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The Effect of Partial and Chronic Sleep Deprivation on Working Memory and Attention in Emergency Medicine Interns

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Abstract

Background: Sleep is an organized behavior that is repeated every day as a vital necessity based on the biological rhythm. Sleep deprivation is known as one of the major problems that can cause functional impairment in individuals. Therefore, it is expected that sleep deprivation in interns also causes problems in their performance.

Objectives: According to the importance of cognitive health in health care workers, we decided to study the effects of partial and chronic sleep deprivation on attention and working memory in the emergency medicine interns in Yazd University of Medical Sciences.

Methods: The number of 50 emergency medicine interns were randomly selected and their demographic information was entered the data collection form. The subjects were examined before and after the one-month period of the shift work. Working memory and attention in participants were compared with the application of working memory and attention tests in 2-time points. Finally, the collected data were entered the SPSS software version 16 and statistical tests were performed subsequently.

Results: The results showed that there is no significant difference between the mean of direct and reverse auditory working memory, direct and reverse visual working memory, as well as the divided attention of participants before and after the one-month period of the shift work, but there was a significant difference between the average of selective attention of participants before and after the one-month period of the shift work (P value < 0.05). Also, this study showed that, regardless of the effect of sleep deprivation, the mean of divided attention and working memory are different between males and females.

Conclusions: According to the results of the study, it can be concluded that the type of sleep deprivation in the emergency medicine interns only reduces the selective attention and this effect was not dependent on the gender.

Keywords: Attention, Male, Partial Sleep Deprivation, Female, Working Memory

1. Background

Sleep plays an important role in protecting the mental and physiological health. Different physical and emotional factors can result in sleep disorders (1). Sleep deprivation (SD) as an important problem can affect physiological and psychological performances (2-4). Total sleep deprivation (TSD) and partial sleep deprivation (PSD) are two types of SD. In TSD, a person at least experiences 24 hours of sleepless but PSD means sleeping less than 6 hours during 24 hours. Several studies showed that total sleep deprivation (TSD) can create health problems such as cardiovascular disorders and psychological impairments (4, 5). One of the critical effects of TSD is the distraction of cognition such as working memory and attention (6).

Attention is a behavioral and cognitive process of selectively concentrating on a discrete aspect of information. Selective attention is the ability to select from many factors or stimuli and to focus on only the one that you want while filtering out other distractions. Divided attention is the ability to process two or more responses or react to two or more different demands simultaneously.

Working memory is a cognitive system with a limited capacity that is responsible for temporarily holding information available for processing. Working memory is important for reasoning and the guidance of decision-making and behavior. The studies about TSD revealed that the distraction of working memory and attention are involved in the reduction of performance (6). On the other hand, people usually experienced the PSD (but not TSD) in their life, for example, the jobs with night shift such as nursing or guarder may lead to repeated PSD and affect their performances.

The effects of PSD could be recovered by sleeping, thus

were less noticeable (7, 8). However, some studies showed that the effects of the repeated PSD during a period of time may be reinforced and finally induce the effects of TSD (6). In addition, according to physiological and psychological differences between males and females, the effects of SD are probably different between them (5).

2. Objectives

We aimed to study the effects of PSD during the one-month period of the night shift on the working memory and attention in male and female emergency medicine interns in Yazd University of Medical Sciences.

3. Methods

All procedures of this study were approved by the Ethics Committee of the AJA University of Medical Sciences, Tehran, Iran, and were in compliance with Helsinki ethical rules. In the current study, 50 healthy student volunteers participated from two genders (25 males and 25 females) with the age range of 23 - 25 years old. The participants have no history of neurological and psychological diseases, sleep disorders, and alcohol or drug abuse. They experienced the first month of their night shifts and had less than 4 hours of sleep per night during 15-night shifts. The participants were examined two times, including before and after the one-month night shift without any intervention. The experimental procedure was explained to the participants at the start of the study.

The Wechsler memory scale (WMS) is a neuropsychological test designed to measure different memory functions in a person. The Wechsler working memory tests contain direct and reverse visual and auditory tests that were used to assess visual and auditory working memories. The working memory tests consisted of single digit numbers that the students repeated them after their direct and reverse presentation. With the progress of the test, the speed of presentation and number of the objects are increased.

Also, the selective and divided attention were assessed using the tasks designed by the SINA institute of cognitive and behavioral sciences, Tehran, Iran. In the selective attention test, a number of images were shown in a random order and the students pressed the certain key after seeing the certain object. On the other hand, in the divided attention test, the different images were shown and the participants pressed the Esc key after seeing the certain objects simultaneously. Similarly, with the progress of the test, the speed of presentation is increased.

After the computerized data collection, two-way ANOVA was used to evaluate the final data using the SPSS software version 16. The statistical level of less than 0.05 ($P < 0.05$) was considered significant and followed by adjusting Bonferroni test to compare differences between groups, and the data were presented in the text as mean ± standard deviation (SD).

4. Results

4.1. The Visual Working Memory

The partial sleep deprivation did not have any significant effect on forward (P = 0.181) and reverse (P = 0.621) visual working memory induced by the night shifts during one month in male and female emergency medicine students. However, forward and reverse visual working memory significantly differ between male and female emergency medicine students (P = 0.008, P = 0.026, respectively) (Table 1).

Table 1. The Effect of Partial Sleep Deprivation on Forward and Reverse Visual Working Memory[a]

	Before	After
Forward visual working memory		
Male	8.88 ± 0.57	8.46 ± 0.25
Female	7.56 ± 0.34	7.16 ± 0.37
Reverse visual working memory		
Male	8.37 ± 0.50	8.96 ± 0.29
Female	7.32 ± 0.73	7.20 ± 0.54

[a]Values are expressed as mean ± SD.

4.2. The Auditory Working Memory

The partial sleep deprivation induced by the night shifts during one month did not have any significant effect on forward (P = 0.520) and reverse (P = 0.619) auditory working. However, forward and reverse auditory working memory significantly differ between male and female emergency medicine students (P = 0.01, P = 0.041, respectively) (Table 2).

4.3. The Selective and Divided Attention

The partial sleep deprivation induced by the night shifts for one month significantly decreased selective attention (P = 0.007). However, no significant difference was seen in selective attention between male and female emergency medicine students (P = 0.185) (Table 3). In addition, the partial sleep deprivation did not have any significant effect on divided attention (P = 0.670). However, there was a significant difference in divided attention between male and female emergency medicine students (P = 0.008) (Table 3).

Table 2. The Effect of Partial Sleep Deprivation on Forward and Reverse Auditory Working Memory[a]

	Before	After
Forward auditory working memory		
Male	8.7 ± 0.36	9 ± 0.29
Female	7.8 ± 0.41	7.56 ± 0.42
Reverse auditory working memory		
Male	8.63 ± 0.5	9 ± 0.32
Female	7.8 ± 0.57	7.8 ± 0.47

[a]Values are expressed as mean ± SD.

Table 3. The Effect of Partial Sleep Deprivation on Selective and Divided Attention[a]

	Before	After
Selective attention		
Male	154 ± 2.4	138.5 ± 6
Female	143.7 ± 2.3	138.8 ± 2.9
Divided attention		
Male	121.3 ± 11.9	120.9 ± 11.5
Female	69.8 ± 15	68.8 ± 14.7

[a]Values are expressed as mean ± SD.

5. Discussion

The sleep deprivation as an important problem can cause distraction of a person's performance (2). This problem is more critical about shifting health workers such as physicians and nurses (4). Thus we aimed to study the effects of repeated partial sleep deprivation on visual and auditory working memory and selective and divided attention in emergency medicine students of Yazd University of Medical Sciences.

The results of our study showed the partial sleep deprivation induced by night shifts during one month could decrease only the selective attention in male and female emergency medicine students while had any significant effects on the other examined cognitive aspects. Some of the previous studies about the effects of sleep deprivation on cognitive aspects had different results.

Voderholzer explained the total and partial sleep deprivation could improve the mood of depressed people and increase their attention; however, the effect of partial sleep deprivation was better than total sleep deprivation (4). In comparison to the results of our study, this result suggests that the effects of sleep deprivation on psychiatric patients may be different from those of a healthy person. Also, Khazaie et al. showed the partial sleep deprivation for a five-day- and night-period had no significant effects on prefrontal cortex performance, time estimation tasks, and decision making ability in medical residents (9). These results may be due to the short period of partial sleep deprivation. On the other hand, many studies showed the negative effects of the total and sleep deprivation on cognitive aspects. Jiang et al. suggested the chronic sleep deprivation impaired the reference memory in rats (10).

Alhola and Polo-Kantola explained the total and partial sleep deprivation could impair the attention, working memory, and decision making; however, the partial sleep deprivation was more effective on attention. Also, they reported there are differences between genders in physiological features. Thus it is possible that physiological responses to SD are different between males and females (5). Also, Goel in their review article, showed the deficits in attention and executive functions after 16 hours wakefulness were demonstrable by testing protocols. However, these deficits were dependent on genetic differences or compensatory changes in the neurological systems involved in cognition (6). Killgore et al. reported the partial sleep deprivation has resulted in a decrease of attention and impairment of decision making (11). Bank and Dinges explained the accumulated cognitive deficits during chronic sleep deprivation were similar to those created after 1 to 3 nights of total sleep deprivation. Also, the other studies have confirmed these results (12).

Lo et al. revealed PSD can increase the formation of false memory and impairment of cognitive functions, subjective alertness, and mood. Also, they showed some cognitive impairments do not recover after 2 night's recovery sleep (13, 14). Cohen-Zion et al. in 2016, showed the information processing speed performance was poorer in the PSD (15). Ballesio et al. in 2018, explained that habitual PSD damaged switching performance (16). Therefore, different studies revealed that the PSD can impair cognition; however, the type of damaged cognitive aspect is dependent on the type and duration of the PSD.

In conclusion, according to the same results of the previous studies and our study, it seems the attention may be more sensitive to PSD induced by shift working than the other cognitive aspects. Moreover, in this study we observed gender differences in cognitive aspects; however, there were no differences in responses to PSD among males and females. Nevertheless, due to little information about the effects of PSD on cognition and its relation to individual differences, further studies are needed to prove these findings.

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Footnotes

Authors' Contribution: All authors contributed in all processes of manuscript.

Conflict of Interests: The authors declare that they have no conflict of interest.

Ethical Approval: All procedures of this study were approved by the Ethics Committee of the AJA University of Medical Sciences, Tehran, Iran, and were in compliance with Helsinki ethical rules.

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References

1. Dollander M. [Etiology of adult insomnia]. *Encephale*. 2002;**28**(6 Pt 1):493–502. French. [PubMed: 12506261].
2. Killgore WD. Effects of sleep deprivation on cognition. *Prog Brain Res*. 2010;**185**:105–29. doi: 10.1016/B978-0-444-53702-7.00007-5. [PubMed: 21075236].
3. Reynolds AC, Banks S. Total sleep deprivation, chronic sleep restriction and sleep disruption. *Prog Brain Res*. 2010;**185**:91–103. doi: 10.1016/B978-0-444-53702-7.00006-3. [PubMed: 21075235].
4. Voderholzer U. Sleep deprivation and antidepressant treatment. *Dialogues Clin Neurosci*. 2003;**5**(4):366–9. [PubMed: 22033748]. [PubMed Central: PMC3181780].
5. Alhola P, Polo-Kantola P. Sleep deprivation: Impact on cognitive performance. *Neuropsychiatr Dis Treat*. 2007;**3**(5):553–67. [PubMed: 19300585]. [PubMed Central: PMC2656292].
6. Goel N, Rao H, Durmer JS, Dinges DF. Neurocognitive consequences of sleep deprivation. *Semin Neurol*. 2009;**29**(4):320–39. doi: 10.1055/s-0029-1237117. [PubMed: 19742409]. [PubMed Central: PMC3564638].
7. Buxton OM, Pavlova M, Reid EW, Wang W, Simonson DC, Adler GK. Sleep restriction for 1 week reduces insulin sensitivity in healthy men. *Diabetes*. 2010;**59**(9):2126–33. doi: 10.2337/db09-0699. [PubMed: 20585000]. [PubMed Central: PMC2927933].
8. Reynolds AC, Dorrian J, Liu PY, Van Dongen HP, Wittert GA, Harmer LJ, et al. Impact of five nights of sleep restriction on glucose metabolism, leptin and testosterone in young adult men. *PLoS One*. 2012;**7**(7). e41218. doi: 10.1371/journal.pone.0041218. [PubMed: 22844441]. [PubMed Central: PMC3402517].
9. Khazaie H, Tahmasian M, Ghadami MR, Safaei H, Ekhtiari H, Samadzadeh S, et al. The effects of chronic partial sleep deprivation on cognitive functions of medical residents. *Iran J Psychiatry*. 2010;**5**(2):74–7. [PubMed: 22952495]. [PubMed Central: PMC3430498].
10. Jiang F, Shen XM, Li SH, Cui ML, Zhang Y, Wang C, et al. [Effects of chronic partial sleep deprivation on growth and learning/memory in young rats]. *Zhongguo Dang Dai Er Ke Za Zhi*. 2009;**11**(2):128–32. Chinese. [PubMed: 19222951].
11. Killgore WD, Balkin TJ, Wesensten NJ. Impaired decision making following 49 h of sleep deprivation. *J Sleep Res*. 2006;**15**(1):7–13. doi: 10.1111/j.1365-2869.2006.00487.x. [PubMed: 16489997].
12. Banks S, Dinges DF. Behavioral and physiological consequences of sleep restriction. *J Clin Sleep Med*. 2007;**3**(5):519–28. [PubMed: 17803017]. [PubMed Central: PMC1978335].
13. Lo JC, Chong PL, Ganesan S, Leong RL, Chee MW. Sleep deprivation increases formation of false memory. *J Sleep Res*. 2016;**25**(6):673–82. doi: 10.1111/jsr.12436. [PubMed: 27381857]. [PubMed Central: PMC5324644].
14. Lo JC, Ong JL, Leong RL, Gooley JJ, Chee MW. Cognitive performance, sleepiness, and mood in partially sleep deprived adolescents: The need for sleep study. *Sleep*. 2016;**39**(3):687–98. doi: 10.5665/sleep.5552. [PubMed: 26612392]. [PubMed Central: PMC4763363].
15. Cohen-Zion M, Shabi A, Levy S, Glasner L, Wiener A. Effects of partial sleep deprivation on information processing speed in adolescence. *J Int Neuropsychol Soc*. 2016;**22**(4):388–98. doi: 10.1017/S1355617716000072. [PubMed: 26892867].
16. Ballesio A, Cerolini S, Ferlazzo F, Cellini N, Lombardo C. The effects of one night of partial sleep deprivation on executive functions in individuals reporting chronic insomnia and good sleepers. *J Behav Ther Exp Psychiatry*. 2018;**60**:42–5. doi: 10.1016/j.jbtep.2018.02.002. [PubMed: 29567512].