HHS Public Access

Author manuscript

Ophthalmology. Author manuscript; available in PMC 2025 February 01.

Published in final edited form as:

Ophthalmology. 2024 February ; 131(2): 140–149. doi:10.1016/j.ophtha.2023.09.011.

The Relationship between Unstable Housing, Food Insecurity and Vision Status in the MI-SIGHT Community Eye Disease Screening Program

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Abstract

Purpose: Housing and food insecurity are social risk factors that can impact eye health outcomes. This study investigated the association of these social risk factors with vision and ophthalmic pathology.

Design: Cross-sectional study from July 28, 2020 – July 27, 2021 for the Free Clinic and January 27, 2021 – January 26, 2022 for the Federally Qualified Health Center.

Subjects, Participants, and/or Controls: —Michigan Screening and Intervention for Glaucoma and Eye Health through Telemedicine (MI-SIGHT) program first year participants.

Methods, Intervention, or Testing: Data collected included socio-demographics, housing and food insecurity, and results from a comprehensive telemedicine assessment. Individual-level

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Conflict of Interest: No conflicting relationships exist for any authors.

Meeting Presentation: Association for Research in Vision and Ophthalmology 2023

Disclaimer: The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

and neighborhood-level characteristics were summarized with descriptive statistics. Differences in participant characteristics between housing and food security status were tested by two-sample t-tests for continuous measures and Chi-square or Fisher exact tests for categorical measures. Logistic regression was used to test the independent associations between housing and food insecurity and ophthalmic disease, adjusted for age. The Holm's procedure was performed to adjust for multiple comparisons.

Main Outcome Measures: Outcomes included: 1. visual impairment (VI, presenting visual acuity [PVA] <20/40), 2. uncorrected or under-corrected refractive error (URE, PVA <20/40 and best corrected VA ≥20/40), 3. glaucoma, 4. diabetic retinopathy, 5. cataract, and 6. macular degeneration.

Results: Participants (n=1165) were on average 55 years old (standard deviation, [SD]=14.5), 62% identified as female sex, 54% identified as Black or African American, 10% identified as Hispanic or Latino, 49.7% had <$20,000 annual household income, and 20% reported no medical insurance. PVA was on average 0.12 logMAR units (SD=0.19; Snellen=20/26±1.9 lines). VI and URE were identified in 10.3% and 8.3% of participants, respectively. Participants reported housing insecurity (3.4%), food insecurity (28.9%) and 2.2% reported both. Among participants with unstable housing, 26.3% had VI and 23.7% had URE. Unstable housing was associated with higher odds of VI (odds ratio [OR]=3.53, p=0.006) and URE (OR=3.74, p=0.006). No associations were observed between unstable housing and other ocular pathology or food insecurity and any ocular pathology.

Conclusion: As unstable housing is associated with visual impairment and uncorrected refractive error, future initiatives could focus on interventions to both address unstable housing and the increased need for eye care among those with unstable housing.

Précis

Unstable housing was associated with higher odds of visual impairment and uncorrected or under-corrected refractive error in the Michigan Screening and Intervention for Glaucoma and Eye Health through Telemedicine program.

Keywords

Food Insecurity; Unstable Housing; vision screening; vision status; social risk factors

Introduction:

In the United States (US), blindness and visual impairment disproportionately impact those who live in poverty and those who are from racial and ethnic minority groups including those who identify as Black and Hispanic or Latino.[1] Black and Latino individuals not only have disproportionately higher rates of blindness and visual impairment compared to Non-Hispanic White individuals,[1] but they also have decreased eye care utilization.[1] Barriers such as cost, unreliable transportation, lack of trust in healthcare providers, and insufficient translation services impact access to eye care.[2,3] These barriers can reinforce preconceived negative perceptions of the healthcare system and decrease an individual's motivation to

access preventive care. Poor vision and blindness can be mitigated with improved access to prescription glasses, cataract surgery, diabetes treatment, and glaucoma care.

Eye health is impacted by where people live, work, play, worship, and age – all factors related to social determinants of health (SDoH)[4,5]; the societal-level forces and systems that shape daily life positively or negatively.[1,3,4] Social risk factors are negative social conditions that adversely impact individual's health outcomes.[6,7,8] On an individual-level, food and housing insecurity are social risk factors for poor health outcomes. Food insecurity refers to an unreliable or limited means to attain adequate quantities of food.[9] Food insecurity has been linked to increased diabetes risk, worse glycemic control, and a greater likelihood of diabetic complications.[10–12] Housing instability is the concern that one may not have ongoing safe and reliable shelter.[13] Housing instability has been associated both with decreased utilization of routine preventative health care and forgoing necessary medications and treatment.[14,15]

The Michigan Screening and Intervention for Glaucoma and Eye Health through Telemedicine (MI-SIGHT) program leverages telemedicine through a community-engaged framework to provide eye disease detection and care navigation in two primary care community clinics, one Federally Qualified Health Center (FQHC) and one free clinic, that serve populations with high levels of poverty. The purpose of the overarching research is to assess if a telemedicine program based in community health centers (i.e., the MI-SIGHT program) effectively detects glaucoma and other eye diseases and can provide vision services such as prescription eyeglasses and care navigation to access appropriate specialty care when needed. The purpose of this study was to assess whether the participants in the first-year cohort of the MI-SIGHT Program who reported social risk factors including food insecurity and/or unstable housing had higher rates of visual impairment and an increased prevalence of the five leading causes of blindness and visual impairment (un- or under-corrected refractive error, cataract, diabetic retinopathy, macular degeneration, and glaucoma). If food and/or housing insecurity impact ocular health, it emphasizes the need for public policy changes to improve vision on a societal level.

Methods:

The MI-SIGHT Program is conducted at two community clinics, including the Hope Clinic, a free clinic in Ypsilanti, Michigan, and the Hamilton Community Health Network, an FQHC in Flint, Michigan. The free clinic is a privately owned, community and volunteer driven primary care focused clinic that also includes dentistry and social work where all services are provided free-of-charge. The FQHC is a federally funded clinic that provides medical care and dental care on a sliding scale based on patient income and also has social work support. The MI-SIGHT program methods are described in detail elsewhere.[16] Both participating clinics reside in cities that have large populations of people from racial and ethnic minority groups as well as large populations of people living with lower incomes. In Ypsilanti, 27% of the population identifies as Black and 6% identifies as Hispanic or Latino. In Flint 54% of the population identifies as Black and 5% identifies as Hispanic or Latino. The two cities have median household incomes at approximately half of the US average - $39,332 in Ypsilanti and $28,834 in Flint, compared to $68,703 nationally.[17] Both clinics

have a 39-year history of service to these two cities. Participants enrolled in the first year of the program in each clinic (July 28, 2020 – July 27, 2021 for the Free Clinic and January 27, 2021 – January 26, 2022 for the FQHC) were included in this analysis.

The MI-SIGHT program recruited community residents interested in a free eye health exam who were 18 years or older. Exclusion criteria, as determined by an initial screening intake, included: 1) significant eye pain; 2) sudden decrease in vision in the past week; 3) binocular diplopia (double vision with both eyes open); 4) cognitive impairment; 5) pregnancy; 6) current incarceration; or 7) planning to move outside of driving distance to the clinic within the next 6 months. Participants were recruited directly from each clinic and were given informational handouts to distribute with family and friends. Wider community outreach was achieved by a combination of advertisements on local buses, radio channels, health fairs and community access television placement; in addition to the placement of 11,000 flyers in community clinics, neighborhood foodbanks, low-income senior housing, barbershops and churches.[1] This recruitment was supervised by the MI-SIGHT Community Advisory Board.

Written informed consent was obtained from all eligible participants. The free clinic serves a population wherein approximately 20% of patients do not speak English and there is no majority second language spoken. Therefore, consent forms were provided in English, Spanish, Albanian, and Arabic. Short form consents were provided in Mandarin, French, Hindi, Korean, Tagalog, and Igbo. People who did not speak any of the above languages were excluded. The Hamilton clinic serves a population wherein approximately 10% of patients do not speak English, where Spanish is the second most frequently spoken language. Thus, a long-form consent was provided in Spanish. This study was reviewed and approved by the University of Michigan Institutional Review Board (HUM00169371), is registered at Clinicaltrials.gov (NCT04274764), and adheres to the Tenets of the Declaration of Helsinki.

Following informed consent, participants at each site completed surveys that included collection of socio-demographic characteristics, address to obtain area deprivation index[18], health status information, and assessment of food and housing insecurity. After completion of surveys, participants underwent a series of tests administered by ophthalmic technicians to assess for glaucoma and other eye diseases. Participants' presenting visual acuity (VA) was measured with a Snellen chart. Refractive error was measured with an autorefractor (ARK-Autorefractor & Keratometer, Marco Ophthalmic, Jacksonville, FL) and subjectively refined with a phoropter. Pupillary response and anterior chamber angle were assessed by penlight exam. Extraocular motility and alignment were also assessed. Three measurements of intraocular pressure (IOP) were obtained (iCare tonometer, Raleigh, NC). Tropicamide 0.5% was used to dilate those without a narrow angle on penlight exam and with IOP <30 mm Hg to mitigate the potential risk of acute angle closure. Mydriatic imaging of the posterior pole was obtained with images focused on the disc, the macula, and the superotemporal arcade (Topcon, Tokyo, Japan) and with Optical Coherence Tomography (OCT) to measure the retinal nerve fiber layer thickness (RNFL; Topcon, Tokyo, Japan). Ophthalmologists remotely reviewed the patient information, test results, and imaging in the electronic health record.

Outcome Variables

Vision Outcomes—Visual impairment was defined as presenting VA in the better eye < 20/40. Un/under-corrected refractive error was defined as presenting VA <20/40 and best corrected VA ≥20/40. Under-corrected refractive error referred to those participants who presented with glasses or contact lenses that no longer sufficiently corrected their vision and uncorrected refractive error referred to those who presented without glasses or contact lenses whose vision could be corrected.

Ophthalmic Pathology Outcomes—Participants with visually significant cataract were defined as those who met criteria per remote physician discretion and were referred for surgical consultation. Diabetic retinopathy was defined according to National Health Service Criteria[19] and macular degeneration was defined according to the Age-Related Eye Disease Study's protocol.[20] Those participants who screened positive for glaucoma or suspected glaucoma were identified by noting evidence of any of the following criteria[21]: 1. Narrow angle on penlight exam; 2. Patient previously treated for glaucoma (e.g. already taking glaucoma medications or previous glaucoma surgery); 3. Cup-to-disc ratio (c/d) ≥0.7[22]; 4. Asymmetry of the c/d by ≥0.2 where the larger cup is ≥0.6mm[22]); 5. Abnormal OCT (overall RNFL thickness <80 microns or thinning at <1% of the population norm in the inferior or superior quadrants),[23]-; and 6. IOP >21 mmHg (median of the three measures taken, interpreted for glaucoma referral according to the subsequently described criteria). If the IOP was 22–24 mmHg and the c/d ratio was <0.35 with no other glaucoma risk factors, then there was no referral; but if the c/d was ≥0.35 then participants were referred within 6 months; participants with IOP 25–29 mmHg were referred within 1 month; IOP 30–40 mmHg were referred within one week; IOP >40 mmHg were referred within 24 hours or immediately. The remote ophthalmologists used their clinical judgement alongside these criteria to determine whether the participant screened positive for glaucoma or suspected glaucoma. All those who screened positive for either glaucoma or suspected glaucoma were referred to an ophthalmologist for an in-person examination. For this analysis, the categories of glaucoma and suspected glaucoma are combined, as either diagnosis led to referral for in-person examination. After data, including the refraction, were reviewed and interpreted by the remote ophthalmologist, the participants returned to receive their screening results, follow-up recommendations, and low-cost prescription eyeglasses from the ophthalmic technician who also assisted in making any needed follow-up appointments.

Participant Social Risk Factor Assessment:

Three survey questions were asked to ascertain whether participants were food insecure or were experiencing unstable housing. The two questions asked to assess food insecurity were: "Within the past 12 months, were you ever worried about whether your food would run out before you got money to buy more?" and "Within the past 12 months, did the food you bought ever not last and you didn't have money to get more?"[24] Response choices for the two questions were: "often true", "sometimes true", "never true", and "prefer not to answer." Participants who were food secure were defined as those who answered, "never true" and participants who were food insecure were defined as those who answered "often true" or "sometimes true". Participants were asked a single question about their housing: "Do you have stable housing?" with response options of "yes", "no", and "prefer not

to answer." If a participant endorsed having unstable housing or inadequate access to food, they were connected with the social worker in either clinic and offered available resources. Participant transportation was ascertained as follows "How did you get to the appointment?" Participant's mode of transportation to the appointment was dichotomized into "driving a personal vehicle to an appointment" versus "not driving a personal vehicle to an appointment" (received a ride from a family member or friend, ride-share service or taxi, public transit, clinic arranged transport, walked, or other). We utilized participants responses to the 9-item National Eye Institute Visual Function Questionnaire (VFQ9) to exclude participants who reported they do not drive due to poor vision. Participant demographics were obtained via a survey as well.

Neighborhood-level Social Risk Factor Assessment: Area Deprivation Index

Participants were geocoded by connecting self-reported home addresses to 2021 Master Address File/Topological Integrated Geographic Encoding and Referencing database provided by the United States Census (SDOH).[1] With this mapping program, area deprivation index (ADI) state decile scores were identified for each neighborhood geocode. ADI is United States Census based calculation produced using a 17-factor characterization and ranking system to identify the socioeconomic contextual disadvantage of a community.[3] It considers a neighborhoods' poverty, education status, housing quality, and employment indicators. The ADI state decile score is on a 1–10 scale with higher values representing greater socioeconomic deprivation for a given location. We successfully geocoded 96% (n=1121 of 1171) of the sample.

Statistical Methods

Individual-level and neighborhood-level characteristics of the first-year MI-SIGHT sample were summarized with descriptive statistics (mean, standard deviation [SD], median, frequency, and percentage) for the overall sample and stratified by housing and food security status. VA was converted to LogMAR for the analyses.[25] Differences in participant characteristics between housing and food security status were tested by two-sample t-tests for continuous measures and Chi-square or Fisher exact tests for categorical measures. Logistic regression was used to test the independent associations between housing and food insecurity and ophthalmic disease, adjusted for age. Model estimates are reported with odds ratios (OR) and 95% confidence intervals (CI). The Holm's procedure was performed to adjust for multiple comparisons.[26] Models also tested an interaction between unstable housing and food insecurity for a multiplicative effect on outcomes. All analyses were performed using R version 4.1.1 (R Foundation for Statistical Computing, Vienna, Austria).

Results

A total of 1,171 participants enrolled in the MI-SIGHT program during the first year and 1,165 completed screening (99.5%), including 34% (n=394) from the free clinic and 66% (n=771) from the FQHC. Of participants who completed screening, 1,116 (96%) completed the housing security assessment, 1,109 (95%) completed the food security assessment, and 1,080 (93%) completed both assessments. Overall, the 1,165 participants who completed the screening were on average 55 years old (SD=14.5), 62% were female, 54% identified

as Black or African American, 34% identified as White, 10% identified as Hispanic or Latino, 50% reported less than $20,000 of annual household income, 68% reported that they drove a personal vehicle to the appointment, and 20% reported that they had no medical insurance (Table 1). The overall ADI of the sample was a mean of 7.2 (SD=3.1). ADI was not significantly related to unstable vs stable housing status (8.0 SD= 2.7 and 7.2 SD=3.1 p=1.0000 respectively) or to food insecurity vs food security (7.4 SD=3.0 and 7.2 SD=3.1 p=1.0000 respectively (Table 1). More than half (56%) of participants had not had a dilated eye exam in the last two years, 38% reported having diabetes, and 54% reported having hypertension. Presenting VA for the better eye was on average 0.12 LogMAR units (SD=0.19; Snellen equivalent=20/26±1.9 lines).

Among participants who answered the survey questions and completed screening, 3% (n=38/1,116) reported unstable housing, 29% (n=321/1,109) reported food insecurity, and 2% (n=24/1,080) reported having both unstable housing and food insecurity (Table 1). Participants with unstable housing presented with worse VA than those with stable housing (Median logMAR VA=0.2 [Snellen=20/30] vs 0.0 [20/20], p=0.0084). A larger percentage of participants with unstable housing had <$10k annual household income compared to those with stable housing (57% vs 23%, p<0.0165). Similarly, a larger percentage of participants in the food insecure group also had <$10k annual household income compared to those in the food secure group (38% vs 18%, p<0.0065). Moreover, participants in both the housing and food insecure groups drove their personal vehicles less to the appointment compared to those in both the housing and food secure groups (42% vs 69%, p=0.0156 and 61% vs 71%, p=0.0180, respectively). Additionally, a larger percentage of participants in the food insecure group had diabetes compared to those in the food secure group (45% vs 36%, p=0.0352). There were no other significant demographic differences (age, gender, race, or ethnicity) between those with and without unstable housing, or those with and without food insecurity. Data was stratified for those self-reporting having both, either one, or none of the social risk factors (Supplemental Table 2).

Visual impairment and uncorrected or under-corrected refractive error was identified in 10% and 8% of participants, respectively. Ophthalmic pathology was identified among participants as follows: 24% had glaucoma/suspected glaucoma; 7% had diabetic retinopathy; 5% had visually significant cataract; and 2% had macular degeneration (Table 3). After stratifying by housing status, prevalence of ophthalmic pathology was identified in participants with unstable housing as follows: 26% had visual impairment; 24% had uncorrected or under-corrected refractive error; 37% had glaucoma/suspected glaucoma; 5% had diabetic retinopathy; 5% had cataract; and 3% had macular degeneration. A larger proportion of participants with unstable housing had visual impairment compared to those with stable housing (26% vs 10%, p=0.0045). A larger proportion of participants with unstable housing had uncorrected or under-corrected refractive error compared to those with stable housing (24% vs 8%, p=0.0021). After adjusting for age, compared to participants who reported stable housing, those with unstable housing had higher odds of screening positive for visual impairment (OR=3.53, 95% CI=1.59–7.31, p=0.0060) and uncorrected or under-corrected refractive error (OR=3.74, 95% CI=1.61–7.90, p=0.0060) (Table 4).

Prevalence of ophthalmic pathology was identified in participants with food insecurity as follows: 10% had visual impairment; 8% had uncorrected or under-corrected refractive error; 25% had glaucoma/suspected glaucoma; 9% had diabetic retinopathy; 4% had cataract; and 2% had macular degeneration (Table 3) Food insecurity was not significantly associated with the prevalence of ophthalmic pathology after adjusting for patient age (Table 4).

The majority of participants reported having stable housing and food security (n=764, 71%), followed by 26% (n=280) reporting only food insecurity, 1% (n=12) reporting only unstable housing, and 2% (n=24) reporting both unstable housing and food insecurity. Of the 24 participants with both unstable housing and food insecurity, 29% had un- or under-corrected refractive error compared to 17% of participants with unstable housing and food security, 7% of participants with stable housing and food insecurity and 8% of participants with stable housing and food security. In a logistic regression model, there was no significant interaction effect between housing status and food security status and un- or under-corrected refractive error (p=0.3). This may be due to the limited sample size given the trend for participants with the combination of unstable housing and food insecurity to have a higher rate of un- or under-corrected refractive error. A similar trend was seen with visual impairment but not with glaucoma, diabetic retinopathy, cataract, or macular degeneration. (Supplemental Table 5).

Discussion

In the first-year MI-SIGHT program, 3% of participants reported unstable housing, 29% reported food insecurity, and 2% reported both unstable housing and food insecurity. Participants reporting unstable housing with or without food insecurity had greater odds of presenting with visual impairment and with uncorrected or under-corrected refractive error compared to those with stable housing. The ADI values for both communities ranged from 7 to 8, without statistically significant differences between those with and without food and housing security, indicating both neighborhood populations experience great levels of socioeconomic deprivation. Neighborhood deprivation is also reflected in the low gross incomes, high rates of food and housing insecurity, and high rates of public insurance or no insurance among study participants. In this cohort, not having the resources to meet the basic human need of stable housing put people at increased risk of presenting with visual impairment and un- or under-corrected refractive error. These results call for additional investigation into policies to address unstable housing as an upstream social risk factor for poor vision to improve vision outcomes on a population level.

Major healthcare systems and insurance companies have begun to recognize that addressing barriers to stable housing decreases healthcare utilization by the chronically homeless and other marginalized groups.[27] Several, healthcare systems and insurance companies have invested in addressing unstable housing which has improved patient health outcomes and decreased both societal and healthcare costs. Medicaid serves 82 million individuals nationwide and 2.8 million individuals in Michigan.[27] Although the program cannot directly provide rent funding,[29] New York found exceptions to assist people with severe housing insecurity by utilizing Waiver 1115 or Section 1915(c) to support minor house

modifications, assist with house searching, and pay for housing transitions.[30] Expanding subsidized or support housing could address instability issues directly and potentially limit the cost burden to the public healthcare system from downstream preventable medical morbidity such as visual impairment and blindness.[31,32]

While 11% of the US population faces food insecurity at some point each year,[33] 29% of MI-SIGHT participants identified as food insecure. Those who reported food insecurity had a higher percentage of diabetes compared to food secure peers, but we did not see this relationship persist to a significant association with food insecurity and diabetic retinopathy. This may be due to our sample in which 38% of participants had diabetes, but only 7% had diabetic retinopathy..[1,34] The lack of an association between presenting with visual impairment and reporting food insecurity in our sample differs from the seminal paper from Kolli and colleagues in which they found a dose-dependent relationship between self-reported visual impairment and food insecurity among participants ≥50 years of age in the National Health and Nutrition Examination Survey (NHANES). [35] The lack of an association seen in our study could have been for several reasons. Our cohort of 1171 participants was much smaller than the cohort studied by Kolli et al of 12,781 participants. Our cohort included those age ≥18 while the NHANES cohort included those ≥age 50, and Kolli et al noted that those over age 65 had an even stronger association between self-reported visual impairment and food insecurity than those age 50–65, so our inclusion of younger participants in our sample may partially explain our lack of an association. Our measure of food insecurity included only two items while that used in NHANES used 10 items, so it may have been less sensitive in identifying food insecurity. Kolli et al noted a stronger association between self-reported visual impairment and food insecurity than objectively measured visual impairment and food insecurity, and we did not look at self-reported visual impairment in this analysis. It is possible that had we had more participants and then limited our analysis to those 65 and older and ascertained food insecurity in a more sensitive way that we too may have identified this important association. These are areas that could all be prospectively explored in future research. Where our study did confirm Kolli and colleagues' findings is among those who reported both food insecurity and housing instability, as we found that those participants had greater rates of visual impairment and worse visual acuity on presentation compared to participants with unstable housing but who were food secure. Identifying policy-level solutions to food insecurity continues to be an important domain to improve overall health and eye health in the US.

The associations between food and housing insecurity and systemic and ophthalmic disease have important public policy implications. The concept of including access to adequate nutritious food and both stable and secure housing as part of the US healthcare system is highly controversial. For the 40 million individuals who are food insecure in the US, their healthcare expenses are greater than the expenses of their food secure counterparts.[35] Federally sponsored programs exist to provide food and shelter for people in the US; the Supplemental Nutrition Assistance Program (SNAP) is a nationwide program that allocates money for pre-approved foods for those with very low incomes.[33] Unfortunately, many may identify as food insecure but do not qualify for SNAP benefits for numerous reasons, including having an income slightly over the qualifying line, not being a citizen, or being an able-bodied adult who is unemployed and has already utilized SNAP benefits for three

months within the past three years.[33] In Michigan, families of four must have an income less than $36,501 with no more than $15,000 in assets including property to be eligible for SNAP – creating a difficult situation for families if their earned income even slightly surpasses the maximum threshold.[36,37]

According to Maslow's hierarchy, the physiologic "basic essentials of life," food and shelter, must be adequately met prior to the pursuit of safety needs such as general health, wellbeing, and social stability.[38] Maslow's hierarchy informs our hypothesis that it is not reasonable to expect people to engage in routine preventive healthcare visits when they are concerned about where they will sleep or if they will eat.[39,40] Traditional eye clinics in which ophthalmic care is typically provided may not align with the social needs of people experiencing food or housing insecurity. Delivering eye care - including dispensing glasses - in homeless shelters or at food banks could help patients access eyeglasses, identify ophthalmic pathology, and aid in accessing further care. But the circle needs to be complete. Hennein and colleagues conducted a free ophthalmology screening program at a homeless shelter and found low rates of attending recommended follow-up for accessing needed treatments and glasses. They implemented an intervention where participants would receive both a transportation voucher and health coaching. The study reported that for participants that were referred for appointments, the difference between the postintervention and the preintervention follow-up rates was 54% (95% CI: 39.8%−67.9%; $p<0.001$).[41] Eye health screening programs in low-resource locations may need additional resources to support access to appropriate care including health care navigation, transportation, interpretation, and resources for food and shelter.[40] These additional resources may seem costly, but may act to improve outcomes not just for eye disease but for systemic disease as well.

The free clinic that serves as one of the two MI-SIGHT program locations has a program called "Whole Person Care," where they provide holistic services to address social needs and physical and mental health as a way to improve health equity.[42] When a patient first comes to the free clinic, their food, shelter, and medical care needs are assessed by a social risk factors survey. The survey is then utilized to connect individuals to the appropriate resources at the free clinic. For example, someone facing food insecurity is connected with the in-house food bank and other food allocation programs. An individual facing housing insecurity is contacted by a social worker versed in finding local housing programs. At the FQHC, if a person is identified as having food or housing insecurity, they are referred to the clinic social worker to connect them with community resources.

To address the upstream social needs that confer risk of visual impairment and un- or under-corrected refractive error, social economic policy can be formed to mitigate homelessness and unstable housing. For example, there are both federal and international policies that address social needs such as food and housing stability to improve population health. One policy is called Universal Basic Income (UBI). [42-44] The three-pronged approach of UBI includes the following: 1. All citizens receive a basic level of income; 2. There are no limitations on purchase types; and 3. Income is on a recurring schedule. [42-44]This structure enables people to have sufficient funds for safe housing and adequate food.[42–44] These programs in Africa, the Americas, and South-East Asia have led to a decrease in hospitalization,[42,45 a] decrease in self-reported hunger, and increased healthcare

utilization.[42] The most notable small scale UBI-like programs in the US occurred in Alaska[46] and Stockton, California.[47] Both yielded positive community results with improved psychological well-being.[46,47] During the COVID-19 pandemic, the US government implemented its own federal UBI-adjacent model by distributing over $3 trillion US dollars in direct cash payments and tax credits as a relief package for American citizens.[43,48] This program lifted 17 million people above the poverty line, reduced the number of people living below the poverty line by one-third, and reduced barriers to food and housing via increasing SNAP benefits, expanding emergency rental assistance, and increasing housing funding for those experiencing homelessness.[49]

There are limitations in the design of this study. First, the most deprived patients probably do not present to the free screenings, so the highest risk patients may be missing from this study. Had the program been run at a homeless shelter, the findings may have differed. Another limitation is that both food and housing insecurity were ascertained from participant responses. As food insecurity and housing instability can be sensitive topics, participants may have responded with socially desirable answers (food secure and stable housing) rather than their actual needs, leading to response bias and leading to an underestimate of the association between food and housing security and ophthalmic pathology. Additionally, demographic composition and geographic location of the two clinic populations may limit generalizability of the study's findings. Lastly, our data is cross-sectional and has demonstrated only an association between housing and food insecurity and visual impairment and not a causative relationship.

Housing instability was a risk factor for presenting with visual impairment and uncorrected refractive error. Future research is needed on ideal interventions to address unstable housing and food insecurity and its subsequent impact both on overall health and on eye health. Upstream policies to address unstable housing and food insecurity are needed to improve population-level eye health and vision outcomes.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Funding:

Financial Support:

This work was supported by the Centers for Disease Control and Prevention (Atlanta, GA; U01DP0064420100, PANC, ARE, MAW, LMN, JZ, AKB, SW, DCM), National Institute for Minority Health and Health Disparities (Bethesda, MD; K23MD016430, ARE), National Institutes of Health (K12GM111725, PMH), Research to Prevent Blindness (Physician Scientist Award, PANC, Career Advancement Award, MAW), and Health Equity in Summer Research Program from the University of Michigan Kellogg Eye Center (MAJG). The funding organizations had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

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Table 1.

Socio-demographic characteristics of the first year MI-SIGHT cohort stratified by housing and food security

	Overall (n=1165)	Unstable Housing (n=38)	Stable Housing (n=1078)		Food Insecure (n=321)	Food Secure (n=788)	
Continuous Variable	**Mean (SD), Median**	**Mean (SD), Median**		**Adj P-value***	**Mean (SD), Median**		**Adj P-value***
Age (years)	55.1 (14.5), 57.0	50.6 (17.0), 52.2	55.5 (14.3), 57.2	0.3663	54.5 (12.8), 55.7	55.6 (15.3), 57.6	0.3544
Area Deprivation Index	7.2 (3.1), 9.0	8.0 (2.7), 9.0	7.2 (3.1), 9.0	1.0000	7.4 (3.0), 9.0	7.2 (3.1), 9.0	1.0000
Presenting LogMAR VA	0.12 (0.19), 0.00	0.26 (0.30), 0.18	0.11 (0.19), 0.00	0.0084	0.12 (0.19), 0.00	0.11 (0.19), 0.00	1.0000
Categorical Variable	**# (Column %)**	**# (Column %)**		**Adj P-value***	**# (Column %)**		**Adj P-value***
Clinic							
Free Clinic	394 (33.8)	12 (31.6)	359 (33.3)	1.0000	125 (38.9)	243 (30.8)	0.0930
FQHC	771 (66.2)	26 (68.4)	719 (66.7)		196 (61.1)	545 (69.2)	
Gender							
Male	436 (37.8)	18 (47.4)	393 (36.8)	1.0000	118 (37.0)	294 (37.6)	1.0000
Female	717 (62.2)	20 (52.6)	675 (63.2)		201 (63.0)	487 (62.4)	
Ethnicity							
Hispanic/Latino	100 (10.4)	7 (23.3)	90 (10.0)	0.1810	26 (10.4)	67 (9.8)	1.0000
Non-Hispanic/Non-Latino	864 (89.6)	23 (76.7)	814 (90.0)		225 (89.6)	615 (90.2)	
Race							
Black/African American	589 (54.1)	17 (53.1)	546 (53.8)	1.0000	167 (55.5)	399 (53.8)	1.0000
White	370 (34.0)	11 (34.4)	352 (34.7)		104 (34.6)	256 (34.5)	
Asian	48 (4.4)	2 (6.2)	41 (4.0)		9 (3.0)	31 (4.2)	
Other	82 (7.5)	2 (6.2)	75 (7.4)		21 (7.0)	56 (7.5)	
Income (USD)							
<$10k	247 (24.9)	17 (56.7)	212 (22.8)	0.0165*	113 (38.2)	120 (18.1)	0.0065*
$10k–$19,999	246 (24.8)	6 (20.0)	237 (25.5)		82 (27.7)	159 (24.0)	
$20k–$29,999	202 (20.4)	4 (13.3)	191 (20.5)		61 (20.6)	136 (20.5)	
$30k–$49,999	170 (17.2)	0 (0)	168 (18.1)		31 (10.5)	133 (20.1)	
$50k–$69,000	60 (6.1)	1 (3.3)	59 (6.3)		6 (2.0)	53 (8.0)	

$70k+	65 (6.6)	2 (6.7)	63 (6.8)		3 (1.0)	61 (9.2)	
Drove Personal Vehicle to Appointment							
No	365 (32.4)	19 (57.6)	326 (31.1)	0.0156	121 (39.4)	226 (29.4)	0.0180
Yes	761 (67.6)	14 (42.4)	723 (68.9)		186 (60.6)	543 (70.6)	
Medical Insurance							
No	226 (19.9)	8 (21.6)	203 (19.1)	1.0000	64 (20.3)	139 (17.9)	1.0000
Yes	911 (80.1)	29 (78.4)	861 (80.9)		251 (79.7)	638 (82.1)	
Dilated eye exam							
<= 2 years	410 (44.2)	11 (40.7)	384 (44.2)	1.0000	126 (49.6)	265 (42.0)	0.3528
> 2 years	517 (55.8)	16 (59.3)	485 (55.8)		128 (50.4)	366 (58.0)	
Diabetes	429 (37.9)	9 (25.7)	403 (38.3)	1.0000	140 (45.3)	276 (35.7)	0.0352
Hypertension	599 (53.5)	18 (50.0)	564 (54.2)	1.0000	172 (56.0)	408 (53.5)	1.0000

SD, standard deviation; USD, United States Dollar; Adj, Adjusted; LogMAR, Logarithm of the Minimum Angle of Resolution; VA, Visual Acuity; FQHC, Federally Qualified Health Center

*2-sample t-tests and chi-square or fisher's exact tests

†Post-hoc pairwise comparison showed significant differences in income between participants with unstable housing and those with stable housing for: <$10k (Holm-adjusted p<0.0001) and $30k–$49,999 (Holm-adjusted p=0.0274)).

‡Post-hoc pairwise comparison showed significant differences in income between participants in the food insecure group and those in the food secure group for: <$10k (Holm-adjusted p<0.0001), $30k–$49,999 (Holm-adjusted p=0.0010), $50k–$69,000 (Holm-adjusted p=0.0011), and $70k+ (Holm-adjusted p<0.0001).

Table 3.

Ophthalmic pathology outcomes stratified by the social risk factors

	Overall	Unstable Housing	Stable Housing		Food Insecure	Food Secure	
Ophthalmic Pathology	**# (Percentage)**	**# (Percentage)**		**Adj P-value**	**# (Percentage)**		**Adj P-value**
Visual Impairment	120 (10.3)	10 (26.3)	104 (9.7)	0.0045	33 (10.3)	81 (10.3)	1.0000
Un/under-corrected Refractive Error	96 (8.3)	9 (23.7)	81 (7.5)	0.0021	26 (8.2)	64 (8.1)	1.0000
Glaucoma	284 (24.4)	14 (36.8)	259 (24.1)	0.2880	80 (25.1)	193 (24.5)	1.0000
Diabetic Retinopathy	85 (7.3)	2 (5.3)	77 (7.1)	1.0000	30 (9.3)	54 (6.9)	1.0000
Cataract	61 (5.2)	2 (5.3)	57 (5.3)	1.0000	13 (4.0)	45 (5.7)	1.0000
Macular Degeneration	23 (2.0)	1 (2.6)	22 (2.0)	1.0000	7 (2.2)	15 (1.9)	1.0000

Adj, Adjusted.

*Chi-square or fisher's exact tests with Holm's procedure for multiple comparison.

Table 4.

Logistic regression model results for the effect of unstable housing or food insecurity on vision and ophthalmic pathology outcomes.

	Unstable Housing			Food Insecure		
Ophthalmic Pathology	**OR**	**95% CI**	**Adj P-value***	**Odds Ratio**	**95% CI**	**Adj P-value***
Visual Impairment	3.53	1.59, 7.31	0.0060	1.01	0.65, 1.53	1.0000
Un/under-corrected Refractive Error	3.74	1.61, 7.90	0.0060	1.00	0.61, 1.59	1.0000
Glaucoma	1.95	0.97, 3.81	0.2124	1.05	0.77, 1.42	1.0000
Diabetic Retinopathy	0.79	0.13, 2.66	1.0000	1.45	0.90, 2.30	0.8405
Cataract	1.15	0.17, 4.36	1.0000	0.84	0.42, 1.57	1.0000
Macular Degeneration	1.39	0.07, 8.09	1.0000	1.51	0.56, 3.74	1.0000

CI, Confidence Interval; Adj, Adjusted.

* Holm's procedure for multiple