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SLEEP AND COGNITIVE ALERTNESS

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Abstract:-

*With today's fast paced lifestyles, 24*7 activity and an increasing screen-time at night, sleep disorders are widespread. Indians are not getting enough sleep in both urban as well as rural India. Sleep loss and related disorders are a silent epidemic affecting adults as well as children. The objective of the current study was to investigate the overall impact of hours of sleep and sleep quality on the cognitive alertness of the research scholars and the psychomotor vigilance Test (PVT) was used to measure the cognitive alertness. The final results of the study show that even though the research scholars are getting the required amount of sleep, their cognitive alertness is still affected and they are indeed suffering from sleepiness.*

Keywords: - Sleepiness, Research scholars, sleep quantity, sleep hours, PVT

INTRODUCTION

It is widely acknowledged that inadequate sleep upsets human performance (Budnick & Barber, 2015). It is likely to increase errors or the time it takes to complete simple tasks, such as the Psychomotor Vigilance Task (PVT) to highly complex jobs (Sylvia, Lemond, Dorrian, Roach & Dawson, 2004). To handle deadlines, employees might be forced to work long hours and to cut back on sleep time (Harma 2006; Van der Hulst, 2003). Moreover, working on deadlines and cutting down on sleep and other activities to complete them are likely to result in activation of the stress axes, which are known to stimulate arousal and suppress sleep (Akerstedt, 2006; Chrousos, 2009). Deadlines, and the potential negative consequences of missing them, are also likely to generate rumination and anxiety, which in turn are associated with sleep disturbances (Cropley, Millward & Purvis, 2003; Cropley, Dijk & Stanley, 2007) and such sleep disturbances might cause a person to miss the deadlines. To the best of the researcher's knowledge, no epidemiologic studies so far has probed the impact of deadlines and anxiety on sleep behaviour.

Sleep deprivation is a common problem in the young adult college student population. It is expected to be higher among research scholars who work on different deadlines (Rugulies et al., 2012). Research scholars who are on the verge of submitting their thesis commonly experience sleep problems (inadequate hours of sleep, poor sleep quality), because of high level of anxiety and stress associated with the submission. However attentional state has not been extensively studied in this population. In this study we have attempted to investigate the sleep quality and sleepiness problem of doctoral students who are in the final process of thesis submission. We assumed that restricted and poor quality sleep would negatively impact the performance of participants on the cognitive tasks such as the Psychomotor Vigilance Test.

Research Objective

To measure the overall sleep quality of research scholars

- To investigate the overall impact of hours of sleep and sleep quality on the cognitive alertness of the research scholars.

Research Methodology

Study Participants

Seventy nine research scholars (24 males, 55 females) aged between 22 years to 35 years participated in the study. All these participants were Ph.D students of reputed educational institutes located in Mumbai, the financial capital of India. For participation, they had to meet the following inclusion criteria:

- they must be in the last segment of their research submission;
 - no history of a sleep disorder;
 - no extreme morning or evening type;
 - no history of psychiatric or medical illness;
 - no history or current drug or alcohol abuse, current use of psycho-active medication, and excessive caffeine use
- Excessive caffeine use is defined as drinking six or more cups of coffee or tea per day..

Research Procedure

On the day of the study, participants were asked to report the number of hours they slept in the previous night, their assessment of the overall quality of the sleep, and overall quality of their sleep in the past 30days. Then they were asked to perform the psychometric vigilance test (PVT). Participants were individually trained to perform the PVT one day prior to the test. During participation in the study, alcohol intake, drugs or oral medication was not allowed from 24 hours prior to the test day until discharged. At testing time, caffeine intake and smoking was not allowed until discharge.

The Psychometric Vigilance Performance (PVT)

Sleep behaviour of the participants was assessed through hours of sleep, sleep quality, sleepiness and alertness. Sleepiness and alertness of the participants was assessed through lapses and reaction time measured by the PVT respectively. The PVT was developed as a neuro-cognitive assay for tracking temporarily dynamic changes induced by interaction of the homeostatic drive for sleep and endogenous circadian pacemaker (Basner & Dinges, 2011). Its focus lies in the measurement of the ability to sustain attention and respond in a timely manner to salient signals (Sylvia et al., 2004). With a combination of PFC (Pre-frontal cortex) executive attention and traditional stimulusresponse testing, the PVT involves a simple (as opposed to choice) reaction time (RT) test- the avoidance of choice RT was deliberate to minimize continued learning and strategy shifts that can occur even in four choice RT tasks. The PVT requires response to a small, bright red light stimulus by pressing a response button as soon as the stimulus occurs, which when pressed further stops the stimulus counter and displays the RT in milliseconds for a 1-second period (Basner & Dinges, 2011) . The subject is instructed to press the button as soon as each stimulus appears, to keep the reaction time as low as possible, but not to press the button too soon (which yields a false start (FS) warning on the display). It is very simple to perform and the PVT has only very minor learning effects on the order of a 1-3 trial learning curve (which contrasts dramatically within the 30 to 60 trial learning curve of the supposedly simple learning tasks such as the digital symbol substitution task). The PVT inter-stimulus interval varies randomly from 2 seconds (sec) to 10 seconds, and the task duration is typically 10 minutes, which yields approximately 90 RTs per trial (i.e., a relatively high signal load). The sensitivity of the PVT can be increased by using longer task durations (e.g., 20 minutes), which can be useful when studying mild to moderate levels of sleepiness or in the assessment of interventions purporting to reduce sleepiness (e.g., various pharmacological agents, naps, work-rest schedules) (Minkel, Banks & Dinges, 2012). Repeated administration (every 2 hour during waking periods) of the PVT to subjects allowed 8 hr sleep per night for 5 nights and demonstrated the reliability of performance on this task

across experimental days. Intra-class correlation coefficients indicated maximal reliability for both, number of PVT performance lapses and median response times (Basner Dinges, 2011). It has been a primary performance assay for demonstrating the cumulative neuro-cognitive effects from chronic to partial sleep deprivation. For example, in the two largest laboratory-controlled dose-response experiments conducted to date on the neurobehavioral effects of chronic sleep restriction, cumulative increases were evident in the average number of PVT lapses per 24 hour across days of sleep restricted to 3, 4, 5, and 6 hour per night. In an earlier experiment, cumulative increases in PVT lapses across 7 days of sleep restricted to approximately 5 hour per night were shown to be strongly related ($r = -0.95$) to sleep onset latency as assessed by the Multiple Sleep Latency Test (MSLT) in a nearly identical protocol (Basner & Dinges, 2011). It appears that PVT performance lapse frequency and the well-validated physiological measure of sleep propensity may reflect the same basic process of escalating sleep pressure with sleep loss (Sylvia, et al., 2004).

PVT has been tested under a number of conditions recognized to induce neuro-cognitive deficits due to sleep loss, including total sleep deprivation, chronic partial sleep deprivation, and sleep fragmentation (Basner & Dinges, 2011). Irrespective of the mode of sleep loss, results of extensive experiments on PVT performance have demonstrated that the task is capable of capturing the effects of sleep loss on stability of sustained attention, and that it can reliably reveal the accumulation of cumulative state instability in chronic sleep loss. As an assay of the neurocognitive effects of sleep loss, the PVT has also been used to assess the effectiveness of countermeasures to sleep loss (e.g., naps, caffeine, modafinil). It has also been used to quantify daytime functioning levels in patients with OSAS (Obstructive sleep Apnea syndrome) in relation to drowsy driving and in alcohol intoxication protocols (Minkel et al., 2012).

Study Results

Descriptive Statistics

The descriptive statistics results are given in the table 1. The mean (\pm SD) age of the participants was 27.16 (\pm 2.74) years. The average hours of sleep reported was 7.75, indicating that the participants were getting the required amount of sleep (in terms of quantity). The average sleep quality for the previous night was .822 and overall sleep quality in the past 30days was .818. The mean lapses were 9.34. According to the interpretation of the scores in the Psychometric Vigilance Test, any score above 3 is said to be indicative of poor sleep. Thus it can be assumed that the entire sample was experiencing poor sleep at the time of the study. From the details of lapses mentioned in table 2, it is indicated that less than 11% of the population have got a score of 3 or below in the Psychometric Vigilance Test. This indicates that the other 89% of the population are experiencing poor sleep

Table 1. Descriptive Statistics of Age, Hours of Sleep, Sleep Quality and Lapses

	Mean	Std. Dev	Std. Error
Age	27.16	2.740	.055
Hours of slp	7.759	1.537	.175
Slp. PN	.822	0.488	.067
Slp.PM	.818	0.482	.101
Lapses	9.34	6.220	.699

Note: Slp.PN –Sleep in previous Night; Slp.PM – Sleep in Previous month

Table 2. Details of Lapses

Lapses	Frequency	Percent	Valid Percent	Cumulative Percent
1	2	2.5	2.5	2.5
2	4	5.1	5.1	7.6
3	3	3.8	3.8	11.4
4	1	1.3	1.3	12.7
5	13	16.5	16.5	29.1
6	12	15.2	15.2	44.3
7	3	3.8	3.8	48.1
8	3	3.8	3.8	51.9
9	5	6.3	6.3	58.2
10	12	15.2	15.2	73.4
11	2	2.5	2.5	75.9
13	3	3.8	3.8	79.7
14	4	5.1	5.1	84.8
15	2	2.5	2.5	87.3
17	3	3.8	3.8	91.1
20	2	2.5	2.5	93.7
22	3	3.8	3.8	97.5
32	2	2.5	2.5	100.0
Total	79	100.0	100.0	

Relationship between Sleep and PVT Results

From the correlation table below, it is seen that age and gender does not correlate significantly with sleep and lapses. Lapses correlate negatively with hours of sleep ($p < .05$), and sleep quality in the past night correlates positively with overall quality of sleep ($p < .01$).

The reaction time of the participant in PVT ranged from 300ms (milliseconds) to 800 ms. According to the Psychometric Vigilance Test, reaction time below 500 ms is considered to be the appropriate time for responding to the stimulus and is also indicative of the behavioural alertness of the participants. In the current research, the average reaction time of the participants was above 650ms, indicating that the behavioural alertness of the participants (research scholars) was below the required level. From the correlation table below it is seen that age and gender does not correlate significantly with any variable. Lapses correlate significantly negative with hours of sleep, and sleep quality in the past night correlates significantly positive with overall quality of sleep. The reaction time of the participant in PVT ranged from 300ms (milliseconds) to 800 ms. According to the Psychometric Vigilance Test, reaction time below 500 ms is considered to be the appropriate time for responding to the stimulus and is also indicative of the behavioral alertness of the participants. In the current research, the average reaction time of the participants was above 650ms, indicating that the behavioral alertness of the participants (research scholars) was below the required level.

Table 3. Correlation Matrix

		Age	Gender	Lapses	SQ	Hr. Slp	Ov.SQ
Age	Pearson Correlation	1	-.163	.027	-.142	.177	-.024
	Sig. (2-tailed)		.151	.814	.210	.118	.833
Gender	Pearson Correlation	-.163	1	-.066	.030	.057	-.010
	Sig. (2-tailed)	.151		.563	.792	.621	.931
Lapses	Pearson Correlation	.027	-.066	1	-.206	-.234*	-.201
	Sig. (2-tailed)	.814	.563		.068	.038	.076
Sleep quality	Pearson Correlation	-.142	.030	-.206	1	-.006	.878**
	Sig. (2-tailed)	.210	.792	.068		.956	.000
Hours of Sleep	Pearson Correlation	.177	.057	-.234*	-.006	1	-.060
	Sig. (2-tailed)	.118	.621	.038	.956		.599
Overall Sleep Quality	Pearson Correlation	-.024	-.010	-.201	.878**	-.060	1
	Sig. (2-tailed)	.833	.931	.076	.000	.599	

Abbreviations: SQ – Sleep Quality; Hr. Slp – Hours of Sleep

Significance levels – $p < 0.05^*$, $p < 0.01^{**}$

The table below indicates that for overall sleep quality, sleep quality at previous night and hours of sleep the $R=.313$, $R^2 = .098$, indicating 9.8% of the variability in lapses is due to sleep quality at previous night, overall sleep quality and hours of sleep. Thus, it can be concluded that sleep quality at previous night and overall sleep quality are significant predictors of sleepiness. However hours of sleep is not a significant predictor of sleepiness.

Table. 4 Results of Regression Analyses

Model	R	R Square	Ad-justed R square	Std.Error of the estimate	F	Sig.	t	Sig
(Constant)	.313	.098	.062	6.02437	2.72		4.156	.000
sleepqualitynight						.051	-2.173	.033
hoursofsleep							-1.201	.234
overallsleepquality							-1.978	.052

- a. Predictors: (Constant), over all sleep quality, hours of sleep, sleep quality night
- b. Dependent Variable: lapses

Discussion, Conclusion and Limitations

Sleep deprivation is a common problem in the young adult college student population. In this study, we found that the average hours of sleep reported was 7.75, indicating that the participants were getting the required amount of sleep (in terms of quantity). However sleepiness was found to be a common problem among the participants. Sleepiness and behavioural alertness of participants were assessed through reaction time measured by the PVT. The PVT measure has been extensively validated to be sensitive to the effects of fatigue and medical conditions. Only 11% of the respondents have got a score of 3 or below in the Psychometric Vigilance Test. This indicates that the other 89% of them were sleepiness. Their behavioural alertness was also low as the average reaction time of the participants was above 650ms. Sleep quality at previous night and overall sleep quality are significant predictors of sleepiness measured through lapses.

Lapses in attention measured by the PVT can occur as a result of lack of sleep and/or prolonged hours on the job (Sylvia, et al., 2004). Sleep loss has been shown to impact the reaction times measured by the PVT by lengthening reaction time values and increasing the number of lapses and false starts (i.e. responding in anticipation of the stimulus). There is a growing literature on the associations between stressful working conditions and sleep problems (Akerstedt, Knutsson et al., 2002). These studies have consistently reported negative consequences of work stressors on sleep. On the other hand,

both sides of the issue should be taken into account that sleep problems are likely to have serious job-related stress outcomes as well (Doi, Monowa, & Tango, 2003).

Thus, it becomes very clear that the broad impact of sleep deprivation and its pervasiveness suggests intervention will need to be focused on the multilevel changes to increase sleep time and reduce the negative impact of sleep deprivation among research scholars. From the study results above it is highly evident that even though the research scholars are getting the required amount of sleep their performance still suffers as seen in the number of lapses and it becomes clear that just getting enough hours of sleep is not a one-stop solution to sleep problems there are a lot of other factors that need to be taken into consideration to make sure that the research scholars are not just sleeping long but also sleeping well which would eventually show in their performance.

The study suffers from a few limitations. The sample size used in this study was small and in the future this study could be replicated with a larger sample size. The participants (research scholars) in this study were from Mumbai and this could also be a possible bias in the study. The future work could consider scholars located in different parts of the country and the results could possibly be different.

REFERENCES

- [1].Budnick, C.J., Barber, L.K. (2015).Behind Sleepy Eyes: Implications of Sleep Loss for Organizations and Employees. *Translational issues in Psychological science*, 1(1), 89-96.
- [2].Harma, M. (2006). Workhours in relation to work stress, recovery and health. *Scandinavian journal of work, environment & health*, 502-514.
- [3].Akerstedt T. (2006). Psychosocial Stress and Impaired Sleep. *Scandinavian journal of work, Environment and health*, 32(6), 493-501.
- [4].Chrousos, G. P. (2009). Stress and disorders of the stress system. *Nature Reviews Endocrinology*, 5(7), 374-381.
- [5].Cropley, M., & Millward Purvis, L. (2003). Job strain and rumination about work issues during leisure time: A diary study. *European Journal of Work and Organizational Psychology*, 12(3), 195-207.
- [6].Cropley, M., Dijk, D.J. & Stanley, N. (2007). Job strain, work rumination and sleep in school teachers. *European Journal of Work and Organization Psychology*, 15(2), 181-196.
- [7].Basner, M., & Dinges, D. F. (2011). Maximizing sensitivity of the psychomotor vigilance test (PVT) to sleep loss. *Sleep*, 34(5), 581-591.
- [8].Minkel, J.D., Banks, S & Dinges, F.D. (2012). Sleep Deprivation and Stressors: Evidence for Elevated Negative Affect in Response to Mild Stressors when Sleep Deprived. *Emotion*, 12(5), 1015-1020. Rugulies, R., Martin, M.H.T., Garde, A.H., & Albertsen, K. (2012). Deadlines at work and sleep quality. Cross sectional and longitudinal findings among Danish knowledge workers. *American Journal of industrial medicine*, 55, 260-269.
- [9].Loh, S., Lamond, N., Dorrian, J., Roach, G., & Dawson, D. (2004). The validity of psychomotor vigilance tasks of less than 10-minute duration. *Behavior Research Methods, Instruments, & Computers*, 36(2), 339-346.