimated between 16.6% (n=193/1165) and 21.2% (n=193+54/1165) of participants. depending on if those with unsure self-reported glaucoma status did or did not already have glaucoma, respectively. Only 13 participants (1.1%) presented with IOP ≥ 30 mm Hg in one or both

eyes necessitating more urgent evaluation. Lastly, screening showed age-related macular degeneration in 2.0% of participants and diabetic retinopathy in 7.3%. Both observed rates were significantly larger than national estimates of 1.5%[23] and 3.4%,[24] respectively (both p<0.0001). Pathology rates for other retinal, corneal, optic nerve, iris, and external eye conditions were low, ranging from 2.2% (hypertensive retinopathy) to 0% (melanoma, corneal ulcer; Supplemental Table 1).

Self-reported visual function from the composite VFQ9 score was on average 79.6 (SD=15.5; Supplemental Table 2). Participants were most confident in their visual function with respect to driving (mean=90.7, SD=20.0) and least confident in their visual function with respect to mental health (mean=58.9, SD=29.9). Mental health was assessed by the item “How much of the time do you worry about your eyesight?” Visual function scores showed similar distributions between clinics (Figure 1; Supplemental Table 2, p-values >0.05). However, participants who screened positive for any pathology (visual impairment, glaucoma, visually significant cataract, diabetic retinopathy, or age-related macular degeneration) reported significantly worse visual function than those without pathology for composite VFQ9 (mean=75.1 versus 82.4, respectively; p<0.0001) and on all subscales (Supplemental Table 3, all Holm-adjusted p-values <0.05). Comparison of self-reported visual function in those with versus without specific pathology are also presented (Supplemental Table 2).

Nearly all participants reported they were very satisfied (90.7%) or satisfied (8.3%) with the program (Supplemental Table 4) and were very likely (92.0%) or likely (6.6%) to recommend the program to a family member or friend. Participants rated the program as very convenient (86.7%) or convenient (11.6%). No significant differences in program satisfaction were found between the free clinic and FQHC (all p>0.05).

Implementation costs for the MI-SIGHT program at two locations, excluding research costs, totaled $702,575 U.S. Dollars (Table 3). Start-up costs were $206,369 (29% of the total) with costs including two optical coherence tomography (OCT) machines ($94,890 combined), ophthalmic supplies including tonometers, lensometers, and phoropters ($75,131), around $20,000 for computer and technology equipment, $12,000 for renovations to convert the original office spaces to clinical spaces, and $3,000 for furniture. Yearly ongoing costs are estimated to be $496,206 or 71% of total first year implementation costs. Most costs (90%) are for personnel salary and benefits for 3 full-time ophthalmic technicians, a full-time administrator, and six part time ophthalmologists (one clinician at 20% effort to oversee the program and be on-call for emergencies and questions from the technicians and five clinicians at 5% effort to read telemedicine examinations). The program occupies donated space in the free clinic and FQHC for the duration of the grant funding. Additional costs for rent are approximated at $20,000 ($10,000 per clinic).

Discussion

The MI-SIGHT program identified higher rates of eye diseases and visual impairment compared to national estimates with a 1.5 times greater rate of visual impairment,[20] 2.6 times greater rate of glaucoma,[22] and 2.1 times greater rate of diabetic retinopathy.[24] This

translates to a 10% prevalence of visual impairment, a 24% prevalence of glaucoma and suspected glaucoma, and a 7% prevalence of diabetic retinopathy among participants. The majority of participants (70%) earned less than $30,000 per year, which is less than half the median national income in the US in 2021.[25] Over half of participants identified as Black (54%) and 10% identified as Hispanic or Latino. Participants in the MI-SIGHT program were very worried about their eyesight. In response to the question “How often do you worry about your eyesight” participants scored on average 59 out of 100, where a lower score indicates more worry. This is in comparison to the population in which the NEI VFQ was validated where participants without disease scored on average 92, participants with glaucoma scored 81, participants with diabetic retinopathy scored 66, and participants with macular degeneration scored 58.[26] In our MI-SIGHT cohort, those without any disease scored 63 while those with disease scored 52. Placing eye care in communities with high rates of poverty may help alleviate some of this intense concern about eye health by improving access to care. However, start-up costs alone for the MI-SIGHT program were approximately $100,000 per clinic site, which is likely beyond the capital capacity for many federally qualified health centers and free clinics that often operate on a tight budget.

The MI-SIGHT program is housed in two clinics serve cities with high levels of poverty. In Flint, MI the median household income is $30,383[27] and 37% of the population lives under the poverty limit. In Ypsilanti, MI the median household $40,028[28] and 30% of the population lives under the poverty limit. These cities also have higher populations of Black Americans than the national average of 14%,[29] with 27% Black Americans in Ypsilanti and 54% Black Americans in Flint. Black Americans and Americans with lower socio-economic status are at increased risk of glaucoma, diabetic retinopathy, and other eye diseases. By placing the clinics in cities with high proportions of Black Americans with lower socio-economic status, we made access to eye care easier for populations known to have higher rates of eye disease. This may explain why the rates of pathology among MI-SIGHT participants are higher than national rates. Additionally, placing the MI-SIGHT program in trusted primary care clinics in easy-to-access locations in the community enabled a successful community outreach strategy to engage participants in the program. Increasing participant volume alongside having eye disease detection rates 1.5 – 2 times as high as the national averages would likely lead to a decreased cost per case of disease detected in an economic analysis. This approach – placing eye disease detection programs in trusted primary care clinics in communities, such as FQHCs, that serve persons with high levels of poverty - could present a targeted national screening strategy that is more cost effective than campaigns that encourage people to visit an eye doctor for screening. Leveraging telehealth to provide high quality eye disease detection in FQHCs could potentially be a cost-effective strategy for large-scale public eye health programs.

There are barriers to the sustainable implementation of eye health programs that serve communities with high rates of poverty. The federal government provides funding for FQHCs through the Health Resources and Services Administration (HRSA). As of 2016, about half of FQHC patients nationally had Medicaid as their primary insurance.[30] Medicaid pays a flat rate, determined by each state, for each patient visit to an FQHC regardless of the services provided during the encounter. In Michigan, for example, this rate was $171 per visit in 2020 (Sherry Pace, COO Hamilton Community Health Network, personal

communication). This is compared to a Level 3 new patient consult (E&M Code 99203) with standard glaucoma testing including OCT, HVF, fundus photographs and pachymetry that would be reimbursed at an average rate of $267.39 by Medicare at an outpatient facility in Michigan in 2020. Thus, the FQHC are compensated 36% less than a private ophthalmology office.

The flat rate payment represents a barrier for subspecialty care, that has in-person diagnostic imaging equipment as part of standard care. In the MI-SIGHT program, the start-up costs for each clinic for set-up, supplies and equipment were $103,184. Our two ophthalmic technicians in the FQHC provide care to approximately 20 new participants and approximately 20 return visits per week. In addition to scheduling patients, our ophthalmic technicians are also responsible for doing outreach to engage participants and helping patients obtain recommended follow-up care in their role as health care navigators. During this first year while enrollment was getting off the ground, each technician spent approximately 20 hours per week making phone calls to recruit and schedule participants. During this first year, our four staff also engaged in approximately 400 hours of outreach work. As time has gone on, and more people heard about the program through word of mouth, scheduling time has gone down to a few hours per week and our outreach efforts are now minimal. At the flat rate of $171/visit, our program would generate gross revenue of approximately $155,000 per year. The gross revenue would support yearly technician salaries and benefits, monthly consumable costs, and equipment maintenance contracts. However, this revenue would not be sufficient to cover any new equipment, clinician salaries, initiation costs or community engagement costs. The high capital costs and the low flat-rate reimbursement are key barriers to providing subspecialty eye care at FQHCs. Prohibitive costs are likely why eye care is only provided at 20% of FQHCs.[31] At the free clinic, there is no cost recovery and thus no way to sustain the program outside of grant funding or philanthropic support.

Providing eye care is equally as expensive at FQHCs or free clinics as it is in other settings. However, indirect, unique barriers exist that require additional personnel support thereby incurring additional cost. As suggested by Maslow’s hierarchy, people only prioritize asymptomatic health conditions, mental health, or wellness after physical needs, such as safe housing and adequate food, are met. People participating in this program have needed extra support through health care navigation in scheduling specialist appointments, accessing and using their insurance, and getting help with transportation to their eye care appointments. People have needed extra staff support to schedule and re-schedule their appointments. People with low income often work in low wage jobs with less autonomy over time away from work. Additionally, people have needed more re-scheduling if they are involved in child-care or elder care. Competing priorities create a higher no-show rate; the no-show rate across our clinics was approximately 30%. When patients do not show for their appointments, there are no incoming funds for the program efforts because of the fee-for-service reimbursement model.

The strengths of this study include the large sample size and the community-based methods of recruitment. The strategy engaged patients for whom the program was intended – people without a recent eye exam and at high risk of eye diseases. Of note, the program does not

use random community-based sampling, so the findings should not be extrapolated to reflect population-level eye disease prevalence. Additionally, as this was not a validation study of ophthalmic telemedicine, there was no in-person gold standard ophthalmologist examination for each participant in the screening program as this was beyond the scope of this study. The screening protocols used herein were already validated by the Technology Based Eye Care Services program through the Veterans Affairs Medical Center.[15]

The UN's "Vision for Everyone" resolution aims to achieve equity in eye health outcomes. Equity is different from equality. To ensure equality, policies ensure that individuals receive the same resources or opportunities. To ensure *equity*, policies ensure that individuals are allocated the resources or opportunities that they need to reach an equal outcome. To promote equity in eye health, expanded resources need to be allocated to communities with high rates of poverty and with high proportions of Black and Hispanic Americans. Only then will policy help mitigate the current socio-economic, racial, and ethnic disparities in eye health outcomes. Because better vision is associated with higher levels of vision-related quality of life and higher levels of economic productivity, ensuring equity in eye care could promote well-being and productivity for everyone.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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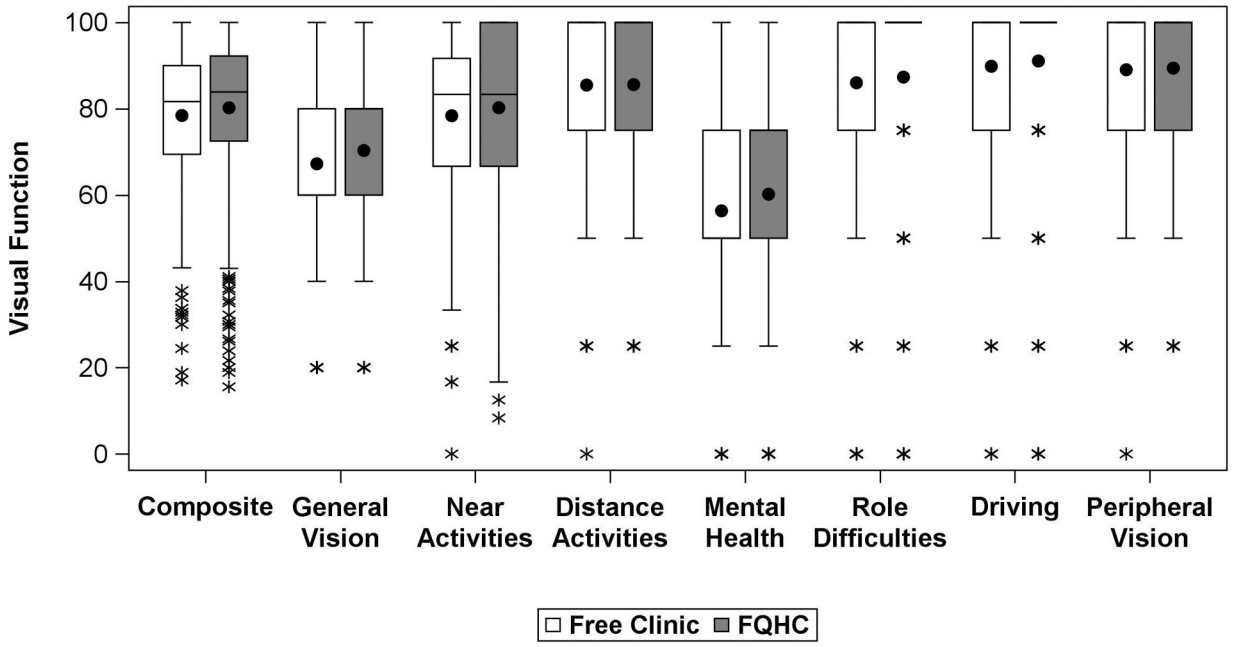

Figure 1.

Boxplots displaying the distribution of self-reported visual function in the first-year Michigan Screening and Intervention for Glaucoma and eye Health through Telemedicine (MI-SIGHT) cohort, overall (n=1171) and stratified by clinic (free clinic [n=397] or federally qualified health clinic [FQHC, n=774]).

Table 1.

Descriptive statistics for patient characteristics of the first-year Michigan Screening and Intervention for Glaucoma and eye Health through Telemedicine (MI-SIGHT) cohort (n=1171)

	Overall (n=1171)		Free Clinic (n=397)		FQHC (n=774)		
Continuous Variable	**N**	**Mean (SD), Median**	**N**	**Mean (SD), Median**	**N**	**Mean (SD), Median**	**P-value***
Age (years)	1171	55.1 (14.5), 57.0	397	55.7 (14.6), 57.8	774	54.8 (14.5), 56.4	1.0000
LogMAR VA	1168	0.12 (0.19), 0.0	394	0.08 (0.17), 0.00	774	0.13 (0.20), 0.10	<0.0001
Categorical Variable		#/total (%)		#/total (%)		#/total (%)	
Sex - Male		437/1158 (37.7)		141/391 (36.1)		296/767 (38.6)	
Race							1.0000
White		371/1093 (33.9)		164/376 (43.6)		207/717 (28.9)	
Black		591/1093 (54.1)		127/376 (33.8)		464/717 (64.7)	<0.0001
Asian		48/1093 (4.4)		44/376 (11.7)		4/717 (0.6)	
Other		83/1093 (7.6)		41/376 (10.9)		42/717 (5.9)	
Ethnicity - Hispanic		101/968 (10.4)		33/312 (10.6)		68/656 (10.4)	1.0000
Education							
<HS		119/1151 (10.3)		37/387 (9.6)		82/764 (10.7)	
HS or Equivalent		373/1151 (32.4)		92/387 (23.8)		281/764 (36.8)	
Some College		391/1151 (34.0)		113/387 (29.2)		278/764 (36.4)	<0.0001
College Degree		139/1151 (12.1)		80/387 (20.7)		59/764 (7.7)	
Graduate Degree		129/1151 (11.2)		65/387 (16.8)		64/764 (8.4)	
Income							
<$10k		248/993 (25.0)		67/320 (20.9)		181/673 (26.9)	
$10k-$19,999		246/993 (24.8)		79/320 (24.7)		167/673 (24.8)	
$20k-$29,999		202/993 (20.3)		75/320 (23.4)		127/673 (18.9)	1.0000
$30k-$49,999		172/993 (17.3)		52/320 (16.3)		120/673 (17.8)	
$50k-$69,999		60/993 (6.0)		24/320 (7.5)		36/673 (5.4)	
$70k+		65/993 (6.6)		23/320 (7.2)		42/673 (6.2)	
Unemployed/Retired/Disable/Homemaker/Student		691/1150 (60.1)		236/386 (61.1)		455/764 (59.6)	1.0000
No Health Insurance		228/1142 (20.0)		174/386 (45.1)		54/756 (7.1)	<0.0001
Primary Language not English		122/1164 (10.5)		77/396 (19.4)		45/768 (5.8)	<0.0001

	Overall (n=1171)		Free Clinic (n=397)		FQHC (n=774)		
Continuous Variable	**N**	**Mean (SD), Median**	**N**	**Mean (SD), Median**	**N**	**Mean (SD), Median**	**P-value***
Self-reported Medical History		#/total (%)		#/total (%)		#/total (%)	
Diabetes		433/1138 (38.1)		94/385 (24.4)		339/753 (45.0)	<0.0001
Hypertension		601/1125 (53.4)		160/379 (42.2)		441/746 (59.1)	<0.0001
Ever Smoker		584/1157 (50.5)		133/389 (34.2)		451/768 (58.7)	<0.0001
Glaucoma		46/917 (5.0)		17/274 (6.2)		29/643 (4.5)	1.0000
Family History Glaucoma		250/917 (27.3)		74/274 (27.0)		176/643 (27.4)	1.0000
Last dilated eye exam >2 year		412/932 (44.2)		120/323 (40.3)		282/609 (46.3)	0.6112

FQHC, Federally Qualified Health Clinic; SD, Standard Deviation; VA, Visual Acuity; HS, High School; k, $1000

*Clinic differences tested by 2-sample t-test (age), 2-sample Wilcoxon test (VA), Fisher's exact test (race), and Chi-square tests (all other categorical variables) with adjustment for multiple comparisons using Holm's procedure

Table 2.

Clinical screening results for the first-year Michigan Screening and Intervention for Glaucoma and eye Health through Telemedicine (MI-SIGHT) cohort

Screening Variable	Overall (n=1165) # (%)	Free Clinic (n=394) # (%)	FQHC (n=771) # (%)	P-value*
Ordered Glasses	831 (71.0)	199 (50.1)	632 (81.7)	<0.0001
Visual Impairment (Better Eye <20/40)	120 (10.3)	28 (7.1)	92 (11.9)	0.0550
Visual Impairment (Either Eye <20/40)	286 (24.6)	69 (17.6)	217 (28.2)	
Un or Under-Corrected Refractive Error (Better eye presenting <20/40, corrected ≥20/40)	96 (8.2)	16 (4.1)	80 (10.4)	0.0014
Un or Under-Corrected Refractive Error (Either eye Presenting <20/40, corrected ≥20/40)	217 (18.7)	43 (10.9)	174 (22.7)	
Cataract	250 (21.5)	83 (21.1)	167 (21.7)	1.0000
Not Visually Significant	189	53	136	
Visually Significant Cataract	61	30	31	
Glaucoma				
Prevalence	284 (24.4)	80 (20.3)	204 (26.5)	0.0928
Incidence**	193 (16.6), 247 (21.2)	48 (12.2), 67 (17.0)	145 (18.8), 180 (23.3)	
Macular Degeneration	23 (2.0)	9 (2.3)	14 (1.8)	1.0000
Diabetic Retinopathy	85 (7.3)	13 (3.3)	72 (9.3)	0.0014
Other - Any***	169 (14.5)	57 (14.5)	112 (14.5)	1.0000

FQHC, Federally Qualified Health Clinic; VA, Visual Acuity

* Clinic difference tested by Chi-square with adjustment for multiple comparisons using Holm's procedure

** The observed rate of incident glaucoma was estimated at between 16.6% and 21.2% of participants, depending on if those with unknown self-reported glaucoma status did or didn't already have glaucoma, respectively.

*** See Supplemental Table 1

Table 3.

Implementation costs for the Michigan Screening and Intervention for Glaucoma and eye Health through Telemedicine (MI-SIGHT) program

Start-up Cost	**$206,369.27**
Renovations	$11,858.96
Furniture	$2,833.14
Moving	$1,838.08
Computers/Scanners/Computer Supplies	$19,632.01
OCT	$94,890.00
Ophthalmology Equipment/Supplies/Tools & Office set-up	$75,130.63
Personnel set-up time/Incidental costs	$80.50
Outreach (nonrecurring)	$105.95
Clinical Recurrent Yearly Cost	**$496,206.09**
Computer/Tablet updates	$1,160.00
OCT Licensing fees	$7,000.00
Software fees	$114.40
Rent	$20,000.00
Clinical Salary	
MD (1 oversight, 5 screening, 1 every other month glaucoma clinic + benefits)	$176,968.22
Technicians (3 full-time technicians + benefits)	$208,570.80
Admin/Clerk helper (full-time salary + benefits)	$60,230.28
Community Outreach/Advertising (flyers, stamps, health fairs, advertisements)	$2,818.10
Ophthalmology Supplies/Meds/Equipment/PPE/Scrubs/Reading glasses/Frames	$4,357.76
Office Supplies (toner, paper, pens/pencils, batteries, tissue paper, etc.)	$13,459.85
IT Support (12 months - storage, memory, backup)	$526.68
Incidental	$1,000.00

OCT, Optical Coherence Tomography; MD, Medical Doctor; PPE, Personal Protection Equipment; IT, Information Technology