Sleep Deprivation: Effect on Mental Task Performance of Military Cadets

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Abstract

In modern society, prolonged wakefulness is a common phenomenon. Amongst students of the military, this is a frequent occurrence. There is a broad consensus that insufficient sleep leads to general slowing of response and increased variability in performance. Attention, long-term memory and decision-making have also been found to be influenced by sleep deprivation. Studies on effects on more demanding cognitive functions and among some essential subpopulations are required.This study was aimed at comparing the effects of varied levels of sleep deprivation on mental task performance of military students. It was hypothesized that deprivation (acute or chronic) would impair performance in mental tasks. A series of mental tasks were administered to military students (n= 76) of the Nigerian Defence Academy (NDA).Results showed sleep deprivation adversely affected mental task performance in the population but no significant difference was found between acute or chronic sleep deprivations on performance on a mental task.

Key words: Sleep deprivation, Military students/ cadets, Mental task Performance

1. Introduction

Sleep is an important part of human existence and functioning and cannot be substituted nor abused without consequences. Sleep is the physical and mental resting state in which a person becomes moderately inactive and unconscious of the environment. Sleepiness is inversely proportional to hours slept. Sleep deprivation exists when sleep is insufficient to support adequate alertness, performance, and health, either because of reduced total sleep time or fragmentation of sleep by brief arousals. Lots of literature document the negative effects associated with less-than-required amounts of sleep (Dinges, Baynard, & Rogers, 2005; Durmer & Dinges, 2005).Despite the recognition of sleep and its importance, sleep habits have worsened world over by most populations. Sleep deprivation consists either of a complete lack of sleep during a certain period of time or a shorter-than optimal sleep time. Pilcher and Huffcutt (1996) defined it to be functioning with less than five hours of sleep from the previous night. This is a common situation experienced by many individuals who perform critical roles in society. These people include medical doctors, firefighters, parents, and members of the military. Sleep deprivation can been viewed as chronic (long-term accumulation of sleep debt) or acute (a period of 1 night, or a few nights, without sleep or with curtailed sleep) (Dinges, Baynard, & Rogers, 2005).

With increased sleep deprivation, performance in a variety of functional domains gets worse. Increased sleep loss, decreases vigilant attention in experimental participants (Doran, Van Dongen, & Dinges, 2001; Dorrian, Rogers, & Dinges, 2005), causes a slower response timing and increased errors in performing mathematical operations(Hursh, Redmond, Johnson, Thorne, Belenky, Balkin, Storm, Miller, & Eddy, 2004; Thomas, Sing, Belenky, Holcomb, Mayberg, Dannals, Wagner, Thorne, Popp, Rowland, Welsh, Balwinski, & Redmond, 2000; Van Dongen, Maislin, Mullington, & Dinges,2003), impaired memory (Drummond & Brown, 2001; Drummond, Brown, Gillin, Stricker, Wong,& Buxton, 2000; Drummond, Gillin, & Brown, 2001; Habeck, Rakitin, Moeller, Scarmeas, Zarahn, Brown, & Stern, 2004; Thomas et al., 2000; Van Dongen, Baynard, Maislin, &Dinges, 2004; VanDongenet al., 2003), and decrements in performance on naturalistic tasks (Caldwell, 2003; Caldwell, Caldwell, Brown, & Smith, 2004; Dinges, 1995; Landrigan, Rothschild, Cronin, Kaushal, Burdick, Katz, Lilly, Stone, Lockley, Bates, & Czeisler, 2004; Tucker, Whitney, Belenky, Hinson, &Van Dongen, 2010). Sleep deprivation affects cognitive and motor processes as well as emotional stability (Pilcherand Huffcutt, 1996).

Uti and Ojeme (1997) opined that the amount of sleep needed to replenish and promote good health of individuals vary with individuals, age and environment. For example, New born infants should have at least 20-22 hours of sleep; while 1-4 years old- 12 hours; 4-12 years old–at least 10 hours; 13-19 years old (adolescents) – 8 to10 hours; Adults – 7 to 8 hours; and Elderly people – 5 to 7 hours.

According to Oyerinde (1991), sleep deprived persons feel tired, irritable and confused even though they are able to do well on motivated tasks with their usual strength and skill. To him, people who work with their minds need just as much sleep as manual workers.

Three categories of measurement commonly used in sleep deprivation studies include cognitive performance, motor performance, and mood. Sleep deprivation induces a wide range of effects on cognitive functions, although cognitive tasks vary considerably in their sensitivity to sleep loss (Durmer & Dinges, 2005). Cognitive performance variability involves both errors of omission (i.e., behavioral lapses evident as failure to respond in a timely manner to a stimulus) and errors of commission (i.e., responses when no stimulus is present or to the wrong stimulus) and these are hallmarks of sleep deprivation. This variability in cognitive performance increases with more sleep loss. Sleep deprivation has been found to affect cognitive function in medical students and nurses in some studies (Parkerson, Broadhead&Tse, 1990; Roth, Zammit, Kushida, Doghramji, Mathias, Wong & Buysse, 2002;Sweileh, Ali, Sawalha, Abu-Taha, Zyoud, & Al-Jabi, 2011) and a positive relationship is seen between adequate sleep and performance (Eliasson, Lettieri & Eliasson, 2010). While in others; sleep deprivation doesn't seem to significantly affect cognitive functions like learning among medical students (Browne, Van Susteren, Onsager, Simpson, Salaymeh& Condon, 1994). Some other studies showed that sleep deprivation does not bare special relevance to students' performance in a standardized test in English language and needs to go beyond a one night deprivation (Oyerinde&Onifade, 2009; Jerome, 1992).

Cadets at Nigerian Defence Academy have limited opportunities for sleep. Unlike other college populations, their first formation is at 0500 hours but many cadets are awake long before that hour to participate in cleaningand other activities even though they go sleep at very late hours. In addition, they are required to attend all academic classes, meals, preps, games and checking, leaving few chances for naps and catch-up sleep. These cadets almost certainly get less sleep than their peers at non-military institutions. Under this condition, many types of performance are likely to be degraded. As part of their duties in these situations, individuals are often required to perform complex cognitive tasks. The performance of these tasks may be compromised during periods of extended wakefulness. Review of literature could not reveal any local study that assesses the relationship between sleep deprivation and performance with this population. This study examines the association between sleep deprivation and cadet performance on a mental task.

In this study, acute sleep deprivation refers to no sleep or a reduction in the usual total sleep time, usually lasting one or two days (sleep of less than 5hours). In contrast, chronic sleep deprivation refers to a prolonged period of time (weeks or months) without sleep or with curtailed sleep (< 150 hours in a month).How much deprivation of sleep is needed before functions such as memory or reaction time are influenced? The relationship between cadet performance in timed mental tasks and the effects of sleep deprivation are hypothesized to be inversely related and are studied in an attempt to support the hypothesis.

1.1 Purpose of Study

The purpose of this study therefore, was to investigate the effect of levels of sleep deprivation on performance of military cadets in a selected mental task. This study serves to examine sleep and performance in the future force/future soldier and will contribute to the recommendations on the level of sleep needed by this population for effective functioning.

In more specific terms, the study will (a) examine the effect of levels of sleep deprivation on performance on a mental task, (b) Determine whether sleep deprivation differs across gender and levels amongst cadet population.

2. Method

2.1 Participants

This cross-sectional study was conducted over a 2-week period during the 2012–2013 academic session at the Nigerian Defence Academy, Kaduna, Nigeria. Military students participating in this investigation were volunteers from all levels of undergraduate cadets of the Faculty of Arts and Social Sciences of the Academy.

The participants (100 – 300 levels) were taking required general studies courses for their level. While those of higher levels (400- 500 levels), were approached at their free periods. In total, 76 cadets participated in the study. They had an age range of 18-26 years, with a mean age of 22.07 (SD 1.975). Of these students, 14.5% (n=11) accounted for 1st year cadets, 30.3% (n=23) for 2nd year cadets, 26.3% (n=20) for 3rd year cadets, 17.1% (n=13) for 4th year cadets and 11.8% (n=9) were 5th year cadets. A total of 8 females and 68 males participated in the study.

2.2 Instruments

The following instruments were used for the study.

(a) Eysenck General Intelligence Test 4 (EGIT-4). This is a 40 item test developed by Eysenck in 1981 to measure general intelligence. Questions from the EGIT cover verbal, quantitative and spatial aptitude as well as logical reasoning, inference making, creativity and problem solving (test-retest reliability = .66, and concurrent validity coefficient = .46 (Ihekuna, 1991)).This test contains 40 questions to be responded to within 30minutes.Questions were scored, according to the scoring procedures of the test (H.J Eysenck, 1981). Each question carried one point, totaling forty marks in all.

(b) Author's sleep questionnaire was used to assess the quantity of sleep received the previous night as well as in an average week and month. The four questions were open-ended questions with the expectation of whole numerical values to measure cadets' level of sleep deprivation.

2.3 Procedure

Investigations were carried out in lecture class rooms of the Nigerian Defence Academy, Kaduna. Participants consent was sought and they were briefed on what the study would involve. They were also told that participation was voluntary. Participants were given the tasks on the EGIT which was retrieved after 30 minutes. They then were each handed the second sheet contain the sleep pattern questions. On completion the participants were debriefed. They received no compensation for this study. Data were gathered anonymously.

3. Result

Three variables were assessed from the participants' surveys: mental task performance and two different levels of sleep deprivation (acute and chronic).

Table 1: Mean and Standard deviation of the scores of cadets

	N	Minimum	Maximum	Mean	Std. Deviation
Gender	76	1	2	1.11	.309
Age	76	18	26	22.07	1.975
Level	76	1	5	2.82	1.230
EGIT Score	76	3	21	13.03	4.424
Av. sleep last night	76	1	8	3.93	1.491
Av. sleep in a month	76	68	264	166.66	51.722
Valid N (listwise)	76				

The average amount of sleep reported on a previous night amongst this population was 3.93 hours (SD = 1.49). Average sleep obtained in a month was reported as 166.66 hours (SD = 59.72). Correlations were calculated between cadets' scores on the task given and the other variables in the study. The highest score obtained on the task was 21 while the lowest was a score of 3 ($\dot{x}$=13.03). Chronic sleep deprivation was found to be significantly associated with acute sleep deprivation ($r=0.599$, $p<0.01$).

To compare these findings, a t-test was performed. The result is presented in Table 2.

Table 2: **Summary of t-test results comparing sleep deprivation levels against mental task performance of cadets.**

Variable	Sleep deprivation	N	X	SD	T	df	P
Mental Task Performance	Low sleep	61	12.51	4.373	-2.105	74	0.039
	Normal sleep	15	15.13	4.121			

Results revealed a significant negative relationship exists between sleep deprivation (low sleep, normal sleep) and mental task performance (t= -2.105, df= 74 p>0.05). Normal level sleepers were found to have a higher mean value (x=15.13) implying they perform better on mental task performance than low level sleepers (x=12.51).

To determine if significant differences occurred among the groups, Two-way Anova was used to compare the groups. The results are presented below in table 3.

Table 3:2-way ANOVA Table for mental task performance as a function of acute and chronic sleep deprivation

Variable and Source	SS	MS	Df	F	P
Acute Sleep Deprivation	9.512	9.512	1	.502	.481
Chronic Sleep Deprivation	9.118	9.118	1	.481	.490
Acute * Chronic Sleep Deprivation	1.446	1.446	1	.076	.783
Error	1364.791	18.955	72	.502	

Table 3 shows that there was no significant difference on mental task performance of both acute sleep deprived (F (1, 72) = 0.502; p>0.05) and chronic sleep deprived cadets (F (1, 72) =0.481; p> 0.05).

A relationship between sleep deprivation and other variables such as educational level and gender were also sought. The results of these are presented in the tables below

Table 4: Independent Sample T-test Conducted on Gender (IV) and Reported Sleep Deprivation over a Period of One Month (DV) Among Cadets

Variable	Gender	N	X	SD	df	T	p
Sleep Deprivation	Male	68	169.26	53.551	74	2.304	<.05
	Female	8	144.50	24.231			

There is a gender difference in reported sleep deprivation over a period of one month among cadets. The female military cadets reported a significantly less average hours of sleep over a period of one month (Mean = 144.50, SD = 24.231, N = 8) compared to their male counterparts (Mean = 169.26, SD = 53.551, N = 53.551).

Table 5: One-Way ANOVA Source Table for Difference in Reported Sleep Deprivation based on the Levels of Military Cadets

Source of Variation	Sums of Square	Df	Mean Square	F	p
Between Groups (Combined)	64098.606	4	16024.652	8.333	<.001
Within Groups	136536.499	71	1923.049		
Total	2000635.105	75			

The table above shows that the result of the one-way analysis of variance conducted is significant: Fisher's ratio (8.333) is significant at less than .001, that is, [F (4, 71) = 8.333, p<.001]. A post hoc test conducted showed that cadets in 500 level reported significantly more sleep hours over a period of one month (Mean = 213.56, SD = 29.963, N =9) than cadets in 200 level (Mean = 140, SD = 26.257, N = 23) and cadets in 100 level (Mean = 128, SD = 43.635, N = 11). The same significant difference is observed in the mean difference of reported sleep hours of 400 level and 300 level cadets over 200 level and 100 level cadets. There is no significant mean difference in the reported sleep hours of 500 to 300 level cadets.

Similarly, there is no significant mean difference in the reported sleep hours of 200 and 100 level cadets.

Table 6: Showing Post-hoc test (LSD): A Multiple Mean Comparison of Sleep Deprivation based on the Levels of Military Cadets

Levels of Cadets		Mean on Sleep Deprivation	N	SD	Mean Difference on Sleep Deprivation				
					1	2	3	4	5
1.	500	213.56	9	29.963	-				
2.	400	184.62	13	47.940	28.940	-			
3.	300	185.80	20	59.634	27.756	-1.185	-		
4.	200	140.00	23	26.257	73.556*	44.615*	45.800*	-	
5.	100	128.00	11	43.635	85.556*	56.615*	57.800*	12.000	-

*Mean difference is significant at ≤ .05

4. Discussion

The findings partially support the hypotheses. A significant negative relationship exists between sleep deprivation (low sleep, normal sleep) and mental task performance (t= -2.105, df= 74 p>0.05). This shows that cadets with more sleep (x=15.13) generally performed better on the mental task than those with less sleep. The less sleep a cadet got, the less his performance on the task. This agrees with Pilcher and Huffcutt's (1996) statement that sleep deprivation affects cognitive processes and also studies like Hursh et al., 2004;Drummond & Brown, 2001;Eliasson et al., 2010.Sleep deprivation seems to have an adverse effect on divergent tasks that are multi-tasking. However, there was no significant difference on mental task performance between acute sleep deprived (F (1, 72) = 0.502; p>0.05) and chronic sleep deprived cadets (F (1, 72) =0.481; p> 0.05).Cadets suffer accumulated sleep debt due to a continuous rigorous routine. This may account for the no significant difference between acutely and chronically deprived individuals. They are engaged from as early as 0500 hours till as late as 2300 hours either by military or academic training after which they have themselves and their seniors to cater for (washing, ironing, and cleaning), though the level of a cadet's engagement may depend on his position, level, roommate, etc. In between these activities there may be little or no time fornaps to catch up on lost sleep. This as seen from results has adverse effect on performance on a mental task.

A significant gender difference was observed in reported sleep deprivation over a period of one month among cadets. The female military cadets reported a significantly less average hours of sleep over a period of one month (Mean = 144.50, SD = 24.231, N = 8) compared to their male counterparts (Mean = 169.26, SD = 53.551, N = 53.551). There is also a significant difference in the mean difference of reported sleep hours amongst the different levels, with 500 level cadets reporting significantly more sleep hours over a period of one month (Mean = 213.56, SD= 29.963, N =9). As a cadet level increased in the Nigerian Defence Academy, the duties he has to perform decrease and therefore he has more time for himself. Result comparing sleep deprivation and level showed this. Also there was a significant positive correlation between level and mental task performance.

Other qualitative data gotten during the study point to the fact that level of sleep deprivation amongst this population is affected by the day of the week, as cadets reported less deprivation at weekends than on week days. Most cadets in this sample reported insufficient sleep during the week, which they tried to make up for at the weekends. Also the semester or training period played a role in the amount of sleep debt felt. This influenced the kind of activities to be carried out during the period or the content of the curriculum and thus determined the amount of sleep gotten by cadets.

Findings showed that this population suffers severe sleep loss. The military seems to view depriving oneself of sleep as a means of demonstrating mental and physical toughness.

5. Conclusion

The findings of this study point to the importance of adequate sleep in the training of cadets. This holds practical implications for the individual cadet. They also show that there is a need to work towards improved sleep time for members of this population, especially since the results show that the average amount of sleep received is less than the recommended seven to eight hours of sleep. Improved sleep practices might increase cognitive performances in general.

On the whole this was a great study to perform but has a number of problems. If the opportunity to perform the study occurred again, an experimental design might produce more robust results. Future studies on this topic may be able to attain more reliable information if a more objective measure of sleep deprivation is administered. These self-reported amounts of sleep need to be verified by objective measures. Further limitations of this study include the sample size used. The author believes that if the study was carried out in this manner, the hypotheses may have been better supported.

This study is relevant to the well-being of the military student, the future soldier who is required to perform efficiently at various levels. It is recommended that the relevant authorities address sleep related issues and policies be put in place to reduce sleep deprivation and its negative effects. Suggested interventions include teaching the importance and methods cadets could employ for good sleep hygiene, enforcing a compulsory lights out, reducing the control of seniors on the junior cadet, and making compulsory some sort of siesta or nap time during the day.

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