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· Review Article ·

Innovative approaches to vision care delivery in the urban school setting

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HIGHLIGHTS

· We presented two large-scale school-based vision programs operating in the urban school districts in the United States. These programs are effective in promoting vision health equity among school children. One in three students failed vision screening. While most of the students who failed vision screening needed eyeglasses, one in seven needed additional care from community providers. Higher demands were observed in schools with more low-income students.

· We summarized the vision screening and eye exam findings from two school-based vision programs. We compared their similarities and population-specific outcomes. We highlighted their impact and discussed the implications for program expansion and future planning.

· There are opportunities for school-based vision programs to establish stronger connections with communities and health care providers, collect data for program evaluation and best practice development, expand and further iterate practices using evidence-based approaches.

Abstract: Schools are an important avenue to tackle the rising prevalence of uncorrected refractive error among children. School-based vision programs are an innovative approach of vision care delivery in the urban school setting in the United States. These programs are effective in improving vision outcomes and advancing health equity, especially among the disadvantaged school districts. While most school-based vision programs provide vision screening, eye examinations, and eyeglasses prescription to students directly in schools, different mechanisms and models have been reported. In this paper, we describe two large-scale school-based vision programs, Vision for Baltimore and Helen Keller International's United States Vision Program, representing national and regional efforts to partner with local communities in improving access to pediatric vision care. These programs also

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serve as data collection platforms and provide evidence to inform public health policy and guide best practice. Collectively, these two programs showed that one in three students failed vision screening. The prevalence of uncorrected refractive error was high and the demand for eyeglasses was great among those who failed vision screening. While most of the students' uncorrected refractive errors could be addressed in the school setting, one in seven needed additional eye care. We found that schools with more socioeconomically disadvantaged students had greater needs of school-based vision program services. We hope this knowledge helps to maximize the impact of school-based vision programs and promote a system that ensures better health outcomes for all children.

Keywords: school-based vision program; health equity; pediatric ophthalmology; access to care

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Over 2 billion people are living with a near or distance vision impairment globally, the majority due to uncorrected refractive error (URE).[1] According to the World Health Organization (WHO), approximately 19 million children and adolescents 5 to 15 years of age have a visual impairment, about two-thirds are due to URE.[1] This is especially salient given the increased prevalence of myopia observed worldwide,[2] particularly during the post COVID-19 era.[3] Public health approaches can help to address most common eye diseases, yet vision loss and access to eye care are greatly affected by social determinants of health.[4] There have been significant inequities in resources for refractive error correction and other vision care, even in developed countries.[5] National and global efforts are being launched to address the burden of URE. For example, WHO recently launched SPECS 2030, an initiative with the goal of increasing the proportion of people with access to appropriate spectacles by 40%.[6] In the school setting, various approaches are being adopted to both screen, and in some cases, deliver mobile eye care directly in the school setting. Besides improving refractive correction coverage, school-based interventions such as increased time outdoors can be effective in delaying the onset, and possibly progression, of myopia.[7-8]

In the United States (US), one in five children has impaired vision.[9-10] While most childhood vision impairment is due to URE that can be corrected with eyeglasses, as many as half of the children needing eyeglasses are not getting them.[11] Children from minority racial and ethnic backgrounds have a disproportionately higher rate of vision problems and unmet vision needs, and face barriers to accessing vision care.[12-14] Children from lower socioeconomic backgrounds, first-generation immigrants, and those living in non-English speaking households were more likely to report poor visual function, less likely to receive vision testing and eye care, and less likely to have an established connection with an eye care specialist.[15-20]

National and regional policies and initiatives have been developed to improve vision health outcomes and promote eye care equity among the pediatric population. At the national level, the US Department of Health and Human Services' Healthy People 2030 initiative[21] outlined goals that aim to promote healthy vision, including reducing uncorrected visual impairment due to refractive error, reducing blindness and visual impairment in children and adolescents, and increasing vision screening among preschool children. Professional advocacy organizations, such as the American Academy of Ophthalmology, have called for actions to enhance accessibility to eye care.[22] Specifically, schools have been identified as an important vehicle to improve pediatric eye care access by the American Academy of Ophthalmology Task Force on Disparities on Eye Care, especially among underserved populations.[23] At the regional level, school-based vision programs (SBVPs), community outreach programs, and mobile clinics have demonstrated success in connecting children to eye care after failed vision screenings, providing access to eyeglasses when needed, and improving vision outcomes.[11, 24-26]

MECHANISM AND MODELS

The rationale for incorporating vision care into school-based health services has been established in different countries and regions. One of the most compelling pieces of evidence is the association between improved vision and better academic achievement[27-29] and students' overall well-being.[30-31] In the US, public schools operate under the jurisdiction of local school districts and educate elementary, middle, and high school students. While districts vary in size, large school districts can operate more than 1,000 schools. SBVPs recognize the interrelatedness of vision health and learning and offer services directly within schools. By partnering with schools or school districts and eye care providers, SBVPs deliver care directly at the school setting to help address vision care needs. Considerations for establishing a successful SBVP includes program planning in collaboration with community partners, ensuring fidelity of service implementation, and establishing the infrastructure for sustainability to increase access to pediatric eye care.[32] In a survey assessing 184 SBVPs across 19 states and the District of Columbia in the US, most of the programs provided vision screening to elementary grades (students 4 to 12 years), followed by middle school grades (students 11 to 16 years) and high school grades (students 14 to 20 years).[33] While most of these programs provide vision screening, eye exams, and eyeglasses prescription when needed, different mechanisms and models have been reported. For example, programs may differ regarding their scale and service capacity (e.g., a few schools or all the schools in a school district), the personnel who conduct vision screening (e.g. school nurses, technicians, volunteers) and eye exams (e.g., licensed eye care providers such as optometrists and ophthalmologists, and medical trainees), the modalities of vision screening (e.g., distance visual acuity, instrument-based photoscreening), the use of cycloplegic eye drops for accurately measuring refraction, the program's communication and feedback system with the parents and school, and the mechanism of connecting students to additional care beyond the scope of SBVP.[33] Here, we discuss two SBVPs representing different delivery models in urban US schools.

Vision for Baltimore

Vision for Baltimore is an ongoing district-wide initiative providing school-based vision care for elementary and middle school students (ages 4 to 16 years) in Baltimore. Baltimore is an urban city in Maryland, with a population of 565,239 and a median household income of $59,623 US dollars in 2023.[34] Students at the Baltimore City Public Schools (BCPSs) are majority Black (69.6%) and of low-income background (73.6%). Hispanic students make up 20.1% of the population and 15.1% are multilingual learners.[35] Vision for Baltimore was established in 2016 with a partnership between Johns Hopkins University, BCPS, Baltimore City Health Department (BCHD), Warby Parker (eyewear retailer), and Vision To Learn (nonprofit optometric provider). All students in prekindergarten (typically ages 4 to 5 years) through eighth grade (typically ages 13 to 16 years) receive a school-based vision screening by BCHD technicians. Those who fail a vision screening and provide consent for an eye examination receive a nondilated eye exam in the mobile vision clinic by Vision To Learn optometrists on a different school day. Eyeglasses are provided to students who need them and supplied by Warby Parker. All services are provided at no out-of-pocket cost to students and their families.

Vision for Baltimore's vision screening includes distance visual acuity testing with Lea and Sloan charts (Good-Lite Company, Elgin, IL) and Spot photoscreener (Welch Ally, Skaneateles Falls, NY). Students fail the vision screening if they do not reach the age-specific visual acuity threshold, have a 2 or more line interocular difference, or receive a referral flag from the photoscreening instrument.[36] The program's eye exam includes autorefraction, distance visual acuity, and near visual acuity testing, when indicated, manifest refraction with a phoropter, an anterior segment exam, and a nondilated fundus exam. Students are dispensed one pair of eyeglasses directly at school and replacement eyeglasses are provided for one year. Students are referred to a community eye care provider for a comprehensive eye exam when nonrefractive pathology is identified, such as suspected amblyopia, strabismus, or posterior segment findings. Parents receive a letter summarizing the eye exam results, and each school receives a list of their students who were prescribed eyeglasses. A Johns Hopkins University School Vision Advocates team works closely with all program partners to support program operations. During 9 years of

operation, the program has provided vision screenings for more than 120,000 students, conducted more than 20,000 eye examinations, and provided over 15,000 pairs of eyeglasses to the students in Baltimore.[37] Even during the COVID-19 pandemic, when most school activities were disrupted, Vision for Baltimore was able to continue modified program operations.

Helen Keller International's US Vision Program

Helen Keller International's US Vision Program is an example of a national program run by a non-profit organization with a significant SBVP field footprint. Established in 1994 in New York state, the program has expanded to multiple states across the country. The program focuses on providing care to schools in urban settings with high demands. After identifying schools in need of vision care services, the program's licensed optometrists provide vision screenings and eye examinations directly in school.

In a retrospective study using the Helen Keller dataset, we analyzed de-identified data from students in prekindergarten through 12th grade (aged 5 to 22 years) during 2016-2022. The 285,285 students who received vision screening represented 540 public schools. At the school level, the overall student population was predominantly Hispanic (52%) and Black (30%). Among them, 13% of students were English language learners, and 85% were eligible for free-and-reduced-price meal (FARM), a metric highlighting the concentration of poverty in these schools.[38] The program's vision screening measured distance visual acuity with Snellen charts. Students whose visual acuity measured 20/40 or worse in either eye underwent an eye exam the same day. Non-cycloplegic autorefraction was performed, followed by manifest refraction, if applicable, a slit lamp exam, and a non-dilated fundus assessment. If additional eye care was warranted for needs beyond the scope of the program, students were referred to community care providers. When needed, the examining optometrists prescribed eyeglasses, and dispensed and fitted them at the school within two weeks following the eye examination. Each student who received eyeglasses was also given a parent information letter specifying the eyeglasses prescription and educational material on how to care for their eyeglasses properly.

These two large-scale SBVPs represent sustainable programs that have established partnerships between school districts and local eye care providers to deliver care to students over a wide age range including different racial, ethnic, and socioeconomic backgrounds. While the two programs operate in different geographic regions and the Helen Keller program includes high school students, the programs are similar in their components, including vision screenings, eye exams, provision and dispensing of eyeglasses, and referral to community eye care providers for non-refractive eye care needs. Not only do these programs improve pediatric vision health in the school districts served, but they have also collected data essential to evaluate program impact and improve performance, which can be used to inform public health policy and best practice. For example, the first 3 years of Vision for Baltimore saw a screening failure rate of 34%,[36] and 36% of the students screened through the Helen Keller program failed a vision screening.[38] These high screening failure rates underscored the magnitude of vision care demand among students in high-poverty urban settings.[29, 39-40] Below, we present some of the latest research findings using program operation data from Vision for Baltimore and the Helen Keller program. All data presented are aggregated and publicly available from published studies. No individual-level identifiable data were used. Therefore, ethical approval was not required.

REFRACTIVE FINDINGS AND EYEGLASSES PRESCRIPTION

Refractive profiles and clinically significant refractive error

SBVPs are well situated to address URE in most school children. As more SBVPs are being developed across the country, it is critical to understand the magnitude of URE among students who fail vision screenings. This group of students differs from population-based or community-based populations and is expected to carry a higher disease burden. While data from Vision for Baltimore and Helen Keller have collectively identified a high prevalence of URE among students who failed vision screening, the students' refractive profiles differed by demographics, including age, gender, race, and ethnicity. In Vision for Baltimore, where Black and Hispanic students made up the majority of the student population, low astigmatism (1.00 D

to <3.00 D cylindrical power, 47%) and mild myopia (–0.50 D spherical equivalent [SE] to < –3.00 D SE, 45%) were the most common types of URE. Clinically significant refractive error, defined as a visual acuity of 20/40 or worse in either eye and refractive error of at least one of the following: myopia of –0.75 D SE or greater; hyperopia of +2.00 D SE or greater without strabismus; hyperopia of +1.00 D SE or greater with esodeviation; astigmatism of 1.50 D or greater, was present in 36% of the students who had failed a vision screening. Clinically significant refractive error was more likely among students in higher grade levels, female, and Hispanic ethnicity.[41] In the Helen Keller program where the majority of students were Hispanic, the most common types of URE were mild myopia (55%) and low astigmatism (39%). Using a similar definition, 82% of the students who failed a vision screening had clinically significant refractive error. This was more common among prekindergarten through 2nd graders, and 5th through 12th graders as compared with the 3rd and 4th graders. Female students, however, had a lower rate of clinically significant refractive error.[38] The higher proportion of students having clinically significant refractive error observed in the Helen Keller program compared with Vision for Baltimore might be due to the wider grade range of students served (prekindergarten through 12th vs. prekindergarten through 8th, respectively), with students in higher grade levels more likely to have myopia. These estimates and their variation indicate that refractive profiles will differ by student population and demographics. It is, therefore, vital to consider the student population characteristics when designing future SBVPs to meet the recipients' needs.

Eyeglasses prescription update

The eyeglasses prescription rate was high among students who failed vision screening and completed a school-based eye exam. Previous studies have found that over 70% of the students who failed vision screening needed eyeglasses.[25,42-43] However, there has been a knowledge gap regarding eyeglasses-wearing status at baseline among those who failed vision screening. Optimal planning and resource allocation for SBVPs could benefit from a better understanding of the need for new eyeglasses among students who do not wear them and the need for prescription updates among those who wear eyeglasses yet still fail vision screening. Among 97,069 students from the Helen Keller program dataset, 27% were current wearers (those who were wearing their prescribed eyeglasses), 31% were inactive wearers (those who reported having eyeglasses, but were not wearing them), and 42% were current non-wearers (those who reported no habitual correction) based on self-reported eyeglasses wearing status during the vision screening. The eyeglasses prescription rate was high (91%) among current wearers. Even among current non-wearers, 63% were prescribed eyeglasses. Factors associated with receiving a new eyeglasses prescription included higher grade level, male, higher myopia, hyperopia, astigmatism, and anisometropia. Among current wearers, 54% had a prescription change of 0.50 D SE or greater, and 16% had a prescription change of 0.75 D cylindrical or greater. Students with at least –6.00 D myopia and at least 3.00 D astigmatism had the greatest likelihood of needing a prescription change.[44] These findings highlight the significant number of students wearing outdated eyeglasses. There was a high demand for new eyeglasses prescriptions among non-wearers and prescription updates among current and inactive wearers. SBVPs are one important strategy to support students' need for initial and updated eyeglasses and their longitudinal services are required to enable continuous care.

SCHOOL CHARACTERISTICS AND SBVP OUTCOMES

Despite the growing evidence of SBVP's positive impact on individual students' vision and academic outcomes, little has been reported regarding which schools may benefit the most from these programs. Because SBVPs provide care at the school level, it is essential to understand the school characteristics associated with higher demands so future programs can be tailored to maximize impact.

From the Helen Keller dataset, we identified 410 public schools with at least 50 students enrolled and at least 60% of the school's grade level screened by the SBVP. These included 151 elementary schools, 155 middle schools, and 104 high schools. We extracted school characteristics, including race and ethnicity composition and the proportion of students qualifying for FARM from the publicly available National Center for Education Statistics. When evaluating SBVP outcomes, the median rates were respectively 38.4%, 25.2%,

and 5.4% for vision screening failure, prescription for eyeglasses, and community eye care referral among each school's SBVP-enrolled students. High schools (9th to 12th grade) had the highest rates of screening failure and prescription for eyeglasses, which can be attributed to the higher prevalence of myopia in older children. They also had the lowest rates of community eye care referral. In multivariable regression analysis, each 10% increase in the proportion of students qualifying for FARM was associated with a 2.6%, 1.8%, and 0.9% increase in screening failure, prescriptions for eyeglasses, and referral rates, respectively. Such associations could be explained by the lower likelihood of accessing vision care services in the community by students with lower socioeconomic status due to barriers including appointment availability, transportation, insurance coverage, and family health literacy. Our findings suggested several implications for SBVP operations and eye care delivery policy. First, large-scale SBVPs are successfully providing vision services in high-need areas, suggesting opportunities for greater investment and expansion. Second, SBVPs can consider serving across the spectrum of grade levels, since high demands are observed from elementary through high schools. Third, SBVPs should anticipate greater needs within schools with low-income populations and direct additional resources to these institutions.[45]

CHILDREN'S VISION CARE NEED BEYOND SBVP

Although SBVPs can help address most URE in school,[42] children with more complex eye care needs and suspected eye pathology, such as amblyopia and severe URE, and those who cannot be properly evaluated in the school setting need additional vision care and follow-up with community eye care providers. Limited information is available regarding the specific eye care needs of children referred from SBVPs to community providers. This knowledge would assist in case management infrastructure to strengthen partnerships between SBVPs and local community eye care providers.

In Vision for Baltimore, about 4% of the students who failed vision screening were referred for further care in the community when non-refractive ocular pathology was suspected. This rate was similar among those who were and were not wearing eyeglasses during vision screening.[46] Cross-sectional analysis of the 97,107 students who failed a vision screening and received an eye examination from the Helen Keller program showed that while most of the students with URE could be successfully addressed in the school setting, 14% of the students were referred for community eye care. The referral rate declined with older age. Students with high hyperopia and high myopia were more likely to receive a referral recommendation than those with emmetropia. Among the subgroup of students where reasons for referral were available in the dataset, the most frequent reasons included refractive error (42%), amblyopia suspect (27%), vision unable to be corrected to at least 20/40 during the eye examination (26%), posterior segment or optic nerve abnormalities (8%), and untestable or limited cooperation (7%). SBVPs need to develop resources and community networks to support students' referral completion.[47] Further, more robust data collection and future program evaluation are warranted to understand the outcomes of these community referrals better.

WHERE DO WE GO FROM HERE?

Access to pediatric eye care in the US continues to face challenges, including the declining vision screening rates nationwide,[48] shortage of eye care providers, imbalance in workforce distribution,[13, 49] and lack of insurance coverage.[50] SBVPs can bridge the gap and improve school-age children's access to vision care.[51-52] As these programs gain increasing popularity across the country, national guidelines and public health policy are warranted to guide best practice. While the current discussion focused on two SBVPs, predominantly serving urban school districts, the lessons learned may be relevant to both urban and rural school settings. Further, as there are different models of school-based care delivery, it is important to design programs that meet the needs of students and the school community. To maximize program impact, efforts are needed for program expansion and performance evaluation through research, community engagement, advocacy, and partnerships with other public and private sectors.[53] Specifically, feedback from stakeholders through qualitative research analysis can help identify program impact, challenges, and areas of improvement. For example, focus groups with parents and teachers in Vision for Baltimore highlighted

the perceived benefits, including location, timing, and cost convenience, program comprehensiveness, and eyeglasses provision. Structural barriers to participation including consent form challenges and lack of parental awareness about the program were identified. Reasons for not participating included misunderstanding about program cost and eligibility, cost concerns, specific negative attitudes about eye care and SBVPs, or having an established eye care provider. Additionally, program outreach and vision health promotion were main areas for teacher and staff involvement in SBVPs.[54-55]

Currently, SBVPs serve as an entry point for many students to access vision care. However, challenges remain, including how to promote school-wide awareness about the importance of addressing vision problems in children, how to obtain parental consent for program participation, how to ensure students wear prescribed eyeglasses, how to connect students in need of further care with local providers and how to financially sustain program operations.[54-56] Additionally, a substantial number of students receiving a referral recommendation do not follow up with community care providers.[57] A stronger network between SBVPs and community eye care providers will be needed to ensure mechanisms that effectively connect children to additional care and improve access to care among the pediatric populations that have the most complex eye care needs. This partnership will also guide SBVPs in better designing a program that maximizes the involvement of local care providers. By collaborating with research facilities and academic medical centers, SBVPs can serve as a data collection platform for addressing essential research questions that form the basis of evolving program best practice guidelines. For example, SBVPs help overcome barriers to obtaining eyeglasses, such as cost and accessibility.[51, 58] However, reported compliance has been low,[59] and questions remain as to how best to engage students to keep wearing the eyeglasses that they need. Such collaborations can provide ongoing and independent program evaluation by assessing the program outcomes and cost-effectiveness of program operations. Further community engagement and enhanced communication with schools, parents, and students can help promote eye health literacy. By partnering with public sectors such as the Health Resources & Services Administration, SBVPs can potentially leverage public resources, including Federally Qualified and Community Health Centers to further expand access to pediatric eye care.

Over the next few decades, we expect to see increasing numbers of children with URE, largely due to the increasing prevalence of myopia in the US.[60] Schools are an ideal venue for detecting URE and other vision problems through screening and eye exams, implementing interventions for myopia correction, prevention and control with approaches such as eyeglasses provision and monitoring use, promoting increased time outdoors, and educating parents and students regarding health literacy. SBVPs have been successful in achieving their goals of improving students' access to vision care, especially those from lower socioeconomic backgrounds. There are opportunities to establish stronger connections with communities and health care providers, collect data for program evaluation and best practice development, expand and further iterate practices using evidence-based approaches. These efforts will help create optimized SBVPs to provide better health outcomes for all children.

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