

## The Role of Blood Pressure, Diabetes Panel, Vitamin D, and Albumin in Sleep Quality Among the Elderly Population

Anastasia Ratnawati Biromo<sup>1\*</sup>, Paskalis Andrew Gunawan<sup>2</sup>, Alexander Halim Santoso<sup>3</sup>, Bryan Anna Wijaya<sup>4</sup>, Raden Seliwat Agung Aditya<sup>4</sup>, Anthon Eka Prayoga Khoto<sup>5</sup>

<sup>1</sup>Department of Psychiatry, Faculty of Medicine, Universitas Tarumanagara

<sup>2</sup>Department of Geriatrics, Faculty of Medicine, Universitas Tarumanagara

<sup>3</sup>Department of Nutrition, Faculty of Medicine, Universitas Tarumanagara

<sup>4</sup>Medical Profession Program, Faculty of Medicine, Universitas Tarumanagara

<sup>5</sup>Undergraduate Medical Program, Faculty of Medicine, Universitas Tarumanagara

E-mail: [anastasiaratnawati@fk.untar.ac.id](mailto:anastasiaratnawati@fk.untar.ac.id)

### Abstract

Sleep disturbances are common among the elderly, influenced by multiple physiological factors, including blood pressure regulation, metabolic markers, nutritional status, and inflammation. Poor sleep quality has been linked to cardiovascular diseases, cognitive decline, and reduced overall well-being. Understanding the relationship between blood pressure, diabetes markers, vitamin D, and albumin levels with sleep quality may provide insights into potential interventions to improve sleep health in older adults. This study aims to analyze the correlation between blood pressure, diabetes panel (fasting blood glucose, fasting insulin, and HbA1c), vitamin D, and albumin levels with sleep quality in the elderly population. This cross-sectional study was conducted at Bina Bhakti Nursing Home in 2024 to 58 elderly participants selected through total sampling. Sleep quality was assessed with the Pittsburgh Sleep Quality Index (PSQI), while physiological parameters were measured using validated clinical and laboratory methods. Data were analyzed using Spearman's Rho test to determine correlations between these factors and sleep disturbances. This study found that diastolic blood pressure and HbA1c level showed weak correlations with sleep quality. Low diastolic blood pressure and poor glycemic control demonstrated weak but statistically significant correlations with sleep quality among older adults. These findings indicate that certain physiological and metabolic factors, particularly diastolic blood pressure and HbA1c, may be associated with variations in sleep regulation among the elderly. Future research should explore targeted interventions, such as blood pressure management and metabolic regulation, that may improve sleep quality and overall health in the aging population.

**Keywords:** Albumin, Blood Pressure, Diabetes Panel, Vitamin D, Sleep Quality

### 1. Introduction

Sleep plays a crucial role in maintaining overall health and well-being throughout life. However, aging comes with significant alterations in sleep architecture, leading to increased prevalence of sleep disorders, particularly insomnia. Approximately 30–48% older adults experience challenges related to sleep onset, maintenance, or overall sleep quality. These disturbances have far-reaching implications, as inadequate sleep has been linked to cognitive decline, increased risk of falls, cardiovascular

complications, and diminished overall quality of life.<sup>1–3</sup>

The aging process also contributes to physiological changes that disrupt sleep regulation. Nocturnal hypertension and non-dipping blood pressure patterns that are frequently observed among older adults are linked to sleep fragmentation and diminished deep sleep due to heightened sympathetic activity, vascular inflammation, and impaired cerebrovascular function.<sup>4–6</sup> Poor glycemic control, insulin resistance, and chronic hyperglycemia have also been associated with sleep disturbances. Elevated fasting

blood glucose and HbA1c levels correlate with reduced sleep efficiency, shorter sleep duration, and frequent nocturnal awakenings. Inadequate sleep, in turn, will exacerbate glucose intolerance and insulin resistance, further compromising metabolic health in elderly individuals.<sup>7,8</sup>

Moreover, vitamin D deficiency and hypoalbuminemia, both prevalent in the elderly due to reduced nutritional intake, impaired synthesis, and limited sun exposure, have been independently linked to impaired sleep quality. Vitamin D influences melatonin production, neurotransmitter regulation, and inflammatory signaling, thereby modulating circadian rhythm and restorative sleep.<sup>9,10</sup> Meanwhile, low serum albumin reflects systemic inflammation and poor nutritional status, both of which contribute to insomnia and obstructive sleep apnea.<sup>11,12</sup>

Despite these well-documented associations, most studies have examined these physiological and biochemical parameters separately without determining their relative contributions to sleep disturbances in older adults. Furthermore, research involving institutionalized elderly populations, such as those residing in nursing homes, is limited, particularly in Indonesia, where lifestyle, dietary intake, and comorbidities may differ substantially from those of community-dwelling older adults.

To address this gap, the present study was conducted at Bina Bhakti Nursing Home, one of the extensive elderly care facilities in Jakarta, which provides a representative model of institutionalized aging with controlled daily routines and dietary intake. This setting allows for more accurate assessment of internal physiological determinants of sleep without major environmental confounders.

Therefore, this study aims to examine the correlation between physiological (blood pressure) and biochemical (glucose, HbA1c, vitamin D, and albumin) parameters and sleep quality among older adults. We hypothesize that dysregulated blood pressure, poor glycemic control, and lower serum vitamin D and albumin levels are significantly associated with poorer sleep quality in institutionalized elderly individuals.

## **2. Method**

This cross-sectional study was conducted in 2024 at Bina Bhakti Nursing Home, involving 58 elderly participants recruited through total sampling. Eligibility criteria are individuals aged 60 years or older with sufficient cognitive function to comprehend procedures, including participation in blood sample collection, and provide informed consent. Participants were excluded if they were using medications that affect sleep physiology, such as sedatives, hypnotics, benzodiazepines, or melatonin supplements. Additionally, the study did not include individuals with severe hepatic, renal, or cardiac failure, as these conditions could significantly alter metabolic parameters.

This study investigates the relationship between blood pressure, diabetes panel, vitamin D, albumin, and sleep quality in the elderly population using standardized clinical assessments. Blood pressure was measured with a sphygmomanometer, documenting both systolic and diastolic values to examine their potential impact on sleep disturbances. The diabetes panel was assessed through validated laboratory techniques, including fasting insulin, fasting glucose, and HbA1c. Fasting insulin ( $\mu\text{IU/mL}$ ) was measured using the ELISA method, ensuring precise protein

quantification, while fasting glucose (mg/dL) was determined via immunoturbidometric analysis, which is a standard approach in metabolic evaluation. HbA1c (%) served as an indicator of long-term glycemic control, reflecting average blood glucose levels over the preceding months. Vitamin D levels (ng/mL) were analyzed using the ELISA method, given the critical role of vitamin D receptors in sleep regulation. Serum albumin (g/dL), a key marker of nutritional and inflammatory status, was measured to explore its association with sleep disturbances. Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI), a widely validated tool evaluating sleep duration, efficiency, disturbances, and subjective sleep experience. By integrating these physiological and biochemical parameters, this study aims to comprehensively understand their collective impact on sleep quality among elderly individuals, facilitating early identification of risk factors and potential intervention strategies. All devices were calibrated before use to ensure accuracy. Standard protocol was also used to ensure the reliability and validity of the measurements and results obtained.

In this study, data analysis was conducted using SPSS version 26 to process univariate and bivariate quantitative data. The normality of the data distribution was assessed using the Kolmogorov-Smirnov test. The relationship between blood pressure, diabetes panel (HbA1c, fasting blood glucose, and fasting insulin), vitamin D, albumin, and sleep quality among the elderly population was analysed using Spearman's Rho. This test is a non-parametric correlation analysis used to determine associations between variables with statistical significance set at  $p < 0.05$ . The strength of the correlation

was classified as follows: negligible (0.00–0.10), weak (0.10–0.39), moderate (0.40–0.69), strong (0.70–0.89), and very strong (0.90–1.00). Descriptive statistics, including means and standard deviations, were used to summarize the characteristics of the respondents. These analytical methods allowed for a comprehensive evaluation of the interplay between cardiovascular, metabolic, and nutritional factors and sleep disturbances among the elderly population. This research has obtained ethics clearance from the Tarumanagara University Human Research Ethics Committee, Institute of Research Community Engagement (Number 013/2024).

### **3. Result**

This study was conducted with 58 respondents, with the majority of respondents are female (81%) and the remaining 19% are male. The average age of the respondents was 75.14 years ( $\pm 7.6$ ). Regarding blood pressure, the mean systolic blood pressure was 136.91 mmHg ( $\pm 23.76$ ), while the mean diastolic blood pressure was 75.79 mmHg ( $\pm 15.21$ ). Metabolic parameters showed an average HbA1c level of 7.81% ( $\pm 1.53$ ), indicating glycemic control status among the respondents. The mean serum albumin level was 3.78 g/dL ( $\pm 0.57$ ) and fasting insulin was recorded at an average of 4.84  $\mu\text{IU/mL}$  ( $\pm 1.8$ ). The mean fasting blood glucose level was 88.1 mg/dL ( $\pm 18.91$ ). Vitamin D (25-OH) levels averaged at 10.1 ng/mL ( $\pm 4.75$ ), reflecting the nutritional and biochemical status of the elderly participants. (Table 1)

Data normality was assessed using the Kolmogorov–Smirnov test, which is appropriate for sample sizes exceeding 50 participants. The results indicated that not all variables were normally distributed. Correlation analysis revealed significant

associations between certain physiological parameters and sleep quality, as measured by the Pittsburgh Sleep Quality Index (PSQI).

Diastolic blood pressure demonstrated a weak negative correlation with PSQI scores ( $r = -0.294$ ,  $p = 0.025$ ), indicating that individuals with lower diastolic pressure tended to have higher (worse) PSQI scores, reflecting poorer sleep quality. Conversely, HbA1c level also showed a weak negative correlation with PSQI ( $r = -0.275$ ,  $p = 0.037$ ); given that higher HbA1c values indicate poorer glycemic control, this finding suggests that

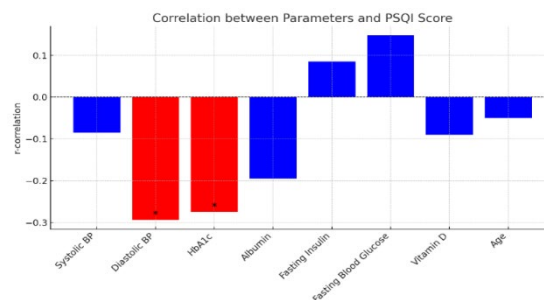
better glycemic regulation (lower HbA1c) was associated with improved sleep quality. Other variables, including systolic blood pressure, albumin, fasting insulin, fasting blood glucose, vitamin D (25(OH)D), and age did not demonstrate statistically significant correlations with sleep quality. These results highlight the potential interplay between cardiovascular and metabolic parameters in influencing sleep regulation among older adults, though causal relationships cannot be inferred from the present data. (Table 2 and Figure 1)

**Table 1. Respondent Characteristics**

Parameter	Results (SD)
Gender	
Male	11 (19%)
Female	47 (81%)
Age (years)	75.14 (7.6)
Systolic Blood Pressure, mmHg	136.91 (23.76)
Diastolic Blood Pressure, mmHg	75.79 (15.21)
HbA1c, %	7.81 (1.53)
Albumin, g/dL	3.78 (0.57)
Fasting Insulin, $\mu$ IU/mL	4.84 (1.8)
Fasting Blood Glucose, mg/dL	88.1 (18.91)
Vitamin D (25(OH)D), ng/mL	10.1 (4.75)

**Table 2. Correlation between Blood Pressure, Diabetes Panel, Vitamin D, and Albumin on Sleep Quality**

Parameter N = 58 respondents	Pittsburgh Sleep Quality Index (PSQI) In point	
	r-correlation	p-value
Systolic Blood Pressure, mmHg	-0.085	0.527
Diastolic Blood Pressure, mmHg	-0.294	0.025*
HbA1c, %	-0.275	0.037*
Albumin, g/dL	-0.195	0.142
Fasting Insulin, $\mu$ IU/mL	0.085	0.527
Fasting Blood Glucose, mg/dL	0.148	0.268
Vitamin D (D25 OH), ng/mL	-0.090	0.504
Age, years	-0.050	0.709



**Figure 1. Correlation between Blood Pressure, Diabetes Panel, Vitamin D, and Albumin on Sleep Quality**

#### **4. Discussion**

Most of the existing studies linked insomnia to hypertension.<sup>13</sup> However, in contrast to the majority of the literature associating elevated blood pressure with sleep disturbances, our findings demonstrated a weak negative correlation between diastolic blood pressure and sleep quality, indicating that lower diastolic pressure was associated with poorer sleep quality. This paradoxical association may reflect age-related physiological adaptations in the elderly, such as reduced autonomic tone, increased arterial stiffness, and diminished baroreceptor sensitivity. These factors may cause exaggerated nocturnal hypotension, compromising cerebral and myocardial perfusion during rest and predisposing individuals to sleep fragmentation.<sup>14–16</sup> Low diastolic blood pressure can lead to low cerebral and cardiac resting perfusion. Low blood flow to the brain can be linked to sleep disorders such as upper airway resistance syndrome (UARS) and sleep apnea. Hence, both abnormally high and excessively low diastolic pressures may impair sleep quality through distinct but interrelated mechanisms, such as hypertension through sympathetic hyperactivation, and hypotension through impaired end-organ perfusion and nocturnal arousals. These findings underscore the delicate hemodynamic balance required for optimal sleep regulation in older adults.<sup>17,18</sup>

A high HbA1c level also shows a significant, weak correlation with poor sleep. An HbA1c of 6.5% or higher is sufficient for diagnosing diabetes. Diabetes may cause frequent urination at night that disrupts sleep and nocturnal hypoglycemia that can cause awakenings at night. People

with diabetes may also suffer from obesity, which contributes to sleep-breathing disorders. Conversely, poor sleep itself can worsen glucose metabolism. Sleep restriction and fragmentation elevate sympathetic drive, alter cortisol secretion, and impair insulin sensitivity, thereby increasing HbA1c levels over time. This bidirectional relationship indicates that sleep disturbance and dysglycemia perpetuate each other, forming a self-reinforcing metabolic cycle that is particularly detrimental in the elderly with reduced physiological reserve and higher comorbidity burden.<sup>19–21</sup>

Vitamin D contributes to sleep homeostasis by modulating melatonin synthesis, neurotransmission, and inflammation. Studies have reported that vitamin D deficiency correlated with poorer sleep quality. However, the results were inconsistent. A survey by Gunduz found no significant difference in the PSQI total score between vitamin D-deficient and non-deficient pregnant women.<sup>22</sup> Another study by Mason also found no significant change in overall sleep quality with vitamin D supplementation in postmenopausal women.<sup>23</sup> These discrepancies across studies may arise from differences in age, comorbidities, and baseline vitamin D status. In institutionalized elderly populations such as those in nursing homes, limited sun exposure and uniform dietary intake reduce variability in vitamin D levels, potentially obscuring statistical associations. Therefore, while vitamin D is biologically linked to sleep regulation, its clinical effect on sleep quality may be subtle and context-dependent. These studies suggested that many other factors also play a role in sleep disorders than just vitamin supplementation.<sup>24,25</sup>

The relationship between albumin and sleep is often indirect. Lower albumin levels in the elderly may indicate underlying health conditions that negatively impact sleep, emphasizing the need for comprehensive nutritional and inflammatory assessments in sleep-related evaluations. Albumin primarily reflects nutritional status and systemic inflammation rather than directly influencing sleep regulation. In elderly individuals, mild hypoalbuminemia may coexist with chronic inflammatory or catabolic states, which independently affect sleep through cytokine-mediated pathways. Thus, the absence of a significant association in this study likely reflects the multifactorial nature of both sleep and albumin regulation.<sup>26–28</sup>

These findings highlight the intricate relationship between blood pressure, diabetes markers, vitamin D, albumin, and sleep quality in the elderly population. However, several limitations should be acknowledged when interpreting the results. The cross-sectional design of this study does not allow for causal inferences, as it captures associations at a single point in time rather than tracking changes over an extended period. Additionally, the study was conducted among elderly residents of Bina Bhakti Nursing Home, which may limit the generalizability of the findings to broader populations with different demographic and clinical characteristics. Furthermore, although efforts were made to control for potential confounders, factors such as medication use, dietary habits, and underlying comorbid conditions may have influenced the observed associations. Reliance on self-reported sleep quality using the Pittsburgh Sleep Quality Index (PSQI) could introduce recall bias, thereby affecting the accuracy of the sleep assessments. Future research should incorporate larger, more diverse

samples, use objective sleep measures such as polysomnography or actigraphy, and employ longitudinal or interventional study designs to establish causality and further elucidate the mechanisms linking these physiological parameters to sleep disturbances in older adults.

## 5. Conclusion

Diastolic blood pressure and HbA1c levels were weakly but significantly associated with sleep quality among elderly individuals, with lower diastolic pressure and poorer glycemic control linked to worse sleep quality. No significant associations were observed for systolic blood pressure, vitamin D, albumin, or other metabolic parameters. These findings suggest that cardiovascular and metabolic regulation may contribute to sleep disturbances in aging populations. Further longitudinal and interventional studies are needed to clarify causality and evaluate the clinical relevance of optimizing blood pressure and glycemic control to improve sleep quality in older adults.

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