Daytime Sleepiness: An Epidemiological Study of Young Adults

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ABSTRACT

Objectives. Although excessive daytime sleepiness is associated with increased risks for accidents, decreased productivity, and interpersonal difficulties, information on its epidemiology is scarce. This paper examines correlates of and suspected risk factors for daytime sleepiness from a longitudinal epidemiological study of young adults.

Methods. The sample consisted of 1007 randomly selected young adults from a large health maintenance organization in southeast Michigan. Data were gathered in personal interviews conducted with 97% of the sample 5.5 years after baseline. Information on sleep characteristics in the last 2 weeks, including daytime sleepiness, nocturnal sleep onset, snoring, and hours of sleep, was collected on a self-administered instrument. Psychiatric disorders were measured by the National Institute of Mental Health's Diagnostic Interview Schedule.

Results. The average length of nocturnal sleep on weekdays was 6.7 hours. Daytime sleepiness was inversely related to hours of sleep and positively related to the ease of falling asleep at night; it varied significantly by employment and marital status. Snoring was associated with increased daytime sleepiness, as was recent major depression.

Conclusions. Factors that might increase daytime sleepiness among young adults include social factors (being single and being employed full time) and pathological conditions (frequent snoring and major depression). (*Am J Public Health.* 1997;87:1649–1653)

Introduction

The connection between insufficient sleep and sleepiness on the following day is universally understood to be a natural fact. While occasional daytime sleepiness following insufficient nocturnal sleep is experienced by everyone, certain subgroups of the population whose regular activities are associated with restricted nocturnal sleep (e.g., college students) experience daytime sleepiness chronically. There is evidence as well that excessive daytime sleepiness may be a symptom of medical conditions not readily reversed by increasing the amount of sleep.[1,2] Regardless of its causes, daytime sleepiness may have grave consequences, including motor vehicle and industrial accidents, decreased productivity, and interpersonal problems.[3] Yet despite these adverse consequences, information on the epidemiology of daytime sleepiness is scarce.

Clinical and experimental research has identified several factors that contribute to a pattern of excessive daytime sleepiness. Foremost among these factors is inadequate nocturnal sleep. Even a modest sleep restriction accumulates over time to increase daytime sleepiness.[4] A related second factor is a pattern of activities that does not conform to the circadian sleep-wake rhythm, a pattern that characterizes shift workers. A third factor encompasses conditions that influence the quality of sleep, primarily those conditions that cause frequent arousal and interfere with sleep continuity, such as sleep apnea.[2] A fourth factor is central nervous system pathology, such as narcolepsy.[1] A fifth factor involves the sedating effects of psychoactive substances such as alcohol and antihistamines.[5]

The accepted laboratory measure of sleepiness is the Multiple Sleep Latency Test, which measures time to sleep onset on repeated occasions at 2-hour intervals throughout the day. This test is based on the assumption that a decreased average sleep latency is a function of increased sleepiness.[6] The development of self-report measures of daytime sleepiness has facilitated the epidemiological study of this phenomenon in the general population.[7,8]

In this paper, we describe the epidemiology of daytime sleepiness in a random sample of young adults from a longitudinal epidemiological study in the Detroit metropolitan area. We examine correlates and suspected risk factors of daytime sleepiness—specifically, the extent to which self-reported daytime sleepiness varies by sex, indicators of social class and key social statuses (e.g., marital status and employment), hours of nocturnal sleep, snoring, and psychiatric disorders.

Methods

Sample and Data

A sample of 1200 was randomly selected from the list of all 21- to

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TABLE 1—Sociodemographic Characteristics (%) of a Sample of Young Adults in Southeast Michigan (n = 973)

Sex	
Male	37.6
Female	62.4
Race	
White	80.7
Black	19.3
Age	
26–30	35.0
31–36	65.0
Marital status	
Married	60.1
Separated/divorced	10.9
Never married	29.0
Education	
<High school	2.8
High school	22.9
Some college	39.1
College	35.2
Employment	
Employed	86.2
Not employed	13.8

30-year-old members of a large (>400 000 members) health maintenance organization in southeast Michigan. Because the sample was of an insured population rather than of persons seeking medical care, selection bias inherent in clinical samples was avoided. A total of 1007 individuals (84% of the sample) were interviewed in 1989. Follow-up interviews were conducted 3.5 and 5.5 years after baseline, in 1992 and 1994, with more than 97% of the initial panel of 1007 participating at each follow-up. Interviews were conducted in person in respondents' homes; those who had moved out of the area during the follow-up interval were interviewed by telephone. The population and sample have been described in detail previously.[9]

Psychiatric disorders were measured by the National Institute of Mental Health Diagnostic Interview Schedule, which was revised to cover disorders accounted for in the *Diagnostic and Statistical Manual of Mental Disorders,* 3rd ed, revised (DSM-III-R).[10,11] Detailed descriptions of the Diagnostic Interview Schedule, a structured interview designed to be administered by interviewers without clinical training, and information on its reliability and validity have been previously reported.[12–14] The following DSM-III-R psychiatric disorders, occurring in the 2-year interval covered in the last follow-up, were used in this analysis: major depression, any anxiety disorder (simple phobia, social phobia, agoraphobia, panic disorder, generalized anxiety disorder, obsessive-compulsive disorder, or posttraumatic stress disorder), and alcohol abuse or dependence. These constitute the prevalent psychiatric disorders among young adults in the general population and are potential factors in daytime sleepiness.

Information on sleep behaviors was gathered at the last follow-up with the use of a structured instrument that was self-administered during the interview and that inquired about sleep patterns in the previous 2 weeks. Hours in bed and hours of sleep were reported for weekdays and the weekend in response to the following two questions, with each inquiring first about weekdays and then about the weekend: "On average, how many hours did you spend in bed each night trying to sleep?" and "On average, how many hours of sleep did you get each night?" Daytime sleepiness and nocturnal sleep onset were measured by sets of items from the Sleep-Wake Activity Inventory.[8] Daytime sleepiness was measured by five items from the inventory that loaded on a factor labeled daytime sleepiness: (1) "I fall asleep when riding in a car"; (2) "I doze off while watching TV"; (3) "I get drowsy within 10 minutes when I sit still"; (4) "I fall asleep when visiting with friends"; and (5) "I have difficulty staying alert throughout the day." The following three items from the inventory's nocturnal factor were used to measure nocturnal sleep onset, or the ease and speed of falling asleep at night: (1) "Even if I take a nap, I sleep well at night"; (2) "I have difficulty falling asleep" (reversed); and (3) "It takes me less than 5 minutes to fall asleep." The following item was used to measure the frequency of snoring: "People complain about my snoring." Each item was scored on a scale of 1 (never) to 9 (always).

The five-item daytime sleepiness scale ranged from 5 to 40, with higher scores signifying greater sleepiness; the mean was 14.25 ± 5.85. The three-item nocturnal sleep onset scale ranged from 3 to 27, with higher scores signifying greater ease of falling asleep at night; the mean was 17.45 ± 5.78. The one-item snoring frequency scale ranged from 1 to 9, with a mean of 2.35 ± 2.19. Level of snoring was classified into four classes: 1 (never; n = 592), 2 to 4 (snoring level 1; n = 196), 5 to 6 (snoring level 2; n = 107), and 7 to 9 (snoring level 3; n = 78).

The Sleep-Wake Activity Inventory, which contains the scales that measured daytime sleepiness and nocturnal sleep onset, was validated on a clinical sample and a sample of normal volunteers.[8] The accuracy of self-reported sleep variables, with laboratory findings used as the criterion, has been found to be higher in normal subjects than in patients with various disorders.[15,16] The validity of these measures outside the laboratory setting has not been evaluated.

Statistical Analysis

The distribution of hours of sleep and daytime sleepiness by sex, education, marital status, and employment was analyzed by displaying means (standard deviations) and tests of statistical significance. To examine the associations between daytime sleepiness and each of the potential determinants, daytime sleepiness was classified into three equal-sized groups according to the scores on the five-item daytime sleepiness scale. Analyses of variance (ANOVAs) were used to test associations with continuous variables (e.g., hours of sleep), and chi-squared analysis of tables of cross-tabulation was used to test associations with categorical variables (e.g., major depression). Multiple regression analysis was used to estimate and test the unique association of each of the variables, controlling for all others in the model. The multivariable model included those variables found to be related to daytime sleepiness in the univariate tests.

Results

Sample Characteristics

The characteristics of the sample at the last follow-up, when information on sleep behaviors was elicited, are described in Table 1. The age of the respondents ranged from 26 to 35. Of the total sample, 60% were married, 35% had completed college, and 86% were employed.

Hours of Sleep and Daytime Sleepiness

The average number of hours of sleep was 6.7 ± 1.2 on weekdays and 7.4 ± 1.4 on weekends. Information on hours of sleep and daytime sleepiness by sex, education, marital status, and employment appears in Table 2. The table presents means, standard deviations, and *t* tests or *F* statistics from ANOVAs. Sex was not significantly related to hours of sleep or daytime sleepiness. However, level of education was significantly re-

lated to weekday hours of sleep, with persons with some college reporting a shorter average than persons with lower or higher education. A similar pattern, although not statistically significant, was detected in weekend hours of sleep. Education was not significantly related to daytime sleepiness. Married persons, on the average, reported significantly longer sleep, on both weekdays and the weekend, and significantly lower daytime sleepiness than nonmarried persons.

The relationship of employment to hours of sleep varied between weekdays and the weekend. On weekdays, those employed full-time had significantly shorter sleep than those employed part-time or not employed. In contrast, weekend hours of sleep did not vary by employment status. Daytime sleepiness varied significantly across employment categories, with those employed full-time scoring the highest, on average, and those not employed scoring the lowest.

Work schedule was not related significantly to weekday hours of sleep or daytime sleepiness, although nightshift workers reported less sleep and more daytime sleepiness than people who worked regular daytime hours or rotating shifts. With respect to weekend hours of sleep, significant differences were found across work schedules, with daytime work associated with longer sleep than shift work.

TABLE 2—Hours of Sleep and Daytime Sleepiness, by Sex, Education, Marital Status, Employment, and Work Schedule: Young Adults in Southeast Michigan (n = 973)

	Weekday Hours of Sleep, Mean (SD)	Weekend Hours of Sleep, Mean (SD)	Daytime Sleepiness,[a] Mean (SD)
Sex			
Male	6.6 (1.2)	7.4 (1.4)	14.0 (5.9)
Female	6.7 (1.2)	7.4 (1.3)	14.4 (5.8)
[*t* =; *P* =]	[1.10; .271]	[0.07; .940]	[0.931; .352]
Education			
<High school	7.0 (1.6)	7.7 (1.6)	11.9 (6.6)
High school	6.7 (1.2)	7.4 (1.5)	14.4 (5.9)
Some college	6.5 (1.3)	7.3 (1.4)	14.3 (5.9)
College	6.8 (0.9)	7.5 (1.2)	14.3 (5.7)
[*F*(3 *df*) =; *P* =]	[5.18; .001]	[2.76; .041]	[1.49; .217]
Marital status			
Married	6.8 (1.1)	7.5 (1.2)	13.9 (5.6)
Not married	6.5 (1.3)	7.3 (1.5)	14.8 (6.2)
[*t* =; *P* =]	[3.74; .0002]	[2.52; .012]	[2.48; .013]
Employment			
Full-time	6.6 (1.1)	7.4 (1.4)	14.5 (5.9)
Part-time	7.0 (1.2)	7.4 (1.4)	14.0 (6.0)
Not employed	7.0 (1.4)	7.3 (1.5)	12.9 (5.5)
[*F*(2 *df*) =; *P* =]	[11.32; .0001]	[0.55; .578]	[4.68; .009]
Work shift			
Day	6.7 (1.1)	7.5 (1.3)	14.4 (5.7)
Night	6.4 (1.5)	7.2 (1.5)	15.0 (6.3)
Rotate	6.7 (0.9)	7.2 (1.6)	14.1 (6.3)
[*F*(2 *df*) =; *P* =]	[1.61; .201]	[2.48; .037]	[0.55; .574]

[a]Scores on the daytime sleepiness scale ranged from 5 to 40, with higher scores indicating greater sleepiness.

Potential Determinants of Daytime Sleepiness

To examine the relationship of daytime sleepiness with hours of nocturnal sleep and other suspected risk factors, daytime sleepiness was divided into three groups of approximately equal sample sizes: low (those scoring 5 to 11 on the daytime sleepiness scale), medium (those scoring 12 to 16), and high (those scoring 17 and over). The levels were defined empirically with the use of cutoffs to form the three approximately equal-sized groups. Table 3 presents comparisons of sleep measures and suspected risk factors across the three levels of daytime sleepiness. ANOVA was used for continuous variables and chi-squared was used for dichotomous variables. Daytime sleepiness was significantly related to weekday hours of sleep, with those in the highest level reporting less sleep than those in lower levels. In contrast, daytime sleepiness was unrelated to weekend hours of sleep. Daytime sleepiness was also significantly associated with nocturnal sleep onset, an indicator of the ease and speed of falling asleep at night, with those reporting higher levels of daytime sleepiness averaging a higher score.

TABLE 3—Potential Determinants of Daytime Sleepiness

	Levels of Daytime Sleepiness				
	Low (5–11) (n = 348)	Medium (12–16) (n = 321)	High (17+) (n = 304)	Statistic	*P*
Hours of sleep/weekday	6.8 (1.1)	6.8 (1.1)	6.5 (1.3)	$F = 5.9$ (2 *df*)	.0027
Hours of sleep/weekend	7.3 (1.3)	7.5 (1.3)	7.4 (1.4)	$F = 1.3$ (2 *df*)	.261
Nocturnal sleep onset	16.9 (5.9)	17.3 (5.4)	18.1 (6.0)	$F = 3.6$ (2 *df*)	.027
Snoring	2.1 (2.0)	2.2 (1.9)	2.8 (2.5)	$F = 8.3$ (2 *df*)	.0003
Major depression, %	4	3.4	9.2	$\chi^2 = 12.3$ (2 *df*)	.002
Any anxiety, %	6.9	10.6	13.5	$\chi^2 = 7.8$ (2 *df*)	.02
Alcohol abuse/dependence, %	3.7	6.2	5.3	$\chi^2 = 2.2$ (2 *df*)	.329
Night shift, %	6.6	8.7	8.6	$\chi^2 = 1.27$ (2 *df*)	.53
Rotating shift, %	8.6	5.3	8.3	$\chi^2 = 3.13$ (2 *df*)	.209

Note. Levels of daytime sleepiness were defined empirically with the use of cutoffs on the daytime sleepiness scale that divide it into three groups of approximately equal sample sizes.

Other factors associated with daytime sleepiness were snoring, major depression, and any anxiety disorder. Persons in the highest level of daytime sleepiness scored, on average, significantly higher on frequency of snoring, and had significantly higher prevalence propor-

TABLE 4—Multiple Regression Analysis of Daytime Sleepiness

	B (SE)	P
Hours of sleep	−0.40 (0.16)	.013
Sex (female)	0.98 (0.40)	.017
Education[a]		
<High school	1.65 (1.16)	.153
High school	0.15 (0.50)	.769
Some college	−0.19 (0.43)	.660
Married	−0.82 (0.38)	.034
Employed full-time	0.98 (0.46)	.032
Snoring[b]		
1	1.48 (0.48)	.002
2	1.05 (0.61)	.085
3	3.10 (0.70)	.0001
Major depression	2.30 (0.82)	.005

Note. B = unstandardized partial regression coefficients.
[a]College is reference.
[b]Snoring 1 = 2–4 on the snoring item (n = 196), snoring 2 = 5–6 (n = 107), and snoring 3 = 7–9 (n = 78), with "never" snoring (n = 592) serving as reference.

tions of recent major depression and any anxiety. Recent history of alcohol abuse or dependence was unrelated to daytime sleepiness.

We used multiple regression analysis to examine the association of daytime sleepiness with major depression and any anxiety, controlling for their co-occurrence (results not shown). The results failed to detect a unique association of daytime sleepiness with any anxiety, independent of major depression. However, the association of daytime sleepiness with major depression, controlling for any anxiety, was statistically significant, with an increment of 2.4 in the score of daytime sleepiness associated with major depression.

Multivariable Model of Daytime Sleepiness

Multiple regression analysis was used to estimate the association of daytime sleepiness with each of the suspected risk factors, controlling for all the others (Table 4). Hours of sleep predicted daytime sleepiness, with each additional hour of sleep associated with a reduction of 0.40 in the daytime sleepiness score. When hours of sleep and the other variables in the equation were held constant, sex, marital status, and employment status were significant predictors of daytime sleepiness, with women scoring higher than men, married subjects scoring lower than single subjects, and those employed full-time scoring higher than those employed part-time or not employed. Snoring signaled increased daytime sleepiness; the excess in daytime sleepiness exceeded 0.5 SD for the highest level of snoring. Major depression was associated with an increase in daytime sleepiness.

Discussion

The key findings of this epidemiological study of young adults indicate the following. First, the average number of hours of sleep was 6.7 on weekdays and 7.4 on weekends. Second, daytime sleepiness was inversely related to hours of sleep and positively related to nocturnal sleep onset. Third, daytime sleepiness varied significantly by employment and marital status, social factors associated also with hours of sleep. Specifically, being single and being employed full-time were associated with shorter nocturnal sleep and higher daytime sleepiness, compared with being married and not being employed full-time. Fourth, snoring was associated with increased daytime sleepiness. Fifth, a recent history of major depression signaled increased daytime sleepiness. Finally, the associations of daytime sleepiness with employment, marital status, snoring, and major depression remained when hours of sleep and other determinants of daytime sleepiness were held constant.

The results suggest that the influence of social factors—specifically, being single and being employed full-time—on daytime sleepiness goes beyond their influence on hours of sleep. Apart from its indirect influence on hours of sleep, full-time employment may reflect role obligations that do not permit flexibility in the amount of sleep when insufficient sleep continues over several days. In contrast, those who are not employed may be more able to delay their rising time or otherwise increase the amount of sleep when needed. Married persons reported lower daytime sleepiness than single persons, an advantage that, at least in part, was independent of their longer nocturnal sleep time. The beneficial effect of marriage on health indicators is well documented. In the absence of social controls provided by marriage, there is a higher probability of engaging in health-compromising behaviors.[17–19] The results of this study suggest that the function of marriage in shaping lifestyle and maintaining orderly patterns of living applies to nocturnal sleep schedules.

Daytime sleepiness was positively associated with nocturnal sleep onset, with those who scored higher on daytime sleepiness reporting greater ease in falling asleep at night. These data, taken together with the observed inverse association of daytime sleepiness with hours of sleep, confirm the laboratory-based model that posits that the amount of nocturnal sleep influences the level of daytime sleepiness, which in turn influences the speed of sleep onset.[20,21] The data extend this model in three important ways, suggesting (1) that this model applies outside the laboratory, (2) that the relationships among these variables hold over periods of time that exceed the night-day circadian unit and might characterize even longer periods than the 2 weeks used in this study, and (3) that a reliable increment in daytime sleepiness can be detected with as little as a 1-hour reduction in the average amount of nocturnal sleep. Further testing of these findings in other surveys and in the laboratory is needed.

Snoring was found to be associated with daytime sleepiness, an association unrelated to the amount of nocturnal sleep. The mechanisms that link snoring and daytime sleepiness might include sleep apnea or other breathing difficulties that interrupt sleep.[22]

The interpretation of these findings must take into account the limitations of the study, primarily the reliance on self-reports about sleep characteristics and the restricted age range of the sample. The scales that measured daytime sleepiness and nocturnal sleep onset were

developed by factor analysis and validated against the Multiple Sleep Latency Test in a clinical sample and in normal volunteers.[8] The validity of these scales outside the laboratory, however, has not been evaluated. Further methodological studies on self-reported measures of sleep characteristics in the general population are needed. It should be also noted that the accuracy of the data on sleep behavior was enhanced by our use of a relatively brief period—2 weeks—as the time period for recall.

The young age of the sample precludes any inferences with regard to older adults. It should, however, be emphasized that young adults have been found to be sleepier than the middle-aged,[23] an observation that renders this age stratum a high-priority population in research on daytime sleepiness.

Of considerable public health interest is the relatively short nocturnal sleep reported by this sample of young adults. On the average, men and women reported less than 7 hours of sleep on weekdays, or 6.6 and 6.7 hours, respectively. Yet laboratory studies on sleep extension suggest that, to be sleep satiated, healthy young adults need between 8 and 9 hours of sleep.[24–26] Although we have no data on daytime napping, it is unlikely that it constitutes an important factor in this population of young adults, 75% of whom were employed full-time. The potential impact of the observed short nocturnal sleep and associated daytime sleepiness on work productivity, motor vehicle accidents, and general well-being among young adults deserves further study. □

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