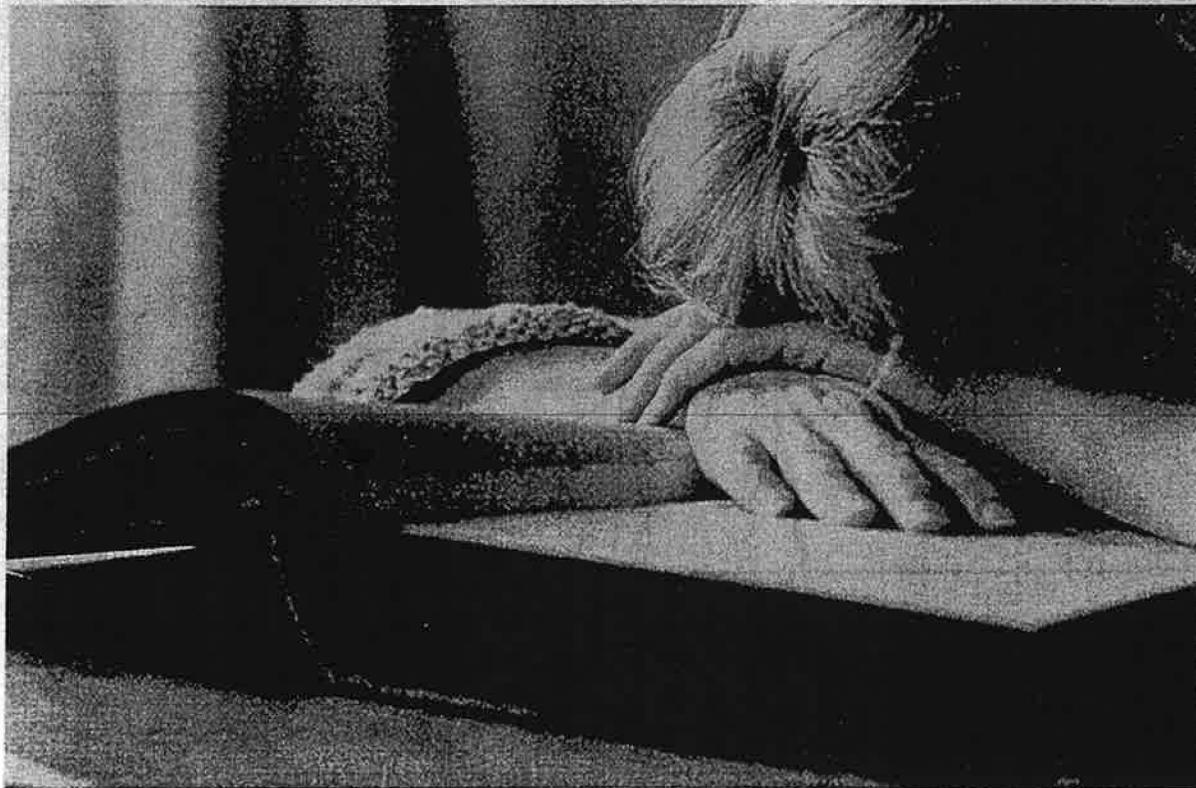

ADOLESCENT

Research Report

SLEEP NEEDS

and Resource Guide

AND PATTERNS



PUBLISHED BY THE NATIONAL SLEEP FOUNDATION

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Table of Contents

| | |
|--|-----------|
| Preface | i |
| PART ONE: Research Report | 1 |
| Introduction | 1 |
| Physiological Patterns | 2 |
| Behavioral and Psychosocial Patterns..... | 2 |
| Consequences of Poor Sleep in Adolescents | 3 |
| What Can Be Done | 4 |
| References | 7 |
| PART TWO: Resource Guide | 11 |
| Pointers for Parents | 11 |
| Tips for Teens | 13 |
| Become a sleep-smart trendsetter | 13 |
| High School Start Times | 14 |
| Summary of Findings..... | 14 |
| Factors to Consider | 15 |
| References..... | 18 |
| The Z's to A's Act | 19 |
| Drowsy Driving Fact Sheet | 20 |
| Who Is Most At Risk?..... | 20 |
| What Are Effective Countermeasures? | 21 |
| Minnesota Medical Association Resolutions: Models for Change | 22 |
| School Start Times..... | 22 |
| Drowsy Driving | 22 |
| American Medical Association House Of Delegates Resolution 418: Sleepy Driving | 23 |
| Other Resources | 24 |
| Organizations..... | 24 |
| Web Resources..... | 26 |

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Preface

The National Institutes of Health (NIH) have identified adolescents and young adults (ages 12 to 25 years) as a population at high risk for problem sleepiness based on "evidence that the prevalence of problem sleepiness is high and increasing with particularly serious consequences." (NIH, 1997) This designation evolved from a Working Group on Problem Sleepiness convened in 1997 by NIH's National Center on Sleep Disorders Research and the Office of Prevention, Education, and Control. The group concluded that steps must be taken to reduce the risks associated with problem sleepiness.

*What are these risks? The most troubling consequences of sleepiness are injuries and deaths related to lapses in attention and delayed response times at critical moments, such as while driving. Drowsiness or fatigue has been identified as a principle cause in at least 100,000 police-reported traffic crashes each year, killing more than 1,500 Americans and injuring another 71,000, according to the National Highway Traffic Safety Administration (NHTSA, 1994). **Young drivers age 25 or under cause more than one-half of fall-asleep crashes.***

The National Sleep Foundation's (NSF) Sleep And Teens Task Force developed this publication to summarize existing research about sleep-related issues affecting adolescents. We hope that this report will serve as a valuable and practical resource for parents, educators, community leaders, adolescents and others in their efforts to make informed decisions regarding health, safety and sleep-related issues within their communities.

A nonprofit, private organization, NSF is a leader in public education efforts regarding the risks associated with drowsy driving and other issues related to sleepiness and sleep loss. We welcome your comments about this document and your suggestions for expanding public awareness and supporting positive changes to protect the safety and well-being of our nation's youth.

For more information, and an online copy of this report please visit NSF's Web site at www.sleepfoundation.org. The Foundation can also be reached by e-mail at nspf@sleepfoundation.org; phone (202) 347-3471; or fax (202) 347-3472. NSF's address is 1522 K Street, NW, Suite 500, Washington, DC 20005.

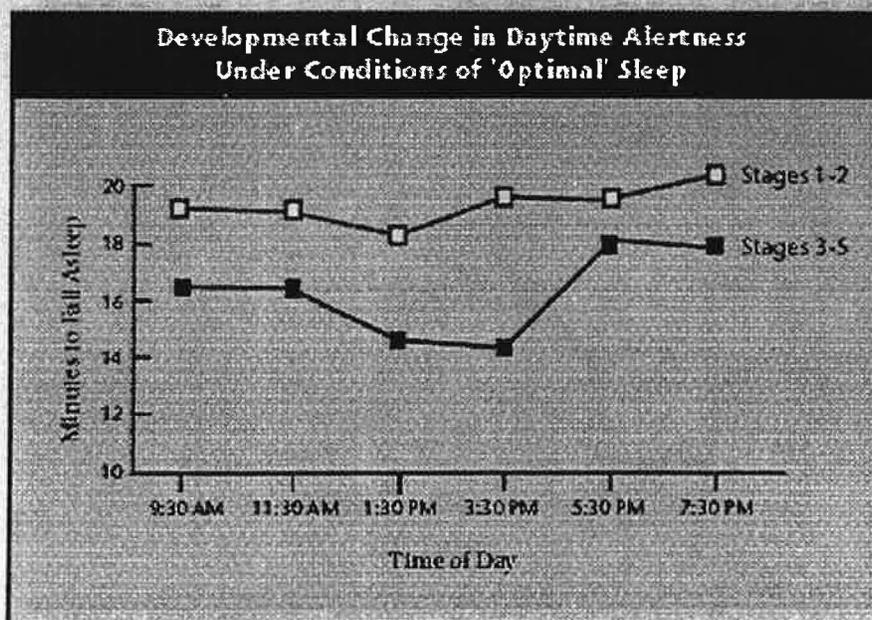
PART ONE

Research Report

Introduction

Sleep is a basic drive of nature. Sufficient sleep helps us think more clearly, complete complex tasks better and more consistently and enjoy everyday life more fully. Although many questions regarding the role of sleep remain unanswered, scientific studies have shown that sleep contributes significantly to several important cognitive, emotional and performance-related functions.

Sleep is, in essence, food for the brain, and *insufficient* sleep can be harmful, even life-threatening. When hungry for sleep, the brain becomes relentless in its quest to satisfy its need and will cause feelings of "sleepiness," decreased levels of alertness or concentration, and, in many cases, unanticipated



Pubertal development is categorized in five stages based upon the occurrence of visible signs of physical maturation, with stage 1 being pre-pubertal, stage 2 early pubertal, and so forth. Stage 5 indicates physical maturity of the secondary sexual characteristics. The first signs of puberty (stage 2) in US children usually begin at about ages 8 to 13 years in girls and 9 to 14 years in boys. Full maturation generally takes about 4 to 5 years to occur after the first signs are seen. A longitudinal study found that when allowed to sleep up to 10 hours a night, adolescents were sleepier during the day when more physically mature (Stages 3, 4, or 5) than when at the early stages of puberty. (Note: in this particular study, the youngest children were 10 years old.)

sleep. Excessive sleepiness is also associated with reduced short-term memory and learning ability, negative mood, inconsistent performance, poor productivity and loss of some forms of behavioral control (NIH, 1997).

Researchers have identified several changes in sleep patterns, sleep/wake systems and circadian timing systems associated with puberty. (Carskadon, 1999) These changes contribute to excessive sleepiness that has a negative impact on daytime functioning in adolescents, including increasing their risk of injury. (Wolfson and Carskadon, 1998) Findings are similar in North America and in industrialized countries on other continents. (Carskadon, 1999)

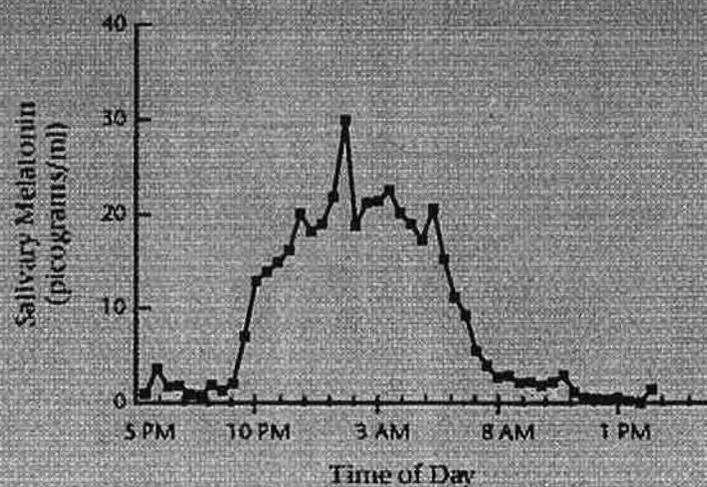
Scientists hypothesize that these sleep-related problems are due largely to conflicts between physiologically-driven sleep needs and patterns, and behavioral and psychosocial factors that influence sleep habits.

Key changes in sleep patterns and needs that are associated with puberty include:

PHYSIOLOGICAL PATTERNS

- **Adolescents require at least as much sleep** as they did as pre-adolescents (in general, 8.5 to 9.25 hours each night). (Carskadon et al., 1980)
- **Daytime sleepiness increases** — for some, to pathological levels — even when an adolescent's schedule provides for optimal amounts of sleep. (Carskadon, Vieri, Acebo, 1993)
- **Adolescents' sleep patterns undergo a phase delay**, that is, a tendency toward later times, for both sleeping and waking. Studies show that the typical high school student's natural time to fall asleep is 11:00 pm or later. (Wolfson and Carskadon, 1998)

Melatonin Secretion to Measure Circadian Timing



Melatonin secretion is a key indicator of the biological (circadian) timing system, in humans and other animals.

This graph illustrates levels of melatonin as secreted in the saliva of adolescents adjusting to a strict 10 pm bedtime and 8 am wake time.

BEHAVIORAL AND PSYCHOSOCIAL PATTERNS

- **Many U.S. adolescents do not get enough sleep**, especially during the week. Survey data show that average total sleep time during the school week decreases from 7 hours, 42 minutes in 13 year olds to 7 hours, 4 minutes in 19 year olds. (Wolfson and Carskadon, 1998) Only 15 percent of adolescents reported sleeping 8.5 or more hours on school nights, and 26 percent of students reported typically sleeping 6.5 hours or less each school night.
- **Adolescents have irregular sleep patterns**; in particular, their weekend sleep schedules are much different than their weekday schedules, to some extent as a direct consequence of weekday sleep loss. These differences include both the quantity and the timing of sleep. One study of more than 3,000 adolescents showed that the average increase of weekend over weekday sleep across ages 13-19 was one hour and 50 minutes. (Wolfson and Carskadon, 1998) In 18-year-olds, the average discrepancy was more than two hours. In addition, 91 percent of the surveyed high school students reported going to sleep after 11:00 pm on weekends, and 40 percent went to bed after 11:00 pm on school nights.

Irregular sleep schedules — including significant discrepancies between weekdays and weekends — can contribute to a shift in sleep phase (ie, tendency toward morningness or eveningness), trouble falling asleep or awakening, and fragmented (poor quality) sleep. (Dahl and Carskadon, 1995)

Consequences of Poor Sleep in Adolescents

Data on children, teens and adults confirm that sleep loss and sleep difficulties can have serious detrimental effects. Research specifically on adolescents and young adults is relatively new and limited, but scientists believe that many effects demonstrated in studies and clinical observations of adults are similar in adolescents. Sleep researchers, therefore, believe that insufficient sleep in teens and young adults is linked to:

- **Increased risk of unintentional injuries and death.** As noted, drowsiness or fatigue has been identified as a principle cause in at least 100,000 traffic crashes each year. In addition, about 1 million, or one-sixth, of traffic crashes in the United States are believed to be attributable to lapses in the driver's attention; sleep loss and fatigue significantly increase the chances of such lapses occurring. A North Carolina state study found that drivers age 25 or younger cause more than one-half (55 percent) of fall-asleep crashes.



The same symptoms of sleepiness that contribute to traffic crashes can also play a role in non-traffic injuries, such as those associated with handling hazardous equipment in the workplace or in the home. Furthermore, adolescents who have not received sufficient sleep and who consume even small amounts of alcohol are at greater risk of injury than those who are not lacking sleep because sleep loss has been shown to heighten the effects of alcohol. (Roehrs et al., 1994)

- **Low grades and poor school performance.** High school students who describe themselves as having academic problems and who are earning C's or below in school report getting less sleep, having later bedtimes and having more irregular sleep schedules than students reporting higher grades. (Note: A causal relationship has not yet been established.) (Wolfson and Carskadon, 1998)
- **Negative moods** (e.g., anger, sadness and fear), difficulty controlling emotions and behavior problems. In one study, female high school students who went to sleep on the weekend two or more hours later than their typical weeknight bedtime reported feeling more depressed than those who did not stay up late on the weekends. (Wolfson and Carskadon, 1998)

Studies also suggest that sleep loss may be associated with a decreased ability to control, inhibit or change emotional responses. (Dahl, 1999) Some signs of sleepiness, such as inability to stay focused on a task, impulsivity, difficulty "sitting still," and problems completing tasks, resemble behaviors common also in attention deficit hyperactivity disorder (ADHD) (Dahl, 1999). In addition, a 1995 study of students in transition from junior high to senior high school found that conduct/aggressive behaviors were highly associated with shorter sleep times and later sleep start time. (Wolfson et al., 1995)

- **Increased likelihood of stimulant use** (including caffeine and nicotine), alcohol and similar substances. (Carskadon, 1990)

Teens who are heavily involved in school and community activities, their jobs and other responsibilities appear to be at greater risk for the above effects of sleepiness than those who are less involved in activities and who either do not hold jobs or who work fewer hours. (Carskadon, 1990)

What Can Be Done

The consequences of insufficient sleep among adolescents are particularly important to understand because they appear to be closely tied to key elements of human development. Achieving developmental goals during adolescence is essential for lifelong success and for what psychologists call social competency. In addition, the transition from childhood to adulthood is a critical time for "seeding" the values and habits that will shape their lives. Therefore, intervention to improve the sleep patterns of adolescents is important.

Influencing Physiological Sleep Patterns

Sleep researchers have established that basic sleep needs within individuals generally remain the same throughout their lifetime. Furthermore, insufficient sleep accumulates into a sleep debt that can ultimately be relieved only through additional sleep.

Circadian timing systems are also very resistant to change. Behavioral methods, such as controlled light exposure and chronotherapy, can sometimes help shift circadian timing to more socially appropriate sleep and wake times. Because the circadian rhythms in teenagers are typically highly sensitive to erratic schedules, to effectively adjust them requires making gradual, persistent and consistent changes. Adapting to an early school schedule following summer or other vacation periods during which very late schedules are typically kept, for example, can take several days to several weeks.

It is important to recognize that excessive sleepiness during the day and other sleep problems can be an indication of an underlying biological sleep disorder. Accurate diagnosis of disorders such as narcolepsy, sleep apnea and periodic limb movement disorder usually requires examination by a qualified sleep specialist and an overnight stay in a sleep laboratory. In most cases, symptoms of sleep disorders can be eliminated or minimized through the use of appropriate behavior modifications, medication or other therapies.

Creating Sleep-Friendly Schools

School systems can help positively influence adolescent sleep patterns in several ways. Suggestions include:

- **Educate** teachers, school health providers and other school personnel about adolescent sleep needs and patterns, and about the signs of sleep loss and other sleep or alertness difficulties. Teachers and school staff should also be informed about accommodations that might be needed by some students with chronic sleep disorders.
- **Integrate** sleep-related education in curricula so that students can learn about the physiology and benefits of sleep and the consequences of sleep deprivation. Relevant academic subjects include, for example, biology, health and psychology. In addition, driver's education courses should cover the prevalence and prevention of crashes related to drowsy driving.



CHANGING SLEEP HABITS

Perhaps the most significant behavioral change that adolescents can make – and that their parents can encourage them to make – is to establish and maintain a consistent sleep/wake schedule. This is a good practice for people at all ages, but may be especially important for adolescents.

Understanding and practicing other behaviors that are considered good sleep habits are also important. These include getting enough sleep, avoiding caffeine and other stimulants late in the day and alcohol at night, gaining exposure to bright light at appropriate times to reinforce the brain's circadian timing system, relaxing before going to sleep and creating an environment conducive to quality sleep.

- Structure the school schedule and related activities to **accommodate** adolescents' sleep needs and behaviors and circadian rhythm at this developmental stage. One approach is to start daily high school schedules when students are most likely to be alert and able to learn. Several school districts in the nation have adopted later school start times; countless more are considering doing so.

Preliminary findings and focus group studies conducted by the Center for Applied Research and Educational Improvement (CAREI) at the University of Minnesota reveal that after schools shifted from early to later start times, students from both urban and suburban high schools reported that they felt more rested and alert during the first hour of class and, in general, throughout the day. (Wahlstrom and Freeman, 1997)

In addition, students in the suburban Edina high school district whose schools delayed their start times reported increased hours of sleep, less erratic sleep behaviors and less depressive feelings and behaviors, better grades and little restriction in time spent in extracurricular activities. (Wahlstrom and Freeman, 1997) Findings in urban (Minneapolis) schools with later start times varied from the suburban schools somewhat; in particular, student mood appeared unchanged and schedule conflicts with extracurricular activities and employment were more pronounced. (Wahlstrom and Freeman, 1997)

For more information about issues related to high school start times, see pages 13-16

Establishing Public Policies

Governmental and organizational policies significantly influence social change. In addition to federal agencies, national medical and health care specialty organizations, education and parent associations and youth groups can play a key role in developing and implementing recommendations, policies and cooperative initiatives. (See *Minnesota Medical Association Resolutions*, page 22.)

Furthermore, state, district and local efforts may be spearheaded through voluntary, professional and governmental organizations such as school boards and parent-teacher associations, state or district medical societies, motor vehicle administration departments, public health departments and social service agencies.

Below are some examples of policy-related approaches that have been or could be used to better match adolescent sleep patterns and needs with cultural expectations and external demands, thereby increasing teens' overall safety and well-being.

- Legislation to encourage starting high schools no earlier than 9:00 am, and appropriations to help defray the school or school district's costs of changing school schedules. (See *Z's to A's Act*, page 19.)
- Legislation or policies to include age-appropriate sleep information in school curricula, grades K through 12.
- Initiatives to include information about the effects of drowsiness on driving ability in drivers' education courses and licensing tests. (See *Resource Guide*.)

- Graduated licensing regulations to reduce the number of adolescents driving unsupervised at night.
- Child labor laws to restrict the number of hours and the time of day that adolescents are permitted to work.
- Funding to support public education and scientific research on topics such as the interrelationships among sleep loss and injury, learning, and performance, as well as epidemiological data. Relevant federal oversight of funded agencies include the National Center for Sleep Disorders Research and other agencies of the National Institutes of Health, the Food and Drug Administration, the Department of Transportation, the Department of Education, the Centers for Disease Control and Prevention, and military branches.
- Initiatives to educate key adults who have frequent and regular contact with adolescents (eg, caregivers and authoritarians) about sleep, the signs and hazards of sleepiness, and appropriate interventions for children and adolescents showing signs of sleep difficulties or disorders. Constituents include parents, teachers, school administrators, school nurses and counselors, coaches, employers, health providers (family practitioners, adolescent medicine specialists, and those who specialize in mental health or learning disabilities) and voluntary group leaders of youth-oriented organizations. In addition, police and emergency care personnel should be trained to recognize problem sleepiness and distinguish its signs from those associated with drug or alcohol use.

Making New Discoveries

Sleep research has established clear relationships between sleepiness, health, safety and productivity. However, the sleep research field in general is relatively young, and scientists still have much to learn about the role of sleep and the effects of sleep loss in humans. Additional studies on the neurobiology, genetics, epidemiology, and neurobehavioral and functional consequences of sleepiness are needed. (NIH, 1997) More studies specifically on the adolescent population are also needed, including interdisciplinary research to further examine sleep's role in adolescent development, health and behavior.

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Table of Contents

| | |
|--|-----------|
| Preface | i |
| PART ONE: Research Report | 1 |
| Introduction | 1 |
| Physiological Patterns | 2 |
| Behavioral and Psychosocial Patterns..... | 2 |
| Consequences of Poor Sleep in Adolescents | 3 |
| What Can Be Done | 4 |
| Reference s | 7 |
| PART TWO: Resource Guide..... | 11 |
| Pointers for Parents | 11 |
| Tips for Teens | 13 |
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| Summary of Findings..... | 14 |
| Factors to Consider | 15 |
| References..... | 18 |
| The Z's to A's Act | 19 |
| Drowsy Driving Fact Sheet | 20 |
| Who Is Most At Risk?..... | 20 |
| What Are Effective Countermeasures? | 21 |
| Minnesota Medical Association Resolutions: Models for Change | 22 |
| School Start Times..... | 22 |
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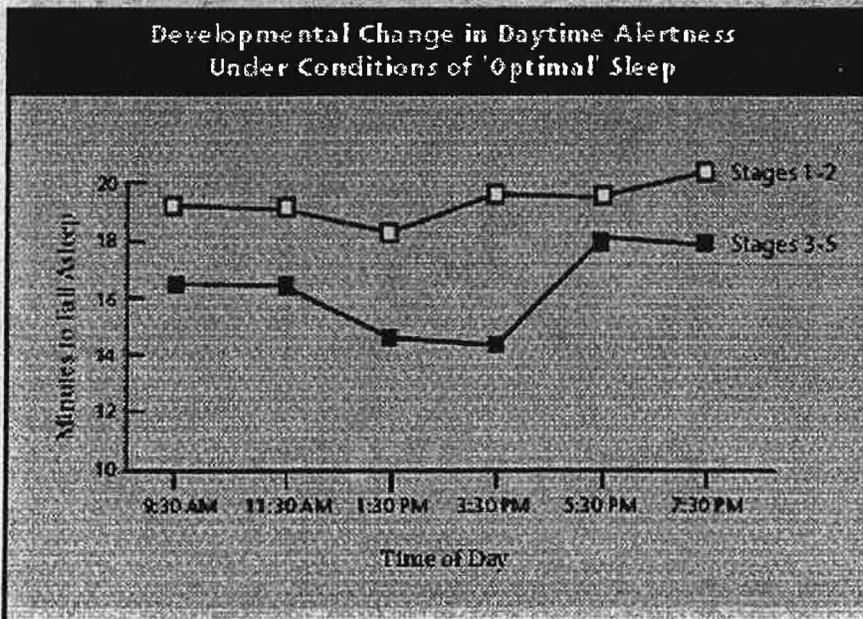
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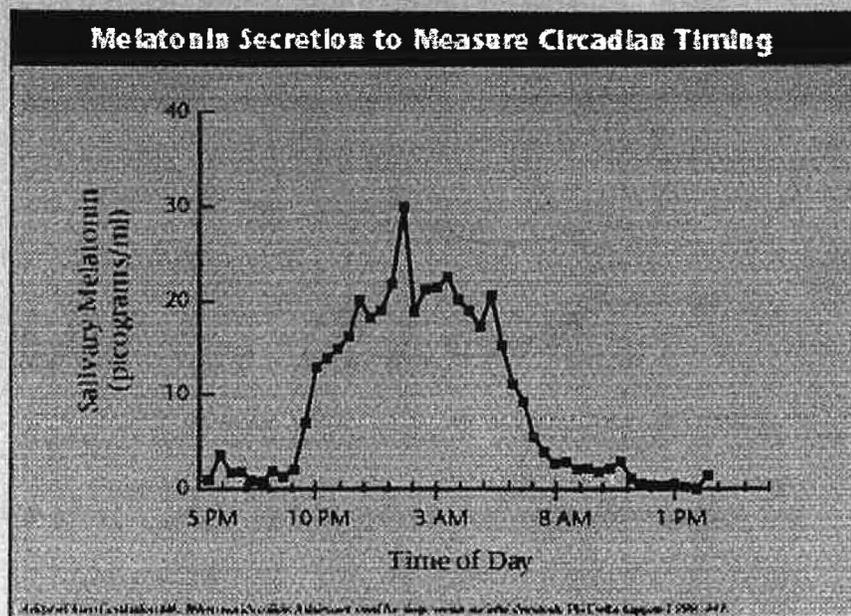
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- **Adolescents require at least as much sleep** as they did as pre-adolescents (in general, 8.5 to 9.25 hours each night). (Carskadon et al., 1980)
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- **Adolescents have irregular sleep patterns**; in particular, their weekend sleep schedules are much different than their weekday schedules, to some extent as a direct consequence of weekday sleep loss. These differences include both the quantity and the timing of sleep. One study of more than 3,000 adolescents showed that the average increase of weekend over weekday sleep across ages 13-19 was one hour and 50 minutes. (Wolfson and Carskadon, 1998) In 18-year-olds, the average discrepancy was more than two hours. In addition, 91 percent of the surveyed high school students reported going to sleep after 11:00 pm on weekends, and 40 percent went to bed after 11:00 pm on school nights.

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Data on children, teens and adults confirm that sleep loss and sleep difficulties can have serious detrimental effects. Research specifically on adolescents and young adults is relatively new and limited, but scientists believe that many effects demonstrated in studies and clinical observations of adults are similar in adolescents. Sleep researchers, therefore, believe that insufficient sleep in teens and young adults is linked to:

- **Increased risk of unintentional injuries and death.** As noted, drowsiness or fatigue has been identified as a principle cause in at least 100,000 traffic crashes each year. In addition, about 1 million, or one-sixth, of traffic crashes in the United States are believed to be attributable to lapses in the driver's attention; sleep loss and fatigue significantly increase the chances of such lapses occurring. A North Carolina state study found that drivers age 25 or younger cause more than one-half (55 percent) of fall-asleep crashes.



The same symptoms of sleepiness that contribute to traffic crashes can also play a role in non-traffic injuries, such as those associated with handling hazardous equipment in the workplace or in the home. Furthermore, adolescents who have not received sufficient sleep and who consume even small amounts of alcohol are at greater risk of injury than those who are not lacking sleep because sleep loss has been shown to heighten the effects of alcohol. (Roehrs et al., 1994)

- **Low grades and poor school performance.** High school students who describe themselves as having academic problems and who are earning C's or below in school report getting less sleep, having later bedtimes and having more irregular sleep schedules than students reporting higher grades. (Note: A causal relationship has not yet been established.) (Wolfson and Carskadon, 1998)
- **Negative moods** (e.g., anger, sadness and fear), difficulty controlling emotions and behavior problems. In one study, female high school students who went to sleep on the weekend two or more hours later than their typical weeknight bedtime reported feeling more depressed than those who did not stay up late on the weekends. (Wolfson and Carskadon, 1998)

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Teens who are heavily involved in school and community activities, their jobs and other responsibilities appear to be at greater risk for the above effects of sleepiness than those who are less involved in activities and who either do not hold jobs or who work fewer hours. (Carskadon, 1990)

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The consequences of insufficient sleep among adolescents are particularly important to understand because they appear to be closely tied to key elements of human development. Achieving developmental goals during adolescence is essential for lifelong success and for what psychologists call social competency. In addition, the transition from childhood to adulthood is a critical time for "seeding" the values and habits that will shape their lives. Therefore, intervention to improve the sleep patterns of adolescents is important.

Influencing Physiological Sleep Patterns

Sleep researchers have established that basic sleep needs within individuals generally remain the same throughout their lifetime. Furthermore, insufficient sleep accumulates into a sleep debt that can ultimately be relieved only through additional sleep.

Circadian timing systems are also very resistant to change. Behavioral methods, such as controlled light exposure and chronotherapy, can sometimes help shift circadian timing to more socially appropriate sleep and wake times. Because the circadian rhythms in teenagers are typically highly sensitive to erratic schedules, to effectively adjust them requires making gradual, persistent and consistent changes. Adapting to an early school schedule following summer or other vacation periods during which very late schedules are typically kept, for example, can take several days to several weeks.

It is important to recognize that excessive sleepiness during the day and other sleep problems can be an indication of an underlying biological sleep disorder. Accurate diagnosis of disorders such as narcolepsy, sleep apnea and periodic limb movement disorder usually requires examination by a qualified sleep specialist and an overnight stay in a sleep laboratory. In most cases, symptoms of sleep disorders can be eliminated or minimized through the use of appropriate behavior modifications, medication or other therapies.

Creating Sleep-Friendly Schools

School systems can help positively influence adolescent sleep patterns in several ways. Suggestions include:

- **Educate** teachers, school health providers and other school personnel about adolescent sleep needs and patterns, and about the signs of sleep loss and other sleep or alertness difficulties. Teachers and school staff should also be informed about accommodations that might be needed by some students with chronic sleep disorders.
- **Integrate** sleep-related education in curricula so that students can learn about the physiology and benefits of sleep and the consequences of sleep deprivation. Relevant academic subjects include, for example, biology, health and psychology. In addition, driver's education courses should cover the prevalence and prevention of crashes related to drowsy driving.



CHANGING SLEEP HABITS

Perhaps the most significant behavioral change that adolescents can make – and that their parents can encourage them to make – is to establish and maintain a consistent sleep/wake schedule. This is a good practice for people at all ages, but may be especially important for adolescents.

Understanding and practicing other behaviors that are considered good sleep habits are also important. These include getting enough sleep, avoiding caffeine and other stimulants late in the day and alcohol at night, gaining exposure to bright light at appropriate times to reinforce the brain's circadian timing system, relaxing before going to sleep and creating an environment conducive to quality sleep.

- Structure the school schedule and related activities to **accommodate** adolescents' sleep needs and behaviors and circadian rhythm at this developmental stage. One approach is to start daily high school schedules when students are most likely to be alert and able to learn. Several school districts in the nation have adopted later school start times; countless more are considering doing so.

Preliminary findings and focus group studies conducted by the Center for Applied Research and Educational Improvement (CAREI) at the University of Minnesota reveal that after schools shifted from early to later start times, students from both urban and suburban high schools reported that they felt more rested and alert during the first hour of class and, in general, throughout the day. (Wahlstrom and Freeman, 1997)

In addition, students in the suburban Edina high school district whose schools delayed their start times reported increased hours of sleep, less erratic sleep behaviors and less depressive feelings and behaviors, better grades and little restriction in time spent in extracurricular activities. (Wahlstrom and Freeman, 1997) Findings in urban (Minneapolis) schools with later start times varied from the suburban schools somewhat; in particular, student mood appeared unchanged and schedule conflicts with extracurricular activities and employment were more pronounced. (Wahlstrom and Freeman, 1997)

For more information about issues related to high school start times, see pages 13-16

Establishing Public Policies

Governmental and organizational policies significantly influence social change. In addition to federal agencies, national medical and health care specialty organizations, education and parent associations and youth groups can play a key role in developing and implementing recommendations, policies and cooperative initiatives. (See *Minnesota Medical Association Resolutions*, page 22.)

Furthermore, state, district and local efforts may be spearheaded through voluntary, professional and governmental organizations such as school boards and parent-teacher associations, state or district medical societies, motor vehicle administration departments, public health departments and social service agencies.

Below are some examples of policy-related approaches that have been or could be used to better match adolescent sleep patterns and needs with cultural expectations and external demands, thereby increasing teens' overall safety and well-being.

- Legislation to encourage starting high schools no earlier than 9:00 am, and appropriations to help defray the school or school district's costs of changing school schedules. (See *Z's to A's Act*, page 19.)
- Legislation or policies to include age-appropriate sleep information in school curricula, grades K through 12.
- Initiatives to include information about the effects of drowsiness on driving ability in drivers' education courses and licensing tests. (See *Resource Guide*.)

- Graduated licensing regulations to reduce the number of adolescents driving unsupervised at night.
- Child labor laws to restrict the number of hours and the time of day that adolescents are permitted to work.
- Funding to support public education and scientific research on topics such as the interrelationships among sleep loss and injury, learning, and performance, as well as epidemiological data. Relevant federal oversight of funded agencies include the National Center for Sleep Disorders Research and other agencies of the National Institutes of Health, the Food and Drug Administration, the Department of Transportation, the Department of Education, the Centers for Disease Control and Prevention, and military branches.
- Initiatives to educate key adults who have frequent and regular contact with adolescents (eg, caregivers and authoritarians) about sleep, the signs and hazards of sleepiness, and appropriate interventions for children and adolescents showing signs of sleep difficulties or disorders. Constituents include parents, teachers, school administrators, school nurses and counselors, coaches, employers, health providers (family practitioners, adolescent medicine specialists, and those who specialize in mental health or learning disabilities) and voluntary group leaders of youth-oriented organizations. In addition, police and emergency care personnel should be trained to recognize problem sleepiness and distinguish its signs from those associated with drug or alcohol use.

Making New Discoveries

Sleep research has established clear relationships between sleepiness, health, safety and productivity. However, the sleep research field in general is relatively young, and scientists still have much to learn about the role of sleep and the effects of sleep loss in humans. Additional studies on the neurobiology, genetics, epidemiology, and neurobehavioral and functional consequences of sleepiness are needed. (NIH, 1997) More studies specifically on the adolescent population are also needed, including interdisciplinary research to further examine sleep's role in adolescent development, health and behavior.

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