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Title: Mobile Eye Clinics as a Community Vision Safety Net: A Retrospective Cross-Sectional Study

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Abstract (350/350 words)

Background:

To assess the efficacy of a community-based mobile vision program in addressing eye care needs in a high risk, underserved population with limited access to routine eye care.

Methods:

This retrospective cross-sectional study included patients ≥ 18 years old evaluated by the University of California, San Diego (UCSD) Adult EyeMobile from August 2024 to August 2025. Standardized medical records were reviewed to extract demographics, clinical characteristics, and referral data. Socioeconomic status was assessed using the national Social Vulnerability Index linked to patients' residential ZIP code. Primary outcome measures were demographic and clinical characteristics, identification of new ocular or systemic disease, referrals to ophthalmology, and the level of urgency of referrals. Descriptive statistics were used to summarize patient demographics, examination findings, referral indications, and referral urgency.

Results:

A total of 1,542 patients were evaluated across various community locations. The mean patient age was 58.9 ± 15.2 years. 53.2% of patients self-identified as Hispanic, followed by Black (19.2%), White (10.6%), and Asian (4.5%). Patients demonstrated a high level of social vulnerability, with a mean national Social Vulnerability Index of 0.89 ± 0.13. After the exams, 151 new glaucoma suspects and 58 new cases of age-related macular degeneration were identified. Diabetic retinopathy was identified in 67 patients (4.3%), with 18 cases occurring in patients without a known diabetes diagnosis, suggesting previously undiagnosed diabetes.

Overall, 299 patients (19.4%) were referred to ophthalmology. The most common referral indications were evaluation for glaucoma (38.3%), cataracts (18.8%), diabetic retinopathy (16.1%), AMD evaluation (8.3%), and general dilated examination (7.2%). 29.4% of these referrals were categorized as urgent.

Conclusions:

Mobile, community-based vision programs, such as the UCSD Adult EyeMobile represent an effective model for delivering essential eye care to high-risk adults who may otherwise lack access to vision services. Furthermore, our findings present key epidemiologic data regarding the prevalence and severity of ocular disease, through stratification of referral urgency, in these underserved adult communities. By identifying previously undiagnosed systemic and ocular disease, correcting refractive errors, and providing appropriate and timely referrals to ophthalmologic care, this program supports early detection and management of vision threatening conditions in high-risk adults.

Keywords: mobile eye care, vision services, glaucoma, diabetic retinopathy

Background

Routine eye examinations are recommended for adults to detect ocular abnormalities and allow for timely management.[1] The leading causes of visual impairment in adults in developed countries include age-related macular degeneration (AMD), cataracts, diabetic retinopathy (DR), glaucoma, and uncorrected refractive error. Many of these conditions have favorable outcomes when recognized and treated early.[2] Furthermore, a comprehensive ophthalmic exam can reveal signs of systemic disease such as diabetes or hypertension, supporting broader health referral and risk stratification.[3] Despite these recommendations, many adults do not undergo the routine vision screenings or eye exams necessary to detect these ocular conditions.[4] Common barriers to care include limited access to eye care services, inadequate insurance coverage, high out-of-pocket costs, and the lack of perceived visual symptoms.[5] For example, a population based study in the Latino community found that nearly 63% had undetected eye disease.[6] These findings highlight the importance of community based vision screening programs in identifying patients who may be underutilizing eye care services and providing them with the appropriate treatment.

One effective approach is mobile eye clinics which can bring vision care directly to the patients and communities which may not have access to eye care. While many existing mobile community vision initiatives have primarily targeted pediatric populations through school-based screenings, few mobile vision programs have focused on adult populations. The University of California, San Diego (UCSD) Adult EyeMobile program delivers mobile eye care services to under-resourced and marginalized communities throughout San Diego County. This program's primary goals include providing vision screening exams to identify patients with ocular pathology, facilitate timely referrals to specialty care, and address uncorrected refractive errors through eyeglass prescriptions. The objective of this study was to assess the impact of a

community based mobile vision program in delivering essential eye care services to a high-risk population that may lack access to routine eye care.

Methods:

Study Cohort

This retrospective, cross-sectional study included all patients examined by the UCSD Adult EyeMobile from August 2024 to August 2025. Patients with incomplete records were excluded. Comprehensive eye exams were completed on the EyeMobile at various community events and senior community centers. Participants were primarily recruited through community outreach efforts and word of mouth (e.g. Facebook groups) as well as through collaboration with community advocates at senior centers. This study was approved by the University of California San Diego Institutional Review Board (IRB #121689) and informed consent was obtained. Demographic and clinical information was collected at the time of examination using standardized intake forms, including age, ethnicity, primary language, event type, residential ZIP code, and prior ocular and medical history.

Comprehensive Eye Exams

Patients underwent a standardized health history and a complete eye exam, including visual acuity, pupil measurements, extraocular motility, refraction, screening visual fields, intraocular pressure measurement using an iCare tonometer, refraction, assessment of the anterior ocular segment, and a full fundus examination. When available, participants received optical coherence tomography and retinal imaging via the Topcon Maestro 2. When clinically appropriate, patients received an updated eyeglass prescription and were able to obtain prescription eyeglasses onsite. All exams and services were done at no cost to the patient. Service utilization metrics are

summarized in Table S1. Referrals to primary care providers or ophthalmologists were made as clinically indicated based on examining optometrist clinical judgment, with referral urgency determined by EyeMobile optometrists.

Social Vulnerability Index

The Social Vulnerability Index (SVI) was used as a proxy for socioeconomic status (SES). SVI is a composite measure developed by the Centers for Disease Control and Prevention that links geographic location to demographic and socioeconomic drivers of community vulnerability. The metric aggregates 16 United States Census variables across broad domains such as SES, household characteristics, racial and ethnic minority status, and housing/transportation to quantify overall vulnerability within a given area.[7] Each community is given a percentile rank from 0 to 1, with higher values indicating greater social vulnerability. Residential ZIP codes were used to link patients to their appropriate SVI.

Statistical Analysis

Descriptive statistics were used to summarize patient demographics, examination findings, referral indications, and referral urgency. Continuous variables were reported as means with standard deviations, and categorical variables were reported as counts and percentages. All analyses were conducted using R version 4.3.1 (R Foundation for Statistical Computing, Vienna, Austria).

Results

Characteristics of Patients Seen

Between August 2024 and August 2025, a total of 1,542 patients were seen at the Adult EyeMobile (Table 1). The mean age of these patients was 58.9 ± 15.2 years (Mean ± Standard Deviation)**.** This

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cohort was ethnically diverse. Patients identified as Hispanic (53.2%), followed by Black (19.2%), Caucasian (10.6%), Asian (4.5%), Multiracial (3.4%), or Pacific Islander (1.2%). English was the most reported primary spoken language (61.3%), followed by Spanish (29.6%) and other (2.0%). These patients were seen across San Diego County at community events (69.8%), senior community centers (25.3%), and other venues (3.2%). Among the patients able to recall this information, the mean time since last eye examination was 2.55 ± 3.57 years.

Patients also demonstrated a high degree of social vulnerability. Linked to home address ZIP codes, the mean national Social Vulnerability Index (SVI) of patients was 0.89 ± 0.13. The distribution of national SVI percentiles of EyeMobile patients were drastically skewed toward higher values, with most patients clustering in the upper quartile of social vulnerability (Figure 1). The geographic distribution of ZIP codes for EyeMobile patients across San Diego County can be seen in Figure S1.

Medical and Ocular History

Self-reported medical and ocular history is summarized in Table 2. 560 patients (36.3%) reported a prior history of ocular disease, specifically 328 patients (21.3%) with cataracts, 79 patients (5.1%) with glaucoma, 15 patients (1.0%) with age-related macular degeneration (AMD) and 3 patients (0.2%) with diabetic retinopathy (DR). Systemic medical conditions were also prevalent. 282 patients (18.3%) reported a history of diabetes mellitus, including 21 patients (1.4%) with type 1 diabetes (DM1) and 261 patients (16.9%) with type 2 diabetes (DM2). Hypertension was also reported by 590 patients (36.3%), and hypercholesterolemia by 405 patients (26.3%).

In their better seeing eye, 76.6% of patients presented with a visual acuity of 20/40 or better, while 8.5% had 20/50-20/80, 2.3% had 20/100-20/200, and 1.6% had worse than 20/200 vision.

Similarly, in their worse seeing eye, 60.6% of patients presented with a visual acuity of 20/40 or better, with 19.8% at 20/50-20/80, 5.2% at 20/100-20/200, and 3.5% worse than 20/200. Refractive error was determined on examination with astigmatism reported in the majority of patients (1,308 patients; 84.8%), followed by presbyopia (1,125; 73.0%), hyperopia (884; 57.3%), and myopia (593; 38.5%). A total of 1,434 (93.0%) of patients received a new glasses prescription.

Prior versus Newly Identified Ocular Disease

Concordance between self-reported ocular disease history and examination findings was assessed to identify discrepancies between previously known and newly detected ocular conditions (Figure 2). While 79 patients reported a history of glaucoma, 230 patients were identified as glaucoma suspects during EyeMobile examination. Similarly, 15 patients reported a history of AMD, while 73 patients were found to have findings consistent with AMD. Self-reported diabetic retinopathy was notably underreported: only 3 patients indicated a prior diagnosis, yet 67 individuals (4.3%) exhibited evidence of diabetic retinopathy upon examination. Among those with DM1, 4 of 21 patients (19.0%) were found to have evidence of diabetic retinopathy, and among those with DM2, 45 of 261 patients (17.2%) had evidence of diabetic retinopathy. Notably, diabetic retinopathy was identified in 18 patients without any history of diabetes, suggesting these patients had previously undiagnosed diabetes. In contrast, all 328 individuals with a self-reported history of cataracts were confirmed upon examination, and no additional cases of cataracts were identified.

Ophthalmology Referral Indications and Urgency

A total of 299 patients were referred to an ophthalmologist, after their EyeMobile examination, for higher level care. Indications for referrals were diverse, with some patients having multiple indications. (Figure 3A) The most common referral indication was glaucoma workup, accounting

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for 143 referrals (38.3%), followed by 70 referrals (18.8%) for cataracts, 60 referrals (16.1%) for diabetic retinal examination, 31 referrals (8.3%) for AMD workup, and 27 referrals (7.2%) for a general dilated fundus exam. 42 referrals (11.3%) were also made for a variety of other indications, including but not limited to optic nerve head evaluation, corneal evaluation, and dry eye. The full list of referral indications can be found in Table S2. Referral urgency, as determined by the performing optometrist, was noted for 288 patients (Figure 3B). Of these, 88 referrals (29.4%) were classified as urgent (≤ 1 month), 84 referrals (28.1%) as semi-urgent (> 1 month and ≤ 3 months), and 116 patients (38.8%) as routine (> 3 months).

Discussion

In this study, we evaluated the impact of a community based mobile vision program on screening for serious ocular disease and providing comprehensive vision care for adult populations. This community centered, mobile approach offers a scalable model for increasing screening rates, detecting disease earlier, and improving visual outcomes among high risk, underserved adult populations. Additionally, this study establishes critical population-based data for high-risk adults who may lack alternative vision care resources and highlights the severity of ocular disease and the need for advanced care in theses communities.

Racial and ethnic minorities are at increased risk for ocular disease, visual impairment, and blindness.[8] The UCSD Adult EyeMobile serves a higher proportion of patients who identify as Black or Hispanic, including a high proportion of Spanish speaking patients. These patients have historically demonstrated a higher prevalence of serious vision threatening conditions, including diabetic retinopathy and glaucoma, compared to their White identifying counterparts.[9,10] By screening these populations, the EyeMobile provides vision care access to patients who are

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disproportionately affected by ocular disease. Additionally, individuals from underserved communities may have limited or no access to eye care providers, which can significantly impact their ability to adhere to medical appointments and recommendations.[11,12] In our study, patients screened at the EyeMobile resided in communities with high social vulnerability. High social vulnerability has been associated with higher odds of developing severe visual impairment from glaucoma, demonstrating the importance of early screening initiatives in these populations.[13] By bringing culturally appropriate and easily accessible vision services directly to underserved neighborhoods, the UCSD Adult EyeMobile reduces structural barriers and supports equitable access to eye care.

Currently, the American Academy of Ophthalmology recommends baseline eye screenings for adults at the age of 40.[1] This evaluation aims to identify common vision threatening eye conditions including cataracts, refractive errors, glaucoma, AMD, and diabetic retinopathy.[14] In the present study, the UCSD Adult EyeMobile successfully screened a high risk population, provided new eye glasses to 93% of patients, and identified 19.4% of patients who required an ophthalmology referral. A key goal of vision screening programs in the early detection of treatable eye disease and facilitation of timely referral. In our study, the EyeMobile was most effective in detecting previously undiagnosed glaucoma, AMD, and diabetic retinopathy. Prior research has demonstrated high rates of undiagnosed ocular disease worldwide, underscoring the need for effective detection strategies.[15–17] Risk factors associated with undetected eye disease include limited access to routine eye care, lack of perceived visual issues, and lower education levels.[17–20] The findings from our program align with those from other community-based mobile eyecare initiatives across the United States, where suspicion for glaucoma, cataracts, diabetic retinopathy, and AMD consistently represented the most common indications for referral.

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Programs such as the Casey Eye Institutes Outreach in Oregon and Vision Detroit have similarly high rates of undiagnosed glaucoma and diabetic retinopathy among underserved adults, reinforcing the value of mobile screening in identifying asymptomatic but potentially vision threatening conditions.[21,22] Our study further extends these findings by provided additional insights regarding disease severity through assessment of referral urgency, which can guide the timing of management by providers.

The EyeMobile also identified retinal findings consistent with diabetic retinopathy in many individuals with previously undiagnosed diabetes, highlighting the role of vision screenings in detecting systemic diseases along with ocular pathology. This mirrors population-based data demonstrating that patients with undiagnosed diabetes may present with diabetic retinopathy at first detection, and to our knowledge, represents a novel observation within the mobile eye care literature.[16] These findings suggest that targeted vision screening programs can serve as a first point of diagnosis for both ocular and systemic diseases, particularly in populations with limited engagement with health care.

Timely detection and management of ocular disease is also pivotal for preservation of vision. Many individuals with glaucoma may remain asymptomatic until significant visual damage has occurred.[23] Similarly, advanced AMD and delays in treatment have been associated with lower visual function.[24,25] In diabetic retinopathy, patients with more advanced presentations had worse visual acuities at the first visit, and treatment delays led to worse visual outcomes.[26,27] Across these conditions, delayed presentation has been linked to socioeconomic status, lack of or delays in referral, and limited access to regular eye checkups.[27–30] In our study, 57.5% of patients were determined to require an urgent (≤ 1 month) or semi-urgent (≤ 3 months) referral, reflecting a

substantial burden of advanced ophthalmic disease within the population served. Compared to other studies, which did not provide granular data on referral urgency timelines, our findings offer novel and important insight into the timing of advanced ophthalmological evaluation needs. By stratifying referral urgency, the EyeMobile likely expedited the specialist evaluation for patients with more advanced pathologies, allowing for prioritization of follow up care and more effective resource allocation. Thus, the program may facilitate escalation of care for late-stage clinical disease, potentially preventing long term complications of delayed or untreated ocular pathology.

A key strength of this study is the large sample size of individuals included. Nevertheless, several limitations should be acknowledged. First, due to the retrospective study design, causality cannot be inferred. Future prospective studies are important to better understand the role of community-based vision screenings on eye health outcomes. Second, patients found to have undiagnosed ocular conditions were based on self-reported ocular and medical history, which may be subject to recall bias. Some patients may have been previously diagnosed with conditions but failed to recall them, potentially leading to an overestimation of newly diagnosed disease. Third, the generalizability of our findings is limited as this study was conducted in the San Diego community. While screening was available to all adults, patients had to give consent to participate in screening, which may have introduced selection bias. Individuals who are more health conscious or experiencing visual symptoms may have been likely to participate, potentially influencing the observed prevalence of disease.

Conclusions

In summary, this study demonstrates that a mobile ophthalmology screening program effectively identifies new ocular and systemic conditions and expedites management of serious pathology to specialists in adult populations. Furthermore, our results provide important epidemiologic data regarding prevalence and severity of ocular pathologies in underserved adult populations, through the novel quantification of referral urgency. Collectively, these findings highlight the role of mobile vision programs as a vital safety net for those that might not have access to care and enables early detection and management of ocular disease to improve long-term visual outcomes.

Abbreviations

UCSD: University of California, San Diego

SVI: Social Vulnerability Index

AMD: Age-related macular degeneration

DR: Diabetic Retinopathy

SES: Socioeconomic Status

DM1: Type 1 Diabetes Mellitus

DM2: Type 2 Diabetes Mellitus

Declarations

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a. Ethics approval and consent to participate: This study was approved by the University of California San Diego Institutional Review Board (IRB #121689) and informed consent was obtained.
b. Consent for publication: Not Applicable
c. Availability of data and Materials: The dataset analyzed during the current study are not publicly available.
d. Competing Interests: All authors have no financial disclosures.
e. Funding: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.
f. Author's Contributions: Conception/Design: AL, NR, IM; Acquisition of data: RL, AR; Data Analysis: NR; Interpretation of Data: AL, NR, NS, SB, IM; Manuscript Draft: AL, NR; Manuscript Revision: AL, NR, RL, AR, NS, SB, IM. All authors approved the submitted version, have agreed to be personally accountable for the author's own contributions, and ensure that questions related to the accuracy or integrity of any part of the work are appropriately investigated, resolved, and the resolution documented in the literature.
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Figure Captions

Figure 1: Distribution of Social Vulnerability Index (SVI) Scores of Adult EyeMobile Patients

This figure displays the distribution of Social Vulnerability Index (SVI) among Adult EyeMobile patients (0 = least vulnerable; 1 = most vulnerable) seen from August 2024 to August 2025.

Figure 2: Prior vs Newly Identified Disease of Adult EyeMobile Patients

This figure displays the self-reported history of age-related macular degeneration (AMD), cataract, diabetic retinopathy, and glaucoma suspicion compared with exam-confirmed findings

Figure 3A: Top Ophthalmology Referral Indications for Adult EyeMobile Patients, Figure 3B: Ophthalmology Referral Urgency for Adult EyeMobile Patients

(A) This figure shows the most common indications for ophthalmology referral among Adult EyeMobile patients (patients may have multiple referral indications). (B) This figure shows the distribution of referral urgency categories: Urgent (≤1 month), Semi-urgent (≤3 months), Routine (>3 months), and Not specified.

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Table 1: EyeMobile Patient Demographics

Characteristic	n (%)
Total Patients	1542
Age (Mean ± SD)[a]	58.9 ± 15.2
Ethnicity	
Asian	69 (4.5%)
Black	296 (19.2%)
Caucasian	164 (10.6%)
Hispanic	820 (53.2%)
Pacific Islander	19 (1.2%)
Multiracial	53 (3.4%)
Missing	121 (7.8%)
Language	
English	946 (61.3%)
Spanish	456 (29.6%)
Other	31 (2.0%)
Missing	109 (7.1%)
Event type	
Community event	1076 (69.8%)

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Senior community center	390 (25.3%)
Other	49 (3.2%)
Missing	27 (1.28%)
Social Vulnerability Index (Mean ± SD)[b]	0.89 ± 0.13
Last Eye Exam (Mean ± SD years)[c]	2.55 ± 3.57

Abbreviations: SD: Standard Deviation
[a]24 (1.6%) patients with missing Age data
[b]571 (37.1%) patients with missing geographic data
[c]449 (29.1%) patients unable to recall last eye exam or missing data.

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Table 2: Medical and Ocular History

History	n (%)
Refractive error (any eye)	
Myopia	593 (38.5%)
Hyperopia	884 (57.3%)
Astigmatism	1308 (84.8%)
Presbyopia	1125 (73.0%)
Visual Acuity (worse eye)[a]	
20/40 or better	934 (60.6%)
20/50-20/80	305 (19.8%)
20/100-20/200	80 (5.2%)
Worse than 20/200	54 (3.5%)
Visual Acuity (better eye)[a]	
20/40 or better	1181 (76.6%)
20/50-20/80	131 (8.5%)
20/100-20/200	36 (2.3%)
Worse than 20/200	24 (1.6%)
Preexisting ocular history[b]	
History of cataract	328 (21.3%)
History of glaucoma	79 (5.1%)

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History of AMD	15 (1.0%)
History of DR	3 (0.2%)
Other ocular history	439 (28.5%)
No known ocular history	982 (63.7%)
Systemic medical history[c]	
Diabetes type 1	21 (1.4%)
Diabetes type 2	261 (16.9%)
Hypertension	560 (36.3%)
High cholesterol	405 (26.3%)
Other systemic history	435 (28.2%)
No known systemic history	579 (37.5%)

[a]170 patients did not have their VA fully assessed
[b]Self-reported data.

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Additional Materials

Table S1: Service Utilization

The table provides the breakdown of the different vision services used by the Adult EyeMobile patients.

Figure S1: Geographic Distribution of Adult EyeMobile Patients

This figure demonstrates the geographic distribution of ZIP codes for Adult EyeMobile patients across San Diego County.

Table S2: Referral Reasons

This table provides the reasons that patients seen at the Adult EyeMobile were referred to an ophthalmologist.

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