


*National Center on Sleep Disorders Research
and Office of Prevention, Education, and Control*

WORKING GROUP
REPORT ON
PROBLEM SLEEPINESS





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SLEEPINESS

*NATIONAL INSTITUTES
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INTRODUCTION

Although problem sleepiness and its consequences affect all segments of society to some extent, the working group selected the target audiences of (1) shift workers and (2) adolescents and young adults because there is evidence that the prevalence of problem sleepiness is high and increasing in these groups, with particularly serious consequences. Problem sleepiness in both these target groups and society in general is largely related to lifestyle, and data are strong enough to warrant directing educational messages to these groups.

OVERVIEW OF SLEEPINESS

Defining Sleepiness

Sleepiness reflects a basic biological need state, analogous to hunger or thirst (Dement and Carskadon, 1982). As eating and drinking reverse hunger and thirst, so sleep reverses sleepiness. Like the former, sleepiness occurs in a rhythmic daily pattern. Although sleepiness is physiologically regulated, its specific neurobiological substrates have yet to be identified. No neurochemical or hormonal assay has been identified that will indicate the presence or intensity of sleepiness. But the magnitude of sleepiness can be inferred by how often and how readily sleep onset occurs, how difficult it is to disrupt sleep, and how long sleep endures (Carskadon and Dement, 1987). Sleepiness is most evident when unintended episodes of sleep occur during routine waking activities. Problem sleepiness may be associated with a range of neurobehavioral complaints including difficulty concentrating, memory lapses, loss of energy, lack of initiative, weariness, fatigue, lethargy, and emotional lability (Dinges, 1989b). Although the terms fatigue and sleepiness are often used interchangeably, they should be differentiated. Sleepiness specifically refers to an increased likelihood of falling asleep; fatigue refers to many different conditions, some of which do not necessarily lead to

falling asleep, and can be characterized by increasing difficulty sustaining a high level of performance.

Magnitude of Problem Sleepiness

Sleepiness can be considered problematic when it has a disruptive impact on activities of daily living. The prevalence of problem sleepiness has been estimated in various limited population surveys to be between 0.5 and 5 percent; however, no representative surveys of the U.S. population have thoroughly assessed the prevalence of problem sleepiness (Roth et al., 1994). Moreover, it is not clear that persons with excessive sleepiness fully appreciate the problems it poses. Problem sleepiness can be caused by either lifestyle factors or sleep disorders (Roth et al., 1994). Lifestyle factors include insufficient time in bed, irregular sleep schedule, and use of alcohol and certain medications. Excessive sleepiness can also be caused by sleep disorders such as sleep apnea, narcolepsy, insomnia, and restless legs syndrome (Guilleminault and Carskadon, 1977). Problem sleepiness in the U.S. population is more likely to be due to lifestyle factors than to specific sleep disorders.

Sleepiness Caused by Sleep Need

Problem sleepiness due to lifestyle factors develops when an insufficient daily amount of sleep is obtained relative to an individual's required biological sleep need and/or when wakefulness is required at a time when the body expects sleep. Biological sleep need is a hypothetical construct that reflects the amount of daily sleep an individual needs to be fully alert during wakefulness (Webb and Agnew, 1975). Biological sleep needs vary among people, across the lifespan, and probably in response to various physiological challenges such as viral infections. These factors make it difficult to identify the specific amount of sleep an individual needs. Sleep need is probably normally distributed, although definitive scientific data are lacking. However, empirical evidence shows that when adults are allowed to sleep without restriction, the average time slept is

8 to 8.5 hours (Roehrs et al., 1989, 1996; Wehr et al., 1993). When daily sleep time is reduced relative to an individual's sleep need, a hypothetical "sleep debt" develops. Even relatively modest daily reductions of sleep time (e.g., 1 to 2 hours) can accumulate across days to induce a sleep debt, and if the debt becomes too great, it can lead to cumulative problem sleepiness (Carskadon and Dement, 1982). Although a sleep debt and cumulative sleepiness may not be perceived by an individual, the resulting deficits can be quite problematic.

Sleepiness Caused by the Biological Clock

Sleepiness and wakefulness also have a daily cycle, referred to as a circadian rhythm (Wever, 1979). This basic biological rhythm is controlled within the brain by a neural system called the biological clock, which is sensitive to daylight and darkness but is slow to adjust to changes in routine. In general, sleepiness is greatest during darkness, especially late at night, and alertness is optimal during daylight, although a secondary period of increased sleepiness occurs over the midafternoon (Roth et al., 1994). The biological clock makes it difficult for people to sleep during the day and to remain awake during the night (Monk, 1991; Dinges, 1989a). Thus, regardless of the amount of prior sleep, sleepiness increases in the early morning hours (in general, between 12 a.m. and 7 a.m.), and regardless of how long one has been awake, sleepiness is reduced during the early evening hours (in general, between 6 p.m. and 11 p.m.).

Effects of Problem Sleepiness

The disruptive impact of problem sleepiness on health and daily living is beginning to be appreciated. Higher rates of automobile crashes among patients with sleep disorders have been consistently reported, and laboratory assessments of simulated driving by patients have clearly shown impairment and its reversal with successful treatment (Pack et al., 1995; Roth et al., 1995a). In several studies, standardized neurocognitive assessments of patients with sleep

disorders have shown deficits in psychomotor and cognitive performance that are reversed with treatment (Roth et al., 1995a).

The distribution of automobile accidents related to drowsiness in the general population across the 24-hour day is highly consistent with what is known about the circadian profile of sleepiness (Mitler et al., 1988). The extensive literature on the effects of sleep deprivation and sleep restriction in healthy people, as determined by laboratory-based performance measures, clearly documents a range of neurobehavioral performance deficits that accompany problem sleepiness (Bonnet, 1994; Dinges and Kribbs, 1991). The performance disruption of the "sleepy" healthy individual can include difficulty sustaining attention, slowed responses, difficulty remembering recent information, and problems maintaining a stable level of performance. Such disruption can result in errors and accidents, including automobile crashes. Although rarely systematically investigated in the laboratory, negative mood states and emotional lability also may accompany problem sleepiness, as indicated by everyday experience and anecdotal reports from laboratory and field studies (Dinges and Kribbs, 1991; Monk, 1991). Finally, very little information is available on the impact of problem sleepiness on physical health and longevity, although studies of the effects of sleep deprivation on human immune functioning are beginning to appear in the scientific literature.

Reversing Sleepiness

Problem sleepiness resulting from accumulated sleep debt can be reversed in healthy persons when sleep time is increased and sleep disruptions are reduced (Roehrs et al., 1989, 1996). However, a single night of extended sleep may not be enough for full reversal. Daily sleep time can be increased by lengthening nocturnal time in bed, preferably by moving to gradually earlier bedtimes. It can also be increased by daytime napping, optimally over the midafternoon during the usual circadian rise in sleepiness. It is

preferable that naps not occur within approximately 4 hours of the usual nocturnal bedtime, because they can disrupt subsequent nocturnal sleep (Dinges and Broughton, 1989; Dinges, 1995). Naps have been shown to reduce sleepiness, but naps shorter than 15 minutes have not been systematically studied. Sleep continuity can be improved by correcting environmental factors that disrupt sleep (i.e., light, noise, temperature), by establishing a consistent nightly sleep schedule, and by scheduling sleep in phase with circadian rhythms and the light-dark cycle. Properly timed exposure to bright light and darkness can be effective in improving sleep that is disrupted by circadian displacement such as occurs with transmeridian travel (jet lag) and shift work (Campbell et al., 1993).

Medications for Sleep and Sleepiness

No chemical or pharmaceutical agent can permanently substitute for sleep or completely reverse problem sleepiness. Direct reversal of problem sleepiness with caffeine, a widely used stimulant, has very limited short-term potential as tolerance develops rapidly. Medications have a limited role in increasing sleep time, improving sleep continuity, or directly reversing sleepiness. The effectiveness of short-term use of standard hypnotics to increase sleep time and sleep continuity has been well described (Roth et al., 1995b), but whether they can be used chronically and the extent to which they improve problem sleepiness and fatigue remain controversial.

SHIFT WORKERS

Introduction

The term “shift work” describes regular employment (full-time or part-time) that occurs outside the conventional 7 a.m. to 7 p.m. window in which “day work” occurs. A number of factors in our society are leading to more shift work. First, capital equipment is becoming more expensive and requires around-the-clock usage to cover the costs of depreciation. Second, the service sector is

rapidly moving toward the provision of around-the-clock services, particularly in the banking, retail, and restaurant industries. Third, because of the high costs of recruitment, training, and fringe benefits, employers are maintaining the same number of employees, even when the demand for their product increases. Fourth, in an era of shrinking real wages, many Americans are working longer hours and taking second jobs to maintain their standard of living.

Magnitude of Problem Sleepiness

Among Shift Workers

Approximately 20 to 25 percent of the working population is involved in some form of shift work. This translates to about 20 million Americans; about 2 million people work the night shift and 3.1 million work rotating shifts (U.S. Congress, OTA, 1991). Survey studies of shift workers (Colligan and Tepas, 1986) indicate that they report an average of about 1 hour less sleep per 24 hours (i.e., about 7 hours less sleep per week) than their day-working counterparts. However, electroencephalographic studies suggest that sleep is reduced even more—by 2 or more hours per day (Torsvall et al., 1989). The sleep reduction is worse for those working night shifts (Colligan and Tepas, 1986), for day shift workers starting early in the morning (Kecklund et al., 1994), for older workers, and for female shift workers with children living at home (Gadbois, 1981). Afternoon shift workers appear to obtain the most sleep.

No definitive studies have been done on the precise prevalence of problem sleepiness among shift workers, but in survey studies, about 60 to 70 percent of shift workers complain of sleep difficulty or problem sleepiness (Rutenfranz et al., 1985; Åkerstedt and Gillberg, 1981).

Physiological measures during simulated late night shift hours indicate a degree of sleepiness that is considered severe and clinically pathological when present during the day (Walsh et al., 1991). Clearly, excessive sleepiness is a major problem for shift workers, especially night shift

workers (Åkerstedt, 1995). Much more research is needed to ascertain the precise magnitude of the problem.

Causes of Problem Sleepiness in Shift Workers

Sleepiness from shift work schedules is related not only to insufficient sleep, but also to the displaced timing of sleep and wakefulness. The human species is diurnal (day oriented). The human circadian system is specifically designed to prepare the body and mind for restful sleep at night and active wakefulness during the day. Thus, there are sound physiological reasons why sleep during daylight hours might be difficult and why active wakefulness is hard to maintain during the night hours, even in those who are well rested (Monk et al., 1996). Circadian rhythms in body temperature, plasma cortisol, and plasma melatonin are all slow to adjust to an abrupt change in routine (Åkerstedt, 1985), particularly to one involving night work where the opposing time cues (zeitgebers) of daylight and darkness have to be overcome. Indeed, full nocturnal adjustment rarely occurs, even in those working permanent night shifts (Åkerstedt, 1985; Czeisler and Dijk, 1995).

It should be borne in mind that biological forces do not represent the only cause of problem sleepiness in shift workers. Human society is also day oriented, and although strong taboos are in place to protect the night sleep of day workers, no equivalent taboos protect the day sleep of night shift workers. Shift workers are often required to sleep in more noisy surroundings and to have demands made on their sleep that do not occur at night for a day-working individual. Thus, strong social and domestic pressures (Walker, 1985; Knauth and Costa, 1996) disrupt the shift worker's sleep in addition to the circadian difficulties. Individual differences, such as age and possibly circadian phase type (morningness-eveningness), also play a role (Härmä, 1995).

In conclusion, problem sleepiness in shift workers is due to both sleep reductions and nighttime working. These come about by the failure of the

(unadjusted) circadian system to prepare shift workers for a restful, uninterrupted bout of refreshing sleep, and the problem is amplified by the demands and distractions of a day-oriented society. Even in those whose sleep is adequate, however, sleepiness will still occur during the night shift and on the drive home from evening shifts because of the natural cycles of sleepiness driven by the circadian system or daily biological clock. Whatever countermeasures are used to improve sleep, sleepiness from this latter cause will be present until the usually slow process of resetting the timing of the clock occurs.

Consequences of Problem Sleepiness for Shift Workers

As several authors have remarked (reviewed in Monk and Folkard, 1992), shift work can be viewed as a stressor, inducing strain in the worker. This strain may itself contribute to the health problems associated with shift work, including gastrointestinal disorders and cardiovascular disease (Scott and LaDou, 1990). Problem sleepiness is but one of these strains, and there are insufficient studies to properly discern how much of the detrimental effects of shift work can be attributed specifically to problem sleepiness. Undoubtedly, though, problem sleepiness is a major component.

The major consequences of problem sleepiness for shift workers are impairment of life quality (Walker, 1985; Koller et al., 1978), a reduction in productivity (Wojtczak-Jaroszowa and Pawlowska-Skyba, 1967), and a potential increase in the risk of accident and injury (Dinges, 1995; Monk et al., 1996). Regarding life quality, shift work has been shown to be associated with increases in neurotic symptoms (Meers et al., 1978), in alcohol and sleeping pill use (Gordon et al., 1985), and in divorce (White and Keith, 1990). Additionally, there are several survey studies and anecdotal reports of shift workers feeling that they live their lives "like zombies" (Monk and Folkard, 1992). Regarding productivity, comparisons are not always easy,

because the tasks often differ between day and night, but in some (but not all) studies of actual on-the-job performance, night performance has been shown to be slower or less accurate (Tilley et al., 1982; Vidacek et al., 1986; Monk et al., 1996). In some cases, this performance decrement can be attributed to intrusive sleep episodes (Åkerstedt, 1988).

Regarding safety, the smaller number of persons present in the workplace at night may make comparisons difficult, but when this is factored out or controlled, a nocturnal increase in work accidents has been documented, at least for motor vehicle crashes (Dinges, 1995). Accidents at night also appear to be more severe than those occurring during the day (Smith et al., 1994; Pack et al., 1995). Anecdotally, there have been a number of high-profile incidents, including "Three Mile Island," "Space Shuttle Challenger," and "Exxon Valdez," where performance failures by shift workers have been implicated as a contributory factor (Mitler et al., 1988). For most shift workers, however, the main exposure to increased risk from problem sleepiness occurs on the commute home. Richardson et al. (1990) found that one in five shift workers reported a traffic accident or a "near miss" due to sleepiness on the drive home from work during the preceding 12 months. A recent focus group study of shift workers in the Cleveland area found that an accident or near miss was reported by all but 2 of the 45 respondents; of those 2, 1 had a commute time of only 15 minutes and the other carpooled (Novak and Auvil-Novak, 1995). This pattern was also confirmed in a survey study for New York State (New York State Task Force, 1994), which showed rotating shift workers to have a drowsy-driving rate nearly double that of steady shift workers.

Countermeasures for Shift Worker Sleepiness

As noted above, the problem of shift work sleepiness is a multifaceted one, resulting from work-related, social, and biological issues. Not surprisingly, therefore, solutions also need to be multi-

faceted. There is no single "magic bullet" by which shift worker sleepiness can be eliminated. The evidence of success for any single countermeasure is limited, owing to few controlled studies. From a work-related point of view, a reduction in the amount of night work required, an increase in ambient illumination at work (coupled with bedroom blackouts and goggles), and a change in the speed and direction of rotation (Knauth, 1995; Czeisler et al., 1990; Eastman, 1987; Czeisler et al., 1982) suggest benefits, although better controlled studies are needed. From a social and domestic perspective, there is consensus that education strategies for shift workers can be helpful, but there is little empirical evidence for their effectiveness. Regular night shifts, however, have been shown to be more easily coped with than irregular ones, probably because of the individual's ability to organize better his or her life and sleep schedule. From a biological perspective, regulation of exposure to sunlight and artificial light (Czeisler and Dijk, 1995), napping (Rosekind et al., 1995), caffeine to promote alertness at night and sleeping pills to help daytime sleep (Walsh et al., 1995), and melatonin to adjust circadian rhythms (Arendt et al., 1995) have all been shown to be helpful in limited studies. Again, however, the evidence is in need of replication and adaptation to other real-world situations.

There is a growing cultural recognition of problem sleepiness in shift workers, evident in media coverage and Federal and private initiatives (especially in transportation sectors). Programs are being developed to "manage" fatigue and alertness associated with shift work, but to date, many of these efforts are inadequately grounded in scientific data. The next decade will be a critical period for establishing the database and process by which problem sleepiness is prevented or managed in shift workers whose sleepiness-related mistakes can lead to catastrophic outcomes for themselves and others.

ADOLESCENTS AND YOUNG ADULTS

Introduction

Adolescence and young adulthood refer to the transitions from early pubertal maturation through the establishment of adult roles in society. Recent human history has witnessed a dramatic lengthening of this interval, as puberty has been occurring at earlier ages while the assumption of adult roles in society (careers and parenthood) is often delayed for longer periods of formal education. Although any single definition is somewhat arbitrary, for purposes of this document, adolescence will cover the span from age 12 years through formal education (high school or college). Young adulthood will include the period from the completion of high school or college through the establishment of adult roles and responsibilities. Together, these periods span (roughly) from age 12 to 25 years.

This interval encompasses a critical period of development for many aspects of life, including careers, interpersonal relationships, and many lifestyle habits likely to affect health, well-being, and productivity across the lifespan.

Magnitude of Problem Sleepiness Among Adolescents and Young Adults

Although few large-scale epidemiologic studies of daytime sleepiness in adolescents and young adults have been performed, existing data indicate that problem sleepiness currently affects a significant percentage of youths. For example, Carskadon and colleagues (1989a) found that 20 to 25 percent of 3,100 9th- through 12th-grade students reported experiencing every week behaviors associated with problem sleepiness, such as difficulty getting up for school, falling asleep in school, or struggling to stay awake while doing homework. Swiss researchers Strauch and Meier (1988) found that 54 to 75 percent of adolescents and young adults expressed a "wish for more sleep," and this wish was coupled with reports of morning tiredness. A New Zealand group similarly reported that 25 percent of 15-year-old youngsters (N = 943)

reported that they need more sleep (Morrison et al., 1992). In a survey of U.S. high school students completed in 1994, 26 percent of students reported that they sleep less than 6.5 hours on school nights, while only 15 percent reported sleeping 8.5 hours or longer (Wolfson and Carskadon, 1996). Together, these data indicate a widespread adolescent pattern of inadequate sleep and consequent problem sleepiness.

Causes of Problem Sleepiness in

Adolescents and Young Adults

Problem sleepiness in adolescents is most commonly associated with problem sleep patterns. A number of factors affect sleep patterns of adolescents and young adults. These factors include the adolescent's biological status and behavioral preferences, parent-child negotiations, and changing school schedules. Relationships among biological and psychosocial factors affecting sleep patterns can be complex. An overview of these factors is useful. In the psychosocial/behavioral realm, adolescent sleep is affected by a number of sources, often in competing ways. Parents, for example, commonly retreat from their role of setting bedtime limits and become more involved in serving a morning alarm clock function (Carskadon, 1990a). Simultaneously, peer relationships begin to encourage later bedtimes through social expectations and opportunities. Academic obligations may require additional school work at night but often require an earlier start to the school day (Allen, 1991). Finally, as teenagers enter the job market, employment can contribute to changing sleep patterns by pushing bedtime later to accommodate evening work hours or by nudging wake-up time earlier if jobs begin before school (Carskadon, 1990a). Students involved in sports also often encounter changes in sleep patterns due to a team's practice schedule. These behavioral and environmental factors have a clear impact on adolescents' sleep schedules (Carskadon, 1990a).

Young adults in the workplace or in college face added psychosocial/behavioral pressures that affect sleep. Many young people leaving home

for the first time to go to college find themselves experiencing a new cultural imperative to delay sleep. In one survey that followed U.S. students over this transition, the average delay of bedtime and rise time between the high school and college years was 2 hours, reflecting a shift to an evening phase preference (Carskadon and Davis, 1989). On the other hand, Ishihara et al. (1990) found no difference in circadian phase preference between junior high school and university students in Japan. Virtually no formal research has been done to examine the sleep patterns of working adolescents and young adults who are not in school. Thus, it is difficult to determine the extent to which young people adjust sleep patterns when they join the full-time work force.

Biological factors in adolescence and young adulthood also play a role but are less well described. One longitudinal laboratory-based study of adolescent sleep demonstrated that sleep need does not appear to decline across adolescence. Youngsters given a consistent 10-hour opportunity for sleep showed no significant changes in nocturnal sleep length (Carskadon et al., 1980). From age 10 to age 17, the average time asleep was approximately 9.2 hours, with older teens requiring wake-up by laboratory staff. One interpretation of these data is that older teens may need even more than 9.2 hours of sleep per night.

A number of surveys of teenagers' sleep patterns indicate that many youngsters begin to exhibit a delay in the preferred time for sleep during pubertal development, i.e., they enjoy staying up later and sleeping in later (Ishihara et al., 1990; Andrade et al., 1992; Carskadon et al., 1993). Recent data indicate that regulation of the circadian timing system may change during pubertal development and contribute to delayed timing (Carskadon et al., 1996). This type of sleep phase delay is in direct conflict with early school starting times, which form an uncontrollable and nonnegotiable aspect of a child's daily program. Youngsters faced with a lengthy commute to school have an even more difficult schedule

problem. Oversleeping during the school week is not a legitimate option for adolescents, and early bedtimes may not be achievable for adolescents at the dawning of the 21st century due to biological and psychosocial impediments.

Whether sleep regulatory processes also change during adolescence is not clear; however, one study found more daytime sleepiness at midpuberty even though the amount of sleep at night did not change (Carskadon et al., 1980). Another fundamental property of the sleep-wake system having a known relationship to problem sleepiness gives some insights into the physiological inevitabilities facing adolescents with short sleep: when sleep is restricted over a series of nights, a cumulative decline in waking alertness follows (Carskadon and Dement, 1981). Several studies have also shown an association between problem sleepiness and irregular sleep patterns, such as those commonly experienced by teenagers and young adults who have short sleep and early rise times on school days and delayed and lengthened sleep on weekends (Billiard et al., 1987; Manber et al., 1996).

In summary, both biological and psychosocial factors contribute to problem sleepiness in adolescents and young adults. The primary factor underlying most problem sleepiness in adolescents is the pattern of insufficient, irregular, and poorly timed sleep. Individual differences in a teenager's sleep requirement and capacity to tolerate insufficient sleep may also contribute to the development of problem sleepiness.

Consequences of Problem Sleepiness for Adolescents and Young Adults

The consequences of problem sleepiness in adolescents and young adults, if at times quite subtle, are also very real. At the extreme, a state of "morbid" sleepiness occurs and is associated with performance failures and lapses, which can have an unfavorable impact on learning and a catastrophic impact on such activities as automobile driving. For example, a study of all fall-asleep auto crashes in North Carolina in 1990, 1991,

and 1992 showed that in 55 percent of the 4,333 crashes the drivers were 25 years of age or younger and predominantly male (Pack et al., 1995). Such crashes in young people occurred mainly in the nocturnal hours.

Although studies are largely correlational and based on student self-report, poorer grades have been associated with short nocturnal sleep lengths (Allen, 1992; Link and Ancoli-Israel, 1995; Manber et al., 1995; Wolfson and Carskadon, 1996), with an implicit assumption that problem sleepiness is a mediating variable. The sleepy teenager potentially may be at greater risk to abuse caffeine, nicotine, and alcohol (Carskadon, 1990a). Risks of alcohol use in sleepy teenagers, such as those working 20 hours or more per week, are heightened in the teenagers who have begun to drive (Carskadon, 1990b). One survey noted that approximately 60 percent of college-age respondents (N = 182) had driven while impaired by excessive sleepiness compared with about 15 to 20 percent reporting driving while impaired by alcohol (Carskadon, 1994).

It also appears that insufficient sleep affects mood, attention, and behavior in teenagers. For example, a study of 9th- through 12th-grade boys under conditions of sleep restriction found evidence of depressive mood during the sleep restriction (Carskadon et al., 1989b). Mood changes associated with insufficient sleep were also indicated by correlations between total sleep time and scores on anxiety and depression scales in a group of 581 college-bound high school seniors (Carskadon et al., 1991). While definitive data are not yet available to determine whether sleepiness causes mood disturbances or vice versa, the two phenomena seem to be closely linked across many studies. If, as it appears, inadequate sleep impairs mood, concentration, and control of some behaviors, such changes may interfere with a youngster's ability to cope with daily stressors and emotional challenges, which are prominent in the lives of many adolescents. One major concern in this area is the likelihood that social competence and peer interactions

(major issues of successful adolescence) are likely to be impaired by deficits in mood, attention, and behavioral control as a consequence of chronically insufficient sleep among teenagers.

Countermeasures for Problem Sleepiness in Adolescents and Young Adults

Effective countermeasures in this age group probably will require a multifaceted approach. The most obvious need is to increase the total amount of sleep in teenagers and young adults. Strategies that may be useful include greater attempts to provide a consistent message regarding the obligatory nature of sleep and the importance of adequate sleep for optimal functioning and well-being. In other words, educational efforts focused toward children, parents, educators, and health care professionals may eventually propel a cultural realignment that puts a positive premium on healthy sleep. Given the impact of the starting time of school on sleep patterns of teens, a number of investigators and clinical groups have suggested that daily classes begin later for adolescents. The Medical Association of the State of Minnesota, for example, passed a set of resolutions encouraging educators to examine the issue and to avoid moving school start time earlier (Minnesota Medical Association, 1993, 1994). To date, however, efforts have begun in only a few areas to delay school start time for adolescents, thus reducing the burden for youngsters to arise so early in the morning. It would be valuable to monitor these efforts and their impact on adolescent problem sleepiness.

The delayed pattern for sleeping in many teenagers and young adults contributes to the problem of insufficient sleep, and techniques that alter sleep timing through changes mediated by the fundamental circadian regulatory processes might be useful. Thus, for example, students might benefit from bright light in the morning and from reduced light exposure in the evening, although more research is needed on the dosage and the practical application of such approaches. Use of melatonin to produce circadian phase shifts in adolescents cannot yet be suggested, since the

effects of exogenous melatonin on reproduction are complex and the effects on maturation are unknown, even if the circadian phase-shifting effects were proved. Efforts to regulate sleep patterns using behavioral methods may have a positive impact. For example, one recent study in college students showed moderate improvement with a pattern that resulted in more regular times for sleeping (Manber et al., 1996).

CONCLUSION

Problem sleepiness engendered by lifestyle can affect many segments of society, especially adolescents, young adults, and shift workers.

Particularly serious are the widespread incidence of problem sleepiness in these target groups and the adverse effects on neurobehavioral functions, emotional lability, and safety while driving and working. Data reviewed from studies of these adverse outcomes in each of the target groups strongly support the need for educational messages directed at these groups.

Shift work is performed by millions of Americans. Studies reveal that sleep difficulties and problem sleepiness are highly prevalent complaints in this population, especially among those persons exposed to night shift work. The causes of problem sleepiness in shift workers relate to the displaced timing of sleep and wakefulness. The working group reviewed studies indicating that the consequences of problem sleepiness in shift workers include reduced productivity, increased risk of accidents, emotional and psychosocial distress, and a general decline in quality of life. Night shift workers are especially at risk for drowsy driving-related crashes. Although there have been relatively few controlled studies of potential countermeasures for problem sleepiness in shift workers, a multifaceted approach involving education, better scheduling, control of light exposure, and napping has promise.

The working group also reviewed evidence that problem sleepiness adversely affects a significant

proportion of youths in the period of development from adolescence through young adulthood. Studies suggest that the primary causes of the problem generally stem from insufficient, irregular, and poorly timed sleep, resulting from a complex interaction between psychosocial factors and biological forces. These include sleep loss engendered by progressively later bedtimes combined with progressively earlier wake times for school and work. These behavioral restrictions of sleep often become worse from prepubescence to young adulthood, despite little or no change in the biological need for sleep across these ages. Although more studies are needed, there is ample evidence to suggest that the consequences of problem sleepiness in adolescents and young adults are serious but often underappreciated by both the target group itself and the culture at large. Significant among the adverse outcomes are studies showing that problem sleepiness can lead to degraded school performance, emotional stress, alcohol and drug abuse, and a disturbingly high rate of fatal motor vehicle crashes in older adolescent and young adult males. Although studies of countermeasures for problem sleepiness in this target group are rare, the working group concluded that a multifaceted approach would be necessary, beginning with a major educational program on the causes, consequences, and prevention of problem sleepiness.

Finally, the well-established relationship between sleepiness, health, and safety makes it clear that additional research is needed on the neurobiology, genetics, epidemiology, and neurobehavioral and functional consequences of sleepiness. Because virtually all segments of society are potentially affected by problem sleepiness, educational messages based on research about its causes and consequences are essential for improving the health, safety, and productivity of Americans. This document reports what is currently known about sleepiness, and at the same time, it serves to identify those areas of sleepiness that are not well defined or are in need of further scientific research.

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