Healthier Students Are Better Learners:
A Missing Link in School Reforms to Close the Achievement Gap

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This essay is dedicated to the urban minority youth of America.

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No matter how well teachers are prepared to teach, no matter what accountability measures are put in place, no matter what governing structures are established for schools, educational progress will be profoundly limited if students are not *motivated and able to learn*. Health-related problems play a major role in limiting the motivation and ability to learn of urban minority youth, and interventions to address those problems can improve educational as well as health outcomes. Healthier students are better learners. Recent research in fields ranging from neurosciences and child development to epidemiology and public health provide compelling evidence for the causal role that *educationally relevant health disparities* play in the educational achievement gap that plagues urban minority youth. This is why reducing these health disparities must be a fundamental part of school reform.

School leaders must prioritize how to use scarce resources to address the critical health problems affecting youth. In this essay, three criteria were used for establishing priorities: prevalence and extent of health disparities negatively affecting urban minority youth; evidence of causal effects on educational outcomes; and feasibility of implementing proven or promising school-based programs and policies to address the health problem. Based on these criteria, seven educationally relevant health disparities were selected as strategic priorities: (1) *vision*, (2) *asthma*, (3) *teen pregnancy*, (4) *aggression and violence*, (5) *physical activity*, (6) *breakfast*, and (7) *inattention and hyperactivity*. Many other health problems affecting youth are also important, and the particular health problems deemed most important in a given school or school district will vary.

The health factors specified in this essay affect a large proportion of American youth. Visual problems have been estimated to affect 20% of youth. Asthma affects an estimated 14% or 9.9 million youth under 18 years old. An estimated 8.4% of school-aged youth, 4.6 million, have received a diagnosis of attention-deficit/hyperactivity disorder (ADHD), with millions more exhibiting symptoms that are below established diagnostic criteria but nonetheless adversely affect teaching and learning. One in three American female adolescents is expected to become pregnant. Aggression and violence are a pervasive part of daily life for American youth, including at school. The majority of school-aged youth do not meet recommended levels of daily physical activity. Millions of youth do not eat breakfast on any given day. Urban minority youth from low-income families are disproportionately affected by all of these problems. If these factors are not addressed, the benefits of other educational innovations will be jeopardized.

Educationally relevant health disparities impede motivation and ability to learn through at least five causal pathways: *sensory perceptions; cognition; connectedness and engagement with school; absenteeism;* and *dropping out*. The causal pathways themselves are interrelated: for example, the student who is struggling cognitively is likely to feel less connected and less inclined to attend, which will further undermine educational progress. The causal connections between *multiple* health factors and motivation and ability to learn will be greater than the effects of individual factors. This is based on the expectation that at least some variance would be additive. However, it is reasonable to believe that the functional effects of reducing multiple impediments to motivation and ability to learn would be not only additive but also synergistic; therefore, school health programs must focus on multiple educationally relevant health disparities to maximize the educational yield from investments.

Schools cannot address all of the conditions that cause educational or health disparities, but proven and promising approaches exist and must

be applied to help close the achievement gap. Children should receive corrective care to enable them to see well enough to acquire basic academic skills. Children with poorly controlled asthma deserve in-school monitoring to help ensure that they receive high quality health care; a school that identifies and ameliorates allergens, irritants, and pollutants that trigger symptoms; and multiple opportunities for daily physical activity. Children need to learn and practice communication and social skills, such as resisting social pressures and negotiating to minimize interpersonal conflict and maximize cooperation, which can reduce risk for various health-compromising outcomes, including unintended pregnancy. For youth who are sexually active, contraceptive services should be available. For youth who become pregnant, targeted health and social services are essential if there is to be any hope of interrupting the intergenerational transmission of poverty.

Children have the right to attend a school that is safe. Progress in achieving this goal will be greatly influenced by the school climate and school connectedness. Measures of school climate and school connectedness should become a norm within measures of accountability—if the school climate is poor, connectedness and engagement in school will be less likely, which in turn will adversely affect educational as well as health outcomes. Youth who exhibit disruptive or aggressive behavior need attention during the early stages of development of these behaviors. Youth have the right to multiple daily opportunities for physical activity and to daily breakfast. Youth with attention and hyperactivity problems need help in learning ways to improve their mental and behavioral performance and, when parents and pediatricians agree, pharmacological treatment.

Most schools are already devoting some attention and resources to addressing important health barriers to learning, but these efforts are too often poor quality, not strategically planned to influence educational outcomes, and not effectively coordinated to maximize linkages between different school health components. Despite compelling evidence linking health and academic achievement, there is no U.S. Department of Education initiative to reduce educationally relevant health disparities as part of a national strategy to close the achievement gap. For the nation's schools to address educationally relevant heath disparities in a strategic and coordinated way, there must be fundamental change in the goals of schools, the way schools are financed, the personnel and services available, and the amount of time devoted to help youth learn social-emotional skills. Such change will not occur without leadership from the U.S. Department of Education. Now is an opportune time for such leadership.

National, state, and local strategies for helping schools implement high quality, strategically planned, and effectively coordinated school health programs are presented. These include policy development; guidance, technical assistance, and professional development; accountability supported by data and software systems; and priorities for a national research agenda. Even if health factors had no effect on educational outcomes, they clearly influence the quality of life for youth and their ability to contribute and live productively in a democratic society. Improving the health of youth is a worthy goal for elementary and secondary education. Indeed, pursuing this goal is a moral imperative.

Low levels of academic achievement and educational attainment among low-income and minority youth, particularly in urban areas, undermine the quality of individual, family, and community life, threatening the very integrity of American society. Educationally relevant health disparities exert a powerful, but generally overlooked, influence on the achievement gap. Disparities in this context are health problems that disproportionately affect low-income urban minority youth as measured by incidence, prevalence and educationally relevant consequences. Health factors have direct and indirect effects on educational outcomes, including standardized test scores. To date, school reform efforts to close the achievement gap have not targeted reduction of educationally relevant health disparities.

To great extent, the educational achievement gap and health disparities affect the same population subgroups of American youth and are caused by a common set of social-environmental factors; it is increasingly clear that both education and health can also exert strong, reciprocal effects. The familial, social, physical, and economic environment in which youth live (Evans, 2004) is strongly associated with academic achievement and educational attainment (Evans & Schamberg, 2009; Murname, 2007; Rouse & Barrow, 2006), with childhood and adolescent health (Chen, Martin, & Matthews, 2007; Evans, 2006; Evans, Gonnella, Marcynszyn, Gentile, & Salpekar, 2005; Evans & Kim, 2007; Geronimus, 2000; Link, Phelan, Miech, & Westin, 2008; Lynch, Kaplan, & Shema, 1997; Marmot, 2002; Melchior, Moffitt, Milne, Poulton, & Caspi, 2007; Poulton et al., 2002), and with social mobility (Case, Fertig, & Paxson, 2005; Case & Paxson, 2006; Geronimus, 2000; Hass, 2006). The strong association between social class and health persists throughout the lifespan (Case & Paxson, 2006; Koivusilta, Arja, & Andres, 2003; Link & Phelan, 1995; Melchior et al., 2007; Paloni, 2006; Poulton et al., 2002).

An important emerging literature implicates children's health factors as causal mechanisms through which low socioeconomic status influences academic achievement and educational attainment (Case & Paxson, 2006; Crosnoe, 2006; Hass, 2006; Hass & Fosse, 2008; Heckman, 2008; Koivusilta et al., 2003; Palloni, 2006). The direction of causality, effect sizes, and hypothesized causal mechanisms mediating relationships among social-environmental factors (e.g., poverty), education, and health has been explored from multiple perspectives. It seems likely that these three factors—(1) familial, social, physical, and economic environment, (2) academic achievement and educational attainment, and (3) health—are causally related in reciprocal ways. The focus of this essay is the influence of selected health factors on educational outcomes.

The Role of Schools

It is neither reasonable nor realistic to expect that, on their own, schools can close the gaps in education or eliminate health disparities among the nation's youth. Schools should not be solely responsible for addressing these complex and recalcitrant problems. There are essential roles to be played by families, communities, health care systems, legislators, media, and by economic policy. All of these (and other) social institutions should, and must, contribute to solving these problems. There are no simple solutions.

However, with more than 50 million students spending a significant portion of their daily lives in school, this social context is surely one of the most powerful social institutions shaping the next generation of youth. By systematically addressing educationally relevant health disparities, schools can reduce both educational and health disparities. But this will not occur efficiently with the current strategy of investment in school health programs.

School health programs have a long history in the

United States (Mann, 1891) but have never been fully embraced. To date, reducing health disparities as a strategy to help close the achievement gap has lacked financial investment, has not had a prominent role in school reform movements, and has not occupied a central place within the educational mission of American schools. Consequently, high quality, strategically planned, and effectively coordinated school health programs and policies have not been widely implemented, and leaders and educators in urban public schools, serving minority youth from low-income families who are disproportionately affected by both educational and health disparities, face particular challenges contexts for developing, implementing and sustaining such school health programs.

Recently, the important role of schools in addressing health issues has been recognized by leading educational professional organizations, policy making, and interstitial groups. For example, policies or guidelines have been identified or proposed by the National Association of State Boards of Education (n.d.), National School Boards Association (n.d.), Council of Chief State School Officers (2008), Association for Supervision and Curriculum Development (n.d.) and their "New Compact to Educate the Whole Child," American Academy of Pediatrics and National Association of School Nurses (n.d.), and A Broader, Bolder Approach to Education (n.d.), and by leading governmental agencies such as the Centers for Disease Control and Prevention (n.d.a, b, c).

An Opportune Time for Change

In the past, the U.S. Department of Education has provided resources to assist schools in addressing some health topics such as safety and drug use prevention, but it has not provided leadership for integrating school health into the fundamental mission of schools and supporting the widespread development and implementation of high quality, strategically planned, and effectively coordinated approaches that address a variety of health-related barriers to teaching and learning. Now is an opportune time for change.

Many schools in the United States provide some health programs or services; however, the quality of school health programs and services vary greatly. Most schools implement some programs or policies that address health (Kann, Telljohann, & Wooley, 2007) through activities such as physical education, breakfast and lunch meals, health services to provide acute care and administration of medications, health-related counseling, and curricula addressing tobacco, alcohol and drugs, nutrition, teen pregnancy and sexually transmitted disease (including HIV/AIDS), and violence. In addition, most schools offer some health care services, and some schools offer more extensive on-site health care services provided by nurses and school-based clinics. Some also offer a variety of health-related after-school programs. Community and full service schools offer in-school programs and services, including health and mental health programs and services to support youth before and after school and during the summer as well as during the typical school day (Coalition for Community Schools, 2008). While published data do not as yet exist, school health programs and services are likely inequitably distributed as are most other school resources—that is, there are both fewer and lower quality resources available in schools that serve low-income minority youth.

Despite the widespread and substantial investment in school health programs and services, current investments are likely to yield only limited educational benefits to students for several reasons. First, current financial investments are not sufficient to address the magnitude and severity of health problems affecting urban minority youth. Second, in too many cases the programs being implemented are not high quality. Third, existing efforts are not strategically planned to influence educational outcomes. Fourth, existing efforts are not effectively coordinated to capitalize on potential linkages between efforts. Though rhetorical support is increasing, school health is currently not a central part of the fundamental mission of schools in America nor has it been well integrated into the broader national strategy to reduce the gaps in educational opportunity and outcomes.

For public schools serving urban minority youth, a strategic approach is essential. Schools facing the greatest and most urgent challenges also have the least human and other resources, even before they attempt to deal with health factors. To make best use of scarce resources, priorities for dealing with health factors must be established. A public-health oriented strategic plan would focus on key health risk behaviors (those linked to leading causes of death in childhood and adolescence and those that are established in youth and contribute to the leading causes of death in adulthood), including unintentional injuries and violence, alcohol and drug use, sexual risk behavior, tobacco use, physical inactivity, and poor eating habits (Kolbe, Kann, & Collins, 1993).

Strategic Priorities

The current analysis establishes strategic priorities based on their relevance to educational outcomes and to closing the achievement gap. Three criteria were considered: (1) prevalence and extent of health disparities, (2) evidence of causal effects on educational outcomes, and (3) feasibility of implementing proven or promising school-based programs and policies. Prevalence and extent of health disparities was used based on the premise that, if a health problem is the cause of an educational disparity, the health problem must affect a large proportion of youth and be more prevalent or have more deleterious effects on urban minority youth. Disparities are described in terms of descriptive epidemiology indices (e.g., prevalence estimates) using data describing nationally representative samples, when available. Local data were used to highlight geographical variation.

If a health problem is the cause of an educational disparity, the health problem must be statistically and temporally associated with the unfavorable educational outcomes. Beyond a temporal statistical association, the case for causation is strengthened by a plausible explanation for why a particular health problem would cause a negative educational outcome: "What are the causal pathways?" Prioritizing health factors in terms

of causal links to educational outcomes may enhance their perceived importance and acceptability to policy makers, school leaders and teachers, and other educational stakeholders. The specific health factors selected by a given school or school system are less important than the fact that multiple educationally relevant health factors are prioritized and addressed collectively through a single set of high quality, strategically planned, and effectively coordinated programs and policies.

The third criterion used in the current analysis was feasibility of implementing proven or promising school health approaches. This criterion focuses on two issues, feasibility and effectiveness. Feasibility is based, in part, on the observation that some health programs and services are already being implemented in many schools and that guidelines and recommendations summarizing what schools can do to address the respective health problems are already available from credible sources. Effectiveness is based the availability of proven or promising approaches from a large body of evaluative research demonstrating that particular approaches can influence the acquisition and practice of various health-related behaviors.[1]

Based on these criteria, the following educationally relevant health disparities were selected as priorities: (1) vision, (2) asthma, (3) teen pregnancy, (4) aggression and violence, (5) physical activity, (6) breakfast, and (7) inattention and hyperactivity. The omission of other

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[1] There are different degrees of evidence concerning the likelihood of influencing particular health behaviors and health status indices. The overwhelming majority of evaluative research on disease prevention and health promotion for children and adolescents has not, however, measured educational outcomes. Another weakness in our current knowledge is that evaluative research has focused on the effects of interventions on individual health problems rather than efforts to address multiple health problems. Several national databases describing school health approaches with proven or promising results are available but apparently not used by many schools in their decision making about which school health programs to adopt and implement.

health topics should not be taken to suggest that they are unimportant. Tobacco, alcohol and drug use, dental problems, ear infections, obesity, accidental injuries, among others, are pervasive problems affecting youth and depending on the local context also warrant consideration. Indeed, all of these problems are rightly priorities of the U.S. Public Health Service. The seven specified priorities are intended to illustrate the effect that addressing particular health disparities can have on educational opportunity and the achievement gap. They illustrate a reasonable set of "starting points" through which school policies and programs might influence the achievement gap among urban minority youth. Schools in different social and economic contexts will have lesser or greater propensity to include various health factors as a priority; this is not problematic as long as problems are addressed with proven or promising approaches, are selected strategically, and are addressed through an effectively coordinated effort.

Causal Pathways

One or more of five causal pathways—the mechanisms by which health factors influence motivation and ability to learn—are identified and described for each health factor: (1) sensory perceptions, (2) cognition, (3) school connectedness and engagement, (4) absenteeism, and (5) temporary or permanent dropping out. It is axiomatic that sensory perception (e.g., seeing and hearing well) and cognition (executive functioning, memory, maintaining attention) have powerful effects on learning opportunities; that student absenteeism adversely affects opportunities to learn academically and to grow socially; and that dropping out adversely affects life course trajectories.

Until recently, what has been less clear, or at least less well documented empirically, is the importance of connectedness and engagement with school. Connectedness is essentially about interpersonal relationships, both with peers and school staff. It is the extent to which students perceive that adults and peers in the school community care about them as students and as individuals. A compelling body of research demonstrates that connectedness and engagement with school is a key determinant of academic achievement and educational attainment (Battlin-Pearson et al., 2000; Bond et al., 2007; Fleming, Haggerty, Catalano, Harachi, Mazza, & Gruman, 2005; Ladd, Birch, & Buhs, 1999; Klem & Connell, 2004; Nelson, 2004; Rosenfeld, Richman, & Bowen, 1998;) as well as child and adolescent health (e.g., reduced risk of substance use, teen pregnancy, aggressive behaviors, and mental/emotional health problems) (Bond et al. 2007; Bonny, Britto, Klostermann, Hornung, & Slap, 2000; Eccles, Early, Fraser, Belansky, & McCarthy, 1997; Manlove, 1998; Mansour et al., 2003; McNeely & Falci, 2004; Resnick et al., 1997; Resnick, Harris, & Blum, 1993; Shochet, Dadds, Ham, & Montague, 2006). There is general consensus that connectedness and engagement in learning are important for success in school (Klem & Connell, 2004).

Because educational outcomes are influenced by many forces differentially across various contexts, each health factor, addressed separately, should not be expected to have large or consistent effects on educational outcomes. For example, the effects of diet on the brain are integrated with effects of other factors such as exercise and sleep (Gomez-Pinilla, 2008). The child who is well nourished, physically active, and well rested is likely to have advantages regarding cognition compared with the child with deficits in any of these areas. The child who has difficulty seeing, difficulty paying attention, or is bullied at school will struggle to succeed academically and will feel less connected and engaged with school. In turn, the child who is less connected and engaged with school will be less motivated to attend. Thus, beyond their individual effects, educationally relevant health disparities, collectively, can have an influential role in shaping the educational and social lives of the nation's urban minority youth. Further, there are synergistic effects of acquiring skills at earlier stages in life whereby capabilities beget capabilities and influence long-term health (Heckman, 2007).

A Coordinated Approach

A coordinated approach is characterized by programs and services involving different groups of people, playing different roles, but forming a team and working toward a common set of priority goals, namely improving students' motivation and ability to learn. Once school health priorities are established, limited resources are used to support integrated efforts to achieve them. This helps to optimize the value of existing resources.

Linkages between teachers and health service personnel are essential in helping to ensure that identified problems (for example, with vision, asthma, or ADHD) receive indicated follow-up care. Linkages between categorical health curricula (for example, dealing with violence and teen pregnancy prevention) can optimize the use of curricular time by recognizing that reducing susceptibility to these different problems requires learning and practicing the same set of mental and social-emotional skills (e.g., self-regulation, dealing with social pressures, communicating assertively but not aggressively). Effective coordination requires a school health coordinator who is cognizant of the different programs, services, and policies and how they can be linked together to use limited resources effectively and efficiently.

Selection of program components can, at least in part, be based on the ability of distinct program or service components to influence the same set of priority outcomes. Thus coordination applies to planning as well as implementing school health efforts. Programs intended to ensure that youth eat breakfast, have daily physical activity, and arrive at school well rested would be addressed through different school health efforts, but could collectively affect cognition to a greater extent than any of the individual efforts.

Delimitations and Overall Intent

Several delimitations narrow the scope of this essay. First, the emphasis is on urban minority youth. Urban minority youth represent a large and growing segment of the U.S. population. The percentage of students comprising all public school students enrolled in kindergarten through 12th grade who were white declined from 77.8% in 1972 to 56.9% in 2006 (Planty et al., 2008). Improved health status for all children is a worthy goal, but need is particularly urgent among urban minority youth who, as with adults, have great intergenerational educational and health disparities. There are, of course, other subpopulations (e.g., Native American and poor rural youth) facing extremely challenging educational and health contexts, which can and should be addressed. Second, though health may influence educational outcomes across the lifespan, attention is limited to health factors that influence school-aged youth. Again, this is in no way intended to minimize the important causal role of intrauterine, neonatal, infant and toddler health on motivation and ability to learn. Indeed, programs aimed at reducing health disparities among infants, toddlers, and children under five should be a top priority. A third delimitation is that health factors were selected based, in part, on feasibility of implementing proven or promising school-based programs and services. Clearly, the achievement gap cannot be closed without extensive involvement from other social institutions, but, at the same time, school health efforts that are high quality, strategically planned, and effectively coordinated are one of the best investments for influencing the health, as well as the minds, of the nation's youth.

This essay fills a significant gap in the current literature. In the following sections, each of the educationally relevant health disparities is described with respect to nature and scope of the problem, prevalence and disparities affecting urban minority youth, causal pathways by which the respective health disparity adversely affects motivation or ability to learn, ways that school programs and policies can address the problem, and evidence supporting proven or promising approaches.

The overall intent of this essay is to make the case for high quality, strategically planned, and effectively coordinated school health initiatives as part of a

national strategy to close the achievement gap by presenting the evidence regarding four main points: (1) urban minority youth are disproportionately affected by both educational and health disparities, (2) healthier students are better learners, (3) school programs and policies can favorably influence educationally relevant health disparities affecting youth, and (4) now is an opportune time for change. Initiatives to move this agenda forward at the national, state, and local levels are proposed.

Vision

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 (Cotter et al., 2007; Harvey, Dobson, Clifford-Donaldson, & Miller, 2007; Harvey, Dobson, Miller, & Clifford-Donaldson, 2008; Hertle et al., 2007; Hunter, 2005; Krumholtz, 2000; Pediatric Eye Disease Investigator Group, 2005, 2008; Wallace et al., 2007).

It has been estimated that more than one in five school-aged youth has some kind of vision problem (Ferebee, 2004). Recent estimates of visual impairment in a nationally representative sample of 12-19 year olds in the United States are available from the National Health and Nutrition Examination Survey—NHANES, 1999-2002 (Vitale, Cotch, & Spreduto, 2006). The rate of visual impairment (distance visual acuity of 20/50 or worse in the better-seeing eye) among 12-19 year-olds (9.7%) was significantly 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 12-19 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 three times as high for individuals with income below the poverty level (12.0%) versus two times the poverty level or greater. 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 (Kemper, Gurney, Eibschitz-Tsimhoni, & Del Monte, 2007). 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 over-treatment and consistency of use of glasses. No current, nationally representative estimates of refractive errors and vision-related learning problems were found for 5-11 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 (Centers for Disease Control and Prevention, 2008; Drews, Yeargin-Allsopp, Murphy, & Decoufle, 1992). Approximately 25 per 1000 youth under age 18 are blind or visually impaired (Cotch, Janiszewski, Klein, Turczyn, Brett, & Ryskulova, 2005).

Recent estimates in children 6-72 months of age indicate that amblyopia is more common in Hispanic

than in African American children (2.6% versus 1.5%). Rates of strabismus were 2.4% and 2.5%, respectively. Rates for white children were not reported (Multi-ethnic Pediatric Eye Disease Study, 2008). Nationally representative estimates of amblyopia and strabismus among school-aged children are not available, but some local estimates (outlined below) are even higher.

In Kentucky, between July 2000 and April 2001, 5,316 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 (Zaba, Johnson, & Reynolds, 2003). In a multi-center study of refractive error among 2,523 youth aged 5-17, 9.2% were myopic, and 12.8% were hyperoptic (Kleinstein et al., 2003). 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%) (Preslan & Novak, 1998). In northern Manhattan, screening of 5,851 students in four intermediate schools determined that 28% had vision of 20/40 or worse in at least one eye. In the majority of cases, follow-up eye examinations confirmed the presence of refractive errors, most of which could be corrected with glasses (Pizzarello, Tilp, Tiezzi, Vaughn, & McCarthy, 1998). Another study in three New York City public elementary schools screened 1,365 students; 29% were referred for further evaluation (Krumholtz, 2000). 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 (Grisham, Powers, & Riles, 2007; Johnson, Blair, & Zaba, 2000; Johnson & Zaba, 1999; Krumholtz, 2000; Maples, 2001, 2003; Mozlin, 2001; Pizzarello et al., 1998; Powers, Grisham, & Riles, 2008; Vision in Preschoolers Study Group, 2005; Zaba, 2001). The association may be due, at least in part, to increased risk of being born prematurely and at low birth weight (Reichman, 2005), both of which adversely affect eye health and processes associated with the development of vision (Chawla, Agarwal, Deorari, & Paul, 2008; Cosgrave, Scott, & Goble, 2008; Hellgren et al., 2007; Holmstrom & Larsson, 2008; Mozlin, 2001; O'Connor, Wilson, & Fielder, 2007; Salt & Redshaw, 2006; Solan & Mozlin, 1997).

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 (Ganz, Zuan, & Hunter, 2006). The authors also found that, when diagnosed with eye care problems, black youth living in poverty received fewer and less intensive health care services (Ganz et al., 2006). These analyses indicate that poor minority youth are both under-diagnosed and under-treated for eye care problems (Ganz et al., 2006, 2007). Local studies (Mark & Mark, 1999; Preslan & Novak, 1998; Yawn, Lydick, Epstein, & Jacobsen, 1996) support these conclusions. In another national sample of 14,000+ (representing almost 200,000) children with special health care needs, black, Hispanic and multi-racial children were two to three times more likely than white children to have unmet vision care needs (8.9%, 10.0%, and 14.3%, respectively, versus 4.1%) (Heslin, Casey, Shaheen, Cardenas, & Baker, 2006). 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, (Grisham et al., 2007; Johnson & Zaba, 1999; Pellicano & Gibson, 2008; Powers et al., 2008; Schuett, Heywood, Kentridge, & Zihl, 2008; Trachtman, 2008; Zaba, 2001).

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 (i.e., ability to move across a line of text when reading), teaming or binocularity (i.e., communication between the eyes and the brain) and focusing (i.e., ability to focus accurately at various distances, to change focus quickly, and to maintain focus as long as necessary) (Harris, 2002). 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 one eye, tilting the head to one 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 (American Optometric Association, 2008). Because visual sensory perceptions and cognition are so strongly interrelated, these topics are combined below.

Sensory Perceptions and Cognition

While all of 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 (Williams, Latif, Hannington, & Watkins, 2005), standardized reading test scores (Krumholtz, 2000), and percentile ranking on the Iowa Test of Basic Skills (Rosner & Rosner, 1997). Uncorrected hyperopia in 4-7 year olds has been adversely associated with emergent literacy skills, including letter and word recognition, receptive vocabulary, and orthography (use of letters in words) (Shankar, Evans, & Bobier, 2007). 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 (Williams, Sanderson, Share, & Silva, 1988). 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 (Saw et al., 2007). One plausible explanation (of several) for the contradictory 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 (e.g., reading) is binocular coordination of eye movements. Binocular coordination is essential for tracking skills (e.g., 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 (Cornelissen, Bradley, Fowler, & Stein, 1991, 1994). 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 (Powers et al., 2008). 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 (Kirkby, Webster, Blythe, & Liversedge, 2008). While 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 (Kulp, 1999); between visual memory and standardized measures of word decoding and math and Stanford total battery score (Kulp, Edwards, & Mitchell, 2002); between visual information processing skills and reading ability (Goldstand, Koslowe, & Parush, 2005); between accommodative facility (focusing at various distances) and stereoacuity (depth perception) and standardized measures of reading performance (Kulp & Schmidt, 1996, 1997); between visual-spatial short-term memory and standardized math test scores (Bull, Espy, & Wiebe, 2008); and between symptoms of visual problems and standardized tests scores (Vaughn, Maples, & Hoenes, 2006). 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 (Powers et al., 2008).

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. (Johnson, Nottingham, Stratton, & Zaba, 1996; Zaba, 2001).

What Can Schools Do to Address Vision Problems?

Despite controversy surrounding choice of screening method (Arnold & Donahue, 2006; Donahue, Johnson, Ottar, & Scott, 2002; Donahue & Leonard-Martin, 2000; Kemper, Margolis, Downs, & Bordley, 1999; Logan & Gilmartin, 2004; Poterio et al., 2000; Robinson, Bobier, Martin, & Bryant, 1999; Vision in Preschoolers Study Group, 2004, 2005; Zaba, Reynolds, Mozlin, Costich, & Slovona, 2007) 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%) (Brener, Wheeler, Wolfe, Vernon-Smiley, & Caldart-Olsen, 2007). 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 (e.g., 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 (i.e., 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 (Harris, 2002; Mark & Mark, 1999; Mozlin, 2001; Preslan & Novak, 1998; Yawn et al., 1996).

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 (Harris, 2002; Mozlin, 2001; Preslan & Novak, 1998; Zaba et al., 2003). There is an ethical standard that guides against conducting screening programs unless follow-up care is available (American Academy of Pediatrics, 2004), 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 (Ethan, Basch, Platt, Bogen, & Zybert, in press; Harris, 2002; Mark & Mark, 1999; Mozlin, 2001; Preslan & Novak, 1998; Yawn et al., 1996).

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 one-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 (Soet & Basch, 1997). 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 (Ethan et al., in press; Harris, 2002; Krumholtz, 2000).

In one recent study in New York City, four of eight 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, two pairs of eyeglasses (one for classroom use and an extra one 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 a 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 (Baltussen, Naus, & Limburg, 2008) and can have significant clinical benefits (Cotter et al., 2007; Harvey et al., 2008; Wallace et al., 2007). Observational (Shankar et al. , 2007; Williams et al., 2005; Williams, Sanderson, Share, & Silva, 1988) and limited intervention research (Krumholtz, 2000) 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.

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