CHILD DEVELOPMENT PERSPECTIVES

Insufficient Sleep and the Socioeconomic Status Achievement Gap

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ABSTRACT—***Research with adults and children has shown that sleep plays a vital and complex role in multiple physiological systems that maintain health and promote optimal functioning across many domains. For children, school is an important domain of functioning, and emerging research links sleep to academic achievement. Many children from lower socioeconomic status (SES) families sleep poorly, and when their sleep is compromised, the effects on cognitive functioning and academic achievement may be greater than for less disadvantaged children. Understanding how sleep affects performance may enrich theory relating to the achievement gap between groups of children differing in SES, and constitutes a new focus for prevention and intervention.***

KEYWORDS—*sleep; socioeconomic status; race; achievement gap; academic achievement; school behavior*

Social class disparities in health and education and attempts to reduce those disparities have been the subject of intense and broad interest in the United States. Children from low socioeconomic status (SES) families are at greater risk for problems in school, including underachievement, behavioral maladjustment, and early dropout. Scholars and policy makers have devoted much attention to possible causes and recommended interventions for narrowing or closing what has come to be called the achievement gap. This article makes a case for a connection between sleep and school performance by children from low-SES families that may enrich theory and guide prevention and interventions for better health and academic achievement. Although the importance of sleep for maintaining health in children is part of common cultural wisdom, scientific understanding of how sleep benefits child health, development, and education is still emerging. It is becoming clear that sleep plays a vital and complex role in multiple physiological systems that maintain health and promote optimal functioning across many domains over the course of child development.

SCHOOL PERFORMANCE AND SES

Low SES is related to significant limitations in families' quality of life. The problems manifest in multiple areas, including nutrition, health, education, employment, and attainment of material resources. Children from low-SES families often have low academic achievement in the form of lower classroom grades, lower standardized test scores, and lower level of grade completion. They also frequently manifest problem behaviors that are not congruent with expectations and rules of the teachers and the school environment. The behavior problems interfere directly with learning and often lead to disciplinary actions, including suspensions, which in turn can hinder achievement.

Every year brings new studies, continued analysis and interpretation, and renewed commitment to initiatives to narrow or close the achievement gap (U.S. Department of Education, 2008), but it remains wide and persistent (Educational Testing Service, 2009). Opinions about what should be done are ample in both public media and academic journals (e.g., Fiscella & Kitzman, 2009; Schemo, 2006). For more than four decades, there has been no consensus about either the cause for the gap or the solution, and scholars today remain deeply divided in positions that often comingle sociopolitical values and scientific views (see, e.g., Murray, 2008; Nisbett, 2009). Although rhetoric

Thanks are due to my colleagues Mona El-Sheikh and Stephen Erath, who read early drafts and offered helpful suggestions. This work was supported by National Science Foundation Grants 0339115 and 0623936.

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and research have been constant and prolific for decades, few new ideas for explaining or changing the achievement gap have appeared in quite some time.

SLEEP, COGNITIVE FUNCTIONING, AND ACADEMIC PERFORMANCE

Neurological Mechanisms

We have long known that in adults, attention, cognition, and memory are significantly impaired after total or partial sleep deprivation (Durmer & Dinges, 2005; Pilcher & Huffcut, 1996). Imaging techniques have recently revealed some primary neurological mechanisms underlying relations between sleep and cognitive functions. Sleep following attempts to learn seems to play a role in the consolidation and strengthening of memory, especially declarative memory (Gais et al., 2007; Walker & Stickgold, 2006). There is evidence that sleep deprivation following a learning task reduces communication between the hippocampus and the prefrontal cortex that ordinarily occurs during sleep, resulting in poorer memory (Born, Rasch, & Gais, 2006). Sleep deprivation before a learning task likewise has been found to have a deleterious effect. Only one night of sleep deprivation can result in impaired learning the following day that is reflected in altered hippocampal activation and functional connectivity with other brain regions (Yoo, Hu, Gujar, Jolesz, & Walker, 2007).

Both slow wave and rapid eye movement (REM) sleep are associated with learning tasks. Slow wave sleep is characterized by slower frequency, high-amplitude EEG (electroencephalogram) waves and occurs early in the sleep period, whereas faster cycling, low-amplitude REM sleep occurs later in the sleep period. By targeted deprivation of sleep stages in adults, investigators have associated REM sleep more with consolidation of emotional and procedural memory and slow wave sleep more with declarative memory (Plihal & Born, 1997). The architecture of sleep changes over the course of the life span, and the decline in percentage of nightly slow wave sleep has been linked with age-related declines in adult declarative memory consolidation (Backhaus et al., 2007). Young children's sleep has large amounts of slow wave sleep compared with that of adults, and this phenomenon is now thought to be related to their high level of neuronal plasticity and potential for rapid learning of new material (Brehmer, Li, Muller, von Oertzen, & Lindenberger, 2007).

Children With No Disorders

Only in recent years has sleep been related to cognitive functioning and academic performance in children who have neither sleep nor cognitive disorders. Reviews of this literature (Buckhalt, Wolfson, & El-Sheikh, 2009; Curcio, Ferrara, & De Gennaro, 2006; Sadeh, 2007) indicate that a number of sleep parameters, including short sleep time, inconsistent sleep and wake schedules, late bedtimes and rise times, and poor sleep quality are all related to a variety of academic outcomes, including lower teacher ratings and grades, and lower scores on achievement tests, narrow tests of cognitive functioning, and comprehensive intelligence tests. More than 30 studies of healthy children with no known sleep or cognitive impairments have taken place, with the majority incorporating cross-sectional correlational designs. These results have been particularly of concern, as national surveys have indicated that children are sleeping fewer hours than pediatric specialists recommend, a trend that is no doubt related to sociocultural changes in lifestyle and technology (National Sleep Foundation, 2004).

Children With Clinical Sleep Disorders

More than 50 studies since 2000 have shown that children who have clinical sleep disorders also have high rates of cognitive and academic impairments (Beebe, 2006; Blunden & Beebe, 2006; Blunden, Lushington, Lorenzen, Martin, & Kennedy, 2005; Halbower & Mahone, 2006). For example, there appears to be a dose-related connection between obstructive sleep apnea in children and numerous neurobehavioral outcomes that may be due to episodic hypoxia and associated sleep fragmentation (Kheirandish & Gozal, 2006). Some evidence also shows that when certain sleep disorders are treated, cognitive performance improves. In a study of children with sleep-disordered breathing, Chervin et al. (2006) reported that adenotonsillectomy resulted in 1-year postsurgery improvements in attention and cognition.

Children With Learning Disorders

Children whose primary diagnosis involves impaired learning and academic achievement have more sleep problems than do typically developing children. Children with attention deficit hyperactivity disorder (ADHD) have atypical sleep in many instances (Cohen-Zion & Ancoli-Israel, 2004; Cortese, Farone, Konofal, & Lecendreux, 2009), and it is becoming clear that some proportion of children diagnosed with ADHD have undiagnosed sleep disorders that are related to, or possibly responsible for, their symptoms. Similarly, children with mental retardation, autism spectrum disorders, and other developmental disorders have high rates of sleep problems (Richdale, Francis, Gavidia-Payne, & Cotton, 2000; Stores & Wiggs, 2001; Williams, Sears, & Allard, 2004).

Longitudinal and Experimental Studies

Researchers are only beginning to conduct longitudinal research to determine whether sleep problems in early childhood have lasting effects on cognitive performance and school achievement, but our own results have shown that the effects of poor sleep in childhood may endure. In a study of 8-year-old children over 2 years, path analyses showed that non-clinical-level sleep problems detracted from later cognitive performance and academic achievement (Buckhalt, El-Sheikh, Keller, & Kelly, 2009). Crucial for verification of direction of effects, a few experimental studies with children have shown that diminished cognitive

performance after sleep is restricted by as little as 1 hr per night (Fallone, Acebo, Seifer, & Carskadon, 2005; Randazzo, Muehlbach, Schweitzer, & Walsh, 1998; Sadeh, Gruber, & Raviv, 2003).

SLEEP, BEHAVIOR PROBLEMS AT SCHOOL, AND ACHIEVEMENT

Success at school depends on more than cognitive functioning. Equally important is having the ability and motivation to behave in compliance with the expectations of the teachers within the constraints of the typical school environment. Children from lower SES families are more likely to engage in behaviors that parents and teachers consider disruptive (Dodge, Pettit, & Bates, 1994; Huaqing Qi & Kaiser, 2003). The precise mechanisms involved in the relationship have been the subject of much inquiry, with much of the speculation involving deficient parenting practices. Parents of lower SES are subject to a greater number and intensity of stressors, which are believed to impair their ability to care as well for their children (Barry, Dunlap, Cotton, Lochman, & Wells, 2005), and studies have noted family disorganization and low expectations (Taylor & Lopez, 2005). In the school setting, lower SES children receive more disciplinary sanctions and are referred to psychologists for behavior disorders evaluation more frequently than their higher SES counterparts (Blair & Scott, 2002; Nelson, Gonzalez, Epstein, & Benner, 2003).

The ability to behave according to expectations and avoid conflict with other children and with teachers has been linked to the construct of emotion regulation. Children who exhibit poor regulation of emotions have lower achievement (Eisenberg, Sadovsky, & Spinard, 2005; Graziano, Reavis, Keane, & Calkins, 2007), and although the issues and interpretations are complex (Raver, 2004), many children from lower SES families have problems with emotion regulation. The relations between sleep, mood, and manifested behavior are well established with adults (e.g., Yoo, Gujar, Hu, Jolesz, & Walker, 2007), with indications that sleep deprivation impairs connectivity between the prefrontal cortex and amygdala. Research with children has been limited in scope, but parental anecdote and available research evidence indicates that when children do not get sufficient, good-quality sleep, they are tired, irritable, emotionally labile, unable to concentrate, and unmotivated to carry out daily tasks (Dahl & Harvey, 2007; Meijer, Habekothe, & van den Wittenboer, 2000). Thus, in addition to direct effects on school achievement via diminished cognitive functioning, emotional dysregulation and low motivation may contribute to low school performance through indirect paths (Meijer, 2008).

Disrupted sleep has been associated with numerous problematic conditions in children, including internalizing problems such as depression and anxiety, and externalizing problems such as conduct disorders (Aronen, Paavonen, Fjallberg, Soininen, & Torronen, 2000; Dahl & Lewin, 2002; Gregory & Eley, 2005; Wolfson & Carskadon, 1998). Children exposed to higher levels of marital conflict and children who show poorer emotional security in family relationships have poorer sleep (El-Sheikh, Buckhalt, Keller, Cummings, & Acebo, 2007; El-Sheikh, Buckhalt, Mize, & Acebo, 2006). Although it is not surprising that children who periodically do not sleep well as a result of a variety of putative problems may show compromised functioning from time to time, children with chronic sleep problems due to exposure to chronic stressors such as those associated with low SES may suffer poor behavioral adjustment and concomitant poor academic achievement over longer periods of time.

SLEEP AND SES

Researchers have discovered significant differences in sleep for groups differing by SES and race. In a review of 30 studies, Durrence and Lichstein (2006) reported that African American adults had rates of sleep-disordered breathing twice that of Euro Americans. Stamatakis, Kaplan, and Roberts (2007) reported that African American and Hispanic adults, and those with less income and education, were more likely than any other American groups to sleep less than 7 hr a night. Using data from the 2004–2007 National Health Interview Survey, Krueger and Friedman (2009) show that being non-Hispanic Black, attaining a low education level, working long hours, and having low financial resources were all risks for short sleep duration. As for children, African American children and those from low-income families have been found to have higher rates of sleep-disordered breathing, shorter sleep times, poorer sleep quality, and more frequent weekend napping (Crosby, LeBourgeois, & Harsh, 2005; Redline et al., 1999; Rosen et al., 2003; Stepanski, Zayyad, Nigro, Lopata, & Basner, 1999).

In our own lab, we have addressed sleep and school performance relations in the context of varying SES and race/ethnicity (African American and Euro American families). To reduce confounding and to allow for separate race/ethnicity and SES analyses, we tested participants from both racial/ethnic groups across a wide range of SES. We assessed sleep with actigraphy, surveys, and sleep diaries, and measured cognitive performance with the Woodcock–Johnson Tests of Cognitive Abilities III (Woodcock, McGrew, & Mather, 2001) and reaction time tasks. In the first wave of a longitudinal study (Buckhalt, El-Sheikh, & Keller, 2007), a primary finding was that SES moderated the relationship between sleep and cognitive performance. When sleep schedules were less variable and sleep quality was high, children from lower and higher SES families performed similarly on cognitive tasks. But when sleep problems were evident, children from lower SES families performed more poorly. Two years later, we again found moderation effects for SES markers, particularly parent education (Buckhalt, El-Sheikh, et al., 2009).

POSSIBLE REASONS FOR LINKS BETWEEN SLEEP AND SES

SES reflects a wide range of circumstances and conditions that may act to amplify or dampen the effects of poor sleep on academic performance. Although lower SES has been related to sleep problems, we know little about which aspects of low SES are influential. Environmental, biomedical, and psychosocial factors have been shown to relate to sleep, and many of these covary with SES. In terms of home environments, homes of low-SES families tend to be relatively small for family size, with fewer bedrooms that more people share. They have less than ideal heating, cooling, and ventilation systems; poor sound insulation; high levels of allergens; and older, lower quality bedding. These conditions, separately and in combination, may affect the amount and quality of children's sleep.

In the biomedical domain, asthma, a medical disorder that is more prevalent among lower SES and African American individuals, has been linked to air quality in neighborhoods and home environments. Children and adults with asthma have higher rates of sleep-disordered breathing (Desager, Nelen, Weyler, & De Backer, 2004). Also in the biomedical realm, overweight and obesity are more prevalent in children with lower SES and have been associated with sleep problems (Redline et al., 1999). Sufficient quality sleep is required for regulation of leptin and ghrelin, which are related to maintenance of weight (Van Cauter et al., 2007). Further, obstruction of the airway due to adipose deposits may be involved in the link (Schwartz et al., 2009).

Children from low-SES families often receive substandard medical care. Children who are sick more often and for longer periods have their sleep disrupted, and sleeping poorly hinders the optimal operation of the immune system. Bidirectional effects between sleep and immune functioning are components of emerging theoretical models showing the central role of sleep in the connections between the immune system, cognition, and mental health (Bryant, Trinder, & Curtis, 2004; Foster & Wulf, 2005; Imeri & Opp, 2009).

In the psychosocial domain, lower SES families are apt to have more chaotic and inconsistent schedules and have more family stressors and insufficient parental monitoring (Evans, Gonnella, Marcynyszyn, Gentile, & Salpekarall, 2005), all of which could feasibly influence sleep habits. Furthermore, factors in these three domains interact. For example, adult smoking, which is more prevalent with lower SES, exposes children to secondhand smoke. A smaller, poorly ventilated house or apartment increases the likelihood and intensity of exposure, which in turn can influence the development of breathing problems that impair sleep. A second example is that parental overweight and obesity may affect children through modeling of eating and exercise patterns, by way of cultural and economic factors in food choices, and by inconsistent monitoring of what and how much children consume. Overconsumption of caffeinated and high-sugar beverages influences sleep directly by their arousing effects (Roehrs & Roth, 2008) and indirectly through weight gain. These are but two examples illustrative of possible links and paths in the manifestation of many problems, including poor achievement at school.

A HYPOTHESIS: SLEEP AND THE ACHIEVEMENT GAP

We offer the foundation we outlined here as support for a new hypothesis: Differences in sleep parameters among children from higher and lower SES families are associated with some portion of the achievement gap. Ample support is now available for one pillar of this hypothesis: Sleep plays a significant role in fundamental cognitive processes underlying academic achievement of all children. The relations between sleep, SES, and race/ethnicity constitute a second pillar of support. Emerging evidence supports a third pillar, a moderating role for SES in the link between sleep and achievement. Insufficient sleep in children from low SES negatively affects them to greater degree than it does more advantaged children. This view is consistent with the idea that when multiple health disparities associated with low SES are present, any single additional stressor has a greater effect (Carter-Pokras & Baquet, 2002). The hypothesis does not imply that sleep is *the* explanation for the gap. Sleep is part of a multisystem dynamic, but if it can be shown to account for any significant part of relations between SES and school performance, there are potentially important implications for enriching theory and formulating interventions.

IMPLICATIONS AND FUTURE DIRECTIONS FOR RESEARCH AND PUBLIC POLICY

Much remains to be learned about the relations between children's sleep and academic achievement. Researchers are only beginning to explore the ways in which individual and group differences in sleep and academic achievement are related. More experimental studies would be helpful, although they are difficult to conduct with children. Large-scale longitudinal studies across ages from infancy to adulthood are needed to examine how sleep is related to different developmental trajectories, to test hypotheses about accumulation of problems with chronically insufficient sleep, and to examine long-term effects of periodic and chronic sleep problems. We need more knowledge about normative patterns of child sleep, and also about clinical versus nonclinical individual differences. Many sleep improvement interventions developed in clinical settings have proven successful with infants, children, and adolescents (Mindell & Owens, 2009), and while reports of interventions in nonclinical settings like schools are fewer and more recent (see review by Buckhalt, Wolfson, et al., 2009), the techniques are applicable to sleep improvement in all children. It has yet to be determined, however, if sleep interventions by themselves or coupled with direct academic interventions will be successful in improving achievement in all children and in narrowing the SES achievement gap.

Improving the various factors and conditions in multiple domains that impair sleep will not be easy, and it will require a multifocused approach. Direct parent education about the importance of children's sleep and how to facilitate better sleep may be effective in some instances, but society-wide primary and secondary prevention approaches such as those applied to improving nutrition and reducing substance abuse will also be necessary. Changes in the home physical environment will require financial solutions, perhaps on the scale of subsidized food and housing. Biomedical interventions such as better screening and treatment for disorders that impair sleep (e.g., tonsillitis, asthma, obstructive sleep apnea) are costly. Similarly, extension of pharmaceutical sleep aids into pediatrics will present many challenges. But even in the face of all of these challenges, sufficient evidence now supports the promise that making children's sleep a priority for prevention and intervention may well reap important and substantial benefits.

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