ORIGINAL ARTICLE

Psychomotor vigilance task- objective sleep disorder screening tool for Indian population

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Abstract

Introduction / Objective: The primary objective of the current pilot observational study was to establish feasibility and acceptability of sleep disorder screening tools, *viz*, Epworth Sleepiness Scale (ESS) and Psychomotor Vigilance Task (PVT) in Indian Population. The study also aimed to compare the sensitivity and specificity of both the screening tests. The outcome of the study will provide the threshold values for PVT to determine positive and negative diagnosis.

Method: It was a community based study in clinical settings. Patients visiting sleep clinic during period of year August 2011 to year September 2012 formed the study population. The sample population included 66 patients; 49 males and 17 females with mean age of 45 (age range 14-75). All subjects administered ESS as well as 10 minute PVT followed by confirmatory tools such as Nocturnal Polysomnogram, MSLT and Actigraphy. ESS score >10 was considered positive. The presence of any of intrinsic or extrinsic sleep disorder is considered a positive diagnosis. Bayesian theorem was applied to determine sensitivity and specificity of tests administered.

Results: Sensitivity of PVT was found to be high as 90.16 % as compared to that of ESS as 39.3%. However the specificity for both the tests was found to be equal at 100%. Among PVT measurements, number of lapses and average reaction time were found to be co-relating with a sleep disorder diagnosis.

Conclusion: Individuals having low ESS score were diagnosed with sleep problems which were well predicted in their PVT results. For Indian population, PVT assessment is more sensitive screening tool for sleep disorders as compared to ESS. Although, when administered together, chances of missing any sleep problem are minimised. It was a pilot study and needs to be further validated with larger population.

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Introduction

Sleep is a necessary part of human functioning. Sleep disorders impair quality of life and thereby poses several health related problems[19]. The disease burden for sleep disorders is huge in Indian population. Commonly found sleep disorders are insomnia, Obstructive sleep apnea, Hypersomnia, Restless leg syndrome and Shift work disorder[17, 19, 22].

A questionnaire based sleep survey conducted in 2009, revealed that 93 per cent of Indians are not sleeping enough and 34 per cent are at risk of Obstructive Sleep Apnea (OSA), which can lead to weight gain and even serious situations such as worsening of the heart conditions [1.] Sleep Medicine being a recent field in Indian sub-continent, the availability of data is sparse. Most of these studies are performed on urban population and are based on subjective questionnaires [19]. Current protocol being followed at sleep disorder clinics in India includes use of subjective sleepiness scales such as Epworth Sleepiness Scale (or its modified versions) to screen the subjects. 'Our observations reflect that because of social factors, there is denial of symptom of EDS in symptomatic as well as asymptomatic people. Modification of ESS for Indian population has been studied but no significant difference has been reported[19]. Reporting heterogeneity in self reports on health has been studied in Indian population. The study revealed an underestimation of health related issues in low-income population and overestimation among high income group[24].

There is a need to objectively screen the symptom of sleepiness. Psychomotor vigilance task is a proven objective tool for screening sleep deprivation[2, 3, 4, 6, 10, 11, 12, 23]. PVT is a sustained-attention, reaction-timed task. It is freely available software based test and can be taken by individuals with normal intellectual skills. It captures the neurocognitive effects of sleep loss on wake state stability as reflected in sustained attention [12]. Research indicated increased sleepiness correlates with deteriorated alertness, slower problem-solving, declined psycho-motor skills, and increased rate of false responding[2, 3, 4,6,12]. PVT sensitivity has been proven in acute sleep loss, chronic partial sleep deprivation, effect on jet lag & shift work syndrome[2]. PVT sensitivity has been extensively studied on sleep disordered breathing[10]

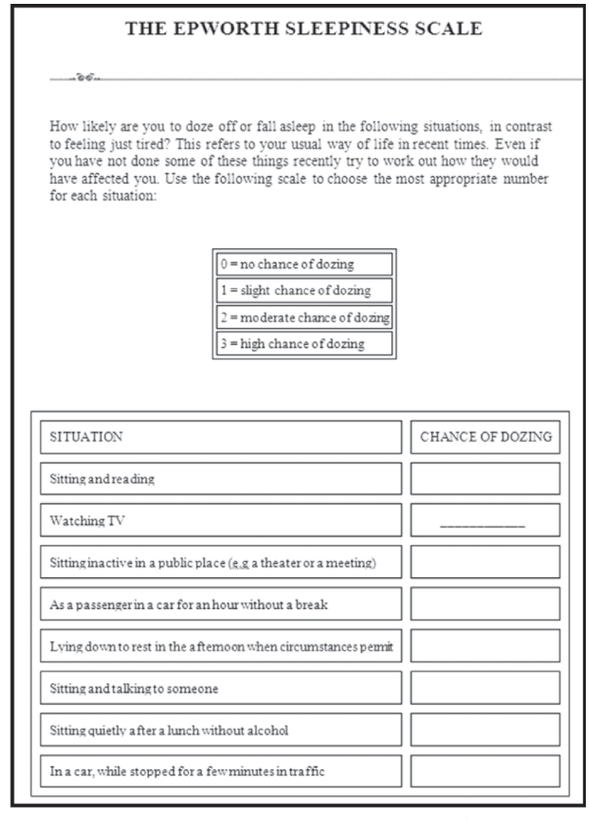
The study aimed to compare subjective and objective sleepiness scores for patients visiting sleep clinic and thereby established a highly sensitive and reliable screening tool. The outcome of the study would determine the cut-off values for PVT parameters to be used in clinical set up.

Methodology

Study Population: The present study was conducted at International Institute of Sleep Sciences, Mulund, Mumbai; over a period from August 2011 to September 2012. The study population comprises of 68 patients; 49 males and 17 females (Table-1). The study subjects were screened with the help of detailed History-Physicals. The subjects were consecutively selected from age group of 14-75 of either gender referred for sleep study at clinic. The tests were performed between 9:00-11:00 am to negate the effect of circadian dip.

Tests: All subjects were administered ESS as well as 10 minute PVT followed by Nocturnal Polysomnogram or Actigraphy or MSLT as per the history-physical data.

In ESS questionnaire, a patient is asked to rate the likelihood that he or she would fall asleep in given situations (Figure 1). The patient rates each situation on a scale of 0 to 3, with 3 being a high chance of dozing or falling asleep, and 0 if they would never doze or sleep in the given situation. The scores are then added up, and the Epworth Sleepiness Scale is revealed. With as many as 3 points possible in each situation, the scale reaches a high of 24. The patient and physician can compare the patient's Epworth Sleepiness Score with the following



THE EPWORTH SLEEPINESS SCALE

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 = no chance of dozing
1 = slight chance of dozing
2 = moderate chance 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 traffic	

Figure 1: Epworth Sleepiness Scale

scale:

0-9 Normal Sleepiness

10-24 Excessively Sleepy

The PEBL software version 0.11(Shane Mueller August 2010) was utilized for PVT. The subject is seated comfortably. The subject is asked to respond as soon as possible to red circle appearing in the center of the screen by pressing "Space Bar" on computer keypad. The red circle keeps on coming in the interval of 2-10 seconds. The reaction time is calculated in milliseconds. The task duration is 10 minutes (Figure - 2).

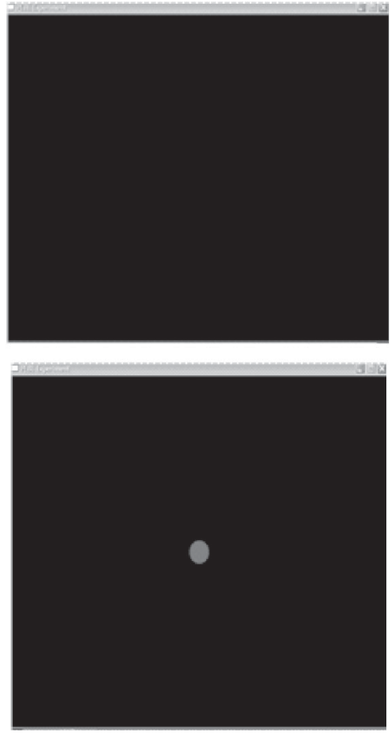


Figure 2: PVT

Scores for PVT

Average Reaction time, No. of lapses/Errors of Omission (RT > 500 milliseconds)
No. of sleep responses (RT > 30 secs) and
No. of too fast responses/ Errors of Commission

Polysomnography studies were conducted and scored as recommended by the American Academy of Sleep Medicine. All EEG electrodes have been placed according to the "International 10-20 System".

Montage Utilized

1) EEG-C4 referenced to A1
2) EEG-O2 referenced to A1
3) REOG- referenced to A1
4) LEOG- referenced to A2
5) EEG – C3 referenced to A2
6) EEG – O1 referenced to A2
7) Chin EMG
8) EKG
9) Left and Right Anterior Tibialis
10) Snore Microphone
11) Nasal and Oral Airflow – Thermocouple
12) Thoracic respiratory effort
13) Abdominal respiratory effort
14) Pulse Oximetry – finger probe

The presence of any of intrinsic or extrinsic sleep disorder is considered a positive diagnosis. In order to eliminate any possible transient improvement in PVT brought about by use of CPAP for titration purposes in split night studies, all subjects underwent PVT as well as ESS before the sleep study.

Statistical Analysis: The Null hypothesis was "diagnosis with PVT was equal to diagnosis with ESS". Paired "t" test was applied as same population is being compared as well as sample size was >30. Bayesian theorem was utilised to determine sensitivity and specificity of tests administered.

Results

Records of 66 patients from sleep disorder clinic were analyzed. Mean age of the subjects was 45 years (range: 14-75). The demographic characteristics of study population are depicted in Table 1. All the subjects performed ESS as well as 10 minute PVT without any difficulty. The study established the feasibility and acceptability of both screening tools for Indian population (Table-2).

The frequency of subjects scoring >10 in ESS was found 36.36 %. PVT outcome metrics used were: number of lapses, number of false starts, average reaction

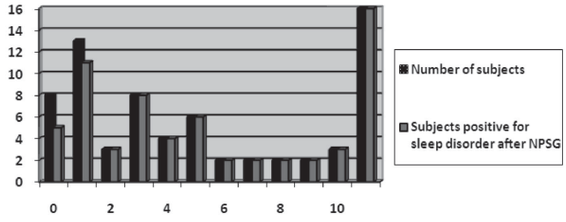
time. The correlation between PVT parameters and sleep disorder diagnosis is clearly evident in graph 1, 2 and 3

Table 1: Demographic characteristic of study population

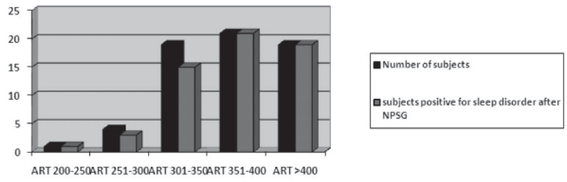
Variables
N = 66
Mean age (range) years 45(14-75)
Male; Female 49;17
Residence
Urban 66
Educational status
School educated 12
College educated 54

Table 2: Acceptability of screening tools

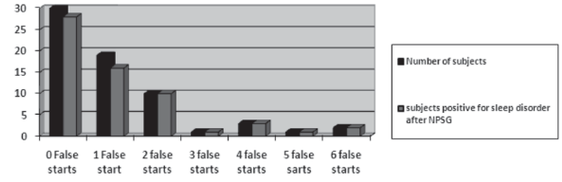
	Given to	**Acceptability**
ESS	68	100%
PVT	68	100%



Graph 1: correlation between number of lapses (X-axis) and positivity of Sleep Disorder. The threshold value is >2 lapses *i.e.* error of omission



Graph 2: correlation between Average Reaction Time (X-axis) and positivity of Sleep Disorder. The threshold value is >350 milliseconds.



Graph 3: correlation between number of error of commission (X-axis) and positivity of Sleep Disorder. The threshold value is >2 error of commission

Table 3: Screening results for ESS

Screening Results for ESS	**True Characteristics in Population**		**Total**
	Disorder	**No Disorder**	
Positive	24	0	24
Negative	37	5	42
Total	61	5	66

Table 4: Screening results for PVT

Screening Results for ESS	**True Characteristics in Population**		**Total**
	Disorder	**No Disorder**	
Positive(>2 errors/ Average ART > 350 ms)	55	0	55
Negative	6	5	11
Total	61	5	66

Table 5: Comparison of diagnostic parameters for ESS and PVT

	ESS	**PVT**
Sensitivity	39.3%	90.16%
Specificity	100%	100%
Positive Predictive Value	100	100
Negative Predictive Value	12	45

Table 6: "t" test scores for ESS and PVT

		Paired Differences					t	df	p-value Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference				
					Lower	Upper			
Pair 1	Correct_ PVT - Correct_ ESS	.470	.561	.069	.332	.608	6.805	65	.000

Table 7: Prevalence of Common Sleep Disorders in study population

Subjects positive for Sleep disorder	**Number**	**Percent**
Obstructive Sleep Apnea	31	47%
REM Related Sleep Apnea	4	6%
Insomnia causing Sleep Deprivation	14	21.12%
Narcolepsy	3	4.5%
Upper Airways Resistance Syndrome	4	6%
Delayed Phase Syndrome causing Sleep Deprivation	2	3.03%

respectively. The threshold values to be used clinically for PVT were found to be > 2 Errors and/ ART > 350 milliseconds. Screening results for both the tests are given in table no 3 and 4 respectively. The sensitivity of ESS and PVT were 39.3% and 90.16 % respectively. The specificity for both the tests was found to be 100%.

Since the p-value was found to be 0.00 (which is <0.05 with 95% Confidence Interval), null hypothesis was rejected.

The prevalence of common sleep disorders in this clinical population is tabulated in Table 7.

Discussion

Low perception of sleep disorders was observed in Indian population. Despite doing few modifications in subjective questionnaires such as ESS, as per Indian context, the scores were not correlated with diagnosis. The frequency of unanswered questions in ESS and modified ESS was found to be as high as 23.9 % and 45.3 % respectively. Therefore, Critical evaluation of the prevalent subjective screening questionnaires for sleep disorders is warranted in the Indian context[19].

Study	PVT outcome metrics
In-Soo Lee et.al; 2010	Count of lapses, Average Reaction Time
Glenn Gunzulmenn et al; 2008	False starts, Alert responses, Lapses and sleep attacks
Adreinne Tucker; 2009	False starts, Lapses and Mean Reaction Time
David Dinges; 1998	Number of Lapses
Basner and Dinges; 2011	Number of lapses, mean RT, mean 1/RT, fastest 10% RT, median RT, slowest 10% RT, slowest 10% 1/RT, number of false starts, fastest 10% 1/RT and lapse probability

The current study investigated the feasibility and acceptability of sleep disorder screening tools *viz*, ESS and PVT. ESS has its known advantage of being a short, simple form that the patient can complete without assistance[5,8]. The present findings suggest that PVT was equally feasible and acceptable. Both the tests were economical for clinical settings.

The PVT parameters reported in earlier studies are tabulated below.

In a previous study, number of lapses and 1/Average Reaction Time are considered to be superior PVT outcome metric to be used as criterion in sleep deprivation experiment [2]. The current study took into consideration basic PVT parameters viz, number of lapses, mean reaction time and false starts which can be easily utilized in clinical setting.

The study results indicate that the number of lapses increases exponentially with confirmed sleep disorder diagnosis. The threshold values for the same are 2. Our findings of a significant relationship between reduced PVT performance and sleep disorder diagnosis was expected and were consistent with previous studies.

The reported prevalence of common sleep disorders in Indian population, such as Insomnia, Obstructive Sleep Apnea (OSA) and Restless Leg Syndrome (RLS) is 18.6%, 9.3% and 2.9 % respectively [19]. In the current study, the prevalence rates for OSA and Insomnia in clinical population were found to be 47% and 21.12% respectively.

The present study was a pilot step with low sample size. The study results are limited to clinical population only; larger studies are needed to validate these findings further in general population. The significance of this study lied in the fact that a highly sensitive screening tool such as PVT, at the clinician's end would reduce the underdiagnosis and/or misdiagnosis of sleep disorder cases. The applicability of combination of these tests can be studied in future. Despite its limitations, the present study has created a platform for effective screening of sleep disorders in Indian population.

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