

## A Correlation between Sleep Deprivation and Cognitive Performance in Nurses Working in Shifts in SRG and SHKBM (Janana) Hospital, Jhalawar Medical College

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### Abstract

**Background:** Nursing health professionals works for prolonged day and night shifts that leads to deprived sleep, affecting cognition and concentration, increased fatigue, compromised health, decreased alertness and detrimental effect of working capabilities. The present study was planned to assess the prevalence of Sleep Deprivation among nurses working in shift and its impact on their cognitive performance.

**Materials and method:** 90 staff nurses were divided into two groups; day and night shift workers (45 each) were assessed for sleep deprivation and cognition impairment using PSQI and MoCA respectively. Both the tests were conducted twice, at the end of eight hour duration day or night shift work, after 3-4 days of the commencement of shift. The data was collected, tabulated and statistically analysed using SPSS version 20.0 software.

**Results:** Among day and night shift workers, female (62.22%) and male (40%) predominance was observed respectively. 68.89% day shift workers had good sleep quality, whereas only 37.78% night shift workers had good sleep quality. In day and night shift workers, total component score was 31 and 17 for good quality of sleep respectively, showing a significant difference ( $p$ -value<0.05) statistically. Intergroup comparison between night and day care workers was done in relation to global PSQI score, showing a significant difference ( $p$ -value<0.05) statistically. Global PSQI and cognitive Score was more in day shift workers than in night shift workers with a statistical significant difference ( $p$ -value<0.05).

**Conclusion:** The night shift workers have a poor quality of sleep than day shift workers. We also found that poor quality of sleep has strong association with reduced cognition. We suggest that replacing current shift system with slowly rotating shift system and optimization of sleep-wake strategy could improve sleep quality of nurses.

**Key words:** Sleep deprivation; Cognition; Day Shift nurses; Night shift nurses

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### Introduction

Sleep Deprivation (SD) is a term defined as, “having an insufficient sleep to sustain the appropriate alertness of daytime”. [1] Prolonged sleep deprivation is linked to an increased neural reactivity, that can effect various physiological processes of body like attentiveness, cognition, working

capability, ability to learn etc. Cognition is the term that highlights the complexities of basic cognitive functions like being alert, vigilant and attentive. [2]

Nursing staff works in day and night shifts in hospitals and due to prolonged work duration, they had restricted sleep. This

deprivation of sleep can cause impaired cognition and concentration, increased fatigue, compromised health, decreased alertness and detrimental effect of working capabilities. Various studies [3-4] have revealed that long-standing de-synchronization of circadian rhythm can cause sleep impairment, leading to effect on duration and quality of sleep, and intricacy in falling asleep. The most common sleep phases that are affected in case of SD are rapid and light eye movement. In a study, it was found that the night shift working nurses are having complaints of non-refreshing sleep and early morning waking-up. [5]

It has been observed that in nursing staff, the symptoms of poor sleep quality, impaired life processes, decreased alertness are due to the reason that during night shift, our body and mind goes against the normal circadian rhythmicity, thus leading to the disruptive effects on health. The prefrontal activity, that involves the higher level of cognition processing like decision-making, is affected due to loss of sleep. As a result, the nurses with SD are susceptible to use inadequate algorithms for solving a problem and making decisions at work, [6] thus increasing the chances of taking wrong decisions, leading to unfavourable outcomes for patients. [7-8] SD even hamper the communication skills of nursing staff, they suffer from difficulty in finding the suitable word, interpreting what patients and his caregivers are saying and what instructions need to be written and followed. This communication confusion causes misjudgement during elementary and critical situations at work. [9]

Sleep deprivation among the nursing staff is a major concern that not only affects them but also affect their duties towards patients. With this background, the present study was planned to assess the prevalence of Sleep Deprivation among nurses working in shift and its impact on their cognitive performance.

### **Materials and Method:**

The present randomized controlled crossover study was conducted from October 2021 to March 2022, among the selected staff nurses, aged 20-40yrs of SRG and Janana Hospital, Jhalawar Medical College, Jhalawar, Rajasthan working on a rotating work schedule i.e., staff posted to day shift of 8 hours for 7 days and the same staff posted to night shift of 8 hours for 7 days. The selection was based on inclusion and exclusion criteria. Staff nurses without any medical or mental illness, having minimum 1yr of rotating shift work experience were included in study. Nurses with history of use of psychoactive substance or drugs affecting central nervous system, those suffering with any metabolic disorders, colour blindness, pregnancy, and those who do overtime and other jobs during off duty were excluded from study.

The sleep deprivation was assessed using the Pittsburgh Sleep Quality Index (PSQI). The Montreal Cognitive Assessment (MoCA) Version 7 scales were used to assess various cognitive domains concerned with visuo-spatial skill, naming, memory recall, attention, language, abstraction, delayed recall and orientation among the same nurses. General information regarding age, literacy, total working experience as nurse, dietary habits, medical illness, sleep disorders (insomnia, somnolence, etc.) and smoking, alcohol, any other drug consumption or any medications (within the last 14 days) were asked and recorded.

After obtaining the approval and clearance from the Institutional Ethical committee (IEC S.NO. 22/81), the study participants were informed about the test procedure and a written informed consent was obtained. A total of 90 subjects were evaluated, out of which 45 were day shift and 45 were night shift nursing workers. Assessment of sleep quality and cognitive performance was done using PSQI and MoCA respectively.

Both the tests were conducted twice, at the end of eight hour duration day or night shift work, after 3-4 days of the commencement of shift. This ensured enough time for the circadian rhythm to reset according to the changed working hours. The data was collected, tabulated and statistically analysed using SPSS version 20.0 software.

### Results:

Among day and night shift workers, female (62.22%) and male (40%) predominance was observed respectively. Mean age of day and night workers was 28.688yrs and

30.288yrs respectively. The distribution of study subjects was assessed based on their subjective sleep patterns in both day and night shift workers. 51.11% had fairly good subjective sleep, with 68.89% having sleep latency <15min and 62.22% had >7hrs sleep duration. 71.11% had habitual sleep efficiency score of 75-84. Among night shift workers, 40% had very good subjective sleep, maximum (35.56%) had sleep latency 16-30min, 28.89% had 5-6hrs sleep duration and 40% had habitual sleep efficiency score of 75-84 (**Table no. 1**).

**Table 1: Distribution of study subjects based their subjective sleep patterns in day and night shift workers**

Characteristics	Categories	Score	Day shift workers		Night shift workers	
			Frequency	Percentage	Frequency	Percentage
Subjective Sleep Quality	Very Good	0	20	44.44	18	40
	Fairly Good	1	23	51.11	17	37.78
	Fairly Bad	2	1	2.22	7	15.56
	Very Bad	3	1	2.22	3	6.67
Sleep Latency	<15MIN	0	31	68.89	6	13.33
	16-30MIN	1	9	20	16	35.56
	31-60MIN	2	4	8.89	14	31.11
	>60MIN	3	1	2.22	9	20
Sleep Duration	>7	0	28	62.22	12	26.67
	6-7	1	15	33.33	11	24.44
	5-6	2	1	2.22	13	28.89
	<5	3	1	2.22	9	20
Habitual Sleep Efficiency Score	>85%	0	5	11.11	2	4.44
	75-84	1	32	71.11	18	40
	65-74	2	5	11.11	12	26.67
	<65	3	3	6.67	13	28.89

Sleep quality (PSQI SCORE) in day and night shift workers was assessed. 68.89% day shift workers had good sleep quality, whereas only 37.78% night shift workers had good sleep quality (**Table no. 2**).

**Table 2: Sleep quality (PSQI SCORE) in day and night shift workers**

Sleep quality	Day shift workers		Night shift workers	
	Frequency	Percentage	Frequency	Percentage
GOOD (PSQI <5)	31	68.89	17	37.78
POOR (PSQI >5)	14	31.11	28	62.22
TOTAL	45	100	45	100

An association of subjective characteristics and quality of sleep was assessed in both day and night shift workers (**Table no. 3 and 4**).

**Table 3: Association of subjective characteristics and quality of sleep in day shift workers**

Characteristics	Categories	Score	Quality of sleep			Fisher exact test	p-value
			Good	Poor	Total		
Sleep disturbances	No disturbance	0	0	0	0	7.225	<0.05
	Mild	0-9	5	1	6		
	Moderate	10-18	22	2	24		
	Severe	19-24	4	11	15		
	<b>Component total score</b>		<b>31</b>	<b>14</b>	<b>45</b>		
Hours of sleep	>7	0	22	6	28	12.998	<0.05
	6-7	1	8	7	15		
	5-6	2	1	0	1		
	<5	3	0	1	1		
	<b>Component total score</b>		<b>31</b>	<b>14</b>	<b>45</b>		

**Table 4: Association of subjective characteristics and quality of sleep in night shift workers**

Characteristics	Categories	Score	Quality of sleep			Fisher exact test	p-value
			Good	Poor	Total		
Sleep disturbances	No disturbance	0	0	0	0	11.716	<0.05
	Mild	0-9	1	0	1		
	Moderate	10-18	9	11	20		
	Severe	19-24	7	17	24		
	<b>Component total score</b>		<b>17</b>	<b>28</b>	<b>45</b>		
Hours of sleep	>7	0	2	10	12	15.007	<0.05
	6-7	1	3	8	11		
	5-6	2	6	7	13		
	<5	3	6	3	9		
	<b>Component total score</b>		<b>17</b>	<b>28</b>	<b>45</b>		

In day shift workers, total component score was 31 for good quality of sleep and 14 with poor quality of sleep, a significant difference was observed between sleep disturbance and quality of sleep. In night shift workers, total component score was 17 for good quality of sleep and 28 with poor

quality of sleep, showing a significant difference (p-value<0.05) statistically.

Intergroup comparison between night and day care workers was done in relation to global PSQI score, showing a significant difference (p-value<0.05) statistically

**Table 5: Intergroup comparison between night and day care workers in relation to global PSQI score**

Sleep quality	Day shift workers		Night shift workers	
	Frequency	Mean score	Frequency	Mean score
GOOD (PSQI <5)	31	7.881	17	6.013
POOR (PSQI >5)	14	2.198	28	1.771
CHI SQUARE	9.165			
p-value	<0.05			

(Table no. 5). Cognitive Assessment was done using Montreal Cognitive Assessment Scale. Visuospatial component was more in night shift workers than day shift workers, whereas rest other components were more in day shift workers (Table no. 6).

**Table 6: Cognitive Assessment using Montreal Cognitive Assessment Scale**

Components	Day shift		Night shift	
	MEAN	SD	MEAN	SD
Visuospatial	3.466	1.26	3.6	1.76
Naming	2.55	1.09	2.55	0.54
Attention	4.667	1.881	4.56	1.76
Language	2.311	0.891	2.17	0.781
Abstraction	1.577	0.54	1.55	0.07
Delayed recall	3.8	1.651	3.74	1.71
Orientation	5.266	0.418	5.10	0.76
<b>Global score</b>	<b>26.26</b>	<b>3.913</b>	<b>23.82</b>	<b>2.164</b>

Global PSQI Score was compared with Global Cognitive Score of Day Shift and Night Shift Workers. Global PSQI Score was more in day shift workers ( $5.03 \pm 1.81$ ) than in night shift ( $3.89 \pm 2.105$ ), with a statistical significant difference (p-

value $<0.05$ ). Global cognitive Score was more in day shift workers ( $26.26 \pm 3.91$ ) than in night shift ( $23.82 \pm 2.16$ ), with a statistical significant difference (p-value $<0.05$ ) (Table no. 7).

**Table 7: Global PSQI Score vs Global Cognitive Score of Day Shift and Night Shift Workers**

Components	DAY SHIFT		NIGHT SHIFT	
	MEAN	SD	MEAN	SD
<b>Global PSQI Score</b>	<b>5.039</b>	<b>1.817</b>	<b>3.892</b>	<b>2.105</b>
<b>Global Cognitive score</b>	<b>26.26</b>	<b>3.913</b>	<b>23.82</b>	<b>2.164</b>
<b>t-test</b>	<b>2.998</b>		<b>2.716</b>	
<b>p-value</b>	<b>0.023*</b>		<b>0.031*</b>	

\*p-value $<0.05$  is significant

### Discussion:

Disturbance of circadian rhythm and inadequate pattern of sleep can cause derangement of physiological functions, leading to cognitive impairment, obesity, cardiovascular disease etc. Thus persons who do night or shift work, and work for longer irregular working hours are generally linked with decreased duration and poor quality of sleep. [10] We assessed various demographic parameters. Similar to our study, Vijaykumar N et al.2, observed that the mean age of night and day shift nurses was  $33.50 \pm 4.00$ , and  $31.23 \pm 5.70$

respectively. In our study, the quality of sleep and its various components was assessed using PSQI questionnaire among participants. In accordance with our study, Vijaykumar N et al.2 and Kaliyaperumal D et al. [11], reported that around 69% of shift working nurses were affected with sleep deprivation. The result of our study supports the fact that poor quality and inadequate quantity of sleep was due to extended shift work, and irregular sleep wake cycle was due to their disrupted circadian rhythms. Different studies conducted among night shift residents' and

nurses' revealed that due to poor concentration, their efficiency, decision making capacity was hampered, that causes increased error rates. [12]

We observed a significant association between subjective characteristics and quality of sleep in both day and night shift workers. No subject was without sleep disturbance. But it was found that nurses on night shift slept 3 hours less than day shift nurses. This reduction in total sleep time was due to decreased duration of day-time sleep which was considerably shorter than in studies conducted in western countries. [13-14]

Thus day-time naps did not compensate for reduced night sleep and by the end of the 3-days night shift period, nurses have accumulated about 10 hours of sleep deprivation. Similar findings were observed by **Zverev YP et al. [15]**, who observed that the interval between 2 night shifts in rotating system was too short, only 10 hours. Therefore it was difficult for the nurses on night to find a consistent 7-hour period to sleep. **Kurumatani N et al. [16]**, demonstrated that more than 16 hours between work shifts was required to allow more than 7 hours of total sleep time.

Therefore, it is not surprising that duration of sleep was prolonged during 5 days off when on average nurses slept 9 to 10 hours per day and accumulated about 15 hours of excessive sleep time, which was higher than cumulative sleep deprivation. Prolonged duration of sleep during days off indicated presence of significant after-effects of night work during the entire recovery period.

Intergroup comparison between night and day care workers in relation to global PSQI score was statistically significant. Similar to our study, **Vijaykumar N et al. [2]** demonstrated global score was significantly higher in night shift nurses than day shift and controls ( $P = 0.02^*$ ). **Zhang et al. [17]** found that among the staff nurses, 75.8% had a PSQI score of  $\geq 5$  and 39.8% had an

inadequate stable sleep ratio on subjective measures.

In our study, Global score was more in day shift workers ( $26.26 \pm 3.19$ ) than night shift workers ( $23.82 \pm 2.164$ ). Similar findings were observed in studies by **Kaliyaperumal D et al., [11]** **Rouch I et al. [18]** and **Chang YS et al. [19]** The authors demonstrated that better cognitive ability was reported among those, who have never exposed to shift work. There was a decline in short-term memory after day and overnight shifts, confirming the high incidence of disturbed sleep. **Hemamalini et al. [20]** and **Wided et al. [21]** revealed that night-shift workers with circadian rhythm alteration have impaired cognitive performance.

Thus the present study showed that due to long working hours of shift workers and the resultant fatigue, there was a significant reduction in cognitive functions at the end of both day and night shifts. Cognitive performance was impaired more during the night shift. These findings are related to the irregularities in the circadian rhythm and the natural cycle of sleep and waking, and also lack of adaptation of circadian rhythm to the new conditions.

In view of findings of our study, we suggest that different preventive measures should be taken. As reducing the working hours can impose undue costs on the organization and, therefore, may not be easily accepted by managers, thus preventive measures like improving the lighting condition and taking naps especially during night shifts, can be useful ergonomic strategies.

#### Limitations of study:

1. The present study was conducted to limited sample size. Thus future studies are required to be conducted on more number of patients.
2. All domains of cognition were also not tested in this study.
3. The measurement of melatonin levels should have done to prove poor quality of sleep.

4. Further studies on a larger population are needed with the aid of actigraphy to assess the prevalence of SD and its impact on all the cognitive domains.

### Conclusion:

Our study concludes that night shift workers have a poor quality of sleep when compared to day shift workers. Our study also concludes that poor quality of sleep has strong association with reduced cognition. We suggest that replacing current shift system with slowly rotating shift system and optimization of sleep-wake strategy could improve sleep quality of nurses.

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