

# The Epworth Sleepiness Scale for Screening of the Drowsy Driving: Comparison with the Maintenance of Wakefulness Test in an Iranian Sample of Commercial Drivers

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**Abstract-** Traffic fatalities are a major cause of morbidity and mortality in Iran. Occupational sleep medicine field needs more cost-effective and applicable tests for screening purposes. This study reports on a pilot screening study for drowsy drivers in an urban Iranian sample of commercial drivers. The Maintenance of Wakefulness Test (*MWT*) measures the ability to remain awake objectively. Sleep latency in *MWT* is a reasonable predictor of driving simulator performance in drivers. In this study, we evaluate whether the Epworth Sleepiness Scale (*ESS*) and *MWT* are equally useful in drivers with possible Excessive Daytime Sleepiness (*EDS*). 46 consecutive road truck drivers in a transportation terminal entered into this study. The *ESS* score of patients with normal and abnormal *MWT* was  $3.24 \pm 2.4$  and  $4.08 \pm 3$  respectively which was not significantly differenced ( $P$  value = 0.34). No significant correlation was found between the *ESS* and sleep latency in *MWT* ( $r = -0.28$ , 95% CI = -0.58 to 0.02). By using the receiver operating characteristic analysis, the area under the curve was found to be 0.57 (95% confidence interval = 0.37– 0.77) which is not statistically acceptable ( $P$  value=0.46). Our finding showed that the *MWT* and *ESS* do not measure the same parameter.

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**Keywords:** Epworth Sleepiness Scale; Maintenance of Wakefulness Test; Commercial drivers

## Introduction

One of the leading causes of death and disability in the Middle East are road traffic injuries. The World Health Organization estimates that by 2020 road traffic injuries will be the third leading cause of disability adjusted years of life lost worldwide (1). Despite the seriousness of this problem, the full impact of morbidity, mortality, and disability that caused by road traffic injuries in the Middle East is inadequately measured (2).

Iran, with a population of 70 million is the world's 17th most populous country; here, like many Middle Eastern countries, road traffic injuries are among the leading causes of death and disability. Motor vehicle collisions are currently ranked the second highest cause of mortality in Iran (3). In a cross-sectional study examining all cases of motor vehicle traffic-related

fatalities which were referred to the Tehran Legal Medicine Organization during 2000-2001, the total number of deaths was 2128 (25% of these cases were referred to the Tehran Legal Medicine Organization for determination of cause of death) (4). According to official estimates by the Iranian Ministry of Road and Transportation and Iranian Center of police Control road traffic, each year there are more than 20,000 fatal motor vehicle crashes and about 250,000 injuries (5).

As the countries of the Middle East increasingly motorized, their traffic fatality rates will inevitably rise. Investigators in Middle Eastern countries should identify interventions to lower this death toll (6,7). Consequently, public health officials, road traffic designers, legislators, and the police should co-operate in an interdisciplinary approach to implement proven effective measures to lower this increasingly heavy

social and economic burden. Sleep and fatigue-related vehicle accidents (SFRVAs) are not only more common than is generally realized, but are more likely to result in death and serious injury owing to the relatively high speed of the vehicles on impact (8-10).

Published estimates of the proportion of crashes attributable to sleepiness vary more than tenfold (11), from 1-3% for the United States (12) to 10% in France (13) and 33% in Australia (14). In the United States, Department of Transportation now considers that there is a high likelihood that every lorry driver will be involved in at least one sleep related crash during the lifetime of the vehicle (15).

To examine and address this public health issue in Iran, a screening program for driver drowsiness in commercial drivers in Tehran is currently under development. Driver fatigue and drowsiness due to medical conditions or self-imposed sleep loss is an important preventable and underappreciated cause of morbidity and mortality, although it remains unclear how to best screen for this source of impairment.

The measurement of daytime sleepiness and alertness is based upon the concepts of physiologic and manifest sleepiness (16,17). Physiologic sleepiness is the tendency to fall asleep in the absence of external alerting factors and is measured by the Multiple Sleep Latency Test (MSLT). Manifest sleepiness changes on a moment-to-moment basis and is determined by factors such as light, noise, motivation, hunger, and recumbence. Manifest sleepiness or the ability of an individual to stay awake under soporific conditions may be more clinically relevant and appears to be a more important measure for situations in which alertness is warranted, such as driving or operating heavy machinery. The Maintenance of Wakefulness Test (*MWT*) was developed to measure ability to remain awake under soporific conditions (17,18).

Recent guidelines by the American Academy of Sleep Medicine state that the *MWT* "may be used to assess an individual's ability to stay awake when his/her inability to remain awake constitutes public or personal safety issue" (19) and sleep latency on the *MWT* is a reasonable predictor of driving simulator performance in sleepy, alcohol-impaired, normal subjects (20).

The Epworth Sleepiness Scale (*ESS*), first described by Johns in 1991 (21), consists of eight questions and yields a score of 0 to 24. It is easy to administer and is currently the most widely used subjective test for sleepiness (22-24). In this study, we evaluate the utility of the Iranian version of the *ESS* (25) for screening of the drowsy driving in comparison with the *MWT* in an Iranian

sample of commercial drivers.

## Materials and Methods

We invited 86 consecutive commercial drivers who came to the center of the road and transportation Ministry to renew their licenses to participate in this study. 70 of these entered the study, and out of these, 46 agreed to be underwent the Maintenance of Wakefulness Test.

The *MWT* consists of four nap opportunities performed at two hours intervals. In nap opportunities, drivers were asked to sit in the bed, having their eyes opened and try to stay awake in a dimly light room. Each nap opportunity was terminated after 20 minutes if sleep does not occur. In two hours intervals between naps, individuals were out of bed and did not have permission to sleep. In each nap, if the driver felled in asleep, the sleep onset latency was calculated (26). The mean sleep onset latency in 4 nap opportunities equal or lesser than 11 minutes considered as abnormal while greater than 11 minutes considered as normal.

Drivers filled in the Iranian version of the *ESS* before undergoing the *MWT*. The *ESS* is an 8-item questionnaire that is being used as a simple and inexpensive measure for subjective evaluation of daytime sleepiness. The questionnaire asks the individuals to score their sleepiness in 8 daily situations from 0 (would never doze) to 3 (high chance of dozing) giving a total score of 0 to 24. The *ESS* score more than 8 considered as a clinically significant daytime sleepiness.

### Statistical analysis

Pearson correlation coefficient was used to assess the correlation between the *ESS* score and mean sleep latency on *MWT*. Difference of the *ESS* score between normal and abnormal *MWT* categories was calculated by using unpaired student t-test. The receiver operating characteristic analysis was done to evaluate how well the *ESS* distinguishes drivers with normal from those with abnormal *MWT*. *P* value less than 0.05 considered as significant. Statistical analysis was done by using SPSS 15 software.

## Result

Forty six drivers ranged in 25 to 64 years (mean age 41.9 years with a standard deviation of 9.7) entered into this study. Table 1 gives the mean, Standard deviation, minimum and maximum for the *ESS* and *MWT* scores.

Based on the results obtained from *MWT*, 33 of drivers had sleep onset latency lesser than 11 minutes but only 2 of drivers had the *ESS* score more than 8. Table 2 shows the distribution of drivers both on the *MWT* and the *ESS*. The *ESS* score of patients with normal and abnormal *MWT* was  $3.24 \pm 2.4$  and  $4.08 \pm 3$  respectively which was not significantly differenced ( $P$  value = 0.34). Figure 1 shows the distribution of the *ESS* score of drivers with normal and abnormal *MWT*.

No significant correlation was seen between the sleep onset latency on *MWT* and the *ESS* score ( $r = -0.28$ , 95% CI = -0.58 to 0.02). By using the receiver operating characteristic analysis, the area under the curve was found to be 0.57 (95% confidence interval = 0.37–0.77) which is not statistically acceptable ( $P$  value = 0.46).

**Table 1. The ESS and MWT scores in participants**

	Mean	Standard deviation	Min	Max
<b>ESS score</b>	3.48	2.66	0.00	10.00
<b>MWT score</b>	13.80	6.02	1.25	20.00

ESS Epworth Sleepiness Scale, MWT Maintenance of Wakefulness Test

**Table 2. Distribution of drivers on the MWT and the ESS**

ESS score	Sleep latency on MWT	
	>11 min	≤11 minute
≤8	32	12
>8	1	1

ESS Epworth Sleepiness Scale, MWT Maintenance of Wakefulness Test

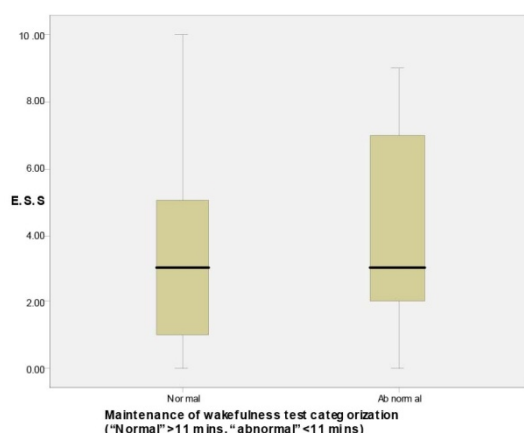


Figure 1. Distribution of ESS for two categories of MWT

## Discussion

The *ESS* is a subjective self-report questionnaire for sleepiness. The *MWT* is an objective assessment of inability to maintain wakefulness. The data presented here showed that there was not a good correlation between the *ESS* score and the mean sleep latency on *MWT*. We were unable to find a study that compared *MWT* and *ESS* in drivers, but some researchers have compared these measurements in narcolepsy (27) and sleep apnea syndrome (28), finding that *MWT* and *ESS* do not measure the same parameter of sleepiness in these disorders. Another study showed while the *MWT* was a good predictor of driving performance, the *ESS* did not predict simulated driving performance (29).

We offer two possible explanations for this phenomenon. The first and the more important is the role of secondary gain. The second and the more challenging is the intrinsic property of each test.

The *MWT* should be measures the manifest sleepiness while the *ESS* measure self-report subjective sleepiness. Manifest sleepiness can be considered from three perspectives: behavioral sign of sleepiness, inability to volitionally remain awake, and performance deficit on psychomotor or cognitive task. The common thread is the transformational effect of underlying sleepiness on outward behavior and abilities (30).

Introspective sleepiness concerns on the individual's self-assessment of an internal state. An important issue related to the validity of the *ESS* is the reliability of any self-report tool in a context that involves potential loss of driving ability. Furthermore, although the manifest and introspective measures may stem from the same underlying drive state, individual differences factor in and modifies the measurable phenomena, Rather than conceptualizing sleepiness and alertness as being inversely related, a complex relationship between these two states is likely to exist (30), in particular in relation to driving performance and other states of task-readiness important in industrial/occupational settings. Not only it is illogical to attempt to use these measures interchangeably but also it misses the importance of the difference between them (31).

In conclusion, our study indicated that the *ESS* and the *MWT* measure different parameters and cannot be used interchangeably. Further research offering cost-effective and reliable screening methodologies to screen for potential impairments due to sleep-related causes would be welcome, particularly if useable in a variety of international occupational settings.

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