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RESEARCH ARTICLE

Vision and the Achievement Gap Among Urban Minority Youth

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ABSTRACT

OBJECTIVES: To outline the prevalence and disparities of vision problems among school-aged urban minority youth, causal pathways through which vision problems adversely affects academic achievement, and proven or promising approaches for schools to address these problems.

METHODS: Literature review.

RESULTS: More than 20% of school-aged youth have some kind of vision problem. In a nationally representative sample of more than 48,000 youth under age 18, those from lower income families were less likely to have diagnosed eye conditions than White children and children living in higher income families. When diagnosed with eye care problems, Black youth living in poverty received fewer and less intensive services. Causal pathways through which vision problems adversely affect academic achievement include sensory perceptions, cognition, and school connectedness. Vision screening is widespread in the nation's schools, but the educational (and public health) benefits from these efforts are jeopardized by lack of follow-up and coordination of efforts.

CONCLUSIONS: Vision problems are highly and disproportionately prevalent among school-aged urban minority youth, have a negative impact on academic achievement through their effects on sensory perceptions, cognition, and school connectedness, and effective practices are available for schools to address these problems. School-based vision screening programs are a logical approach for the early detection and treatment of vision problems affecting youth and are widely implemented in the nation's schools. To more fully realize the educational (and public health) benefits of current investments in screening, programs will require improved follow-up and coordination between and among agencies conducting screening, school nurses, teachers and parents, and in some cases community resources.

Keywords: vision, sensory perceptions; cognition; school connectedness; child and adolescent health; coordinated school health programs; academic achievement; achievement gap; socioeconomic factors.

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OVERVIEW AND DISPARITIES

Childhood and adolescent vision problems are diverse in nature and severity, ranging from mild refractive errors to permanent vision impairment and blindness. Many vision problems entail a variety of symptoms that greatly affect skills and systems related to learning. Low-income minority youth appear to suffer from a disproportionately high prevalence of educationally relevant vision problems, and are clearly at high risk for inadequate treatment of vision problems. Left untreated, vision problems can have severe adverse effects on educational achievement through several causal pathways.

The most common vision problems are refractive errors that impair visual acuity at far distance (myopia/nearsightedness) or at near distance (hyperopia/farsightedness); these are often correctable with eyeglasses. Other important vision problems include astigmatism (irregular curvature of the cornea), strabismus (crossed or misaligned eyes), amblyopia (lazy eye), problems with binocular coordination of eye movements, and problems with the integration of visual sensory perception and the brain. These problems can typically be addressed with eyeglasses, medication, or vision therapy.[1-9]

It has been estimated that more than 1 in 5 school-aged youth has some kind of vision problem.[10] Recent estimates of visual impairment in a nationally representative sample of 12- to 19-year-olds in the United States are available from the National Health and Nutrition Examination Survey—NHANES, 1999-2002.[11] The rate of visual impairment (distance visual acuity of 20/50 or worse in the better-seeing eye) among 12- to 19-year-olds (9.7%) was significantly

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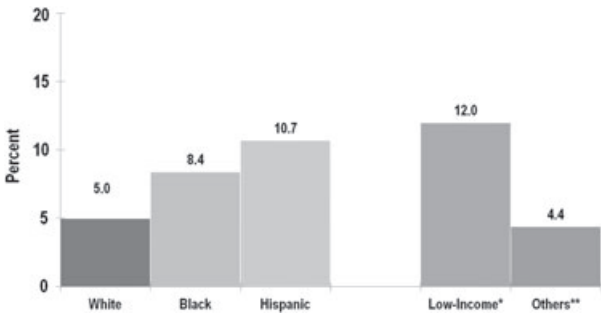
higher than among adults aged 20-39 (5.6%) or 40-59 (4.3%); but not significantly different from adults aged 60 and older (8.8%).

Over 90% of the visual impairment among 12- to 19-year-olds was due to uncorrected refractive error. In the total sample (all age groups), rates of visual impairment were significantly higher for Blacks (8.4%) and Hispanics (10.7%) compared with Whites (5.0%), and almost 3 times as high for individuals with income below the poverty level (12.0%) versus 2 times the poverty level or greater (Figure 1). A recent analysis of the same data set indicated that almost one third of youth aged 12-18 reported wearing corrective lenses; rates were higher among females and those with private insurance.[12] Compared with Whites, Blacks and Hispanics were less likely to have had their corrective lenses available at the time of the study. The authors concluded that variance in use of corrective lenses may be due to a combination of under- and overtreatment and consistency of use of glasses. No current, nationally representative estimates of refractive errors and vision-related learning problems were found for 5- to 11-year-olds, but data from school-based vision screening programs and local studies indicate that a substantial portion of children and adolescents are affected.

Severe visual impairment and blindness among children is not common. According to the Centers for Disease Control and Prevention, 1.4 per 1000 8-year-olds (around 1 in 715) have vision impairment and approximately 7 in 10,000 10-year-olds are legally blind.[13,14] Approximately 25 per 1000 youth under age 18 are blind or visually impaired.[15]

Recent estimates in children 6-72 months of age indicate that amblyopia is more common in Hispanic than in African American children (2.6% vs 1.5%). Rates of strabismus were 2.4% and 2.5%, respectively. Rates for White children were not reported.[16] Nationally representative estimates of amblyopia and strabismus among school-aged children are not available, but some local estimates (outlined below) are even higher.

Figure 1. **Rates of Visual Impairment in the United States Among Persons Age 12 and Above, by Race/Ethnicity and Income**



*Income below poverty level; **income ≥2× poverty level. Source: NHANES 1999-2002.

In Kentucky, between July 2000 and April 2001, 5316 eye exams were conducted among children entering school. As a result, 13.4% received a prescription for glasses, 3.4% were diagnosed with amblyopia, 2.3% with strabismus, and 0.8% received other diagnoses; thus approximately 1 in 5 children entering school had a vision problem.[17] In a multicenter study of refractive error among 2523 youth aged 5-17, 9.2% were myopic, and 12.8% were hyperoptic.[18] In Baltimore, vision screening and examination of 285 elementary school children resulted in diagnoses of amblyopia (5.3%), strabismus (3.2%), and refractive errors (7.4%).[19] In northern Manhattan, screening of 5851 students in 4 intermediate schools determined that 28% had vision of 20/40 or worse in at least 1 eye. In the majority of cases, follow-up eye examinations confirmed the presence of refractive errors, most of which could be corrected with glasses.[20] Another study in three New York City public elementary schools screened 1365 students; 29% were referred for further evaluation.[6] Different methods and operational definitions account for some of the variation in findings.

Some data suggest that low-income children and children experiencing problems in school are disproportionately affected by vision problems.[6,20-29] The association may be due, at least in part, to increased risk of being born prematurely and at low birth weight,[30] both of which adversely affect eye health and processes associated with the development of vision.[26,31-37]

Empirical evidence also documents that low income and minority youth are at greater risk of underdiagnosis and undertreatment of vision problems, and unmet need for vision care services. In a nationally representative sample of 48,000+ youth under age 18 (Medical Expenditure Panel Surveys,1996-2001), those from lower income families were less likely to have diagnosed eye conditions than White children and children living in higher income families, perhaps reflecting inequities in access to eye care services.[38] The authors also found that, when diagnosed with eye care problems, Black youth living in poverty received fewer and less intensive health care services.[38] These analyses indicate that poor minority youth are both underdiagnosed and undertreated for eye care problems.[38,39] Local studies[19,40,41] support these conclusions. In another national sample of 14,000+ (representing almost 200,000) children with special health care needs, Black, Hispanic and multiracial children were 2 to 3 times more likely than White children to have unmet vision care needs (8.9%, 10.0%, and 14.3%, respectively, vs 4.1%).[42] The proportion affected by unrecognized or untreated vision problems may also be higher among youth

with academic and behavioral risks; sequelae include intellectual disabilities and dyslexia.[21,23,27,29,43-45]

Additional data are needed to describe the nature and extent of vision problems affecting youth in general, and urban minority youth in particular. Data are lacking on the prevalence of problems with binocular coordination of eye movements and problems with the integration of visual sensory perception and the brain. Research is warranted to improve understanding of optimal ways to define and treat learning-related vision problems. In the meantime, ample evidence indicates that a substantial proportion of youth are affected by vision problems, and common sense indicates that untreated vision problems can hamper the learning of essential academic skills and adversely influence educational outcomes.

CAUSAL PATHWAYS AFFECTING EDUCATIONAL OUTCOMES

Considerable evidence supports the associations between vision-related learning problems and educationally relevant outcomes, and both theoretical and empirical evidence suggests that some of the associations may be causal. Critical vision skills specifically related to learning include tracking (ie, ability to move across a line of text when reading), teaming or binocularity (ie, communication between the eyes and the brain) and focusing (ie, ability to focus accurately at various distances, to change focus quickly, and to maintain focus as long as necessary).[46] Symptoms of visual problems that threaten educational achievement include frequent eye rubbing or blinking, short attention span, avoidance of reading and other close activities, frequent headaches, covering of 1 eye, tilting the head to 1 side, holding reading materials close to the face, eyes turning in or out, seeing double, losing place when reading, and difficulty remembering what has been read.[47] Because visual sensory perceptions and cognition are so strongly interrelated, these topics are combined below.

Sensory Perceptions and Cognition

Although all the senses are important for growth and development, a preponderance of learning occurs through visual systems. Good eyesight facilitates learning in school and development in general. To the extent that sensory input—the ability to see clearly—is less than optimal, youth may be more likely to become demoralized, fatigued, and avoid learning tasks that require good eyesight. It is axiomatic that academic success will be more difficult for a child who cannot see well in school. But even if a child can see well, vision-related learning problems may still impede learning.

In elementary-level children, hyperopia (inability to see clearly at near distance) has been adversely associated with standardized measures of literacy,[48] standardized reading test scores,[6] and percentile ranking on the Iowa Test of Basic Skills.[49] Uncorrected hyperopia in 4- to 7-year-olds has been adversely associated with emergent literacy skills, including letter and word recognition, receptive vocabulary, and orthography (use of letters in words).[50] The studies cited are cross-sectional, but the relationship between hyperopia and lowered reading ability has also been demonstrated longitudinally among children aged 7-11.[51] Complementing these results are those showing the opposite: that compared with children (aged 10-12 years) who did not have myopia, children with myopia read more and have higher levels of academic achievement.[52] One plausible explanation (of several) for the findings is that children with uncorrected hyperopia, who struggle to see at close distance, are more likely to avoid tasks such as reading, that depend on close vision.

Another aspect of visual processing that plays a role in acquiring basic academic skills, cognition, and learning (eg, reading) is binocular coordination of eye movements. Binocular coordination is essential for tracking skills (eg, the ability to move across a line of text when reading). In children, the stability of binocular control has been associated with reading and with spelling skills.[53,54] In adolescents, saccadic tracking skill deficits, such as those required for following letters and words across a line of text, have been suggested as a risk factor for low levels of reading ability.[27] Data suggest that there are systematic changes in binocular control in reading (and nonreading) tasks for children (and adults) that are not driven by cognitive development.[55] Although a causal relationship between ocular control and academic achievement in areas such as reading has not been unequivocally established, evidence suggests that deficits in ocular control may contribute to learning problems.

Sensory problems (obstacles to seeing well) can impair learning, but so can obstacles to integration between visual sensory perception and the brain. Various aspects of this integration process have been associated with educationally relevant outcomes. Associations have been reported between visual-motor integration and both teachers' ratings of children's ability in reading, math, spelling and writing, and standardized reading test scores;[56] between visual memory and standardized measures of word decoding and math and Stanford total battery score;[57] between visual information processing skills and reading ability;[58] between accommodative facility (focusing at various distances) and stereoacuity (depth perception) and standardized measures of reading performance;[59,60] between visual-spatial short-term memory and standardized math test scores;[61] and between symptoms of visual problems and standardized tests scores.[62] Most research on vision skills has been conducted

in elementary children, but tracking skills have also been associated with low levels of reading achievement among adolescents.[27]

Connectedness

It is not unreasonable to assume that the child who struggles with vision problems will tend to avoid certain kinds of work because of fatigue, strain, and demoralization. Vision problems cannot be overcome by simply trying harder, but need to be addressed with timely and appropriate treatment. A likely outcome for children demoralized by ongoing struggle coupled with lack of academic success is disengagement from school. A child with an undetected or untreated vision problem is more likely to develop social or emotional problems. Thus, a child's vision problems can affect not only their own learning, but that of their peers.[29,63]

WHAT CAN SCHOOLS DO TO ADDRESS VISION PROBLEMS?

Despite controversy surrounding choice of screening method[28,64-72] there is no doubt that school-based vision screening can help identify vision problems that adversely affect educational outcomes. The initial goal of screening is to identify youth who warrant further evaluation via a comprehensive eye exam conducted by an eye care specialist (ophthalmologist or optometrist).

Many states (71%) require school-based vision screening programs, as do the majority of school districts (93%).[73] More elementary schools (91%) than middle (82%) or high schools (64%) require vision screening. Among states that require vision screening almost all require parental notification of results. Less than half (41%) require teacher notification. Teachers are obviously well placed not only to help identify children with learning-related vision problems, but also to encourage children to follow recommended actions (eg, wear their glasses as needed). This is, of course, yet another responsibility placed on teachers, which may or may not be reasonable to expect.

There are few data available describing the nature, scope, quality, or yield (ie, amount of previously unrecognized vision problems that are detected and effectively treated) of school-based vision screening programs. There is no evidence that these programs ensure timely follow-up exams and indicated treatment, an issue known to be especially problematic among low-income families.[19,26,40,41,46]

Once identified, vision problems need to be corrected. This will not happen without deliberate emphasis on follow-up to receive a comprehensive eye examination and recommended follow-up care.[17,19,26,46] There is an ethical standard that guides against conducting screening programs unless follow-up care is available,[74] but this appears to be commonly violated with respect to school-based children's vision screening programs. Typically, a positive screening test results in a note being sent home to parents recommending that their child receive an eye examination by an optometrist or ophthalmologist; no further action may be taken. In some contexts, this approach suffices, but this is generally not the case in low-income families.[19,26,40,41,46,75]

At least two broad approaches can help increase the chances that referred youth will receive an examination and recommended care. One is intensified outreach to parents to motivate, enable, and support them to use existing community-based eye care services. Interpersonal interaction is more likely to be effective than a 1-way written communication. Parents should be informed about the nature of their children's vision problem(s), about the potential importance, and about strategies to minimize adverse educational and health effects. Telephone outreach has proven effective in a variety of related applications and warrants consideration here.[76] A second approach is direct provision of services on-site within schools. Several examples of such school-based services have been reported and results are promising.[6,46,75]

In 1 recent study in New York City,[75] 4 of 8 elementary schools were assigned randomly to receive a follow-up program in which all students who ''failed'' the routine vision screening received a professional optometric screening and, where appropriate, 2 pairs of eyeglasses (1 to be kept by the teacher). In addition, teachers encouraged eyeglass use as prescribed. Eyeglass use by children was assessed by direct observation prior to and after the optometric screening. At baseline, mean rates of eyeglass use for students in intervention and control groups at baseline were 22% and 19%, respectively ($p > .10$). At follow-up, eyeglass use rose to 47% in the intervention group, whereas the control group's rate remained consistent at 19% ($p < .001$). Significant differences persisted for boys and girls. These results demonstrate both the lack of follow up that can be expected subsequent to routine screening as well as the feasibility of increasing use of eyeglasses in an elementary school setting.

Vision screening programs limited to identifying and correcting visual acuity do not address the full range of vision-related learning problems affecting youth. However, correcting visual acuities through use of glasses is cost-effective[77] and can have significant clinical benefits.[1,3,9] Observational[48,50,51] and limited intervention research[6] suggests that identifying and correcting visual acuity due to refractive errors can favorably affect academic achievement. Ensuring that children who need glasses receive them is an important first step. Ensuring that children who have glasses wear them is another. Improving vision by correcting significant refractive errors will make it easier for children to learn.

Vision screening, even if the focus is on visual acuity, is also likely to identify children with more significant visual problems, such as amblyopia and strabismus.[17] These conditions are ideally treated before age 3 or 4.[5] Effective programmatic efforts must help ensure that children with these vision impairments receive appropriate treatment in a timely way. For vision problems involving eye-brain or eye-motor system integration the indicated treatment is often vision therapy. Although current data may not support widespread implementation of vision therapy to improve tracking ability, smaller scale demonstration studies warrant consideration. Availability and accessibility to such services, and efforts to help ensure high rates of utilization through school-based services or referrals, would be an important innovation. One role of a nurse, other school health service practitioner, or school health program coordinator should be to establish a referral network of vision care services in the community, particularly those serving low-income children.

Ideally, school-based vision screening and service programs would address a full range of ocular factors including binocularity, visual-motor functioning, and other aspects of functional vision skills (listed above), which have been associated with the acquisition of reading, written and spoken language, math, and other academically relevant skills. Multifactorial screening and follow up would, of course, require more time and more highly trained personnel, and thus more funding. Realization of the benefits of multifactorial school-based vision screening would also require a more complex and intensive follow-up strategy to ensure that the full spectrum of recommended actions and indicated treatment are received. The ultimate value of such services on educational outcomes remains to be documented in rigorous studies, but warrants testing.

PROVEN OR PROMISING APPROACHES

First, observational studies have consistently found an association between various kinds of vision problems and academic skills and measures of academic performance. Second, school-based programs can identify many,[17] although not all, youth with undetected and untreated vision problems that disproportionately affect youth with lower levels of academic achievement. Third, effective and feasible treatments for vision problems exist: eyeglass use can correct refractive errors that impede visual acuity and a strong base of biomedical and clinical research demonstrates the efficacy of interventions to prevent or minimize other eye diseases that affect youth, including amblyopia, strabismus, and astigmatism.[1-9] Evidence also supports the value of vision therapy as a means to reduce learning problems and improve educational outcomes.[6,46] Fourth, although very few intervention studies have been conducted, 2 small studies provide preliminary evidence that correcting acuity problems, such as hyperopia, and functional vision problems, such as difficulties with tracking, can favorably influence educational outcomes, including standardized tests scores.[6,46] Additional intervention studies are clearly warranted.

SUMMARY

There are large gaps in current knowledge regarding the number and percentage of school-aged youth who participate in different kinds of vision screening programs, the incidence and prevalence of various vision problems among youth, and the kinds of vision services that are, and more importantly are not, being delivered. It is, however, known that urban minority youth are less likely to receive appropriate and timely treatment for vision problems. Despite scant research on the magnitude of educational consequences of vision problems, evidence suggests that vision problems among urban minority youth may have very substantial adverse affects on educational outcomes.

Because of schools' unparalleled and consistent access to youth, school-based vision screening programs are a logical approach by which to identify educationally relevant visual health disparities affecting urban minority youth. Without appropriate follow up, the full educational benefits of vision screening cannot be realized. Screening programs can encourage receipt of indicated follow-up services by improved communication with parents, facilitation of access, and use of existing community resources and/or direct provision of services on-site. Accomplishing these objectives will require not only financial investment, but investment of effort by parents and teachers to monitor and encourage youth to follow recommended actions, whether that be using glasses, taking medications, or practicing vision therapy.

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