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The Correlation Between Serum Vitamin D Levels, Sleep Quality, and Fatigue Among Neurology and Psychiatry Resident Doctors

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Abstract

Health workers, including resident physicians, are integral to delivering healthcare services. Engagement in both physical and non-physical tasks under rotating shift schedules may adversely impact sleep quality and precipitate fatigue among this cohort. Given the existing evidence, this study aims to examine the correlation between serum vitamin D levels, sleep quality, and fatigue among resident doctors. An analytical cross-sectional study was performed at Ngoerah Hospital from May to June 2022. Serum 25-hydroxyvitamin D [25 (OH)D] concentrations were quantified to ascertain vitamin D status. Sleep quality was evaluated using the Pittsburgh Sleep Quality Index (PSQI), and fatigue severity was measured via the Fatigue Severity Scale (FSS). Serum 25(OH)D levels demonstrated a strong and statistically significant negative correlation with PSQI scores ($r = –0.664$, $p < 0.001$) and with FSS scores ($r = –0.734$, $p < 0.001$). Regression analysis revealed that each one-unit increase in serum vitamin D was associated with a 65.7 % reduction in PSQI score and a 68.2 % reduction in FSS score. Most participants exhibited insufficient to deficient vitamin D status, likely attributable to limited occupational sun exposure. Monitoring and management of vitamin D status, including education on adequate sunlight exposure and consideration of vitamin D supplementation, are critically important for healthcare professionals, who are at elevated risk for deficiency, to support optimal sleep quality and minimize fatigue that may adversely affect clinical performance.

Keywords: Fatigue, Sleep Quality, Vitamin D, Serum 25(OH)D levels, Health Workers

BACKGROUND

Health services constitute a critical sector, particularly during the COVID-19 pandemic. Among healthcare professionals, physicians are considered a vulnerable group due to increased workloads, prolonged working hours, and reduced rest periods, factors that have received considerable attention in recent years (1). Resident doctors, or medical residents, play a vital role in healthcare services within teaching and affiliated hospitals and are especially susceptible to fatigue and sleep disturbances. The unpredictable working hours of resident doctors subject them to having responsibilities in various aspects, including patient care, academic responsibilities, and social roles. The absence of formal regulations regarding their working duration contributes to reduced sleep duration among resident doctors. Moreover, the role of resident doctors during the pandemic was crucial, as they served both as frontline healthcare providers and as medical students. This dual responsibility significantly increased their workload and overall burden (2-3).

The topic of sleep quality has garnered significant research interest, both in the general population and among healthcare professionals. Approximately 50% of adults are affected by sleep disorders, including insomnia, excessive daytime sleepiness, circadian rhythm disorders, and disturbances associated with specific sleep stages. A meta-analysis by Lu et al, reported the prevalence of sleep disorders in adults in China, Egypt, and South Korea to be 35.9%, 33.4%, and 32.7%, respectively (3-6). Harijanto et al. conducted a study on anaesthesiology and intensive therapy residents at Cipto Mangunkusumo Hospital, which revealed that 70% of participants experienced poor sleep quality, as assessed using the Pittsburgh Sleep Quality Index (PSQI). Poor sleep quality was correlated

with shorter sleep duration, increased daytime sleepiness, and sleep-related complaints. A similar study by Herwanto et al. on paediatric residents at Sam Ratulangi University reported that residents with reduced sleep duration experienced memory decline and fatigue. These data highlight the significant impact of sleep quality on the work performance of residents doctor (7-8).

Several studies have shown an association between low serum vitamin D levels and sleep quality. The diagnostic status of serum vitamin D deficiency is defined as concentration of 25-hydroxyvitamin D (25(OH)D) less than 30 ng/ml in the serum. The classification of vitamin D status is insufficiency (20-30 ng/ml), deficiency (10-20 ng/ml), and severe deficiency (0-10 ng/ml) (9-11). Studies conducted in Korea have shown that vitamin D levels tend to be lower among younger individuals who spend more time indoors and frequently use sunscreen (12-13). A study conducted by Sintarani et al. (2021), which investigated the association between serum vitamin D levels and sleep quality among medical resident at Ngoerah General Hospital, found that medical residents with vitamin D deficiency had an increased risk of poor sleep quality compared to those with sufficient vitamin D levels (14).

The relationship between vitamin D status and fatigue remains limited. Nevertheless, several studies have suggested a link between low serum vitamin D levels and higher fatigue levels, particularly in patients with chronic conditions. Vitamin D plays a role in calcium homeostasis, and its deficiency may contribute to bone abnormalities and muscle weakness, both of which are associated with fatigue (15). A case report by Johnson and Sattari also highlighted the association between low serum vitamin D and fatigue, often related to insufficient sun exposure and prolonged indoor activity. However, further research is needed to establish a definitive causal relationship (16). Given the existing evidence, this study aims to examine the correlation between serum vitamin D levels, sleep quality, and fatigue among resident doctors.

METHODS

This study was an analytical observational study with a cross-sectional design, conducted on a population that met the eligibility criteria established by the researchers. The inclusion criteria were: resident doctors from the Neurology and Psychiatry Departments at Ngoerah General Hospital from May to June 2022, aged between 25 and 35 years, cooperative, and willing to participate by signing an informed consent form.

Exclusion criteria included: subjects with severe or very severe levels of depression, anxiety, or stress; a history of hypnotic, stimulant, or alcohol use in the last 30 days; a history of liver or kidney disease and impaired renal function; a history of gastrointestinal diseases such as ulcerative colitis or Crohn's disease; resident doctors with professions other than medical doctors; obesity (body mass index > 25 kg/m^2); and individuals with indoor activity duration of less than 8 hours per day.

All participants were required to complete a primary data form provided by the researchers and fill out the DASS-21 questionnaire. Subjects identified as experiencing anxiety, depression, or stress based on the DASS-21 were excluded from the study. Eligible participants then underwent blood sampling to measure serum vitamin D levels, specifically 25-hydroxyvitamin D [25(OH)D] with ELISA method using Biomerieux washer 470 reader 27 in the Pathological Clinic Ngoerah Hospital, and were instructed to complete the Pittsburgh Sleep Quality Index (PSQI) and the Fatigue Severity Scale (FSS) questionnaires. This study was approved by the Ethics Committee of the Faculty of Medicine, Universitas Udayana, with protocol number 2022.02.1.0529. Data analysis was performed using SPSS Statistics software, version 20.

RESULTS

The study employed numerical scales for the variables of serum vitamin D levels, sleep quality (assessed using the

Pittsburgh Sleep Quality Index, PSQI), and fatigue (measured using the Fatigue Severity Scale, FSS). The characteristics of the study sample are presented in Table 1. Overall sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI), which evaluates seven components of sleep. The median PSQI score among the study subjects was 12, with a minimum score of 2 and a maximum of 18. Fatigue was measured using the Fatigue Severity Scale (FSS), yielding a median score of 40, with scores ranging from 12 to 58.

Serum vitamin D levels were evaluated by measuring 25(OH)D) concentrations. The median serum vitamin D level was 18.1 ng/mL, with a range from 7.4 to 41.6 ng/mL. Based on these measurements, 5 participants (9.8%) had normal serum vitamin D levels, 15 participants (29.4%) were classified as having insufficiency, 28 participants (54.9%) as having deficiency, and 3 participants (5.9%) were categorized as having severe deficiency, as shown in Table 1.

Table 1. The Characteristics of Subjects

Variable	N	%
Age (year) median (min-max)	29 (26-35)	
Gender		
Male	24	47,1
Female	27	52,9
PSQI median (min-max)	12 (2-18)	
Subjective sleep quality	2 (0-3)	
Sleep Latency	2 (0-3)	
Sleep Duration	2 (0-3)	
Habitual Sleep Efficiency	2 (0-3)	
Sleep Disturbances	2 (0-5)	
Use of Sleeping Medication	0 (0-1)	
Daytime Dysfunction	2 (0-3)	
FSS median (min-max)	40 (12-58)	
Serum vitamin D level (ng/ml) median (min-max)	18,1 (7,4-41,6)	
Normal		
Insufficiency	5	9,8
Deficiency	15	29,4
Severe deficiency	28	54,9
	3	5,9

The correlation between serum vitamin D levels and PSQI scores was analysed using Spearman's rank correlation test, as the data were not normally distributed. Table 2 presents the results of this analysis, indicating a significant negative linear correlation between serum vitamin D levels and PSQI scores. The correlation coefficient (r) was −0.664, demonstrating a strong negative linear correlation, with a statistically significant p-value.

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Table 2. Correlation Analysis Results between Serum Vitamin D Levels and PSQI Score

	Serum Vitamin D Levels	
Variable	Correlation Coefficient (r)	p-value
PSQI	-0,664	<0,001

The correlation between serum vitamin D levels and Fatigue Severity Scale (FSS) scores is presented in Table 3. The results indicate a negative linear correlation, suggesting that lower serum vitamin D levels are associated with higher fatigue severity. The strength and direction of this relationship were assessed using Spearman's rank correlation coefficient, given the non-normal distribution of the data. The correlation coefficient was −0.734, indicating a strong inverse relationship, with a statistically significant p-value.

Table 3. Correlation Analysis Results between Serum Vitamin D Levels and FSS Values

	Serum Vitamin D Level	
Variable	Correlation Coefficient (r)	p-value
FSS	-0,734	<0,001

DISCUSSION

This study demonstrated a strong negative correlation between serum vitamin D levels and PSQI scores, indicating that lower vitamin D levels are associated with poorer sleep quality. These findings are consistent with previous research conducted by McCarty et al. (2012), which found a significant association between low serum vitamin D levels and sleep disturbances, particularly excessive daytime sleepiness (17). Similarly, Massa et al. (2015) reported a correlation between low vitamin D levels and sleep disturbances, especially in relation to shorter sleep duration[18]. Based on a physiological perspective, low vitamin D levels can disrupt neuronal excitability, leading to increased GABA and decreased NMDA activity, both of which contribute to sleep dysregulation. Additionally, vitamin D influences the conversion of tryptophan to 5-hydroxytryptophan via TPH-2, which expresses vitamin D receptors (VDR) at the gene level. A reduction in 5-hydroxytryptophan leads to lower serotonin levels, ultimately affecting melatonin production and sleep regulation (19,20).

The characteristics of vitamin D status in this study mostly fell into the categories of insufficiency and deficiency among the participants. This may be attributed to the indoor nature of resident doctors' work, which limits sun exposure (12,19). According to Dawson-Hughes et al. (2010), UVB radiation accounts for 80–90% of vitamin D synthesis in the body, while dietary intake and supplementation contribute only 10–20% (13). This study aligns with the findings of Jung et al. (2017), who reported that indoor factory workers with limited sunlight exposure exhibited significantly lower serum vitamin D levels and poorer sleep quality compared to the general population. These findings support the recommendation for vitamin D supplementation, especially for populations with limited sunlight exposure, including resident doctors (13). Given the evidence that low vitamin D levels have a significant correlation with poorer sleep quality. A case-control study by Sintarani et al. (2021) among resident doctors found that vitamin D deficiency increased the risk of poor sleep quality by 12.6 times compared to individuals with normal vitamin D levels. Maintaining good sleep quality and minimizing fatigue is essential to reduce the risk of diagnostic errors, serious medical mistakes, and needlestick injuries (14,21).

This study also suggests that higher vitamin D levels are associated with reduced fatigue severity. Fatigue, character-

ized as a state of reduced energy or the inability to sustain effort, adversely affects social life, quality of life, and work performance. Previous studies have linked low vitamin D levels with increased fatigue, particularly in individuals with chronic illnesses (15). These results are consistent with theories that vitamin D plays a role in modulating fatigue. Deficiency in vitamin D may disrupt calcium homeostasis and increase the production of TNF-α, NF-κB, and prostaglandin D, all of which contribute to bone abnormalities, muscle weakness, and pain, thereby promoting fatigue (17). A case report by Johnson and Sattari (2015) also highlighted an association between low serum vitamin D levels and fatigue, particularly in individuals with limited sun exposure and frequent sunscreen use (15,16). Fatigue is multifactorial in origin, encompassing circadian rhythm disturbances, sleep deprivation, sleep fragmentation, health conditions, medication or supplement use, mood disorders, and rotating work schedules (22). Fatigue is particularly detrimental in healthcare settings, where it can increase the risk of workplace accidents, reduce concentration, and impair clinical performance, especially among resident doctors (20).

CONCLUSION

The results of the study suggest that vitamin D deficiency is associated with sleep disturbances and increased fatigue via dysregulation of neurotransmitter systems and other related physiological processes. Accordingly, monitoring and management of vitamin D status, including education on adequate sunlight exposure and consideration of vitamin D supplementation, are critically important for healthcare professionals, who are at elevated risk for deficiency, to support optimal sleep quality and minimize fatigue that may adversely affect clinical performance.

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