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## Surveying medical interns' visual short-term memory and response inhibition function before and after a night shift, sleep quality and smoking habits in Rasht 2020: a cross-sectional study

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### Abstract

**Introduction:** Physicians whether during training years or working years are involved with the shift work system. Night shifts and the sleep deprivation that ensues have many adverse effects both physical and mental. Hence any decrease in doctors' mental capacities will potentially put his and his patients' health at risk, we decided to conduct a study to check medical interns' Visual Short-Term Memory (VSTM) and Response Inhibition Functions changes after a night shift compared to the day before.

**Materials and Methods:** In this study, 32 medical interns from the Guilan University of Medical Sciences were recruited by random sampling. Each participant completed a Pittsburgh Sleep Quality Index questionnaire and was asked about his/her smoking habit and prior night's sleep. Each examinee then was tested in the morning before and after the night shift for VSTM by forward Corsi Block Tapping Test (CBTT) and for Response Inhibition by Stroop Word/Color Test implemented in the PEBL software version 2beta6. The data were coded and analyzed in SPSS v21.

**Results:** There was no significant change in the intern's CBTT and Stroop Test results after a night shift and their VSTM and Response Inhibition Functions remained fairly intact. According to their PSQI results, 29 interns had poor sleep quality and only two had an acceptable PSQI score (5 or less).

**Conclusion:** We argued that the consistent results of the CBTT and the Stroop Color Test could be due to many causes from small sample size to overall lower function under chronic sleep deprivation.

**Keywords:** Night Shift, Intern, Visual Short-Term Memory, Response Inhibition, Smoking, Sleep Quality

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## Introduction

Since the Libby Zion Case and the issuing of “The Law of Libby Zion” based on Bell Commission's work, sleep deprivation (SD) due to night shifts and its toll on doctors' and patients' safety and their overall life satisfaction is of major regard for both doctors and health authorities. High serious and fatal errors are prevalent among sleep-deprived Interns and Residents after the regular night shifts which can easily lead to 36 or 48 hours of SD (1). A higher rate of self-injuries during invasive procedures combined with loose sensory-motor coordination comparable to considerable blood alcohol levels that had resulted in motor vehicle accidents during the commute to the hospital and home makes everyone in contact with a sleepy doctor reasonably anguished (2,3). Many scholars have studied different aspects of SD (acute and chronic) and its effect on different functions of the human brain in acute forms. Working memory and its proposed two subcategories Visual Short Term Memory and Verbal Short Term Memory are regarded as a unit that allows representations to be actively extended over time in the absence of sensory input, making such information available to more complex cognitive operations ranging from mental arithmetic to problem-solving, therefore we assume it as the main storage unit for the data gathered by history taking and physical examination before writing them down or putting an order since short term memory (STM) “must support memory for previously unencountered information, the storage of multiple tokens of the same type, and variable binding” (4-6). As the brain uses the same memory unit to analyze the data and to reference Long Term Memory content, any shortcoming in this capacity is potentially harmful to the efficacy and integrity of the service provided by a doctor or the material learned by an intern or a resident. The other interesting function that seems to keep a human on the perceived (or learned and exercised) right track by mitigating external influence on the decisions he makes is the response inhibition function, which we use to rethink our response to external stimuli right before acting it out a.k.a self-control. Executive function, the cognitive control of behavior, depends on the prefrontal cortex, which is highly developed in higher primates and especially humans. The diverse inputs and back projections to both cortical and subcortical structures

put the prefrontal cortex in a position to exert what is often called “top-down” control or cognitive control of behavior (7). This executive function is crucial to make the right decisions under pressure like when somebody is very sleepy or a doctor is handling a rude or inappropriate patient. Overall sleep quality of a medical student is important for him/her to retain learned material and conduct a healthy lifestyle for years to come (8,9). A chronic poor sleep pattern harms the hippocampus and memory system (10). Speaking of lifestyle; Smoking cigarettes is one of the most harmful risk factors for many health aspects, it is a treatable and preventable cause, but beforehand we need to have a clear assessment of the situation, physicians must be a living example of what they propagate if they believe in it. Due to the lack of study in this area among medical students in Guilan, we decided to conduct a study to evaluate the function of short-term visual memory and inhibit response before and after shift and sleep quality in the internships of educational hospitals in Rasht, Iran.

## Materials and Methods

### Participants

Conducted a cross-sectional analytical study among 32 interns in Poursina Hospital in Rasht during June and July of 2020. Sampling was done by asking available interns if they are interested in participating. The use of self-report questionnaires was limited by clarifying the questions and selecting options that have limited interpretation. Lack of control over variables such as sleep patterns and recreation of the subjects included in the study, which tried to reduce their effect by defining appropriate exclusion criteria. Fatigue and lack of cooperation of the interns after the watch and tightness of the intern program in the hospital were other problems of the project. The exclusion criteria were being on any long-term medication, already having sleeping problems that require using sleeping aids agents and not adherence to the complete study. We used a checklist of two questions regarding being a smoker and starting period of smoking regularly.

### Corsi Block Tapping Test (CBTT)

We conducted a session of testing visuospatial short-term working memory using PEBL (v2.6 portable)

software running on an iLife ZedAir2™ notebook with 14" screen and an ordinary wireless mouse.

**Stroop Color and Word Test (SCWT):** We used Corsi Block Tapping Test (forward) and Stroop Word Color Test to gather data about the examinee's VSTM and Response Inhibition Function.

### Pittsburgh Sleep Quality Index (PSQI)

We use 19-item self-rated questionnaire pittsburg sleep quality index. It assesses subjective sleep quality in the previous month. The total score ranges from 0 to 21, with higher scores indicating poorer sleep quality. The reliability and validity of the Persian version of the PSQI have been assessed previously in Iran. A total PSQI score > 5 indicates poor sleep quality Thus, those with a PSQI of less than five were considered good sleepers.

All the tests were conducted in a quiet room with an air conditioner and a suitable desk and chair to accommodate the examinee's height and eliminate intruding factors as much as possible. Interns were willing to be tested after the morning report and having their breakfast and we had to comply.

### Sample size

In determining the sample size based on Sarabadani et al.'s study with 95% confidence interval and 90% power, due to the inverse relationship between sleep quality and working memory in students (-0.52), we reached the number 32 as sample size.

### Statistical Analysis

The statistical analysis was performed using SPSS v21 software. Mean and standard deviation (95% confidence interval) were used to describe quantitative variables with normal distribution and median and mean range were used for quantitative variables with the abnormal distribution. Qualitative variables were also described based on number and percentage. The normal distribution of the study quantitative variables was measured using elongation and skewness values, histogram diagram, Q-Q plot diagram and Shapiro-Wilk test. To compare abnormal quantitative variables of visuospatial short-term working memory score and response inhibition score before and after internship shifts using nonparametric Wilcoxon equivalent.

## Results

From the total of 32 interns were entered the study, the results of one intern were excluded due to the exclusion criterion of "regular use of sleep aid agents". The mean age of 31 participants was  $25.42 \pm 0.720$  years with ages 24 to 27 years. Descriptive results which are shown in table 1, exhibited 20 (64.5%) interns were male and 11 (34.5%) interns were female. 14 (45.2%) were smokers with the majority beginning smoking from Physio path/Stager 6 (19.4%). More than half of the participants 16 (51.6%) had slept 4-6 hours during the last night and the duration of the night shift sleeping of 21 (67.7%) of them was 0-2 hours.

**Table 1.** Descriptive result of medical interns.

Age (year)	Mean $\pm$ SD
	25.42 $\pm$ 0.720
Sex	N (%)
Female	11 (35.5)
Male	20 (64.5)
Smoking, n (%)	
Yes	14 (45.2)
No	17 (54.8)
Beginning of smoking, n (%)	
high school	3 (9.7)
Science Basic	3 (9.7)
Stager/Physio path	6 (19.4)
Internship	2 (6.5)
Sleep duration last night (hour)	
2-4	3 (9.7)
4-6	16 (51.6)
> 6	12 (38.7)
Sleep duration night shift (hour)	
no sleep	5 (16.1)
0-2	21 (67.7)
2-4	4 (12.9)
4-6	1 (3.2)

Results of pre-shift and post-shift examinations regarding the visuospatial short-term working memory score and response inhibition score shows in table 2. The Wilcoxon signed rank test on the Corsi block-tapping test and Stroop color-word test exhibited no significant change before and after the night shift. The mean PSQI was  $9.0 \pm 2.49$  with poor sleep quality (PSQI > 5) only in 2 (6.5%) interns.

**Table 2.** The difference of visuospatial short-term working memory score according to CBTT and response inhibition score according to SCWT before and after the night shift in medical interns.

	Before shift Median (IQR)	After shift Median (IQR)	Negative Rank	Positive Rank	Ties	Z <sup>a</sup>	P
<b>Corsi block-tapping test</b>							
Block span	8 (6-8)	11 (9-11)	5	5	21	-0.105	0.917
Total score	88 (54-88)	6.5 (5.5-6.5)	6	14	11	-1.046	0.295
Correct trial	8 (6-8)	11 (10-12)	6	14	11	-1.454	0.145
Memory span	88 (60-96)	6.5 (6-7)	6	14	11	-1.599	0.110
<b>Stroop color-word test</b>							
MRTC	726 (674-812)	747 (654-779)	15	15	1	-0.113	0.910
MRTI	766 (709-824)	794 (725-886)	17	14	0	-0.549	0.583
MRTN	760 (689-812)	752 (677-837)	16	15	0	-0.245	0.806

CBTT: Corsi Block Tapping Test; SCWT: Stroop Color and Word Test; IQR: Inter Quartile Range; a Wilcoxon Signed Rank test. M: mean R: response T: time C: congruent I: incongruent N: neutral.

## Discussion

The consistency of CBTT and Stroop Word/Color Test among examined interns was contrary to our initial expectations. These results could be due to the small sample size. Conducting the test before and after a shift with the same equipment and in the same room suggests that there is little chance for a systematic error; as we assigned random available Interns to the study and sampling was by choosing available random samples.

The second possible explanation is that due to changes in health facilities priorities and more workload and responsibilities put on residents in the COVID-19 era, interns were not as engaged in the shift work and direct contact with the patients as before due to safety regulations and therefore didn't get exhausted.

The other interesting interpretation that we put forward is, by combining the results of these two tests with PSQI results we suggest that the overall and long-term poor sleep quality of the medical interns had put them in a steady low functional capacity that there was no room for reduction of VSTM span or Increase in Response Inhibition Errors and Response Times after one night of acute SD, meaning they could not manifest their best performance cause their night sleep was part of a vicious continuous cycle of poor sleep quality and wouldn't give them enough rest to retrieve their full functional capacity.

45.2% smoker prevalence is quite high for a sample of medical interns and it is highly skewed toward smokers. But regarding the pattern of increase in smokers ratio from 16.6% in 2004 to 23% in 2010<sup>1</sup> and no existing program to actively target this problem, probably the high ratio reported by this study is not far away from reality (11,12).

Combining the results of PSQI scores and the self-declared sleep hours during the night before shift night opens a window into the wrong habit of self-imposed chronic sleep deprivation and derangement in "Sleep Duration" and "Sleep Efficiency" components of sleep hygiene and the necessity of intervention. Limitation of sample size and time limit The availability of interns for review is one of the most important limitations in this study. Also, the impossibility of repeating the test several times and the safe presence in the hospital environment were other limitations of this study.

Focusing the study on surgical interns with the aim of homogenizing the results and better examining them deprived this study of having insight and judgment about the condition of interns in other areas (such as internal, cardiac, ENT, etc.). Insomnia is a part such as the interior having a significant impact on the performance of interns.

Also, reducing the burden of internships and the permanent presence of residents (especially first-year

residents) has been effective in reducing internship fatigue and not changing test results.

The publication of the results of the present study can provide a basis for comparing future studies in each of the areas of smoking or sleep quality with the comparison of the time of this study with the future or statistical samples different from the sample of this study.

Also, educational planners use these results or review the form and content of this study to make more informed decisions about training planning, changing the number of interns on duty and training items provided the day after the intern interns.

## Conclusions

Consistent results of CBTT and Stroop Color Test show that Acute Sleep Deprivation during a night shift among surveyed interns did not affect their VSTM and response inhibition and we suggest it may be the effect of chronic sleep deprivation or the changes due to COVID-19 pandemic caused it. Poor sleep quality and the high prevalence of cigarette smoking among interns need appropriate interference and more research.

## Author contribution

**ZR** and **AD** wrote and compiled this article. **AA** wrote and edited the manuscript comprehensively. All authors confirmed the final version of the paper.

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## Ethical Considerations

The proposal of this study was approved by the Ethics Committee of Guilan University of Medical Sciences IR.GUMS.REC.1399.155.

## Conflict of interest

The authors declare that they have no conflict of interests.

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