

ORIGINAL RESEARCH

Association between Shiftwork and Cognitive Performance on the Trail-Making Test in Female Nurses

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ABSTRACT

Background And Objectives: Shift work is necessary to ensure round-the-clock health care in the hospital. A large body of literature reports cognitive decline in shift workers due to de-synchronisation of the inherent circadian rhythm though the results are varying and inconclusive. Hence, this study explored the cognitive function among day and night shift nurses in a tertiary care hospital.

Material And Methods: A cross-sectional study was conducted on 38 female nursing staff working at a tertiary care centre. The participants were asked to complete the Trail Making Test (TMT), a neurocognitive test consisting of two parts (TMT-A and TMT-B), at the start of the shift and the end of their day/night shift. Wilcoxon signed-rank tests were used to compare post-shift TMT performance to baseline in nursing staff.

Results: 50% nurses working on a day shift basis completed the TMT-A and TMT-B pre and post-day shift conditions, and the rest of the 50% completed the TMT-A and TMT-B pre and post-night shifts. There was a median increase in TMT-B post-night shift of 8 sec ($p < 0.001$) compared to baseline but no change in TMT-A. However, there was no significant difference in post-day shift TMT-A times or TMT-B compared to their baseline values.

Conclusion: Based on our study findings, it was evident that working extended night shifts has a direct correlation with cognitive decline in the female nurses. This may indicate decreased visual attention, processing speed, task switching and executive function. Hence, efficient organization of shift work within the healthcare sector is recommended to safeguard the psychological well-being of Nurses without compromising patient care and personal safety.

Keywords: Shift work, Night work, Circadian Rhythm, Cognition, Trail Making Tests.

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INTRODUCTION

Empirical evidence from various studies on healthcare workers has established an association between shift work and impaired cognitive performance.¹ The observed alterations in cognitive function may be attributed to the disruption of the intrinsic sleep-wake cycle, compounded by the physical and mental exhaustion that often accompanies extended periods of night work.² The combination of these factors can result in a variety of cognitive changes, which may manifest as memory impairment, reduced attention span, and decreased response time on neurocognitive tests.³ However, research on the correlation between shift work exposure and cognitive performance in nurses is limited and inconclusive. Shiftwork is essential in the healthcare sector to ensure round-the-clock patient care services in the hospitals. It is a well-

established fact that night shift work and working long hours lead to fatigue and sleep deprivation, which inevitably increases the risk of medical negligence, occupational accidents, and needlestick injuries.⁴ Further investigation is needed to understand the link between reduced cognitive performance and shift work in Indian nurses, and its potential impact on patient safety. The human biological clock is regulated by the Suprachiasmatic Nucleus (SCN) located in the hypothalamus and its activity is driven by environmental and humoral cues.⁵ Melatonin secretion by the pineal gland increases two hours before regular bedtime and its level is maintained throughout the night and exerts an inhibitory action on the suprachiasmatic nucleus.⁶ Misalignment of natural behavioural cycles and our internal biological clock may destabilize the circadian rhythm of various

physiological variables, leading to cognitive deficits.⁷The Trail Making Test (TMT) is a pen-and-paper neuropsychological test popularly used in behavioural neuroscience to assess frontal lobe function.⁸ The TMT test comprises two parts- TMT A and B, each requires the linking of 25 randomly placed items- TMT A involves linking numbers(1-2-3-4-5) and TMT B, which is comparatively challenging, involves linking numbers alternating with letters (1-A-2-B-3-C-4-D) as fast as possible without lifting the pen from the paper. TMT score for nurses is based on completion time and number of errors made.⁹The objective of the present study was to further investigate the association between shift work and cognitive performance among nursing staff by measuring the time taken to complete the TMT at the start of the day (as the baseline) and after a day/night shift to evaluate if there was a difference between these times.

THE RATIONALE FOR THE STUDY

Nurses are an integral part of the healthcare sector and their mental well-being is a key to cognitive ability and better work performance. As we become aware of how shift work can affect cognitive function in nurses, suitable safety protocols may be implemented to mitigate errors and accidents that can jeopardize patient care and personal safety.

MATERIAL AND METHODS

Study design This observational study employed a cross-sectional research design.

Subject recruitment: The study groups comprised 38 female healthcare workers aged between 18-50 years (mean age 29.2 ± 6.0) recruited from casualty and wards of the Government Institute of Medical Sciences, Greater Noida. **Group 1:** Nurses working in morning shifts (9 am to 2 pm) and **Group 2:** Nurses working in night shifts (9 pm to 9 am). The inclusion criteria were the female nurses who have worked at least 40 hours per week in the day/night shift for at least one year. Pregnant, subjects with H/o smoking, chronic alcoholism, frank diabetes, cardiovascular disease, neurological, renal, or any organic disease, or subjects receiving medication for any acute and chronic illness were excluded from the study. The participants were informed that this was a study using the Trail Making Test; however, they were blinded to the specific aim of the study. The written informed consent from the subjects and clearance from the GIMS Institutional Ethics Committee were obtained before the commencement of the study.

Sampling method: Simple random sampling

Data collection method: Age, marital status, no of children, work experience(years), and working area was noted. The participants were asked to complete two tests - Trail Making Test A (TMT-A) and Trail Making Test B (TMT-B). The time taken to complete each test was recorded in seconds. All participants received the same instructions before starting the test, and in case of an error, the same corrective instructions were given to everyone. The use of stimulants like tea, and coffee was strictly prohibited before the test. The time recorded began once the instruction to start was given and was stopped once the trail was completed or once the maximum time (150 seconds for TMT-A and 300 seconds for TMT-B) was reached. During the study, the participants were asked to complete the Trail Making Test (TMT) two times: baseline assessment at the start of a shift and the end of the day shift/night shift. The order in which the assessments were completed by each participant was determined based on their availability.

STATISTICAL ANALYSIS

Statistical analysis was performed using IBM SPSS Statistics version 20.0 (IBM Corporation, Armonk, NY, USA). Shapiro–Wilk’s test was used to check the normality of the distribution of variables. Wilcoxon signed-rank test was used to compare TMT completion times for day/night shifts to the participants’ baseline. Univariate analysis of variance was used to assess if the covariates: nurse’s age, years of education, hours of daily sleep, and use of caffeine were statistically significant predictors of TMT completion times. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Age, years of education, hours of daily sleep, and use of caffeine are shown in Table 1. The total number of the study subjects was 38 female nurses aged between 18-45 years (mean age 29.2 ± 6.0). The median years of education were 16 years and the median hours of daily sleep was 7 hours. 78.6% of the participants had worked for 1-2 years in the hospital while 21.4% (9) had >2 years of work experience. Nearly 50% (19) of nurses working on a day shift basis completed the TMT-A and TMT-B pre and post-day shift conditions, and the rest of the 50% completed the TMT-A and TMT-B pre and post-night shifts. There was a median increase in TMT-B post-night shift of 8 sec ($p < 0.001$) compared to baseline but no change in TMT-A (Table 2). However, there was no significant difference in post-dayshift TMT-A times or TMT-B when compared to their baseline values.

Table: 1 shows the Nurse's demographic data

Characteristics	Values
Median age bracket (years)	18-45(mean age 29.2 ± 6.0)
Median years of education (years)	16 (IQR 16–17; range 16–27)

Median daily sleep (h)	7 (IQR 6–8; range 6–10)
Median daily caffeine use (caffeine units)	1 (IQR 1–2; range 0–4)

Table 2: Pre-shift and Post shift Trail Making Test (TMT) performance of nurses

Baseline, median (IQR)	Baseline, median (IQR)	Post-shift, median (IQR)	P value
Day shift workers(n)			
TMT-A	20.5 (18.5–24.9)	21.8 (16.9–28.4)	0.87
TMT-B	49.7 (47.2–57.1)	48.6 (38.7–64.1)	0.45
Night shift workers(n)			
TMT-A	20.0 (19.2–24.8)	21.6 (18.63–28.0)	0.57
TMT-B	49.0 (46.2–61.7)	57.0 (48.8–65.7)	<0.001

Wilcoxon signed-rank test comparing post-shift (day and night) with baseline Trail Making Test times in Nurses. Time is recorded in seconds.

DISCUSSION

Our study investigated the association between shift work and cognitive performance in female nurses. The findings indicate that nursing staff take significantly longer to complete the Trail Making Test (TMT) after working a night shift. As the TMT is a neuropsychological test assessing visual attention, processing speed, task switching and executive function, this suggests that these cognitive domains are likely to decline after continuous night shift work.¹¹ TMT-A completion times were less affected as compared to TMT-B may be because TMT-B also reflects task switching and executive function and is a more complex test than TMT-A.¹² Empirical evidence has irrefutably proven that complex tasks are significantly prone to deterioration when subjected to sleep deprivation and circadian rhythm disruption. These findings are similar to a study¹³ on internal medicine residents who reported a longer time to complete TMT-A after night duty compared to a night off duty. In addition, petrochemical workers reported a decline in visual attention, working memory, and reaction time following a night shift.¹⁴ Our findings differ from a research study¹⁵ conducted on thirteen emergency medical officers which showed a non-significant difference in TMT performance post-night shift compared to a night off-duty. In yet another study conducted on 23 internal medicine staff who have manoeuvred a car on a moving track, assessing attention span, hand-eye coordination, reaction time and executive function, there was a significant reduction in age accuracy after a night on-call when compared to before a night on-call ($P < 0.01$) and a night off-duty ($P < 0.03$).⁸ Furthermore, in a triage simulation, doctors made more errors ($P = 0.02$) and took longer to intubate a mannequin (31.6 vs 42.2 s; $P = 0.04$) at the end of a night shift compared to the day shift.¹⁶ Given these findings, preventive measures should be taken to improve nurses cognition, especially during night shifts. This may include the implementation of compulsory scheduled rest breaks, reducing working hours, and improving lighting in the work environment. Short rest

breaks have been shown to reduce subjective fatigue, improve performance and be effective in controlling the accumulation of risk associated with prolonged task performance.¹³

CONCLUSIONS

Based on our study findings, it is evident that working extended night shifts has a direct correlation with cognitive decline in female nurses. Hence, efficient organization of shift work within the healthcare sector is recommended taking into consideration several key factors viz. number of working hours, frequency of night shifts, slower rotation speed between shifts, and provision of adequate rest periods between shifts to optimise work efficiency and mitigate any negative impact on mental health of Nurses. By implementing these measures, healthcare organizations can safeguard the psychological well-being of Nurses without compromising patient care and personal safety.

LIMITATIONS OF THE STUDY

The findings of the study are limited to a small sample size of a single tertiary care hospital. The data can be extrapolated and extensive multicentric study can be further planned in collaboration with nearby hospitals. The order in which the subject performed the study was not in researcher's hands and allocation was purely on the availability of the subject.

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