The impact of sleep toward executive functions among rapidly rotating shift nurses of emergency departments in Indonesia

Lilis Setyowati,[1] Hsiao-Yean Chiu,[2] Anggraini Dwi Kurnia,[1] Nur Aini,[3] Erma Wahyu Mashfufa,[3] Ollyvia Freeska Dwi Marta[3]

[1]Departement of Nursing, Faculty of Vocational, Universitas Muhammadiyah Malang, Malang, Indonesia; [2]College of Nursing, Taipei Medical University, Taipei, Taiwan; [3]Department of Nursing, Faculty of Health Science, Universitas Muhammadiyah Malang, Malang, Indonesia

Correspondence: Lilis Setyowati, Departement of Nursing, Directorate of Vocational Education, Universitas Muhammadiyah Malang, Malang, Indonesia. E-mail: lilis@umm.ac.id

Key words: emergency department; executive function; nurses; rotating shift; sleep.

Contributions: LS, Conceptualization, Data Curation, Formal Analysis, Methodology, Validation, Visualization, Writing – Original Draft, Review & Editing; HYC Conceptualization, Investigation, Methodology, Validation, and Writing – Original Draft, Review & Editing; ADK Conceptualization, Methodology, Formal Analysis, Validation, and Writing – Original Draft, Review & Editing; NA, Methodology, Visualization, Writing – Review & Editing; EWM, Resources, Investigation, and Writing –Review & Editing; OFDM, Formal Analysis, Validation, Writing – Review & Editing.

Conflict of interest: the authors declare no conflict of interest.

Ethics approval and consent to participate: the Ethical number clearance from the Universitas Muhammadiyah Malang was E.5.a/122/KEPK-UMM/VIII/2018.

Patient consent for publication (in Indonesia version): written informed consent was obtained for anonymized patient information to be published in this article.

Funding: this research did not receive external funding.

Availability of data and materials: all data generated or analyzed during this study are included in this published article.

Acknowledgement: the author would like to thank the Emergency Nurses of Malang City Regional Hospital, especially Universitas Muhammadiyah Malang Hospital, Dr. Soepraoen, Saiful Anwar Hospital, Wava Husada Hospital - Kepanjen, East Java, Indonesia, for their participation. This research was fully supported by the Universitas Muhammadiyah Malang (UMM). The author would like to thank UMM for its support in implementing this research.

Received: 10 September 2023.
Accepted: 13 October 2023.
Early access: 31 October 2023.

Healthcare in Low-resource Settings 2023; 11:11744
doi:10.4081/hls.2023.11744

Abstract

Sleep problems are significant and are closely related to attention issues, impacting executive function disorders, especially among healthcare professionals, including nurses. In contemporary times, shift work has emerged as a new challenge for healthcare professionals, affecting their health, wellbeing, and cognitive functions. This study aimed to investigate the relationship between sleep and executive function among staff working in the Emergency Department (ED). The research was a cross-sectional study conducted on emergency nurses (EN) from four hospitals in Malang, Indonesia. Sleep quantity parameters, including total sleep time (TST), sleep onset latency (SOL), wake after sleep onset (WASO), and sleep efficiency (SE), were collected based on 7-day sleep diaries. Sleep quality was measured using the Pittsburgh Sleep Quality Index (PSQI). Executive function was assessed using a Trail Making Test (TMT). Data analysis was carried out using one-sample T-tests and multiple linear regression with a stepwise model. Around 82% of ER have poor sleep quality (PSQI > 5). Other findings WASO, TST, and SE reported a shorter duration compared to the healthcare population, while the duration of SOL was twice as long. the sources of executive function TMT-A, TMT-B, and TMT B-A were longer, and TMT B/A was shorter than the normal population. TST was negatively related to simple (TMT-A), alternating (TMT-B), and performance difference (TMT B-A) p values =0.000. This study concludes that fast-rotating shift ED nurses experienced poor sleep and executive function. The most significant factors influencing executive function were TST and BMI.

Introduction

The critical relationship between sleep and cognitive processing has been confirmed in normal and abnormal populations over the past decade. Sleep is controlled by the Suprachiasmatic Nucleus (SCN) of the hypothalamus. The circadian rhythm regulates melatonin production, which induces sleep.[1–4] Sleep promotes several cognitive functions, including decision-making, language learning, categorization, memory, and executive functions.[5,6] Most work focuses on the effects of sleep on various types of mind, especially work that uses work shifts, especially among medical professionals.[7–9]

Shift work is widely recognized for its substantial impact on desynchronizing the circadian rhythm, with a notable focus on the disruption caused by night-shift work on regular circadian physiology. Sleep deprivation has adverse effects on the functioning of specific areas of the brain, resulting in a decline in cognitive performance. After completing a night shift, nurses demonstrated reduced prefrontal brain activity and diminished cognitive abilities.[10–12] A correlation is observed between shift work among EN and a decline in performance on neuropsychological testing.[13,14] Cognitive domains such as visual attention, processing speed, hand-eye coordination, task-switching, and executive function experience a deterioration when individuals engage in night-shift work.[15] Poor sleep has implications for the quality of patient treatment, as it is associated with increased rates of errors and personal safety concerns, particularly in driving following shift work.[10] Executive function (FE) is a top-down mental process needed when you have to concentrate and pay attention when it runs automatically.[16,17]

Executive function (EF) refers to a top-down mental process required when you need to concentrate and pay attention consciously, as opposed to automatic processes.[18] EF involves an effort to engage in an activity with the intention of minimizing deviations and making decisions that require careful consideration before taking further actions. At its core, EF encompasses inhibition (inhibitory control, which includes self-control in terms of behavior and the management of impulses), working memory (WM), and cognitive flexibility (also known as set-shifting, mental flexibility, or shifting mental sets, closely associated with creativity). EF skills are crucial for mental and physical health, success in academics and life, as well as cognitive, social, and psychological development.[18,19] In general, sleep problems are of considerable significance related to attention problems. Sleep problems that impact the disruption of executive functions are very prone to occur in health professions, especially nurses.

Nurses have a high potential to suffer mental stress, especially in treating patients. Clinical nurses must stay on guard throughout the night.[10] This mode of work makes their sleep time irregular. The problem of nurse sleep quality has become a prominent social focus.[20] Previous studies have shown that sleep disorders in nurses affect not only their health but also the nursing quality and even psychological health and patient care processes.[16] In contemporary medical settings, the issue of overcrowding in the emergency department (ED) has risen to critical concern. Impaired cognitive functions can heighten the risk of medical errors, thereby jeopardizing patient safety and potentially leading to adverse outcomes. However, no prior studies have specifically examined executive function, which represents the subset of cognitive functions responsible for task monitoring, response inhibition, error detection, and compensatory behavior. Therefore, the primary objective of this study was to investigate both the qualitative and quantitative aspects of sleep in ED nurses and to explore the potential association between sleep and executive function.

Materials and Methods

Design, setting, and sample

In this study, a cross-sectional design was employed, and a multi-stage sampling technique was used to recruit participants. Data was collected from 115 ED nurses in four hospitals in Malang City, Indonesia, in 2018. Participants had to meet the following inclusion criteria: i) nurses who had worked in the ED for more than three months, ii) those working on a consecutive seven-day duty schedule with one day off during the study period, and iii) participants needed to have the ability to complete cognitive tasks on the last day of their duty. Excluded from this study were individuals who were pregnant and those with a diagnosed sleep disorder. The first step in the research involved obtaining informed consent from participants in four hospitals: Saiful Anwar Hospital Malang, Wava Husada Kepanjen, Muhamaddiyah University Malang, and DR. Soepraoen Military Malang. The participants in this study were emergency nurses. Before signing the informed consent, the researcher provided a detailed explanation of the research topic, objectives, benefits, and the research plan. After obtaining written consent, participants were provided with a sleep diary to fill out for seven days. Each morning, participants recorded their sleep data, including Trail Making Test (TMT), wake after sleep onset (WASO), sleep efficiency (SE), and sleep latency (SL), as well as their work shift for that day. The Pittsburgh Sleep Quality Index (PSQI) and TMT evaluations took place during the morning service attendance over the course of seven days. The total time required for completing the PSQI and TMT questionnaires was approximately 60 minutes. This sampling method was chosen due to the numerous hospitals in the East Java area, with only education and high-accreditation hospitals included in this study.

Instrument and data collection

Data were collected by questionnaires, which were translated into the Indonesian language. A self-administered questionnaire has been completed: the questionnaires, Seven-day sleep diary was used to assess the sleep quantity the present, including TST, SE, SOL and WASO,[22] and this instrument was validated.[23] Other questionnaires of sleep quality in version Indonesia[24] and executive function by Trail Making Test (TMT).[25-26]

Table 1. Number and percentage of demographic characteristics of participants (n=115)

Characteristics of respondent	n	(%)
Age, mean (SD)	32.2	(8.8)
20-29	60	(52.2)
30-39	32	(27.8)
≥ 40	23	(20)
Gender		
Male	52	(45.2)
Female	63	(54.8)
BMI, mean (SD)	23.6	(3.0)
Marital status		
Single and divorced	44	(38.3)
Married	71	(61,7)
Education level		
Licensed practical nurse (LPN)	91	(79.1)
Registered nurse (RN)	24	(20.9)
Working experience (year), mean (SD)	9	(8.5)
< 4 years	45	(39.1)
≥ 5 years	70	(60.9)
Personal income a month		
< $ 250	59	(51.3)
≥ $ 250	56	(48.7)
Coffee intake every day		
No	55	(47.8)
Yes	60	(52.2)
Tea intake every day		
No	40	(34.8)
Yes	75	(65.2)
Exercise habit every week		
No	57	(49.6)
Yes	58	(50.4)
Total	115	100

A seven-day sleep diary assesses the sleep quantity present, including Total sleep time (TST), which is the time filling in sleep last night and the time of getting up this morning. Sleep Efficiency (SE) is a proportion of the whole sleep time and the entire time in bed multiplied by 100%. Sleep Onset Latency (SOL) is the time calculated from lying down to sleep onset after the light is off. Wake After Sleep Onset (WASO) is a wake-up time to attend sleep onset. PSQI for measuring sleep over the past month.[27] The partners or roommates answer an additional five items, which are not counted for analysis. The 19 items generate seven components, including subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep deficiency, frequent use of sleeping medication, and daytime dysfunction — each item measured by the four-point Likert scale (0-3). The global score is between 0 and 21. Individuals with a global score of PSQI of > 5 are considered poor sleepers.

The Trail Making Test (TMT) was generated from the correct number of connections minus the wrong amount. The results of the validity of the Trail Making test are evident, suggesting that performance simple TMT-A represented visual, conceptual tracking, psychomotor processing speed, and attention. Alternating TMT-B assesses visual, conceptual tracking, and psychomotor processing speed. Difference performing TMT B-A considers the set-switching task required in part B. Performance B/A ratio represents more reliable executive control task-switching.

Data analysis

All data analyses were conducted using the Statistical Package for the Social Sciences 23 (IBM Corp., Armonk, NY, USA). Descriptive analyses were employed to estimate sociodemographic data, sleep parameters, and TMT scores. Continuous variables were presented as mean ± standard deviation, while categorical variables were expressed as case numbers and percentages. A one-sample T-test was used to assess differences between sleep parameters and norm data, as well as between TMT scores and norm data. The selected variables were then included in a multivariable linear regression stepwise model to investigate the associations between sleep and executive functions in ED nurses. The selected variables were then entered into a multivariable linear regression stepwise model to examine associations between sleep and executive functions in ED nurses. The significant level is set as 0.5. Ethical permission The Ethical number clearance from from the Universitas Muhammadiyah Malang was E.5.a/122/KEPK-UMM/VIII/2018.

Results

The results presented as follows: descriptive analysis included demographic characteristics of the participants (age, gender, BMI, material status, education, working experience, income, and habitually); distributions of self-reported sleep parameters, distributions of TMT scores of the study, and factors predicting TMT.

Table 1 showed the results of sociodemographic characteristics. Regarding the consequence of score BDI and hypnotic use, no one in the study has symptoms of depression and does not use any medication for sleep disorders. The mean age of the respondents was 32.24 years (SD = 8.77). Approximately half of the participants were female (54.8%). The mean BMI was 23.59 (SD = 3.02). Furthermore, the mean of working experience was nine years. Around 60.9% of participants worked in the ED for over five years (n =70). Half of the participants' monthly personal income was < $ 250; with education level, more than half percent of the participants were Licensed Practical Nurses (LPN) or graduated from a Diploma-3 nurse (79%). There were 52.2% and 65.2% of participants having habits of consuming coffee and tea, and more than half of participants (n = 58) regularly exercise every week.

Results of sleep parameters are shown in Table 2, including WASO, TST, SOL, SE, and the global score of PSQI presented in Table 3. The ED nurses were more likely to have prolonged SOL, shorter TST, poorer SE, and a higher global score of PSQI than the published norm (all the p 0.000). It should be noted that the value of WASO in our participants was much lower than data from the health population (p 0.000).

In Table 3, TMT was used to test the performances in the speed of processing, cognitive flexibility, sequence alternation, visual search, and executive function. The distribution of simple TMT A, alternating TMT B, the difference TMT B-A, and the ratio TMT B/A are presented in Table 4. The values of TMT A, TMT B-A, and TMT B were higher in ED nurses than those of norm data p value < 0.001), reflecting that our participants needed more time to complete the task than the healthy population. Besides, more participants produced lower scores than TMT B / A compared to the norm (p<0.001). TMT B / A performance proves that participants do not experience interference in the process of executive control functions and task-switching ability.

Multilinear regression analysis was conducted to examine the significant associations between sleep and executive function variables. After reviewing the assumption of the linear regression, the independent variables include WASO, TST, SOL, SE, PSQI, age, gender, BMI, material status, education level, working experience, personal income, habits (drinking coffee, tea, and exercise) interred in the stepwise multiple regression model.

The stepwise regression model revealed that sleep parameters, including the effect of TST, SE, and BMI, were significantly related to executive function among ED nurses in Malang, East Java, Indonesia. Table 4 shows that the effect of TST and BMI combined accounted for 89.8% of the variants representing visual, conceptu-

Table 2. Distributions of self-reported sleep parameters (n=115).

Variable	Norm means	Participants		
		Mean	SD	p
WASO (minutes)	15	8.7	5.5	0.000
TST (minutes)	420	327.7	66.59	0.000
SOL (minutes)	12	29.89	20.49	0.000
SE (%)	92	88	6	0.000
PSQI	5	7.68	2.73	0.000
< 5 (n, %)	-		21	18.3
>5 (n, %)	-	94	81.7	

WASO, Wake After Sleep Onset; TST, Total Sleep Time; SOL, Sleep onset Latency; SE, Sleep Efficiency; PSQI, Pittsburgh Sleep Quality Index.

Table 3. Distributions of TMT scores of the study (n=115).

Variable	Norm means	Participants		
		Mean	SD	p
TMT A	25.4	34.92	15.22	0,000
TMT B	59.3	67.87	22.86	0,000
TMT B – A	27.69	32.95	9.35	0,000
TMT B/A	2.41	1.99	0.19	0,000

al tracking, psychomotor processing speed, and attention. The effect of TST and BMI significantly correlated to 96.2% of the variants representing visual, conceptual tracking, and psychomotor processing speed. Besides, we found that TST and SE were associated with variants that indicated TMT B-A function ($R2 = 0.770$). SE and BMI were significantly associated with TMT B / A of 22.7% of reliable variants of executive control and task shifting. The strongest association of TMT B-A executive functions is TST (Beta= 0.874) followed by T.ST with TMT-B correlation (Beta= 0.631). The equation for the executive function of the TMT B-A, SE association gives the lowest significance (Beta=0.133).

Discussion

On average, the 115 participants slept only five hours, which is notably less than the seven to eight hours of sleep typically observed in the normal population.[28] Other sleep parameter results, including WASO, TST, and SE, were likely shorter than usual but have a prolonged SOL[22]. PSQI analysis showed that the majority of respondents have poor sleep quality. The participants' lack of sleep was due to the many patients coming to the ER and the severity of the treated cases.[29] Apart from that, lack of staff is also one of the causes of work overload.[30] On the other hand, the impact of burnout is a sleep problem.[31,32] Sleep disorders that occur in nurses, especially in the ED, will impact patient care, the occurrence of medication errors, and the most fatal effect is death.[33]

The previous research that supports nurses experiencing decreased cognitive function associated with lack of sleep.[28,34,35] Our findings suggest that ED nurses working fast rotating shifts have poor executive function. Sleep disturbances and rapid shift changes can have consequences; however, our study could not confirm the possible effects or mechanisms of sleep and shift work on executive function.[10,36-37] Further investigation should examine this issue. Another important finding was that only TST was negatively related to executive function. A possible explanation is that our participants may have experienced light sleep compared to deep sleep, as we found that they had greater WASO than their counterparts. Executive function is associated with non-REM sleep and REM sleep stages.[34] The most significant decrease in brain activity during slow-wave sleep occurs in the frontal lobes.[38] Multiple findings support the benefits of slow-wave sleep for cognition. The highest delta activity during slow-wave sleep is associated with cognitive performance.[39,40]

Another important finding was that only TST was substantially associated with executive function. Our results found lower TST scores compared with the healthy population. Most participants spent about five hours daily in bed, followed by a shorter WASO. Previous meta-analyses suggest that short sleep can impact cognitive performance.[35] In line with this statement, sleep duration is correlated with cognition. Executive function is associated with non-REM sleep stages for REM cycles when a person has lower sleep time.[41] Lower sleep can prevent people from progressing generally through sleep stages and limit the time spent in slow-wave sleep.[42] The most significant decrease in brain activity during slow-wave sleep occurs in the frontal lobe; multiple findings support the benefits of slow-wave sleep for cognition. Results indicated that participants took longer to complete the TMT (A, B, B-A) portion.

Only TMT B/A had a completion time shorter than the norm. The results indicated a correlation between findings, demonstrating an increase in the duration of wake after sleep onset (WASO), sleep efficiency (SE), and completion time for TMT-A, B, and B-A. These results suggest that participants who experience longer sleep and TMT completion times often report visual disturbances, sluggishness in taking action due to fatigue, and increased susceptibility to distraction when faced with fast-paced tasks.[43,44] On the other hand, TMT B-A results are shorter than usual. Participants could still do it correctly when they simultaneously received the doctor's advice, but it took longer to concentrate fully. B-A TMT performance predictions influence the consideration of set-switching tasks.[44]

This study has certain limitations, including the utilization of cross-sectional data and self-report measures. While there are theoretically valid reasons to believe that the mentioned factors can influence nurses' sleep quality, it is important to note that causal relationships cannot be definitively established from the data collected in this cross-sectional study. The generalizability of these findings to all clinical nurses in Indonesia is constrained by the inclusion of only one level of hospital nurses in this study. Furthermore, this study solely incorporated quality-of-life measures and did not consider other factors that may contribute to sleep disturbances, thereby limiting the analysis of the relationship between mental health and sleep disturbances. A further limitation is the lack of exploration into the quantitative interactions between psychological, quality-of-life, work-related, and personal factors. Future research should explore the interplay between these intermediary factors to construct comprehensive models of sleep disturbances among clinical nurses.

Conclusions

The study emphasized that emergency room (ER) nurses with rapidly rotating shifts experienced poor sleep quality, longer sleep latency, lower sleep efficiency, shorter sleep duration, and higher wake after sleep onset (WASO) compared to healthy populations. The study also found a negative relationship between sleep duration and participants' executive function, which could result in reduced responsiveness due to quick fatigue and increased susceptibility to task-related distractions. These findings provide valuable evidence for the development of health promotion initiatives and strategic programs aimed at enhancing the wellbeing of ED nurses, particularly in the context of managing rotating shift work that can influence the health and safety of both nurses and patients. By addressing these issues, the aim is to minimize the occurrence of medical errors during duty shifts.

References

1. Beligala DH, De A, Geusz ME. A meta-analysis characterizing stem-like gene expression in the suprachiasmatic nucleus and its circadian clock. Biomed Res Int 2018; DOI: 10.1155/2018/3610603.
2. Teoh AN, Kaur S, Mohd Shukri NH, et al. Psychological state during pregnancy is associated with sleep quality: preliminary findings from MY-CARE cohort study. Chronobiol Int 2021;38:959-970.
3. Tse LA, Wang C, Rangarajan S, et al. Timing and Length of Nocturnal Sleep and Daytime Napping and Associations with Obesity Types in High-, Middle-, and Low-Income Countries. JAMA Netw Open 2021;4:e2113775.

4. Roestamadji RI, Luthfi M, Surboyo MDC, et al. Sleep time duration does not affect oral inflammation and periodontal health status in night-shift workers: A cross-sectional study. Nat Sci Sleep 2020;12:1083-1090.
5. Zare Khormizi H, Salehinejad MA, Nitsche MA, et al. Sleep-deprivation and autobiographical memory: Evidence from sleep-deprived nurses. J Sleep Res 2018;28:e12683.
6. Hastoro MFR. Relationship Between Physical Workload, Sleep Quality, Work Climate, And Noise Level With Work Fatigue In Rolling Mill Workers In Sidoarjo Steel Industry. Indones J Public Heal 2022;17:319-330.
7. Weinmann T, Vetter C, Karch S, et al. Shift work and cognitive impairment in later life - Results of a cross-sectional pilot study testing the feasibility of a large-scale epidemiologic investigation 11 Medical and Health Sciences 1117 Public Health and Health Services. BMC Public Health 2018;18:1-8.
8. Putra EK, Machfoed MH. Correlation of sleep quality and anxiety with pain intensity in primary headache patients. Medico-Legal Updat 2020;20:843-847.
9. Efendi F, Tonapa SI, Has EMM, et al. Effects of chair-based resistance band exercise on physical functioning, sleep quality, and depression of older adults in long-term care facilities: Systematic review and meta-analysis. Int J Nurs Sci 2023;10:72-81.
10. Durán-Gómez N, Guerrero-Martín J, Pérez-Civantos D, et al. Night shift and decreased brain activity of ICU nurses: A near-infrared spectroscopy study. Int J Environ Res Public Health 2021;18:11930.
11. Setyowati A, Yusuf A, Agianto, et al. Factors affecting shift work sleep disorder in female shift work nurses: Integrating shift workers' coping with stress and transactional stress coping theory. J Public Health Res 2023;12:22799036231182024.
12. Dewanti NP, Jingga NA, Wahyudiono YDA. The relationship between work shifts and work environment with nurse fatigue in the emergency department. Int J Occup Saf Heal 2022;11:178-186.
13. Sun J, Stewart P, Chiew A, et al. Association between shift work and cognitive performance on the Trail Making Test in emergency department health officers. EMA - Emerg Med Australas 2021;33:711-717.
14. Setyowati A, Yusuf A, Haksama S, et al. Validity and Reliability of Shift Work Disorder Questionnaire among Indonesian Female Nurses. Malaysian J Public Heal Med 2021;21:145-150.
15. Gumenyuk V, Howard R, Roth T, et al. Sleep Loss, Circadian Mismatch, and Abnormalities in Reorienting of Attention in Night Workers with Shift Work Disorder Sleep 2014;37:545-556.
16. Kanda T, Tsujino N, Kuramoto E, et al. Sleep as a biological problem: an overview of frontiers in sleep research. J Physiol Sci 2016;66:1-13.
17. Tedjasukmana R, Budikayanti A, Islamiyah WR, et al. Sleep disturbance in post COVID-19 conditions: Prevalence and quality of life. Front Neurol 2023; DOI: 10.3389/fneur.2022.1095606.
18. Diamond A. Executive Functions. Annu Rev Clin Psychol 2014;64:135-168.
19. Lehto JE, Uusitalo-Malmivaara L. Sleep-related factors: Associations with poor attention and depressive symptoms. Child Care Health Dev 2014;40:419-425.
20. Dong H, Zhang Q, Sun Z, et al. Sleep disturbances among Chinese clinical nurses in general hospitals and its influencing factors. BMC Psychiatry 2017;17:241.
21. Feleke SA, Mulatu MA, Yesmaw YS. Medication administration error: Magnitude and associated factors among nurses in Ethiopia. BMC Nurs 2015;14:1-9.
22. Ohayon MM, Carskadon MA, Guilleminault C, et al. Meta-analysis of quantitative sleep parameters from childhood to old age in healthy individuals: Developing normative sleep values across the human lifespan. Sleep 2004;27:1255-1273.
23. Dietch JR, Sethi K, Slavish DC, et al. Validity of Two Retrospective Questionnaire Versions of the Consensus Sleep Diary: The Whole Week and Split Week Self-Assessment of Sleep Surveys Jessica. Sleep Med 2019;63:127-136.
24. Alim IZ. Uji validitas dan reliabilitas instrumen pittsburgh sleep quality index versi Bahasa Indonesia [Test validity and reliability of the instrument pittsburgh sleep quality index Indonesia language version.] Jakarta: University of Indonesia , 2015.
25. Giovagnoli AR, Del Pesce M, Mascheroni S, et al. Trail making test: normative values from 287 normal adult controls. Ital J Neurol Sci 1996;17:305-309.
26. Sánchez-Cubillo I, Periáñez JA, Adrover-Roig D, et al. Construct validity of the Trail Making Test: Role of task-switching, working memory, inhibition/interference control, and visuomotor abilities. J Int Neuropsychol Soc 2009;15:438-450.
27. Buysse DJ, Reynolds CF, Monk TH, et al. The Pittsburgh sleep quality index: A new instrument for psychiatric practice and research. Psychiatry Res 1989;28:193-213.
28. Wolf LA, Perhats C, Delao A, et al. The Effect of Reported Sleep, Perceived Fatigue, and Sleepiness on Cognitive Performance in a Sample of Emergency Nurses. J Nurs Adm 2017;47:41-49.
29. Ruggiero JS, Avi-Itzhak T. Sleep Patterns of Emergency Department Nurses on Workdays and Days off. J Nurs Res 2016;24:173-180.
30. Kumar A, Sinha A, Varma JR, et al. Burnout and its correlates among nursing staff of intensive care units at a tertiary care center. J Family Med Prim Care 2021;10:443-448.
31. Knowlton M, Riseden J. Emergency Department Nursing Burnout and Resilience. Adv Emerg Nurs J 2022;44:54-62.
32. Membrive-Jiménez MJ, Gómez-Urquiza JL, Suleiman-Martos N, et al. Relation between Burnout and Sleep Problems in Nurses: A Systematic Review with Meta-Analysis. Healthcare (Basel) 2022;10:954.
33. Di Muzio M, Reda F, Diella G, et al. Not only a Problem of Fatigue and Sleepiness: Changes in Psychomotor Performance in Italian Nurses across 8-h Rapidly Rotating Shifts. J Clin Med 2019;8:47.
34. Nakakubo S, Makizako H, Doi T, et al. Impact of poor sleep quality and physical inactivity on cognitive function in community-dwelling older adults. Geriatr Gerontol Int 2017;17:1823-1828.
35. Wardle-Pinkston S, Slavish DC, Taylor DJ. Insomnia and cognitive performance: A systematic review and meta-analysis. Sleep Med Rev 2019;48:101205.
36. Ferri P, Guadi M, Marcheselli L, et al. The impact of shift work on the psychological and physical health of nurses in a general hospital: A comparison between rotating night shifts and day shifts. Risk Manag Healthc Policy 2016;9:203-211.
37. Dall'Ora C, Ball J, Recio-Saucedo A, et al. Characteristics of shift work and their impact on employee performance and wellbeing: A literature review. Int J Nurs Stud 2016;57:12-27.
38. Kantrowitz J, Citrome L, Javitt D, et al. GABA(B) receptors, schizophrenia and sleep dysfunction: a review of the relation-

ship and its potential clinical and therapeutic implications. CNS Drugs 2009;23:681-691.

39. Wilckens KA, Ferrarelli F, Walker MP, et al. Slow-Wave Activity Enhancement to Improve Cognition. Trends Neurosci 2018;41:470-48
40. Singh A, Cao S, Kingyon J, et al. effects of cerebellar delta and theta frequency tACS on cognitive performance in patients with schizophrenia. Brain Stimul 2019;12:e99-e100.
41. Galván A. The Need for Sleep in the Adolescent Brain. Trends Cogn Sci 2020;24:79-89.
42. Wilckens KA, Woo SG, Kirk AR, et al. Role of sleep continuity and total sleep time in executive function across the adult lifespan. Psychol Aging 2014;29:658-665.
43. Kuula L, Pesonen AK, Martikainen S, et al. Poor sleep and neurocognitive function in early adolescence. Sleep Med 2015;16:1207-1212.
44. Blackwood J, Shubert T, Forgarty K, et al. Relationships between Performance on Assessments of Executive Function and Fall Risk Screening Measures in Community-Dwelling Older Adults. J Geriatr Phys Ther 2016;39:89-96.