Sleep, 14(6):540–545

A New Method for Measuring Daytime Sleepiness: The Epworth Sleepiness Scale

Murray W. Johns

Sleep Disorders Unit, Epworth Hospital, Melbourne, Victoria, Australia

Summary: The development and use of a new scale, the Epworth sleepiness scale (ESS), is described. This is a simple, self-administered questionnaire which is shown to provide a measurement of the subject's general level of daytime sleepiness. One hundred and eighty adults answered the ESS, including 30 normal men and women as controls and 150 patients with a range of sleep disorders. They rated the chances that they would doze off or fall asleep when in eight different situations commonly encountered in daily life. Total ESS scores significantly distinguished normal subjects from patients in various diagnostic groups including obstructive sleep apnea syndrome, narcolepsy and idiopathic hypersomnia. ESS scores were significantly correlated with sleep latency measured during the multiple sleep latency test and during overnight polysomnography. In patients with obstructive sleep apnea syndrome ESS scores were significantly correlated with the respiratory disturbance index and the minimum SaO_2 recorded overnight. ESS scores of patients who simply snored did not differ from controls. **Key Words:** Sleepiness—Questionnaire—Sleep propensity—Insomnia—Obstructive sleep apnea syndrome.

A large proportion of adult patients who present to sleep disorder centers have disorders associated with excessive daytime sleepiness. These include obstructive sleep apnea syndrome (OSAS), periodic limb movement disorder (PLMD), narcolepsy, idiopathic hypersomnia and other miscellaneous disorders (1). The severity of their chronic daytime sleepiness is an important aspect of each patient's assessment. Thus, there is a great need for a simple standardized test for measuring a patient's general level of sleepiness, which is independent of short-term variations in sleepiness, with the time of day and from day to day.

The multiple sleep latency test (MSLT) is widely used and is generally believed to provide a valid measurement of sleepiness on the particular day of the test (2,3). It is based on the premise that the sleepier the subject, the quicker he will fall asleep when encouraged to do so while lying down in a nonstimulating environment. The MSLT has a reasonably high test–retest reliability over periods of months in normal subjects (4). Assuming the same reliability holds true for patients, the MSLT must be considered the standard method for measuring their chronic daytime sleepiness. However, the MSLT is very cumbersome, time-consuming and expensive to perform. It takes all day, both for the subject and the polysomnographer and is not easy to justify as a routine test for all patients.

Other measures of sleepiness have been devised (5,6). In the maintenance of wakefulness test (MWT) the latency to sleep onset is measured with the subject sitting in a dimly lit, warm, quiet room, trying to stay awake rather than to fall asleep (5). However, all such tests share the disadvantage of the MSLT in being cumbersome and expensive. Similar criticisms can be levelled at tests of sleepiness based on pupillometry (7), or cerebral evoked potentials (8). Other assessments of sleepiness have involved prolonged psychomotor performance tests, the results of which are not related in any simple or consistent way to sleepiness in different subjects (9).

By contrast, the Stanford sleepiness scale (SSS) is a quick and simple test (10). It involves the subject's own reports of symptoms and feelings at a particular time. Visual analogue scales (VAS) of sleepiness/alertness have also been used in this context (11). However, these tests do not attempt to measure the general level of daytime sleepiness, as distinct from feelings of sleepiness at a particular time. Nor, it appears, is the subjective sleepiness that they measure the same as the objective sleepiness measured by the MSLT (3,7). Scores on the SSS or on a VAS of sleepiness are not significantly correlated with sleep latency in the MSLT,

Accepted for publication July 1991.
Address correspondence and reprint requests to Dr. Murray W. Johns, Sleep Disorders Unit, Epworth Hospital, Melbourne, Victoria 3121, Australia.

TABLE 1. *The Epworth sleepiness scale*

THE EPWORTH SLEEPINESS SCALE

Name: _____
Today's date: _____ Your age (years): _____
Your sex (male = M; female = F): _____

How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just tired? This refers to your usual way of life in recent times. Even if you have not done some of these things recently try to work out how they would have affected you. Use the following scale to choose the *most appropriate number* for each situation:

0 = would *never* doze
1 = *slight* chance of dozing
2 = *moderate* change of dozing
3 = *high* chance of dozing

Situation	Chance of dozing
Sitting and reading	
Watching TV	
Sitting, inactive in a public place (e.g. a theater or a meeting)	
As a passenger in a car for an hour without a break	
Lying down to rest in the afternoon when circumstances permit	
Sitting and talking to someone	
Sitting quietly after a lunch without alcohol	
In a car, while stopped for a few minutes in the traffic	

Thank you for your cooperation

even when measured at virtually the same time (12). These subjective reports may be related more to tiredness and fatigue than to sleep propensity, as manifested by the tendency to fall asleep.

The present report describes the development and use of a new questionnaire, the Epworth sleepiness scale (ESS), designed to measure sleep propensity in a simple, standardized way. The scale covers the whole range of sleep propensities, from the highest to the lowest.

Development of the ESS

The concept of the ESS was derived from observations about the nature and occurrence of daytime sleep and sleepiness. Some people who suffer from excessive daytime sleepiness keep themselves busy and choose not to lie down nor to sit and relax during the day, thereby purposely avoiding daytime sleep. Others who may be bored, with spare time or who are socially withdrawn but who may not be very sleepy, choose to lie down and sleep during the day. About 50% of ostensibly healthy medical students usually sleep during the day at least once in an average week (13). Among 17–22-year-old recruits entering the French army, 19% reported sleeping during the day, regularly or occasionally. But only 5% complained of daytime sleepiness (14). Thus, knowing how frequently or for how long subjects usually sleep during the day will probably not provide a useful measurement of their sleepiness.

By contrast, sleepy people often describe how they doze off inadvertently while engaged in activities that involve low levels of stimulation, relative immobility and relaxation, such as sitting and watching TV. Earlier questionnaire surveys have indicated which situations, commonly encountered in daily life, are the most soporific (15). A large survey among adults in New Mexico asked about their frequency of falling asleep in five situations (16). The authors derived a score from the three "most sleepy" questions, which referred to falling asleep while "inactive in a public place", "at work", and "in a moving vehicle as passenger or driver". MSLTs on 116 of these subjects showed a statistically significant correlation between their sleep latency (SL) and their answers to those three questions ($r = -0.32$, $p < 0.001$).

The ESS is based on questions referring to eight such situations, some known to be very soporific; others less so. The questionnaire, which is self-administered, is reproduced in Table 1. Subjects are asked to rate on a scale of 0–3 how likely they would be to doze off or fall asleep in the eight situations, based on their usual way of life in recent times. A distinction is made between dozing off and simply feeling tired. If a subject has not been in some of the situations recently, he is asked, nonetheless, to estimate how each might affect him.

The ESS tries to overcome the fact that people have different daily routines, some facilitating and others inhibiting daytime sleep. For example, the ESS does not ask how frequently the subject falls asleep while watching TV. That would depend on how frequently he watched TV as much as on his sleepiness. Instead, the subject rates the chances that he would doze off whenever he watches TV.

One question asks how likely the subject would be to doze off while lying down to rest in the afternoon when circumstances permit. It was felt that normal people probably would, and sleepy people certainly would tend to doze off in that situation. Never to do so would indicate an unusually low level of sleepiness, as described by some insomniacs. Some other situations were included in the questionnaire because it was believed that only the most sleepy people would doze in them—while sitting and talking to someone, and in a car while stopped for a few minutes in traffic. These suppositions proved correct.

The numbers selected for the eight situations in the ESS were added together to give a score for each subject, between 0 and 24. These ESS scores proved capable of distinguishing individuals and diagnostic groups over the whole range of daytime sleepiness.

TABLE 2. *The groups of experimental subjects, their ages and ESS scores*

Subjects/diagnoses	Total number of subjects (M/F)	Age in years (mean ± SD)	ESS scores (mean ± SD)	Range
Normal controls	30 (14/16)	36.4 ± 9.9	5.9 ± 2.2	2–10
Primary snoring	32 (29/3)	45.7 ± 10.7	6.5 ± 3.0	0–11
OSAS	55 (53/2)	48.4 ± 10.7	11.7 ± 4.6	4–23
Narcolepsy	13 (8/5)	46.6 ± 12.0	17.5 ± 3.5	13–23
Idiopathic hypersomnia	14 (8/6)	41.4 ± 14.0	17.9 ± 3.1	12–24
Insomnia	18 (6/12)	40.3 ± 14.6	2.2 ± 2.0	0–6
PLMD	18 (16/2)	52.5 ± 10.3	9.2 ± 4.0	2–16

METHODS

Subjects

A total of 180 adult subjects completed the questionnaire. There were 30 controls who were mainly hospital employees, working during the day, who gave a history of normal sleep habits without snoring. There were 150 patients with various sleep disorders, whose ages, sex and diagnostic categories are shown in Table 2. Every new patient who presented to the Epworth Sleep Disorders Unit answered the ESS at their first consultation. After investigation, all patients with the diagnoses listed in Table 2 were included in the study until there were 150. The ages of patients ranged from 18 to 78 years. The mean age within diagnostic groups varied from 36 to 52 years. Men greatly outnumbered women in the snoring, OSAS and PLMD groups. The sexes were about equal in the other groups, apart from the insomniacs where women outnumbered men.

A total of 138 patients had overnight polysomnography, but another 12 who were clearly suffering from either chronic psychophysiological or idiopathic insomnia did not. The latter diagnoses were made on the basis of each patient's history, using the criteria set out in the International Classification of Sleep Disorders (1). Other insomniacs, with mood disorders or drug effects, were excluded.

Twenty-seven patients had MSLTs after overnight polysomnography. They had four naps, at 1000, 1200, 1400 and 1600 hours. Sleep latency was measured from the time lights were switched off until the onset of stage 1 sleep of at least 1 minute duration, or the onset of either stage 2 or rapid eye movement (REM) sleep. The early onset of REM sleep was indicated by the occurrence of REM sleep within 20 minutes of sleep onset. Of the 27 patients, 11 had narcolepsy diagnosed from the patient's history, particularly of cataplexy, associated with an SL of less than 10 minutes and the early onset of REM sleep in two or more naps (10 patients) or in one nap (1 patient with cataplexy). Fourteen of the 27 patients had idiopathic hypersomnia, diagnosed from their excessive daytime sleepiness in the absence of either cataplexy or the early onset of REM sleep in the MSLT. The remaining two patients had excessive daytime sleepiness due to OSAS. The ESS scores for the 27 patients who had MSLTs ranged from 11 to 24.

All patients with primary snoring had presented initially because of the intensity and persistence of their snoring, on most nights at least. Many had been observed at home to pause in their breathing at night, suggesting that they may have had sleep apnea, but this was found not to be of clinical significance by polysomnography. The respiratory disturbance index (RDI) was calculated as the number of apneas and hypopneas causing a drop of >3% in the arterial oxygen saturation per hour of sleep. The RDI for primary snorers was ≤5. The 55 patients with OSAS were divided into three subcategories according to their RDI, regardless of their complaints about daytime sleepiness or insomnia (Table 3). The RDI for mild OSAS was within the range >5–15; for moderate OSAS the range was >15–30, and for severe OSAS it was >30.

A diagnosis of PLMD was made only if there were at least 90 separate movements in one or both legs per night. The mean periodic movement index for these subjects, calculated as the number of movement events per hour of sleep, was 43.6 ± 30.4 (SD). Patients who had both PLMD and OSAS were excluded from this study. However, 9 of the 18 subjects with PLMD snored during polysomnography without having OSAS.

Statistical methods

The ESS scores of male and female control subjects were compared by a Student's *t* test. Differences in ESS scores between the diagnostic groups were tested by one-way ANOVA and then by posthoc Scheffé tests. A separate ANOVA and posthoc Scheffé tests were

TABLE 3. *ESS scores in mild, moderate and severe OSAS*

	Mean RDI ± SD	Total number of subjects (M/F)	ESS scores (mean ± SD)	Range
Mild OSAS	8.8 ± 2.3	22 (21/1)	9.5 ± 3.3	4–16
Moderate OSAS	21.1 ± 4.0	20 (20/0)	11.5 ± 4.2	5–20
Severe OSAS	49.5 ± 9.6	13 (12/1)	16.0 ± 4.4	8–23

used to test the differences in ESS scores between primary snorers and the three categories of OSAS. The Scheffé test is conservative and is suitable for groups with unequal numbers of subjects (17). The distribution of sleep latencies ,measured in minutes, was highly skewed positively and was normalized by $\log_e$ transformation. The relationships between pairs of continuous variables, such as RDI and sleep latency during overnight polysomnography, were tested by Pearson correlation coefficients and linear regression. Statistical significance was accepted at $p < 0.05$ in two-tailed tests.

RESULTS

The mean ESS score for control subjects was 5.9 ± 2.2 (SD) and their modal score was 6. There was no significant difference in the scores between male and female controls (males = 5.64 ± 2.56; females = 6.06 ± 1.84, $t = 0.520$, $p = 0.607$). Consequently, no distinction was made between the sexes in other groups.

Patients suffering from disorders known to be associated with excessive daytime sleepiness reported the likelihood of dozing under circumstances that were not conducive to sleep in normal subjects. For example, 96% of the patients with either narcolepsy or idiopathic hypersomnia reported some chance, and often a high chance, of dozing while sitting and talking to someone, or in a car while stopped for a few minutes in the traffic. Only 6% of controls reported a slight chance of doing so.

Patients with persistent psychophysiological or idiopathic insomnia reported either a complete inability or only a slight chance of dozing while lying down to rest in the afternoon when circumstances permitted. By contrast, 94% of controls reported some likelihood of dozing then.

One-way ANOVA demonstrated significant differences in ESS scores between the seven diagnostic groups in Table 2 ($F = 50.00$; df = 6,173; $p < 0.0001$). Posthoc tests between paired groups showed that the ESS scores for primary snorers did not differ from controls ($p = 0.998$). Scores for OSAS, narcolepsy and idiopathic hypersomnia were significantly higher than for controls ($p < 0.001$) or primary snorers ($p < 0.001$). The insomniacs had significantly lower scores ($p < 0.01$) than all groups other than controls, for which the difference did not quite reach statistical significance ($p = 0.063$). The ESS scores of patients with PLMD did not differ significantly from controls ($p = 0.149$).

A separate one-way ANOVA for the ESS scores of primary snorers and the three subcategories of OSAS showed significant differences between these groups ($F = 23.11$; df = 3,82; $p < 0.001$). Posthoc tests then showed that ESS scores for each level of OSAS were significantly higher than for primary snorers ($p = 0.035$ for mild OSAS; $p < 0.001$ for moderate and severe OSAS). Scores for severe OSAS were higher than for moderate OSAS ($p < 0.001$), but the difference between mild and moderate OSAS did not reach statistical significance ($p = 0.085$).

Considering all 55 patients with OSAS together, there was a significant correlation, on the one hand, between ESS scores and RDI ($r = 0.550$, $p < 0.001$) and on the other hand, between ESS scores and the minimum SaO_2 recorded during apneas overnight ($r = -0.457$, $p < 0.001$). The RDI and the minimum overnight SaO_2 during apneas were also significantly correlated ($r = -0.687$, $p < 0.001$). The linear regression equations for these three relationships, in the form $Y = a + bx$, were as follows:

$$(\text{RDI}) = -0.674 + 2.006(\text{ESS score})$$
$$(\text{minimum } SaO_2\%) = 86.47 - 1.055(\text{ESS score})$$
$$(\text{minimum } SaO_2\%) = 84.15 - 0.440(\text{RDI})$$

Among the 138 patients who had overnight polysomnography there was a significant correlation between ESS score and (ln) sleep latency at night ($r = -0.379$, $n = 138$, $p < 0.001$). In the smaller group of patients who had MSLTs, the correlation between ln (SL) during the day and ESS score was also statistically significant ($r = -0.514$, $n = 27$, $p < 0.01$. The linear regression equation for this relationship was ln (SL) = 3.353 − 0.091(ESS score).

Individual ESS scores of 16 or more, indicating a high level of daytime sleepiness, were found only in patients with narcolepsy, idiopathic hypersomnia or OSAS of at least moderate severity (i.e. RDI > 15). All patients with either narcolepsy or idiopathic hypersomnia had higher ESS scores than the controls (i.e. ESS > 10) as did 12 of 13 patients with severe OSAS. The remaining patient in the latter category had an ESS score of 8 and was clinically not much affected by his sleep apnea.

Within the group of patients with PLMD, the periodic movement index, which ranged from 16 to 122 movements per hours of sleep, was not significantly correlated with ESS scores ($r = 0.049$, $n = 18$, $p > 0.1$).

DISCUSSION

These results provide evidence that a questionnaire-based scale as brief and as simple as the ESS can give valid measurements of sleep propensity in adults. ESS scores significantly distinguished groups of patients who are known from other investigations to have differences in their levels of sleepiness, as measured by the MSLT (2,18). ESS scores were significantly correlated

with sleep latency measured during the day with MSLTs and at night with polysomnography. This is despite any effect of the first night in the laboratory. Others have found a significant positive correlation between the SL at night and during the day in the same subject (19).

ESS scores greater than 16, indicative of a high level of daytime sleepiness, were encountered only in patients with moderate or severe OSAS (RDI > 15), narcolepsy or idiopathic hypersomnia. These disorders are known to be associated with excessive daytime sleepiness as measured by the MSLT (2,18). Nevertheless, high ESS scores, by themselves, are not diagnostic of a particular sleep disorder, any more than is an SL of 5 minutes in an MSLT.

ESS scores were correlated with both the RDI and the minimum SaO_2 recorded during polysomnography in patients with OSAS of differing severity. In the past, these measures of the severity of OSAS have been found to be related to the SL in MSLTs in some, but not in all investigations (18,20). The finding that ESS scores can distinguish patients who simply snore from those with even mild OSAS is evidence for the sensitivity of the ESS. The questionnaire should be useful in elucidating the epidemiology of snoring and OSAS, and any associated cardiovascular or cerebrovascular risks. Previous investigations of this kind have tended to blur the distinction between primary snoring and OSAS (21).

In the patients with PLMD, the finding of an almost zero correlation between their periodic movement index and ESS scores suggests that whatever level of daytime sleepiness is associated with PLMD, it is not related simply to the frequency of limb movements. It may be more closely related to the frequency of those movements producing arousal rather than those that do not. This distinction was not made here and further investigation is required to clarify this relationship.

The low ESS scores of patients with idiopathic or psychophysiological insomnia are consistent with evidence that such patients have a low sleep propensity, even when they are able to relax (22). It must not be assumed, however, that this is necessarily so for other kinds of insomnia, such as with mood disorders.

The relatively wide range of ESS scores in the control subjects [2–10] is consistent with evidence that some healthy adults, without recognizable sleep disorders, remain sleepier than others during the day (23). Such differences persist in MSLTs, even after extending the hours of nocturnal sleep to overcome possible sleep deprivation (24). The sleep propensity of a subject on a particular day would be influenced by the quality and duration of prior sleep or of sleep deprivation, the time of day, the presence of various sleep disorders, drug effects, the level of interest and motivation induced by the situation at hand, as well as longer-term physiological differences. The ESS does not distinguish the nature of long-term physiological or pathological processes that produce a particular level of sleep propensity. Other investigations, including overnight polysomnography, are required for that.

The ESS assumes that subjects can remember whether or not and under what circumstances they have dozed off during the day as part of their "usual way of life in recent times". The present results suggest that most patients can give meaningful self reports about this aspect of their behavior and that their ESS scores provide a measurement of their general level of daytime sleepiness, from low to very high levels. This has not been achieved previously by any other published questionnaire.

Acknowledgement: Irene Lehel assisted with the administration of questionnaires to the control subjects.

1. American Sleep Disorders Association. *The international classification of sleep disorders.* Rochester, MN, 1990.
2. Richardson G, Carskadon M, Flagg W, Van Den Hoed J, Dement W, Mitler M. Excessive daytime sleepiness in man: multiple sleep latency measurements in narcoleptic vs. control subjects. *Electroencephalogr Clin Neurophysiol* 1978;45:621–7.
3. Carskadon MA, Dement WC. The multiple sleep latency test: what does it measure? *Sleep* 1985;5:S67–72.
4. Zwyghuizen-Doorenbos A, Roehrs T, Schaeffer M, Roth T. Test–retest reliability of the MSLT. *Sleep* 1988;11:562–5.
5. Mitler M, Gujavarty KS, Browman CP. Maintenance of wakefulness test: a polysomnographic technique for evaluating treatment in patients with excessive somnolence. *Electroencephalogr Clin Neurophysiol* 1982;153:658–61.
6. Erman MK, Beckham B, Gardner DA, Roffwarg HP. The modified assessment of sleepiness test (MAST). *Sleep Res* 1987;16: 550.
7. Pressman MR, Fry JM. Relationship of autonomic nervous system activity to daytime sleepiness and prior sleep. *Sleep* 1989;12: 239–45.
8. Broughton R, Aguirre M, Dunham W. A comparison of multiple and single sleep latency and cerebral evoked potential (P300) measures in the assessment of excessive daytime sleepiness in narcolepsy–cataplexy. *Sleep* 1988;11:537–45.
9. Johnson LC, Spinweber CL. Gomez SA, Matteson LT. Daytime sleepiness, performance, mood, nocturnal sleep: the effect of benzodiazepine and caffeine on their relationship. *Sleep* 1990;13: 121–35.
10. Hoddes E, Zarcone V, Smythe H, Phillips R, Dement WC. Quantification of sleepiness: a new approach. *Psychophysiology* 1973;10:431–6.
11. Herbert M, Johns MW, Doré C. Factor analysis of analogue scales measuring subjective feelings before and after sleep. *Br J Med Psychol* 1976;49:373–9.
12. Cook Y, Schmitt F, Berry D, Gilmore R, Phillips B, Lamb D. The effects of nocturnal sleep, sleep disordered breathing and periodic movements of sleep on the objective and subjective assessment of daytime somnolence in healthy aged adults. *Sleep Res* 1988;17:95.
13. Johns MW, Gay TJA, Goodyear MDE, Masterton JP. Sleep habits of healthy young adults: use of a sleep questionnaire. *Br J Prev Soc Med* 1971;25:236–41.
14. Billiard M, Alperovitch A, Perot C, Jammes A. Excessive daytime somnolence in young men: prevalence and contributing factors. *Sleep* 1987;10:297–305.
15. Roth T, Roehrs T, Carskadon M, Dement W. Daytime sleepiness and alertness. In: Kryger MH, Roth T, Dement WC, eds.

Principles and practice of sleep medicine. Philadelphia: Saunders, 1989:14–23.
16. Schmidt-Nowara WW, Wiggins CL, Walsh JK, Bauer C. Prevalence of sleepiness in an adult population. *Sleep Res* 1989;18: 302.
17. Munro BH, Visintainer MA, Page EB. *Statistical methods for health care research.* Philadelphia: J. B. Lippincott Co., 1986.
18. Roehrs T, Zorick F, Wittig R, Conway W, Roth T. Predictors of objective level of daytime sleepiness in patients with sleep-related breathing disorders. *Chest* 1989;95:1202–6.
19. Kaplan J, Fredrickson PA, Renaux SR. Nighttime sleep latency as an indicator of daytime sleepiness. *Sleep Res* 1990;19:241.
20. Guilleminault C, Partinen M, Quera-Salva MA, Hayes B, Dement WC, Nino-Murcia G. Determinants of daytime sleepiness in obstructive sleep apnea. *Chest* 1988;94:32–7.
21. Waller PC, Bhopal RS. Is snoring a cause of vascular disease: an epidemiological review. *Lancet* 1989;1:143–6.
22. Stepanski E, Zorick F, Roehrs T, Young D, Roth R. Daytime alertness in patients with chronic insomnia compared with asymptomatic control subjects. *Sleep* 1988;11:54–60.
23. Lavie P, Segal S. Twenty-four-hour structure of sleepiness in morning and evening persons investigated by ultrashort sleep–wake cycle. *Sleep* 1989;12:522–8.
24. Roehrs T, Timms V, Zwyghuizen-Doorenbos A, Roth T. Sleep extension in sleepy and alert normals. *Sleep* 1989;12:449–57.