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How is good and poor sleep in older adults and college students related to daytime sleepiness, fatigue, and ability to concentrate?

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Abstract

We compared good sleepers with minimally and highly distressed poor sleepers on three measures of daytime functioning: self-reported fatigue, sleepiness, and cognitive inefficiency. In two samples (194 older adults, 136 college students), we tested the hypotheses that (1) poor sleepers experience more problems with daytime functioning than good sleepers, (2) highly distressed poor sleepers report greater impairment in functioning during the day than either good sleepers or minimally distressed poor sleepers, (3) daytime symptoms are more closely related to psychological adjustment and to psychologically laden sleep variables than to quantitative sleep parameters, and (4) daytime symptoms are more closely related to longer nocturnal wake times than to shorter sleep times. Results in both samples indicated that poor sleepers reported more daytime difficulties than good sleepers. While low- and high-distress poor sleepers did not differ on sleep parameters, highly distressed poor sleepers reported consistently more difficulty in functioning during the day and experienced greater tension and depression than minimally distressed poor sleepers. Severity of all three daytime problems was generally significantly and positively related to poor psychological adjustment, psychologically laden sleep variables, and, with the exception of sleepiness, to quantitative sleep parameters. Results are used to discuss discrepancies between experiential and quantitative measures of daytime functioning.

Keywords: Insomnia; Sleep; Wake; Daytime functioning; Age; Fatigue; Sleepiness; Concentration; Psychological adjustment

Introduction

Primary insomnia is defined in the Diagnostic and Statistical Manual of the American Psychiatric Association [1] as a persistent complaint of difficulty in initiating or maintaining sleep (DIMS) that causes an individual significant distress and is associated with impaired social, occupational, or other areas of functioning. Additionally, the diagnosis of primary insomnia is made only after excluding insomnia associated with a mental disorder (e.g., depression), a general medical condition, another sleep disorder (e.g., periodic limb movement disorder, sleep apnea), or the physiological effects of a substance or medication.

The experience of DIMS is a common health problem that increases over the life cycle [49]. Its prevalence ranges from 30% to 40% in the general population and rises to 50–60% in individuals over 60 [45]. The pattern of sleep difficulties in older adults with insomnia seems to differ from that of younger individuals. Older adults tend to have difficulty in maintaining sleep, whereas, younger poor sleepers tend to experience greater difficulty in initiating sleep [48,49].

People who complain of difficulty in falling or staying asleep during the night often complain of being impaired in their ability to function during the day. For example, they report feeling unrefreshed, sleepy, and tired, and they

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report problems with memory and concentration [21,62]. Most people cite fatigue (tiredness, lethargy) as a greater problem than sleepiness (feeling sleepy, struggling to stay awake) [6,60].

In spite of the ubiquity of complaints about daytime functioning by poor sleepers, studies have consistently failed to find significant differences between people with insomnia and normal controls on quantitative measures of daytime functioning [40,46,58].

Observational and self-report measures of daytime functioning

A major concern is understanding why there are such dramatic discrepancies between observed and self-reported impairments. One line of investigation has involved an examination of what it is that observational and self-report measures assess with respect to fatigue, performance, cognitive efficiency, and sleepiness. Another has been to determine what, exactly, the term "insomniac" means and how this is related to daytime functioning.

Fatigue

Fatigue has a number of components. For example, Kobashi-Schoot et al. [33] identified three components in a factor analytic study: physical fatigue (e.g., trembling arms and legs), mental fatigue (thinking difficulty), and malaise (tired, no energy). Although fatigue can be defined objectively as the "inability to sustain power" [5] and subjectively as the sensation of tiredness [36], fatigue, sleepiness, and difficulty in concentrating are often confused in the literature (e.g., Refs. [20,24,43,52]). Objective weakness in the muscles can be measured electro-physiologically [44]. The subjective perception of fatigue can be evaluated through single items and visual analogue scales, where respondents make a mark on a horizontal line to indicate how tired they are [15,19,30,35]. Multiple item scales, such as Chalder et al.'s [5] recently developed measure of physical and mental fatigue, have shown to discriminate medical patients from non-patients. Although this is not a well-developed research area, the available data generally show that observed aspects of fatigue are unrelated to either subjective perceptions of tiredness or to insomnia. For example, unpublished data from our laboratory show that fatigue scores on Chalder et al.'s [5] scale were not significantly correlated with either a single item measure of perceived daytime fatigue or with self-reported sleep parameters such as total sleep and wake times.

Performance and cognitive efficiency

Performance in good and poor sleepers has been assessed through visual shape identification, digit symbol substitutions, recall and recognition, logical reasoning, addition, card sorting, and auditory vigilance. Despite poor sleepers' complaints of increased difficulty with attention, memory, and concentration, objective studies have typically not found significant differences between these two groups on daytime performance [46,58].

Sleepiness

Sleepiness, perhaps the most obvious "consequence" of insomnia, has posed especially thorny problems. First, even when subjective perceptions of sleepiness during the day are evaluated, analyses comparing good and poor sleepers have yielded mixed results. While some studies have found that people with insomnia report greater subjective sleepiness (e.g., Refs. [15,41]), other studies have failed to find significant differences between poor and normal sleepers (e.g., Refs. [41,58]). In addition, good and poor sleepers have generally not been found to differ on the most widely accepted objective measure of daytime sleepiness — the multiple sleep latency test (MSLT) [40,58].

The use of the MSLT as the gold standard for measuring sleepiness has recently been questioned (e.g., Ref. [28]). Indeed, it has been argued that the MSLT is confounded in that it measures both sleep need and the hyperarousal that interferes with the sleep onset of people with insomnia [6]. The maintenance of wakefulness test (MWT), which quantifies wake tendency by measuring the ability to remain awake during sleep-inducing circumstances, may constitute a more appropriate means of measuring sleepiness among poor sleepers [11]. To date, however, no investigation has compared individuals with and without insomnia on the MWT.

Correlations between subjectively experienced sleepiness and self-reported behavior (e.g., the likelihood of dozing off in various situations encountered in daily life; cf. Refs. [25–27,53]) have tended to be low. Indeed, the lack of correspondence between behavioral and experiential measures of sleepiness, as well as data that show similarities in sleep onset latencies of poor and normal sleepers in sleep deprivation studies, have led some researchers to conclude that the widely held assumption that insomniacs are sleep deprived may be false (cf. Ref. [6]).

Definition of "insomniac"

An alternate explanation for the poor correspondence between behavioral and experiential measures of daytime functioning is suggested by our own research on highly and minimally distressed poor sleepers. Our data on older adults show that poor sleepers are comprised of at least two distinct groups of individuals: those who are quite upset by their sleep problem and those who are relatively unconcerned about their poor sleep [15,17,38]. These two groups were found to be similar in their experience of disrupted sleep, and they both experienced substantially worse sleep quality than good sleepers. However, on both state and trait measures of psychological maladjustment and negative adaptation, it was the good sleepers and the minimally distressed poor sleepers who had similarly low levels of anxiety and maladjustment — substantially lower than those who were highly distressed about their sleep problem. In

addition, and perhaps more important, we found that highly distressed poor sleepers reported experiencing significantly greater sleepiness and fatigue than did either good sleepers or low-distress poor sleepers [15].

These findings suggest an alternate reason why previous studies have not consistently found differences between insomniacs and normal sleepers on behavioral measures of daytime functioning. Most investigations have failed to distinguish between highly and minimally distressed poor sleepers. Because it is possible that only highly distressed poor sleepers experience daytime problems, the failure to distinguish high- and low-distress poor sleepers may have led to an underestimation of behaviorally measured daytime sequelae experienced by an important subset of poor sleepers — those who are highly distressed.

The present study

Because older poor sleepers tend to suffer from a different kind of sleep impairment than younger individuals (difficulty in maintaining sleep rather than difficulty in initiating sleep), the impact of disrupted sleep on daytime performance may be different in older adults than in younger persons. Therefore, the first objective of this study was to investigate subjective perceptions of daytime functioning in both young and older good and poor sleepers. Measures of sleepiness, fatigue, and performance were used. The second objective was to compare subjective perceptions of daytime functioning of highly distressed poor sleepers and poor sleepers who manifest little if any distress about their sleep. The third objective was to explore the relationship between the various aspects of daytime functioning and sleep parameters (e.g., total sleep time, total wake time, and sleep efficiency), psychologically laden sleep variables (tension during nocturnal awake times, distress about the sleep problem), and psychological adjustment (depression, anxiety).

We hypothesized that (1) poor sleepers would experience more daytime symptoms than good sleepers, and (2) highly distressed poor sleepers would report greater impairment in daytime functioning than either good sleepers or low-distress poor sleepers. Since highly distressed poor sleepers are characterized by psychological maladjustment, corollaries to Prediction 2 are that (3) daytime symptoms of fatigue, sleepiness, and cognitive functioning would be more closely related to observational, psychologically laden sleep variables (distress about sleep problem, tension during nocturnal awake times) than to the more quantitative sleep parameters (total sleep time, total wake time, and sleep efficiency), and (4) daytime symptoms would be more closely related to longer wake times than to shorter sleep times (i.e., that "sleep deprivation," as measured by total sleep time, would be less closely related to perceived daytime functioning than the presumed unpleasantness of spending long periods awake during the night).

Method

Measures

Background Information Form

This modified version of a short questionnaire used in our previous studies on aging provides socioeconomic, personal, and demographic descriptors (e.g., age, sex, and marital status) [15,38].

Sleep Questionnaire

This brief objective questionnaire inquires about typical sleep experiences, including hours slept per night, duration of nocturnal arousals, and frequency (0–7 days/week) of experienced difficulty in falling asleep and getting back to sleep after nocturnal awakenings. The information provided allows us to (1) compute Sleep Efficiency scores (% of bedtime spent asleep), and (2) obtain ratings of respondents' subjective perceptions of the frequency of sleep problems (Sleep Difficulty: 1 = *very rarely*, 10 = *very often*) and the associated distress (Sleep Distress: 1 = *not at all*, 10 = *very much*).

Scores based on this measure have acceptable psychometric properties for research use; test–retest correlations indicate reasonable temporal stability (r values for variables used in this investigation range from .58 to .84), and the pattern of correlations among variables shows logical, highly significant relationships [15]. Our convergent validity data indicate significant and high correlations between corresponding scores on the Sleep Questionnaire and on 7 days of self-monitoring on a daily sleep diary (e.g., Total Sleep Time, $r(156) = .82, P < .001$; Total Wake Time, $r(146) = .72$, $P < .001$; and Sleep Efficiency, $r(154) = .77, P < .001$) [39].

Tension Thermometer

A single item developed by our team asks, "When you are lying in bed trying to fall asleep, how tense do you generally feel?" Responses are made on an 11-point scale: 0 = *not at all tense*, 100 = *very tense*, with ratings made at 10-point intervals. Our data indicate reasonable temporal stability [$r(35) = .67$, $P < .001$], and the pattern of correlations between scores on this measure and relevant sleep variables shows logical, highly significant relationships [15,17,38].

Stanford Sleepiness Scale

This scale, developed by Hoddes et al. [23], is frequently used to assess subjective perceptions of daytime sleepiness. It consists of seven Guttman scaled items ranging from 1 (*feeling active and vital, alert, wide awake*) to 7 (*lost struggle to remain awake*). Respondents select the one option that best describes how sleepy they feel. For the present study, the measure was modified to permit evaluation of how sleepy subjects felt "on most days." Our data on older individuals indicate acceptable temporal stability for this modification [$r(46) = .56$, $P < .001$] [15].

Difficulty in Concentrating Due to Lack of Sleep

A single item inquires about participants' assessment of the frequency of difficulty in concentrating on things to be done due to lack of sleep during a typical week (days/week). This item too has acceptable temporal stability for research use [$r(42) = .51$, $P < .001$].

Fatigue Due to Lack of Sleep

A single self-report item inquires about participants' evaluations of the frequency of fatigue due to lack of sleep during a typical week (days/week). Data indicate good temporal stability for this item as well [$r(74) = .70$, $P < .001$] [15].

Eysenck Personality Inventory (EPI) [13]

This reliable and valid empirically based questionnaire is among the most frequently used measures of personality [10]. It evaluates the dimensions of Neuroticism and Extraversion–Introversion, and incorporates a Lie Scale that evaluates the tendency to respond in a socially desirable direction. Higher scores indicate greater Neuroticism, Extraversion, and Lie scores. Only the Neuroticism subscale is used in the present investigation.

Spielberger State–Trait Anxiety Inventory (STAI) — form Y2 [57]

This frequently used measure consists of two separate 20-item self-report scales for measuring trait and state anxiety. In the present investigation, only trait anxiety is evaluated. The trait measure asks people to describe how they generally feel on a four-point Likert-type scale (1 = *almost never*, 4 = *almost always*). Scores range from 20 to 80. The authors report the following means for the normative sample of older adults: males $M = 33.86$, standard deviation (S.D.) = 8.86; females $M = 31.79$, S.D. = 7.78. Higher scores indicate greater anxiety. Psychometric properties of this scale, including reliability and validity, have been shown to be excellent.

Test Anxiety Scale (TAS) [54,55]

This well-known 37-item true–false measure of test anxiety has been used for many years to assess anxiety about taking tests. Data indicate that the measure is reliable and valid, and that scores on this state anxiety measure are related to various aspects of trait anxiety (e.g., Refs. [50,55,56]). Higher scores indicate greater anxiety.

Beck Depression Inventory (BDI)

The 21-item BDI [2] is one of the most frequently used measures of depression. Items are scored on a four-point scale (0–3); scores are summed and produce a range from 0 to 63. Higher scores indicate greater depression. A meta-analysis of psychometric properties indicates a mean coefficient $\alpha = 0.81$ for non-psychiatric subjects. Concurrent validity data indicate that mean correlation between BDI scores and clinical ratings was .60, and the correlation with the Hamilton Psychiatric Rating Scale for Depression was .74. The data also suggest that the BDI differentiates depression from anxiety [3]. A score over 20 is usually considered indicative of clinical depression, while scores of 10 or less are generally considered non-depressed. Scores between 11 and 20 are generally considered "somewhat depressed." In the present investigation, the two items that deal with sleep were omitted, and scores were prorated to reflect the customary 21 items.

Subjects and procedure

Older adults

This sample included 194 older individuals (49 men and 145 women; mean age = 73, range = 57–96) who met the selection criteria for our larger investigation of sleep, aging, and non-drug treatment of insomnia [15,38]. For this larger investigation, both good and poor sleepers were recruited through media publicity consisting of press releases, presentations and mailings to seniors' groups, and notices in community clinics and residences for seniors. The only eligibility requirements were: over age 55, community resident, sufficient cognitive abilities to complete the measures, and sleep medication, if used, is used a maximum of three times per week (this criterion is consistent with sample selection in published studies on psychological interventions for insomnia; see Ref. [16]). Participants were instructed to provide answers concerning their usual practices and to base their responses on a typical week.

Approximately 75% of subjects belonged to university or college seniors' groups, making this an unusually well-educated sample. Little information is available on the physical health status of most of the participants; a minority had been screened for major health problems as part of a larger on-going investigation.

College students

A total of 136 second-year volunteer Abnormal Psychology students (63 men, 73 women, mean age = 20, range = 17–47) also completed a variety of measures. Approximately 95% of students present on the days of testing volunteered to participate.

Procedure

All participants completed the Background Information Form and the following measures: Sleep Questionnaire, Tension Thermometer, Stanford Sleepiness Scale, Difficulty Concentrating Due to Lack of Sleep, and Fatigue Due to Lack of Sleep. These measures provided scores for the following nocturnal variables. Sleep parameters: Total Sleep Time, Total Wake Time, and Sleep Efficiency % (total sleep time/bed time). "Psychologically laden" sleep variables: Distress about one's sleep problem, Nocturnal Tension (tension experienced while trying to fall asleep). The measures also provided the following evaluations of daytime

functioning: Sleepiness, Fatigue frequency, and Concentration difficulty frequency.

In addition, a subset of both samples completed evaluations of psychological adjustment: 157 older adults completed the Trait Anxiety Scale of the STAI and the BDI. Among college students, 109 participants completed the TAS, and 40 completed the EPI Neuroticism Scale. In some cases, participants failed to complete all of the measures. Therefore, degrees of freedom (*df*) for different comparisons vary.

Grouping participants into sleep status groups: good, poor, and "medium quality" sleepers

Sleep status was based on Sleep Questionnaire scores. Poor sleepers were those who met the typical research criteria [12,16,42,47] used for the diagnosis of DIMS (i.e., 30 min of undesired awake time at least three times per week, problem duration at least 6 months) and whose Sleep Questionnaire responses indicated a subjective rating of Sleep Difficulty above the mid-point of the 10-point scale. Data on older adults from an unpublished study conducted by our team, where a somewhat less stringent version of these criteria were used, indicate that 82% of participants grouped as poor sleepers answered "Yes" to a question that asked, "Do you have insomnia?"

Good sleepers were individuals who (1) failed to meet the criteria for diagnosis of DIMS and who met the following requirements: (2) subjective Sleep Difficulty score below the mid-point of the 10-point scale, (3) subjective Sleep Distress score of 3 or lower on a 10-point scale, and (4) no sleep medication use. Data from an unpublished study, which used a somewhat less stringent version of these criteria, indicate that 94% of participants grouped as Good Sleepers answered "No" to a question that asked, "Do you have insomnia?"

Some individuals had elements of both good and poor sleepers and were designated "medium quality" sleepers. Their data are included in all analyses that do not specifically require good and poor sleep. Longitudinal data on older adults indicate that membership in these sleep status groups is reasonably stable over a 2-year period [37].

Among older adults, 85 participants were classified as good, 48 as "medium quality," and 61 as poor sleepers. Poor sleepers had experienced poor sleep for an average of 20 years (range = 2–65 years), suggesting that they were experiencing a chronic rather than acute sleep problem. Of the 61 poor sleepers, 20 (33%) had only a sleep onset problem, 24 (39%) had only a sleep maintenance problem, and 17 (28%) had both. Only 17 of the 61 poor sleepers (28%) took medication to help with sleep; medication in these cases was generally taken once a week (individuals who took sleep medication more than three times a week were excluded from the study). Good and poor sleepers spent similar amounts of time in bed (M = 7.72 and 8.01 h, respectively, $t(145) = 1.26$, $P > .10$). Initially, we attempted to evaluate early morning awakenings as well, since the literature indicates that this is a frequent characteristic of older individuals with sleep problems. However, we were unsuccessful in defining the phenomenon in a manner that ensured that all participants consistently perceived early morning awakenings as a distinct difficulty and distinguishable from a sleep maintenance problem. Apparently, this problem is not unique to our research (cf. Ref. [22]).

In the student sample, 75 participants were good, 40 were "medium quality," and 21 were poor sleepers. Poor sleepers had experienced poor sleep for an average of 5 years (range = 1/2 –10 years). Of the 21 poor sleepers, 15 (71%) had only a sleep onset problem, 1 (5%) had only a sleep maintenance problem, and 5 (24%) had both. Only three subjects took medication to help with sleep; medication in these cases was taken once or twice a week. Good and poor sleepers spent similar amounts of time in bed (M = 7.94 and 7.44 h, respectively, $t(86) = 1.29$, $P > .10$).

Classifying participants as high- and low-distress poor sleepers

Distress was evaluated using a single item that asked, "How distressed are you by an insomnia problem?" Responses were provided on a 10-point scale, with 1 being "*not at all*" and 10 being "*very much*." In the sample of older adults, there were sufficient poor sleepers to allow us to classify 38 as low-distress poor sleepers (poor sleepers whose Sleep Distress score fell below the mid-point of the scale) and 23 as high-distress poor sleepers (poor sleepers whose Sleep Distress score fell above the mid-point of the scale). Low- and high-distress poor sleepers spent similar amounts of time in bed [M = 7.80 and 8.33 h, respectively, $t(59) = 1.17$, $P > .10$]. The limited number of poor sleepers (n = 21) in the college student sample rendered insufficient power for analysis once participants were separated into high- and low-distress subgroups.

Results

Findings in Table 1 illustrate the differences on sleep variables, and show that good and poor sleepers, regardless of age, differ significantly on virtually all sleep parameters and psychologically laden sleep variables. After a Bonferroni adjustment to the α levels, all significant comparisons, except those on Sleepiness, remained significant.

Tests on psychological adjustment in Table 2 show significant differences on anxiousness; while means were in the same direction, the comparison on depression was not significant.

Data in Tables 3 and 4 show that all daytime variables are not equivalent, and that daytime Sleepiness is quite unlike the other variables. First, Table 3 shows that correlations between Sleepiness and the other two daytime variables are substantially lower than those between Fatigue and Con-

Table 1
Mean scores of good and poor sleepers on sleep and daytime functioning variables

	Good sleepers	Poor sleepers	*t*	df	P
Sleep parameters					
Total Sleep Time (h)					
Older adults	6.84 (0.99)	5.04 (1.46)	8.92	145	<.001
Students	7.28 (1.15)	6.14 (1.48)	3.72	91	<.001
Total Wake Time (h)					
Older adults	0.08 (0.23)	2.44 (1.96)	10.94	145	<.001
Students	0.07 (0.08)	1.35 (1.08)	10.19	92	<.001
Sleep Efficiency (%)					
Older adults	90 (0.13)	66 (0.22)	8.03	144	<.001
Students	92 (0.13)	85 (0.16)	1.97	84	=.10
Experiential measures of daytime functioning					
Fatigue (0–7 days/week)					
Older adults	0.76 (1.53)	3.45 (2.39)	8.28	144	<.001
Students	2.70 (1.57)	4.95 (1.57)	5.64	88	<.001
Sleepiness (0–7 scale)					
Older adults	2.17 (1.33)	2.88 (1.35)	3.03	135	<.01
Students	2.72 (1.29)	3.70 (1.32)	2.97	88	<.01
Concentration difficulty (0–7 days/week)					
Older adults	0.45 (1.14)	2.05 (2.03)	6.07	144	<.001
Students	1.81 (1.42)	4.35 (1.27)	7.21	87	<.001
Psychologically laden sleep variables					
Nocturnal tension (0–100)					
Older adults	20.52 (22.52)	35.40 (26.27)	3.63	146	<.001
Students	15.42 (15.28)	57.50 (19.97)	10.14	94	<.001
Distress about sleep problem (1–10)					
Older adults	1.49 (1.47)	5.06 (2.47)	11.79	145	<.001
Students	1.37 (.73)	6.35 (2.50)	15.17	93	<.001

Note: Values in parentheses are S.D.

centration. Second, Table 4 shows that Fatigue and Concentration function in essentially similar ways when they are related to sleep parameters, psychologically laden sleep variables, and psychological adjustment. The pattern for Sleepiness is different. First, Sleepiness is generally not significantly related to sleep parameters. Second, even though the sizes of the coefficients rise and become significant when psychologically laden variables are considered, these remain the lowest in this group. The pattern of correlations between daytime Sleepiness and psychological adjustment, however, are similar to the pattern for the other two daytime variables.

Table 2
Mean scores of good and poor sleepers on psychological adjustment

	Good sleepers	Poor sleepers	*t*	df	P
Depression					
Older adults (BDI)	6.88 (6.79)	8.74 (5.88)	1.51	134	n.s.
Anxiety					
Older adults (STAI)	34.26 (9.47)	37.77 (9.00)	2.05	122	<.05
Students (EPI)	11.08 (3.78)	17.00 (3.96)	3.61	29	<.05
Students (TAS)	15.42 (7.48)	20.37 (8.15)	2.37	76	<.05

Note: Values in parentheses are S.D. n.s. = not significant.

Table 3
Correlations among measures of daytime functioning

	Fatigue	Sleepiness	Concentration
Fatigue			
Older adults		.27	.68
Students		.43	.70
Sleepiness			
Older adults	.27		.36
Students	.43		.50
Concentration			
Older adults	.68	.36	
Students	.70	.50	

Note: All values are significant at the .05 level or better.

Table 4 also shows that, contrary to expectations (Hypothesis 4), correlations between daytime variables and total sleep time were consistently higher than correlations with total wake times among both the older adult and the student samples.

To explore the relative contribution of sleep parameters and psychological variables to the daytime experience, a series of partial correlations were carried out on variables presented in Table 4. Results show that both total sleep time and distress play independent roles. For example, when total sleep time was controlled for, all correlations between daytime functioning and psychological variables remained significant, although the coefficients were generally somewhat lower; this was true for both older adults and college

Table 4
Correlations with daytime functioning

	Fatigue	Sleepiness	Concentration
Sleep parameters			
Total Sleep Time			
Older adults	**−.53**	−.08	**−.44**
Students	**−.34**	**−.25**	**−.37**
Total Wake Time			
Older adults	**.43**	.04	**.41**
Students	**.29**	.14	**.29**
Sleep Efficiency			
Older adults	**−.34**	−.16	**−.27**
Students	**−.20**	−.10	**−.19**
Psychologically laden sleep variables			
Nocturnal tension			
Older adults	**.29**	**.21**	**.34**
Students	**.34**	**.23**	**.45**
Distress about sleep problem			
Older adults	**.56**	**.35**	**.51**
Students	**.41**	**.24**	**.47**
Psychological adjustment			
Depression			
Older adults (BDI)	**.17**	**.48**	**.29**
Anxiety			
Older adults (STAI)	**.22**	**.47**	**.28**
Students (EPI)	**.27**	**.50**	**.54**
Students (TAS)	**.28**	**.30**	**.35**

Note: Bold values are significant at the .05 level or better.

Table 5
Mean scores of older good sleepers and older high and low-distress poor sleepers

Variables	Good sleepers	Poor sleepers		Tukey HSD test ($P < .05$)
		Low distress	High distress	
"Objective" sleep variables				
Total Sleep Time (h)	6.85	5.01	5.16	G > LD = HD
Total Wake Time (h)	0.09	2.43	2.52	G < LD = HD
Sleep Efficiency (%)	89.74	65.78	69.11	G > LD = HD
Daytime functioning variables				
Fatigue (0–7 days/week)	0.76	3.05	4.14	G < LD = HD
Sleepiness (0–7 scale)	2.17	2.55	3.31	G = LD < HD
Concentration difficulty (0–7 days/wk)	0.45	1.54	2.77	G < LD < HD
Psychologically laden sleep variables				
Nocturnal tension (0–100)	20.53	29.87	45.87	G = LD < HD
Distress about sleep problem (1–10)	1.49	3.45	7.70	G < LD < HD
Psychological adjustment				
Depression (BDI)	7.33	6.99	11.80	G = LD < HD
Anxiety (STAI)	34.26	37.06	39.44	n.s.

Note: All one-way ANOVAs were significant at the .05 level or better, except for the comparison on the STAI, which failed to reach significance, $F(2,120) = 2.51$, $P < .10$. G = Good sleepers, LD = Low-distress poor sleepers, HD = High-distress poor sleepers.

students. When distress was controlled for, all significant correlations with total sleep time remained significant — again, with smaller coefficients — although some of the significant correlations with the other two sleep parameters were no longer significant.

Table 5 presents data on good sleepers and on high- and low-distress poor sleepers. Only data for older adults are presented; the small number of poor sleepers among college students did not permit analyses for the student participants. The comparison on age was not significant. Results presented in Table 5 show that high-distress poor sleepers did not differ from low-distress poor sleepers on nighttime sleep parameters (Total Sleep Time, Total Wake Time, and Sleep Efficiency). A different picture emerged during the day, however. Here, highly distressed poor sleepers experienced significantly greater impairments than low-distress poor sleepers on two of the three variables. This pattern of findings is similar to significant findings on psychologically laden sleep variables and on psychological adjustment, where high-distress poor sleepers experienced significantly poorer scores than either low-distress poor sleepers or good sleepers. Although the mean scores on the STAI were in the same direction, the comparison failed to reach significance.

Discussion

Limitations

Before making firm conclusions about the findings, it should be noted that this study had a number of limitations. While the number of participants in this investigation was reasonably large and the findings were replicated for two distinct and very different samples, the samples were by no means typical of younger and older adults. Our samples consisted of college students and older individuals who lived in the community, were generally healthy, well adjusted, well educated and financially comfortable. These results may therefore not be generalizable to other less advantaged populations.

It should also be noted that the absence of physiological measures of sleep, wake, and daytime functioning to corroborate and supplement subjects' self reports is a serious limitation of this investigation and may have led to an overestimation of differences in sleep and wake times between good and poor sleepers. Nevertheless, it has been suggested that objective evaluations of sleep according to polysomnographic criteria should not be used as the sole basis of sleep quality [16,31]. This is consistent with a recent policy statement by the Standards of Practice Committee of the American Sleep Disorders Association [59], which suggested little role for PSG in the assessment of insomnia. People complain about sleep, and it is in fact this complaint that is of primary interest to clinicians and policy makers. As noted by Zammit [62], clinicians and researchers must be sensitive to the experiences of individuals if they are to be successful at treating the symptoms.

Findings

The overall results of this investigation suggest that people complaining of insomnia not only experience significantly worse sleep during the night than good sleepers but that they also perceive more impairments in functioning during the day. Poor sleepers and, more particularly, highly distressed poor sleepers, reported significantly more fatigue, sleepiness, and difficulty in concentrating during the day

than good sleepers. This was true in both the young and the older samples in our study. Thus, Hypothesis 1 is confirmed.

Poor sleepers in the present study were also found to be less well adjusted psychologically than good sleepers both on measures of anxiety during the day as well as tension during the night. This is consistent with findings reported in the literature [7,15,49]. The findings on depression, although in the same direction, were not significant. This may have been due to a measurement artifact; to avoid confounding poor sleep and depression, we removed the two items that dealt with sleep problems on the BDI.

The findings on good and poor sleepers are qualified, however, when highly distressed and minimally distressed older poor sleepers are examined separately. First, consistent with some of our other findings [15,34], the results of the present study indicate that highly distressed poor sleepers were less well-adjusted psychologically than either good sleepers or low-distress poor sleepers. Second, while high- and low-distress poor sleepers did not differ significantly on nighttime sleep parameters such as total sleep and wake times, highly distressed poor sleepers consistently indicated that they suffered greater daytime sleepiness and difficulties in concentrating than did low-distress poor sleepers. Scores on daytime fatigue, while in the same direction, did not reach significance. These results partially confirm Hypothesis 2, which stated that highly distressed poor sleepers report greater impairment during the day than either good sleepers or low-distress poor sleepers. Because of the limited number of poor sleepers in the college student sample, data analyses could not be carried out and Hypothesis 2 could not be tested for this group.

Why are there few differences on observational measures of daytime functioning in spite of self-reported impairments?

Our results suggest that failure in the literature to examine aspects of daytime functioning separately in highly and minimally distressed poor sleepers may have obscured differences between good and poor sleepers. This is likely to be true for both experiential as well as for observational measures of daytime functioning.

For example, it is possible that low-distress poor sleepers — and perhaps even high-distress poor sleepers — need less sleep than do good sleepers, but that only low-distress poor sleepers accept this. They are not actually sleepy, because they are getting adequate sleep. The reported problems with daytime fatigue and concentration, according to this explanation, are likely to be related to distress about the sleep problem and to daytime and nocturnal psychological adjustment.

Although this possibility seems compelling, our results on partial correlations suggest that psychological factors alone are not likely to fully explain the findings. As expected, when the effects of total sleep time were kept constant, correlations between daytime functioning and psychological variables remained significant. This is consistent with a "short sleeper" explanation of the findings. However, when distress was kept constant, the relationship between total sleep time and daytime functioning variables also remained significant, indicating that distress alone can not adequately explain the findings and demonstrating that time spent asleep is also important. This suggests independent roles for distress and sleep time in the reports of subjective aspects of daytime functioning. To better evaluate these possibilities, additional investigations using data from larger and more diverse samples, which take into account individual differences in sleep need and psychological adjustment, are needed.

Another possibility for the poor correspondence between qualitative and observational measures of daytime functioning may revolve around a more basic issue. It is generally assumed in the lay population that subjective perception reflects an objective reality. In other words, it is assumed that feeling sleepy is isomorphic with the likelihood of dozing off in various everyday situations and with the speed at which one falls asleep when given a nap opportunity. This assumption may be inaccurate. It has been found that a variety of experiential measures of daytime functioning are correlated with each other — as are observational measures; however, correlations between experiential and observational measures of the same construct are generally low and non-significant (cf. Ref. [29]). Therefore, subjectively experienced daytime symptoms and behavioral or biological expressions of these aspects of daytime functioning may not be fully controlled by the same physiological mechanisms. Further study, which includes physiological nocturnal measures (e.g., polysomnography) and behavioral daytime measures, is needed to explore this possibility in both high- and low-distress poor sleepers.

Relationship between sleep parameters, psychological adjustment, and experiential evaluations of daytime functioning

Our findings indicate that "daytime symptoms" do not reflect a unitary construct. Feeling sleepy during the day, widely believed to be the best indicator of sleep loss, was unrelated to total wake time and to sleep efficiency in both samples. Only one correlation between sleepiness and the three sleep parameters evaluated was significant — and even this was low and significant only in the student sample. Thus, our findings show that while poor sleepers do report greater daytime sleepiness, this does not seem to be due to insufficient sleep per se. These results support Chambers and Keller's [6] hypothesis that daytime sleepiness experienced by poor sleepers is not due to sleep deprivation.

On the other hand, subjective feelings of fatigue and cognitive inefficiency during the day were highly and significantly related to total wake time and total sleep time during the night as well as to each other. In Hypothesis 3, we predicted that perceived daytime functioning would be more closely related to psychologically laden sleep variables and to psychological adjustment than to

sleep parameters. This hypothesis was only partially upheld. Sleepiness was significantly related only to psychological variables, while the other two daytime variables, fatigue and concentration, were significantly related both to psychological variables as well as to sleep parameters. This was true for both samples and raises the question, "What is it about sleepiness that is different from fatigue and difficulties with concentration?" It is possible that our findings reflect the specific measures used in the present study. It is our contention, however, that the results reflect a single cause of sleepiness — or lack of sleepiness — during both the day and the night: cognitive and/or physiological hyperarousal (cf. Refs. [4,6,8,9,32,51,61]).

In Hypothesis 4, we predicted that daytime symptoms would be more closely related to longer wake times than to shorter sleep times. Contrary to expectations, both fatigue during the day and difficulty in concentrating showed slightly stronger relationships with shorter sleep time than with longer wake time. This result was consistent in both samples. Thus, Hypothesis 4 was not confirmed, and the findings are consistent with both a sleep deprivation as well as with a psychological explanation of reported daytime impairments in functioning. Elsewhere, we describe a cognitive model of insomnia that proposes a mediational mechanism concerning how this can occur [14,18].

Conclusions

The findings of this investigation underscore the multifaceted nature of the insomnia complaint and suggest that at least five aspects of the insomnia experience must be taken into consideration during assessment and treatment: (1) nocturnal sleep–wake experiences such as total sleep and wake times, (2) psychologically laden sleep variables such as sleep-related distress and tension, (3) aspects of daytime psychological adjustment, such as anxiety, depression, and cognitive and/or physiological hyperarousal, (4) various aspects of both experiential as well as (5) observational aspects of daytime functioning (e.g., fatigue, sleepiness, and cognitive inefficiency).

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