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WHAT RESEARCH SAYS ABOUT TEENAGERS AND SLEEP

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In the past few years, new scientific research has addressed the sleep needs and patterns of teenagers. Parents and policymakers often assume that teenagers are similar to adults with respect to sleep needs. Research indicates, however, that teenagers require approximately the same amount of sleep as younger children. In addition, teenagers' optimal sleep cycles apparently begin later at night than for younger children.

For example, Mary Carskadon¹ reported in the January 1999 issue of *Phi Delta Kappan* on one study that gets directly to the issue of quantity of sleep. At Stanford University, a longitudinal study examined how much sleep teens need. Boys and girls aged 10-12 were enrolled in the university's "sleep camp" and came to the sleep lab for an assessment each year for five or six years after enrollment. Participants were asked to keep a fixed schedule that included 10 hours of sleep per night during the week preceding camp attendance. For three nights in the clinical environment of the camp, the sleep of these youngsters was measured from 10 p.m. until 8 a.m. Researchers predicted that older youngsters would demonstrate reduced need for sleep, but that was not what happened. Instead, regardless of age or developmental stage, the subjects all slept for about 9.25 of the 10 hours. One conclusion of this experiment was that the need for sleep by adolescents does not decline during puberty.

The Stanford researchers cited by Carskadon also used the Multiple Sleep Latency Test (MSLT) to measure the speed with which subjects fell asleep by engaging in repeated 20-minute trials. In MSLT scoring, a child who stays awake for 20 minutes after preparing to sleep can be considered "alert," while a child who falls asleep within 5 minutes can be considered "excessively sleepy." Throughout the longitudinal study, there was a distinct association between alertness and pubertal development. More mature adolescents showed signs of reduced alertness, even though they slept an amount of sleep equivalent to that of younger subjects. The researchers concluded that adolescents may, indeed, require *more*—not less—sleep than younger individuals. These findings confirm the results of other studies, including animal studies, which indicate that during periods of brain maturation, the quantity of sleep needed increases (cited in Dahl, 1999).

¹ Carskadon is the director of sleep and chronobiology research at E.P. Bradley Hospital in East Providence, R.I. and a professor at Brown University School of Medicine

Despite clinical evidence suggesting that adolescents' need for sleep is similar to or greater than that of younger children, other changes that occur during adolescence also affect sleep. Carskadon and other researchers attribute these changes to modifications in the "biological clock" that regulates certain physiological cycles. Many body functions—temperature, hormonal secretions, and the sleep-wake cycle—appear to fluctuate in highly predictable ways over a period of about 24 hours. These "circadian rhythms" are fairly resistant to being reset, although they will tolerate a certain amount of "stretching" at the price of reduced efficiency.

As youngsters grow older many report an increase in the amount of homework required each night, and some have after-school jobs or engage in sports or other extracurricular activities. To compensate, they may push their homework time later. Meanwhile, parents typically allow teens greater autonomy in setting their own schedules. As a consequence, most teenagers report going to bed relatively late at night.

Analyses indicate that levels of melatonin—a hormone associated with sleep—are especially elevated during sleeping hours. In clinical settings, it has been observed that melatonin production has both a sharp onset and fall-off (Carskadon, 1999). In adolescents, a sharp spike is observed in melatonin levels beginning at about 10 p.m., increasing from 2 picograms to nearly 20 picograms by midnight. Production peaks at about 35 picograms at 3 a.m, with levels remaining elevated until about 7 a.m. By 8 a.m., levels of melatonin drop to their daytime levels, registering under 5 picograms by 9 a.m. *If teenagers, then, are aroused from sleep at 6 a.m. to prepare for a 7:30 start of school, their bodies are still flooded with melatonin, which is associated with sleep. Moreover, teenagers attempting to fall asleep before 10 p.m. are unlikely to be successful. Their bodies are still fully awake, as indicated by the relatively low melatonin levels.*

The indication, then, is that social expectations and norms for teenagers work in direct opposition to the needs of their bodies. At the time when their developing bodies are seeking more sleep, teenagers experience a change in behavior regulation (from parent-imposed regulation to self-imposed regulation), opportunities to stay engaged in waking activities (after-school jobs, extracurricular activities, homework), and social expectations ("older children need less sleep than younger children"). The result is that many teenagers are chronically sleep-deprived, trying to make up for the loss on the weekends, when they can sleep later, or by napping ("dosing off") during the day (Carskadon et al, 1980).

Among the known consequences of insufficient sleep are memory lapses, attention deficits, depressed mood, and slower reaction time. Animal studies have demonstrated that denying sleep can even be fatal. Ronald Dahl, M.D., discusses the consequences of sleep deprivation for teenagers in the January 1999 *Phi Delta Kappan* cited above. Among the consequences that Dahl describes is "tiredness," which he links directly to decreased motivation.

The effects of tiredness are less apparent, Dahl says, when tasks are naturally engaging, exciting or threatening. However, the effects of tiredness are more pronounced for tasks that require motivation to be derived from abstract goals or consequences. Similarly, tasks requiring planning, strategy or complex sequences of activities are more difficult when one is tired. This general category of tasks, Dahl says, involves abstract processing areas in the front of the brain in the pre-frontal cortex. This area of the brain appears to be especially sensitive to sleep deprivation (Dahl cites James A. Horne, 1993.) The fact that many school tasks are precisely like the tasks described

by Dahl suggests that tiredness will have important—and negative—consequences for middle school and high school students.

Dahl also describes emotional changes in teenagers that may be exacerbated by sleep deprivation. While most of the work in this area has focused on children and youth with sleep disorders, a number of on-going research activities measure emotional change or response after varying degrees of sleep or deprivation. The major theme across these studies is greater variability in emotional response following sleep deprivation, with less control over emotional response on the part of teenagers. When confronting a frustrating task, a sleep-deprived youngster is likely to respond in an angry or aggressive way. In response to a humorous task, the same youngster may act more silly than he/she might if less tired. Several adolescents in Dahl's laboratory at Stanford reported increased crying reactions during sad scenes in videotapes they watched while sleep-deprived. While these results are preliminary, Dahl notes that these findings fit within a pattern of similar observations regarding an apparent decrease in ability to control, inhibit or modify emotional responses. Such control over emotion involves regions of the prefrontal cortex of the brain that are similar to those associated with abstract goals.

It can be argued that the research is not yet sufficiently compelling to make any changes. However, it is worth noting that in 1994, the Minnesota Medical Association, after reviewing the research then available, sent letters to every school superintendent in the state urging that high school starting times be set back, to accommodate teenagers' sleep needs. The effects of such action in 17 Minnesota school districts that start high schools later in the day is being studied now. Preliminary results reported by researchers at the University of Minnesota indicate improved student achievement, reduced school tardiness, and better social relations for students in the schools with later start times.

In any case, the research on the physiology of teenagers is both suggestive and consistent: sleep needs do not diminish until well into the teen years, although timing of the onset of sleep does change in significant ways. That research, while still in progress, has begun to link a lack of sleep with specific impacts on the emotional, intellectual, and social lives of teens.

Sources of Further Information

Carskadon, M. A. (1999a). "Sleepy Students Fight the School Clock", *The Education Digest*, 64 (9), 12-14.

Carskadon, M. A. (1999b). "When Worlds Collide: Adolescent Need for Sleep Versus Societal Demands", *Phi Delta Kappan*, 80 (5), 348-353.

Carskadon, M. A. (1990). "Patterns of Sleep and Sleepiness in Adolescents" *Pediatrician*, 1990, 17 5-12.

Carskadon, M. A. (nd). "Adolescent Sleepiness: Increased Risk in a High-Risk Population", *Alcohol, Drugs, and Driving*, 5 (4) and 6 (1).

Carskadon, M. A.; Harvey, K.; Duke, P.; Anders, T.F.; & Dement, W.C. (1980). "Pubertal Changes in Daytime Sleepiness". *Sleep*, 2, 453-460.

- Carskadon, M. A.; Vieira, C.; and Acebo, C. (1993). "Association Between Puberty and DelayedPhase Preference", *Sleep*, 16, 258-262.
- Carskadon, M. A.; Wolfson, A.R.; Tzischinsky, O.; and Acebo, C. (1995). "Early School Schedules Modify Adolescent Sleepiness". *Sleep Research*, 24, 92.
- Cofer, L. F.; Grice, J.W.; Sethre-Hofstad, L.; Radi, C.J; et al. (1999). "Developmental Perspectives on Morningness-Eveningness and Social Interactions", *Human Development*, Jul/Aug 99, 169-198.
- Center for Applied Research and Educational Improvement (CAREI). (1998). *School Start Time Study*. Minneapolis: University of Minnesota, College of Education and Human Development.
- Dahl, R. E. (1999). "The Consequences of Insufficient Sleep for Adolescents: Links Between Sleep and Emotional Regulation", *Phi Delta Kappan*, 80 (5), 354-359.
- Dahl, R. E. and Carskadon, M. A. (1995) "Sleep and Its Disorders in Adolescents". In *Principles and Practice of Sleep Medicine in the Child*, edited by Richard Ferber and Meir H. Kryger. W.B. Saunders Company.
- Horne, J. A. (1993) "Human Sleep, Sleep Loss, and Behavior Implications for the Prefrontal Cortex and Psychiatric Disorder", *British Journal of Psychiatry*, 162, pp. 413-419.
- Kowalski, N. A. & Allen, R. P. (1995). "School Sleep Lag is Less But Persists With a Very Late Starting High School" *Sleep Research*, 24, 124.
- Kubow, P. K., Wahlstrom, K.L., and Bemis, A.E. (1999) "Starting Time and School Life: Reflections from Educators and Students", *Phi Delta Kappan* 80 (5), 366-371.
- Lawton, M. (1995). "Too Little, Too Late", *Education Week*, October 11, 1995.
- North Carolina Department of Public Instruction, Instructional and Accountability Services, Division of Accountability Services, Evaluation Section. (1999). *Report on Delaying the Start of the School Day*. Raleigh, NC: Author.
- Wahlstrom, K. L. (2000). "School Start Time and Teen Sleep", *High School Magazine*, 7 (9), 40ff.
- Wahlstrom, K. L. (1999). "The Prickly Politics of School Starting Times". *Phi Delta Kappan* 80 (5), 345-347.
- Wolfson, A., and Carskadon, M. A. (1996). "Early School Start Times Affect Sleep and Daytime Functioning of Adolescents". Paper presented at annual meeting of the Associated Professional Sleep Societies, May, 1996.
- Wolfson, A., and Carskadon, M. A. (1999). Sleep Schedules and Daytime Functioning in Adolescents *Child Development* 69, 875-87.
- Wrobel, G. D. (1999). "The Impact of School Starting Time on Family Life", *Phi Delta Kappan* 80 (5), 360-364.

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