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# Community Outreach Vision Screenings With Student-led Eye Health Education Improves Student Eye Health Knowledge and Ophthalmic Health Disparities Awareness

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**Abstract**

*Background*: **The high prevalence of vision impairment and discordant lack of eye care utilization makes it essential to develop effective avenues to educate the future physician work force regarding basic eye health knowledge and ophthalmic health disparities. The public is often not aware that blinding eye diseases can begin asymptomatically. It is important for medical students to understand basic eye health knowledge, such as blinding eye diseases can begin asymptomatically. The purpose of this study was to assess the impact of an eye health knowledge 5-Point Teaching Intervention (5PTI) and structured patient intake form on student eye health knowledge and ophthalmic health disparities during community vision screenings.**

*Methods*: **Between 2015 and 2018, 71 first through fourth year medical students participated in community vision screenings via the Vision Detroit Project (VDP). They conducted structured patient interviews including ophthalmic and systemic health history, burden of eye disease, and barriers to eye care. Students delivered a 5-Point Teaching Intervention (5PTI) for patients. Pre- and post-surveys assessed changes in student eye health knowledge, using descriptive statistics and t-tests for chi-square test, ANOVA and multiple regression for analysis.**

*Results*: **Analysis of 97 paired pre- and post-surveys indicated a significant increase in student eye health knowledge ($p < .001$). Students with prior COVS experience scored higher on pre-surveys than first-time participants ($p = .030$), demonstrating long-term knowledge retention. The two most commonly missed questions by medical students were: Blinding eye conditions will have some kind warning pain associated ($p = 0.003$) and blinding eye conditions will have some warning visual symptoms ($p < 0.001$) showed the largest increase in post-test scores. Students reported increased awareness of ophthalmic health disparities ($p = .01$).**

*Conclusions*: **Medical students may not be aware that blinding eye diseases can occur without pain or without symptoms. These are two important eye health knowledge gaps to address in medical student education. A student led eye health education intervention that is integrated into community vision screenings can improve medical student eye health knowledge. Structured student-led patient interviews including burden of eye disease and barriers to eye care in a community outreach vision screening setting can improve medical student awareness of ophthalmic health disparities.**

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## Introduction

Blindness and vision impairments affect over 4.2 million individuals aged ≥40 in the United States, with racial and ethnic minority populations often bearing the highest burden of ocular disease.[1,2] The prevalence of eye diseases is projected to double by 2050, underscoring the importance of equipping all graduating medical students with fundamental knowledge of ophthalmology, including common eye diseases and basic eye examination techniques, to effectively assess, manage, and refer future patients.[1,3] Primary care practitioners (PCPs) may often act as the first line of ophthalmic care providers. However, in a recent sample of 216 PCPs, only 15.4 % reported "always" counseling their patients on comprehensive eye examinations (CEE) and 48.1 % reported "usually" counseling their patients on CEEs based on the American Academy of Ophthalmology Preferred Practice Pattern (PPP) guidelines. Furthermore, only 13.4 % of PCPs would not refer a young patient with a family history of glaucoma until they developed visual symptoms.[4] Therefore, understanding the visual system, its interactions with other bodily systems, and the consequences of disease states are crucial for all medical practitioners.[5] Despite this, only 59 % of adults have been referred and had a dilated eye exam in the past 2 years.[6] The United States Preventive Services Taskforce (USPSTF) recommends physicians utilize clinical judgement when deciding to refer a patient for vision screening exams.[7] However, the number of medical schools requiring formal ophthalmology rotations has declined from 68 % to 16 % over the last two decades.[8–10] This may lead to medical students lacking clinical judgement on knowing when to refer for comprehensive eye exams and skills to perform eye examinations, with fewer than 50 % of incoming residents meeting the ophthalmology competency standards outlined by the Association of University Professors of Ophthalmology (AUPO).[11–13] The growing educational gap necessitates new approaches for ophthalmology exposure and basic eye health knowledge.

Undergraduate medical education plays a critical role in addressing healthcare disparities, and there has been increasing interest in utilizing student-run free clinics and community outreach/service programs to support current health equity initiatives.[14] Student participation in these efforts provides a valuable educational opportunity that enhances perceived student knowledge, clinical reasoning skills, compassion towards patients, and eye examination proficiency, while also improving the well-being of the communities served.[15–22] Furthermore, a recent study demonstrated that only 66 % of ophthalmology residents nationwide are confident in managing patients with health disparities.[23]

The familiarity of residents and PCPs with CEE guidelines remains suboptimal.[4,6] Student learning in clinical volunteer settings may offer a feasible solution to limited ophthalmology curriculum time and can also play a key role in addressing basic eye health knowledge gaps via integrated eye health education interventions during vision screenings. A significant number of AUPO affiliated programs offer outreach vision screening extra-curricular experiences for their medical students.[10] While some studies have assessed student learning of ophthalmology in classroom or other non-clinic setting, few have measured short and long term knowledge retention following experiences in ophthalmology outreach clinics.[19,20] Since required curricular time is limited, it is important to evaluate novel teaching methods in community outreach vision screening settings.

The Vision Detroit Project (VDP) at Wayne State University School of Medicine (WSUSOM), a grant-funded program, offered free community outreach vision screenings (COVS) to underserved communities in Detroit. Previous studies have highlighted a significant gap in patients' awareness that blinding eye conditions can progress without ocular pain or symptoms.[24,25] The primary objective of this study was to assess if similar knowledge gaps also existed among medical students and to determine if students' administering a 5-Point Teaching Intervention to patients, could simultaneously increase students' eye health knowledge during community outreach vision screenings.

## Methods

### *Setting and participant selection*

Between July 2015 and August 2018, medical students were invited to volunteer with Visions Detroit for their COVS program. The primary patient demographic served by VDP and medical students

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consisted of Spanish-speaking Hispanic/Latino, African American and other underserved individuals residing in Metro Detroit.[24,25] Medical student participants were recruited through email sign-up links shared with the student body or via individual email invitations to students who had expressed interest in volunteering with VDP. Prior exposure to ophthalmology or previous participation in a COVS event was not a prerequisite for inclusion in the study. The Institutional Review Board at WSU determined this study to be exempt from full review and waived the requirement for study subject consent.

*Study design*

Upon arrival at COVS, prior to any participation or patient contact, medical students received a paper copy of the pre-survey to complete. The students were then given a briefing on the grant process. This included following the structured Vision Detroit grant packet that included a patient history intake form and the 5PTI. All students were instructed to verbally administer the grant packet and conduct a questionnaire to assess potential burden of eye disease, social disparities and barriers to receipt of eyecare. Bilingual medical students and staff were available for translation when needed.

The patient information collected during the initial screening through the patient survey encompassed various aspects: patient reported demographic information, medical history, social history, and ocular history. Further inquiries into health history consisted of topics such as the presence of a primary care physician (PCP), whether the patient had been referred for or recommended to undergo an eye exam, obstacles perceived by the patient in attending past and future eye exams, present vision concerns, the duration of vision-related problems, the impact of visual issues on work and independence, and the timing of the patient's most recent eye exam. Past medical history information collected from patients included previous diagnoses of conditions such as hypertension or diabetes mellitus, blood sugar control and family history of eye diseases. Furthermore, insurance coverage, the availability of transportation, and the knowledge required for obtaining an eye exam were assessed to evaluate potential barriers that patients may face in following up on their ocular health. The grant packet and 5PTI were verbally administered to accommodate potential challenges stemming from limited health literacy, language barriers, and impaired vision. This also facilitated active involvement of both patients and students in the learning process.

The 5PTI covered the following points regarding eye health awareness:

1) People can have blinding eye conditions without warning signs.
2) People can have blinding eye conditions without pain.
3) Good care of diabetes and high blood pressure can protect your vision.
4) Eye doctors can help diagnose diabetes, high blood pressure, and other diseases with an eye exam.
5) Blindness can be preventable.

The medical students administered a pre-survey and a post-survey to assess patient pre and post learning of the 5-PTI.[24] Additionally, technicians, residents, and faculty members taught the students various elements of the eye exam. The ophthalmic assessment comprised several components, including Snellen visual acuity (VA), tonometry, corneal pachymetry, pupillary examination, assessment of ocular motility, and gross examination of ocular alignment and the external anterior segment. Habitual visual acuity (HVA) was determined using the patient's uncorrected or currently worn eyeglasses during the screening session. Medical students then repeated this process with each new patient they encountered during COVS.

Upon concluding the screening event, students were asked to complete a post-survey. Survey participation was optional, and students had the choice to omit their names to remain anonymous (Fig. 1).

*Data analysis*

Student pre- and post-surveys were collected at COVS between July 2015 and August 2018. The survey questions were categorized into knowledge-based questions (KBQ) and ranking questions (Table 1). Knowledge-based questions objectively assessed students' understanding of fundamental ophthalmology concepts and their role in

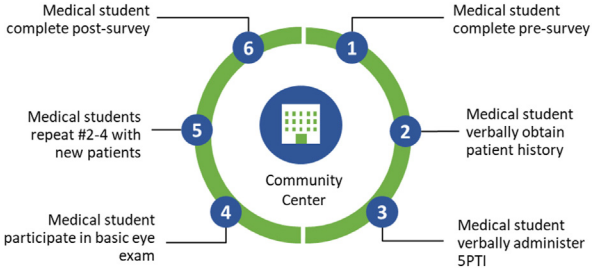


*Fig. 1. Step-by-step overview of the Vision Detroit Project community outreach vision screening student participation process.*

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*Table 1. Survey questions.*

**Knowledge-based Questions:**
1. Who is a medical eye doctor, please circle all that apply: Optometrist/Ophthalmologist
2. Findings on an eye exam can lead to a systemic disease diagnosis: True/False
3. Blinding eye conditions will have some kind of warning pain associated: True/False
4. Blinding eye conditions will have some warning vision symptoms: True/False
5. Early screening can prevent blindness even if a patient has no symptoms: True/False
6. Patients who are healthy only need to see an eye doctor if they have problems: True/False
7. Because ocular care requires specialty training, only eye doctors are responsible for a patient's eye care needs: True/False
8. Systemic medications and care can help treat eye conditions: True/False

**Medical Student Comfort Questions:**
9. Do you feel comfortable with your understanding of ocular anatomy? (Scale: 1–5)
10. Do you feel comfortable with taking a patient's ocular history? (Scale: 1–5)

**Health Disparities Questions:**
11. Working with an underserved population in an outreach setting adds a new element of understanding to the barriers patients face compared to learning in a hospital setting: (Scale: 1–5)
12[a]. I am aware of ocular health disparities: (Scale 1–5)
13[a]. I am aware that I can address health disparities through ophthalmic care: (Scale 1–5)
14[a]. Based on your current knowledge of eye diseases, how likely are you to address eye care with your patients in the future: (Scale 1–5)

**Community Outreach Vision Screening Satisfaction Questions:**
15[b]. The Vision Detroit Volunteer Experience helped me better understand the relationship between systemic disease and eye health: (Scale 1–5)
16[b]. Administering the patient questionnaire helped me better understand elements in a patient's history that can be important for the eye exam: (Scale 1–5)
17[b]. This exposure to the eye exam has increased my awareness of the importance of ocular health: (Scale 1–5)
18[b]. I feel more interested in learning about ophthalmology and its role in primary medical care: (Scale 1–5)
19[b]. I feel more confident in counseling patients on the importance of eye exams as part of their overall healthcare: (Scale 1–5)
20[b]. I enjoyed this experience and would recommend continuing this for future students: (Scale 1–5)

[a] Questions were only included in final two vision screening surveys - sample size for these questions is n = 16 first time participants.
[b] Questions were only included in the post-survey at the conclusion of the volunteer event.

healthcare, with True/False responses. Ranking questions employed a 5-point Likert-type scale to gauge student comfort levels in ocular anatomy, taking ocular histories, and their agreement with various statements.

The pre-survey also gathered data on students' year in medical school, number of prior COVS volunteer experiences, and any previous exposure to ophthalmology. The post-survey assessed student knowledge, comfort, and satisfaction after participating in COVS. For the two final vision screenings in March and August 2018, additional questions on awareness of ocular health disparities and the importance of eye care when treating patients were included, resulting in a smaller sample size for these three questions. 26 surveys from students with 3 or more COVS exposures were excluded from the study. Following the collection of paper surveys, the student names were de-identified and replaced with numbers 1–71 in a spreadsheet to allow for tracking of repeat volunteers.

Data were analyzed using basic descriptive statistics, paired and unpaired t-tests, McNemar test, Wilcoxon Signed Rank test, analysis of variance, Spearman's Rank Correlation, Chi-square test and multiple regression analysis. The data was analyzed using IBM SPSS Statistics for Windows, version 27.0 (IBM Corp., Armonk, N.Y., USA)

## Results

### *Demographic information*

Seventy-one individual medical students who took part in COVS completed a total of 97 paired pre- and post-surveys from July 2015 to August 2018. Of the 71 medical students, 31 were first time participants and 38 had one prior exposure to COVS. All students with more than one prior COVS exposure were excluded from this study. The COVS sessions each ranged from 3 to 5 h in length depending on the number of community members seeking care during each screening. Details of the participants, including previous COVS involvement and prior exposure to ophthalmology, are provided in Table 2. Out of the 71 medical students, 29 were first-year students (MS1), 13 were second-year students (MS2), 10 were third-year students (MS3), and 19 were fourth-year students. Among the medical students in this study and including those who were repeat participants, 80 (82 %) had prior exposure to ophthalmology. Prior exposure to ophthalmology was defined as prior experience in the workplace (e.g., scribe, shadowing, or technician), research experience or from formal medical school education. For relevant statistical analysis and data, please refer to Tables 3–7.

### *Eye health knowledge*

A paired-samples t-test was conducted to compare students' eye health knowledge between pre and post surveys. The results indicated a

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*Table 2. Characteristics of medical student participants.*

| Year in Medical School | # of Students | # of Surveys Completed | Prior Exposure to COVS; n, (%) | Prior Exposure to Ophthalmology; n, (%) |
|---|---|---|---|---|
| 1 | 29 | 33 | 3 (3) | 18 (19) |
| 2 | 13 | 18 | 6 (6) | 16 (16) |
| 3 | 10 | 21 | 16 (16) | 21 (22) |
| 4 | 19 | 25 | 13 (13) | 25 (26) |
| Total | 71 | 97 | 38 (39) | 80 (82) |
| Other[a] | 3 | 3 | 1 | 1 |

[a] Other (e.g., pre-medical students) were excluded from analysis. Prior exposure to ophthalmology was defined as prior experience in the workplace (e.g., scribe or technician), research experience or from formal medical school education.

*Table 3. Paired means comparison of eye health knowledge (KBQ) in all students Pre vs. Post survey.*

| | Pre-Survey Mean ± SD. | Post-Survey Mean ± SD. | P[a] |
|---|---|---|---|
| KBQ (n = 71) | 89.358 ± 10.886 | 95.946 ± 6.578 | <0.001 |

[a] Paired *t*-test between Pre-survey vs. Post-survey. *KBQ = Knowledge Based Questions (Questions 1–8).*

*Table 4. Comparison of pre- and post-survey knowledge-based questions (Q1-8) scores (%): results for first-time volunteers.*

| Question | Pre-survey | Post-survey | p[a] |
|---|---|---|---|
| | Correct Responses % | | |
| 1 | 93 | 95 | 0.852 |
| 2 | 100 | 100 | 1.00 |
| 3 | 80 | 97 | 0.003 |
| 4 | 53 | 86 | <0.001 |
| 5 | 100 | 100 | 1.00 |
| 6 | 100 | 100 | 1.00 |
| 7 | 91 | 85 | 0.406 |
| 8 | 98 | 100 | 0.898 |

[a] McNemar test.

*Table 5. ANOVA comparison for pre-survey averages of KBQ Q1-Q8 among year of medical school.*

| Year in Medical school | Participants (n) | Mean ± SD. | p[a] |
|---|---|---|---|
| 1 | 29 | 83.190 ± 10.709 | <0.001 |
| 2 | 13 | 90.385 ± 9.063 | |
| 3 | 10 | 91.250 ± 11.859 | |
| 4 | 19 | 96.711 ± 7.024 | |

[a] ANOVA test with post-hoc Bonferroni correction demonstrates statistically significant difference in pre-survey average between year 1 and year 4. All other differences are not statistically significant. *KBQ = Knowledge Based Questions (Questions 1–8).*

significant increase in eye health knowledge from pre-to post-surveys (89.358 ± 10.886 vs. 95.94 6 ± 6.778, $p < 0.001$) among all medical student participants (Table 3). The two most commonly missed questions: Blinding eye conditions will have some kind warning pain associated ($p = 0.003$) and blinding eye conditions will have some warning visual symptoms ($p < 0.001$) showed the largest increase in KBQ survey scores (Table 4). As a result, the remaining knowledge-based questions were excluded from subsequent analyses, as they did not exhibit statistically significant changes between pre and post surveys in Table 3.

To explore the relationship between prior COVS exposure and eye health knowledge, a Chi–Square test of Independence was performed. Students with one prior COVS exposure had significantly higher pre-survey scores with respect to questions 3 and 4 [Q3, $X^2$ (2, 71) $p = 0.038$, Q4, $X^2$ (2, 71) $p = 0.030$)]. Additionally, a one-way between subjects ANOVA was conducted to compare the effect of year in medical school (1–4) on baseline eye health knowledge (Presurvey Q1-Q8). The analysis revealed a significant increase in baseline eye health knowledge with each advancing year in medical school [$F(3,71) = 7.664$, $p < 0.001$]. Post-hoc Bonferroni correction showed a significant increase in pre-survey scores only between first- and fourth-year students, while other differences were not statistically significant (Table 5).

Furthermore, a multiple regression analysis was performed to predict pre-survey scores from year in medical school and prior exposure to ophthalmology. The results showed that these variables significantly predicted pre-survey scores in KBQ [$F(2,71) = 17.317$, $p < 0.001$, $R2 = 0.581$]. Both variables were found to be statistically significant predictors of higher pre-survey scores ($p < 0.005$) (Table 6).

### *Medical student comfort*

A Wilcoxon-signed rank test was conducted to compare students with and without prior ophthalmology exposure in terms of their comfort with understanding ocular anatomy (Q9) ($Mdn = 2.722$ vs. $Mdn = 3.911$, $p < 0.001$) and taking a patient's ocular history (Q10) ($Mdn = 2.222$ vs. $Mdn = 3.786$, $p < 0.001$). Students with prior ophthalmology exposure demonstrated significantly higher comfort levels for both of these questions. Additionally, Spearman's rank correlation was computed to assess the relationship between medical school year

*Table 6. Multiple regression analysis of factor effect on pre-test score of knowledge-based questions (Q1-8).*

| Model | Unstandardized Coefficients | | Standardized Coefficients | t | p | 95 % confidence interval for B | |
|---|---|---|---|---|---|---|---|
| | B | SE | Beta | | | LB | UB |
| Constant | 75.723 | 2.542 | | 29.787 | <0.001 | 70.651 | 80.796 |
| Year in Medical School | 2.829 | 1.001 | 0.321 | 2.827 | 0.006 | 0.832 | 4.827 |
| Prior Exposure to Ophthalmology | 9.193 | 2.981 | 0.350 | 3.084 | 0.003 | 3.245 | 15.141 |

A multiple regression was run to predict KBQ score (Q1-Q8) from year in medical school and Prior ophthalmology exposure. These variables statistically significantly predicted KBQ score, $F(3, 93) = 13.476$, $R^2 = 0.303$, $p < 0.0001$. LB= Upper bound, UB = Upper Bound.

*Table 7. Pre- and Post-survey scores of medical student comfort, understanding of ocular health disparities and satisfaction.*

| | Question | Likert scores out of 5 | | p[a] |
|---|---|---|---|---|
| | | Pre-survey Median (n) | Post-survey Median (n) | |
| Comfort | 9 | 3.840 (77) | 4.330 (77) | <0.001 |
| | 10 | 3.660 (72) | 4.430 (72) | <0.001 |
| Disparities | 11[b] | 4.710 (72) | 4.850 (72) | 0.079 |
| | 12[b] | 3.750 (16) | 4.500 (16) | 0.006 |
| | 13[b] | 4.310 (16) | 4.690 (16) | 0.116 |
| | 14[b] | 4.190 (16) | 4.630 (16) | 0.076 |
| Satisfaction | 15[c] | – | 4.770 (97) | – |
| | 16[c] | – | 4.820 (97) | – |
| | 17[c] | – | 4.91 (97) | – |
| | 18[c] | – | 4.840 (97) | – |
| | 19[c] | – | 4.740 (97) | – |
| | 20[‡] | – | 4.970 (96) | – |

[a] P-value by Wilcoxon signed ranks test.
[b] Questions were only included in final two vision screening surveys; sample size for these questions is n = 16.
[c] Questions were only administered after the session during the post-test survey, n = 97 with exception of 1 missing response in question 20.

and comfort levels in understanding ocular anatomy ($\rho(72) = 0.556$, $p < 0.001$) and taking a patient's ocular history ($\rho(72) = 0.690$, $p < 0.001$). The results indicated that an increase in medical school year was positively correlated with higher comfort levels for both aspects.

Furthermore, another Wilcoxon-signed rank test was conducted to compare students with prior COVS exposure to those without on their pre-survey answers to Q9 and Q10. It was found that students with prior COVS exposure had significantly higher pre-survey scores for Q9 ($Mdn = 3.407$ vs. $Mdn = 4.467$, $p < 0.001$) and Q10 ($Mdn = 3.068$ vs. $Mdn = 4.733$, $p < 0.001$) than first-time participants.

Overall, all participants experienced a significant increase in comfort with ocular anatomy ($3.622 \pm 1.043$ vs. $4.214 \pm 0.731$, $p < 0.001$) and taking ocular history ($3.405 \pm 1.313$ vs. $4.283 \pm 0.841$, $p < 0.001$) between pre- and post-surveys after participating in COVS.

*Health disparities awareness*

The Wilcoxon-signed rank test was utilized to compare pre- and post-results of students' awareness of ocular health disparities (Q12) ($Mdn = 3.750$ vs. $Mdn = 4.500$, $p = 0.006$; $n = 16$). Q12 was included only in the final two vision screening surveys, resulting in a sample size of $n = 16$ for these questions. The findings revealed a significant increase in awareness of ocular health disparities after exposure to COVS.

To assess the relationship between year in medical school and awareness of ocular health disparities, as well as the potential for addressing them through ophthalmic care, Spearman's rank correlation was computed. The results indicated a positive correlation between year in medical school and awareness of ocular health disparities ($\rho(14) = 0.675$, $p = 0.011$), and a moderately positive correlation between year in medical school and awareness of the possibility of addressing ocular health disparities through ophthalmic care ($\rho(14) = 0.513$, $p = 0.073$).

Furthermore, students strongly agreed that working with an underserved population in a COVS setting provided a new perspective in understanding barriers to care compared to working in a hospital setting after COVS participation ($4.661 \pm 0.611$ vs. $4.811 \pm 0.483$, $p = 0.018$).

*Community outreach vision screening satisfaction*

The average satisfaction rating of medical students with their participation in COVS proved highly promising (4.84 ± 0.09/5). Notable takeaways from the experience included an increased understanding of the interplay between systemic diseases and ocular health, a deeper grasp of crucial elements in patient history relevant for eye examinations, heightened awareness of the significance of ocular health, enhanced interest in delving into ophthalmology and its role in primary care, and a newfound confidence in counseling patients about the importance of eye exams as a vital component of comprehensive healthcare.

Furthermore, participating students overwhelmingly recommended the COVS experience to future students (4.97 ± 0.17/5). A selection of student testimonials emphasized the invaluable nature of the experience: "This encounter was incredible! The hands-on practice with direct and indirect ophthalmoscopes was exceptionally valuable and eye-opening (pun intended)," and "An inspiring experience; addressing ocular health disparities felt gratifying; observing a patient's journey from start to finish was motivating; thank you!!" These quotes echo the robust support and appreciation expressed by the students for the COVS program.

## Discussion

Given that previous studies have demonstrated a significant gap in patients' awareness that blinding eye conditions can progress without eye pain or symptoms[24,25] our study primarily aimed to assess if similar knowledge gaps also existed among medical students. Furthermore, this study aimed to assess the impact of the 5-Point Teaching Intervention (5PTI), in conjunction with a comprehensive patient intake form, on increasing medical student basic eye health knowledge, medical student confidence with ophthalmic health history taking, and understanding ophthalmic health disparities, during community outreach vision screenings.

*Improved medical student eye health knowledge via integrated eye health education intervention during community outreach vision screening*

A recent study on medical student volunteers participating in a community vision screening program revealed a subjective increase in their confidence and understanding of ophthalmic principles after program involvement. In our study, we sought to build upon these observations by objectively demonstrating a significant enhancement in eye health knowledge between pre- and post-surveys.[26] Notably, students who had previously engaged in COVS exhibited higher pre-survey scores compared to first-time participants, indicative of long-term knowledge retention. Conversely, both return COVS volunteers and first-time participants demonstrated similar post-survey scores, signifying short-term knowledge retention for the latter group.

When analyzing the score improvements on the Knowledge in Ophthalmology Questionnaire (KBQ), we noted relatively modest absolute changes. This can be attributed to the high baseline scores, with several first-time pre-survey attempts yielding perfect scores (100 %). Our survey questions were initially tailored to target audiences with little ophthalmology background, typically first- and second-year medical students. However, as COVS expanded, the screenings began to attract student volunteers with diverse backgrounds, including those interested in ophthalmology as a career, individuals with prior exposure to the field, and more senior medical students.

Our findings demonstrated that students with prior ophthalmology exposure or in higher medical school years exhibited higher baseline eye health knowledge. Notably, year in medical school emerged as the most significant predictor of increased pre-survey eye health knowledge scores. Despite these variations, all students displayed a statistically significant increase in eye health knowledge from pre- to post-surveys.

Overall, our study highlights that while senior-level students exhibited the highest baseline eye health knowledge, all participants who engaged in COVS experienced a meaningful and statistically significant improvement in their understanding of ophthalmology. These observations are particularly noteworthy considering the decline in formal ophthalmic education within medical school curricula, reinforcing the value of volunteer student-run clinics like COVS as a robust and supplementary avenue for ophthalmology education.[20]

This study found that the top two missed questions by medical students were: (1) Blinding eye conditions will have some kind warning pain associated and (2) blinding eye conditions will have some warning visual symptoms. Questions 3 and 4 were designed to heighten medical students' awareness of the insidious nature of common blinding eye diseases emphasizing the potential for blindness to manifest without pain or symptoms. These questions, being the most frequently answered incorrectly across all participants, regardless of year in medical school, highlight an

important knowledge gap regarding eye health knowledge among medical students. The same top 2 missed questions were found amongst patients participating in the Vision Detroit screenings and found in other work.[24,25] Our findings align with the conclusions of Moustafa et al., who demonstrated that residents in primary care specialties are notably less inclined to counsel patients on comprehensive eye examinations (CEE) and tend to recommend eye exams only after symptoms appear, even in cases involving a family history of glaucoma. Strikingly, only 15 % of primary care physicians consistently advise patients to undergo CEE.[6] The similar gaps in eye health knowledge regarding awareness of the insidious nature of blinding eye diseases amongst the public, medical students, and some primary care focused residents is striking. This underscores the importance of creating a strong foundation in eye health knowledge for all medical students, so that they can raise awareness for their future patients as they matriculate in their training and careers.

Educating medical students about the possibility of sight-threatening eye conditions occurring without pain or recognizable symptoms can lay a cornerstone for students to appreciate the significance of identifying risk factors and making timely referrals for eye examinations. Our study confirms that these specific questions exhibit the sole instances of statistically significant score improvements between the pre- and post-surveys. Intriguingly, initial engagement in the 5PTI program correlated with notably lower pre-survey scores in comparison to those of recurrent participants. Moreover, a substantial number of students who initially provided incorrect responses to these questions on the pre-survey subsequently arrived at correct answers on the post-survey. This enhancement in understanding may be largely attributed to a combination of factors, including their recurrent communication of this information to patients through the 5PTI program, previous participation in COVS, and prior exposure to ophthalmology through formal education, research, or workplace experiences.

This underscores the relevance of instructing and counseling patients as an effective strategy for enhancing eye health knowledge, not just among students with a keen interest in ophthalmology, but across the entire spectrum of medical students. Overall, these findings highlight the impact of the 5PTI and COVS program on students' basic eye health knowledge, confidence with ophthalmic history taking, and awareness of ophthalmic health disparities. This supports the practical utility of patient-oriented teaching methodologies and patient interactions in fostering comprehension of intricate medical concepts through service-based learning,[22,27] in the context of ophthalmology.

Questions 9 and 10, designed to assess students' comfort levels with ocular anatomy and taking a patient's ocular history, yielded invaluable insights into the student experience. Notably, students reported a perceived increase in comfort levels from pre-to post-surveys. Moreover, a notable trend emerged wherein students who had prior volunteer experience at COVS exhibited higher comfort levels in these areas during their pre-surveys compared to first-time volunteers. This observation suggests a lasting impact resulting from students' previous volunteer engagements, which aligns with existing literature indicating that medical students participating in student-run clinics demonstrate enhancements in clinical reasoning skills and hands-on clinical abilities.[17,21,27]

Similarly, among first-time volunteers, those with prior exposure to ophthalmology displayed higher baseline comfort rankings for questions 9 and 10, a finding that aligns with expectations. Furthermore, Spearman's correlation analysis revealed a strong association between the year of medical school and student comfort levels (Q9 and Q10).

### *Increasing awareness of ophthalmic health disparities*

Embracing the ethos of allyship,[28,29] our concerted efforts were directed not only towards the provision of comprehensive eye care but also towards fostering trust within the community and cultivating relationships with community leaders. Our team encountered a diverse patient population across different clinical settings, often comprising individuals with limited to no proficiency in English. In fostering inclusive practices, students engaged in comprehensive discussions with each patient, employing the 5PTI document and implementing a closed-loop communication approach to ensure mutual understanding. Recognizing the importance of cultural and linguistic sensitivity, students and healthcare providers, hailing from diverse ethnic backgrounds themselves, enlisted the assistance of family members, friends, and community representatives to facilitate effective communication in the patients' preferred languages. By actively engaging diverse language resources and ensuring clear communication, we aimed to bridge the gap in healthcare accessibility and advocate for the ocular health of marginalized communities. Recognizing the significance of cultural humility and sensitivity, our collaborative approach sought to promote a supportive and inclusive environment, fostering

enduring provider–patient relationships grounded in mutual respect and understanding.

The results of questions 12 and 13, which assessed students' awareness of ophthalmic health disparities, demonstrated a significant increase in awareness after participating in COVS, consistent with previous research.[30,31] The systematic delivery of the intake form, as described in the methods, enabled students to gain awareness of the burden of eye diseases and barriers to eye care, such as financial constraints, insurance-related challenges, level of education, and employment status published in previous VDP work.[25] This experience demonstrated its effectiveness in enhancing students' comprehension of community services, barriers, social determinants of health, and the various roles of health professionals. Furthermore, irrespective of language barriers or educational status, students learned that effective communication can enhance a patient's knowledge of eye health and may consider adapting these communication and health education strategies for their own practices.

Student involvement in service learning and outreach vision screenings can increase student awareness of social determinants of health.[32,33] Providing medical students with structured intake history forms that include burden of eye disease and barriers to eye care may increase student awareness of ophthalmic health disparities. These invaluable insights serve as pearls of knowledge that medical students can acquire through COVS, complementing their formal medical school education and better preparing them for patient care in their future roles as medical professionals.

### *Limitations*

The present study is not without limitations. An observational, mixed-method study that assessed the impact of near-peer education in a student-run ophthalmology clinic revealed that while students acknowledged that the experience helped develop their teaching skills and comfort when volunteering and mentoring junior students, they expressed a desire for more formal instruction in the subject matter. Furthermore, the results indicated that near-peer education in a field with limited formal curricular education would be more effective when students have already established a solid foundation of knowledge.[34] Due to time constraints related to both student and faculty/attending schedules, we were unable to offer a separate lecture or training session outside the core curriculum to accommodate all interested participants. To address some of these logistical barriers, we integrated student education into the event itself by having the students teach patients the 5-Point Teaching Intervention (5PTI) as described in the methods section. Despite this unconventional approach, we observed significant student learning and perceived improvements in comfort in the absence of formal didactic sessions. Furthermore, as the COVS expanded, we incorporated assessments pertaining to ophthalmic health disparities, leading to a relatively modest sample size ($n = 16$) for these specific analyses. Future investigations should consider evaluating the measurement of student learning progress and increased awareness of social determinants of health in the context of ophthalmic care.

As mentioned earlier, a major limitation was the discrepancy between the question difficulty and the intended audience, resulting in many KBQ pre-survey scores of 100 %. For this reason, future studies should consider redesigning the surveys to present more challenging questions to students, to create a more sensitive measure of knowledge changes. A significant limitation of this study is its confinement to a single-institution context. Subsequent research is warranted across multiple institutions to ascertain the generalizability and validity of the 5PTI approach within a COVS framework. Additionally, although some long-term follow-up was possible with repeat volunteers, we were unable to achieve long-term follow-up with all student participants throughout the duration of this survey (2015–2018). Future investigations should take this aspect into account to better evaluate long-term knowledge retention following an educational experience like VDP-COVS.

## Conclusion

This study identified key eye health knowledge gaps in medical students regarding the often-insidious nature of many blinding eye diseases. Similar eye health knowledge gaps have been demonstrated in the public. Our study demonstrates an innovative 5-point Eye Health Teaching Intervention that can be integrated into community outreach vision screenings to overcome these knowledge gaps. Students became simultaneous learners as they verbally taught key eye health education points to patients during vision screenings. Our study results show this to be efficacious for both short- and long-term eye health knowledge retention. Additionally, providing a structured eye health history intake that includes barriers to eye care and burden of eye disease can increase student awareness of ophthalmic health disparities during community outreach vision screenings. These methods can be implemented at other institutions to improve

medical student eye health knowledge and awareness of ophthalmic health disparities. This may bolster a stronger foundation in our future physician workforce's awareness of recognizing their key role in encouraging their patients to receive timely eye exams and recognition of barriers to eye care, to improve eye care utilization.

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## Conflict of interest

None declared.

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