

Original Article

Association between sleep quality and pre-hemodialysis blood pressure among patients undergoing hemodialysis: A cross-sectional study

Robiatul Adawiyah¹, Dwi Soelistyoningsih^{1*}, Achmad Rifai², Wira Daramatasia¹, Angernani Trias Wulandari¹

¹ Program Studi S-1 Keperawatan, STIKES Widyagama Husada, Malang, Jawa Timur, Indonesia

² Divisi Ginjal Hipertensi, Departemen Ilmu Penyakit Dalam, RSUD Saiful Anwar/Fakultas Kedokteran Universitas Brawijaya, Malang, Jawa Timur, Indonesia

***Corresponding Author:**

Dwi Soelistyoningsih

Program Studi S-1 Keperawatan, STIKES
Widyagama Husada, Malang, Jawa Timur,
Indonesia

Email:

dwi_soelistyoningsih@widyagamahusada.ac.id

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Abstract

Background: Chronic kidney disease (CKD) is an ailment of kidney function that develops gradually and in advanced stages requires long-term hemodialysis therapy. Sleep disturbances are common among patients due to both physiological and psychological factors. Poorer sleep quality may elevate the sympathetic nervous system's responsiveness, disrupt fluid balance, and contribute to elevated blood pressure, particularly pre-hemodialysis blood pressure, which reflects the patient's hemodynamic status prior to dialysis initiation.

Objective: This study aimed to assess the association between sleep quality and pre-hemodialysis blood pressure, including systolic and diastolic, in patients undergoing hemodialysis.

Methods: This research utilized a quantitative, cross-sectional methodology that was conducted in September 2025 at the Hemodialysis Unit of Universitas Muhammadiyah Malang Hospital, among 80 patients selected using purposive sampling, undergoing routine hemodialysis for at least three months at Universitas Muhammadiyah Malang Hospital, who were conscious and able to communicate verbally. The Pittsburgh Sleep Quality Index (PSQI) questionnaire was utilized to assess quality of sleep, whereas pre-hemodialysis blood pressure including systolic and diastolic measurements was weighed prior to the dialysis procedure using a standard sphygmomanometer. Data were evaluated using the Spearman Rank test, with an established significance threshold of $p < 0.05$.

Results: Of the total respondents, 42 (52.5%) had good sleep quality, while 38 (47.5%) experienced poor sleep quality. The median pre-hemodialysis blood pressure was 130/80 mmHg, indicating stage 1 hypertension. Statistical assessment disclosed a significant association between quality of sleep and pre-hemodialysis blood pressure category ($p = 0.014$) with a weak positive correlation ($r = 0.274$), revealing that poorer sleep quality was associated with higher blood pressure category, although the effect size was small.

Conclusion: Sleep quality is significantly associated with blood pressure in patients of pre-hemodialysis. Poorer sleep quality leads to be collaborated with higher blood pressure. However, the weak correlation ($r = 0.274$) suggests that sleep quality is one of several contributing factors to blood pressure variability in this population. These verdicts highlight the significance of assessing and managing sleep quality as part of comprehensive care in hemodialysis patients.

Background

Chronic kidney disease (CKD) defines a gradual, enduring decline in renal operation. This condition is identified by a diminished glomerular filtration rate persisting over a period exceeding three months. This condition has become a worldwide health problem because of its rising prevalence and its contribution to elevated morbidity and mortality rates. Globally, CKD affects approximately 788 million people aged 20 years and older, with an age-standardised prevalence of 14.2%, representing a significant increase from 378 million cases reported in 1990. At the global level, an estimated 4.59 million

individuals required kidney failure replacement therapy in 2023, a number that continues to rise annually (GBD 2023 Kidney Failure with Replacement Therapy Collaborators, 2025). In Indonesia, hypertensive kidney disease remains the leading cause of end-stage kidney disease requiring hemodialysis, reflecting the high burden of hypertension in the Indonesian population, where its prevalence reaches 34.1% according to national health survey data (Andhika et al., 2025). In advanced stages, patients require renal replacement therapy, particularly hemodialysis, to maintain metabolic homeostasis, including the disposal of metabolic waste products and the

ordinance of fluid and electrolyte balance (Fatimah et al., 2025)

Despite its life-sustaining role, hemodialysis is connected with various physiological and psychological disorders that adversely affect patients' quality of life. Sleep disorders is one of the most prevalent yet often underrecognized problems in this population. Previous studies report that 40% to over 80% of hemodialysis patients experience low sleep quality, including insomnia, sleep fragmentation, and sleep-disordered breathing (Alosaimi et al., 2020). This prevalence is substantially higher than in the population, and a recent systematic review and meta-analysis confirmed that poor sleep quality remains highly prevalent among hemodialysis patients globally, driven by neurological impairment caused by uremic toxins, dialysis-related circadian rhythm disturbances, and comorbid psychological disruption (Yu et al., 2026). These disturbances are clinically important, as they are associated with fatigue, impaired cognitive function, and decreased functional capacity (Aneja & Fatrida, 2026; (Sari et al., 2026)

In addition to sleep disturbances, hypertension is another major complication in patients undergoing hemodialysis. The prevalence of hypertension among regular hemodialysis patients is estimated at 70–80% globally, and blood pressure control remains inadequate in a large proportion of this population (Ademola et al., 2024). Various factors, such as fluid retention, renin-angiotensin system disorders, and changes in cardiovascular function, can influence hypertension in hemodialysis patients (Bucharles et al., 2019). Pre-hemodialysis blood pressure is particularly important, as it reflects the patient's intravascular volume status and hemodynamic condition prior to dialysis initiation (Utomo et al., 2024).

Emerging evidence suggests that sleep disturbances may affect blood pressure regulation through increased sympathetic nervous system activity, hormonal dysregulation, and disruption of circadian rhythms (Saraswati et al., 2022). Poor sleep quality has been shown to increase vascular resistance and disrupt the normal nocturnal dipping pattern of blood pressure, resulting in a non-dipping or reverse-dipping profile associated with increased cardiovascular risk (Al Ashari & Muhdar, 2024). Furthermore, hormonal dysregulation involving the hypothalamic-pituitary-adrenal axis and elevated cortisol secretion further contributes to sustained blood

pressure elevation. In hemodialysis patients, these mechanisms are compounded by uremia-related autonomic dysfunction and fluid overload, making the relationship between sleep quality and blood pressure particularly complex in this population (Septimar & Nurmalahayati, 2019).

However, previous findings remain inconclusive. Whereas some studies demonstrate a significant link amid poor sleep quality and elevated blood pressure, others report non-significant or weak relationships. These inconsistencies may result from differences variations in study populations, measurement tools, and clinical settings (Alshammari et al., 2023). Furthermore, evidence from Indonesian hemodialysis populations remains limited, particularly in hospital-based clinical contexts. Existing Indonesian studies have primarily examined sleep quality in relation to quality of life outcomes rather than hemodynamic parameters such as blood pressure (Putri et al., 2024). Studies specifically investigating the association between sleep quality and pre-hemodialysis blood pressure within Indonesian hospital-based clinical settings remain scarce, highlighting the need for locally contextualized evidence.

Therefore, this study is necessary to address these gaps by examining the relation between quality of sleep and pre-hemodialysis blood pressure in a specific clinical setting. The objective of this research is to determine the association between sleep quality and pre-hemodialysis blood pressure in patients undergoing routine hemodialysis. It is hypothesized that poorer sleep quality is significantly correlated with higher pre-hemodialysis blood pressure.

Methods

Study Design

A cross-sectional, analytical approach design was adopted for this study. In this design, exposure (sleep quality) and outcome (blood pressure) variables were measured simultaneously at one specific time point. A cross-sectional design was considered suitable because the principal objective of this study was to deliberate the association amid sleep quality and blood pressure rather than to establish causal relationships or temporal effects. Additionally, this design allows efficient assessment of the distribution of variables and their interrelationships within a defined clinical population, particularly in a relatively stable cohort of patients undergoing routine hemodialysis. Such an approach is

commonly used in clinical epidemiological studies to identify potential associations that may inform further longitudinal research (Subhaktiyasa, 2024).

Study Setting

This research was conducted in September 2025 at the Hemodialysis Unit of the Universitas Muhammadiyah Malang Hospital, a second-level referral hospital in East Java, Indonesia. The unit provides regular hemodialysis services for patients with chronic kidney disease, operating six days a week. Patients typically undergo hemodialysis therapy two to on a thrice-weekly basis, with each session lasting approximately four hours. The unit manages approximately 100 active patients annually, most of whom require long-term dialysis therapy. Clinical services are supported by a multidisciplinary team, including nephrologists and certified hemodialysis nurses.

Participants and Sampling Procedure

The study population comprised patients diagnosed with chronic kidney disease receiving hemodialysis at Universitas Muhammadiyah Malang Hospital (N = 100), based on hospital medical records. The required sample size was calculated based on the Krejcie and Morgan table with a 95% confidence level, resulting in a minimum sample of 80 participants (Bukhari, 2021). A purposive non-probability sampling was applied to recruit participants who fulfilled predefined eligibility criteria. The criteria of inclusion were: (1) patients 18 years of age or older, (2) experiencing hemodialysis for a minimum of three months to ensure clinical stability, (3) having adequate cognitive function and ability to communicate, and (4) willingness to participate as indicated by signed informed consent. Patients with acute clinical instability or incomplete data were excluded. Of the total population (N = 100), all patients were initially screened for eligibility. A whole of 85 patients complied with the inclusion criteria, while 15 patients were excluded due to not meeting the criteria or having incomplete data. Among those eligible, 5 patients declined to participate, resulting in a final sample of 80 patients who were included in the analysis. The sampling procedure followed several steps: (1) identification of eligible patients from the hemodialysis registry, (2) screening based on inclusion and exclusion criteria, (3) provision of comprehensive details

concerning the research aims and procedures, and (4) obtaining documented consent before prior to data collection. This procedure aligns with STROBE recommendations to clearly describe participant selection and eligibility processes.

Variables and Measurement

The Pittsburgh Sleep Quality Index (PSQI), a validated instrument commonly used to assess sleep-related problems over the past month in clinical populations was used to measure sleep quality. This included individuals undergoing hemodialysis (Savsar, 2025). The PSQI includes 19 questions divided into seven domains: quality of subjective sleep, sleep latency, sleep duration, habitual sleep efficiency, sleep alteration, use of sleep remedies, and daytime dysfunction. Individual domains are rated on a 0–3 point scale, contributing to a total score between 0 and 21. A global PSQI score of ≤ 5 reflects good quality of sleep, while a score > 5 reflects poor sleep quality, based on established cut-off criteria. The Indonesian adaptation of the Pittsburgh Sleep Quality Index (PSQI) was utilized in this study, given its established validity and reliability in previous national research. The validity test showed item correlation coefficients ranging from $r = 0.47$ to 0.61 , indicating moderate to strong correlations, while the tool showed good internal consistency, with a Cronbach's alpha coefficient of 0.83 (Ramadhani et al., 2025). These psychometric properties from prior research served as the basis for adopting this instrument in the present study; no additional reliability testing was conducted on the current sample. In this study, quality of sleep was analyzed using the total PSQI score (0–21) for correlation analysis. The categories of good and poor sleep quality were only defined by the distribution of respondents.

Blood pressure was measured prior to the hemodialysis session (pre-hemodialysis) using a calibrated sphygmomanometer to reflect the patient's baseline hemodynamic status. Measurements were performed after the patient had rested for at least 5 periods in the seated position, with the arm positioned at heart level and an appropriately sized applied to ensure accuracy (Merdekawati et al., 2024). Blood pressure was recorded in millimeters of mercury (mmHg) and included systolic blood pressure (SBP) and diastolic blood pressure (DBP). Subsequently, the values were categorized

according to the American Heart Association (AHA) guidelines as normal, elevated, stage 1 hypertension, stage 2 hypertension, and severe hypertension (Johnson et al., 2025). In this study, blood pressure was analyzed based on hypertension categories based on the American Heart Association (AHA) classification for correlation analysis. All blood pressure measurements were conducted during the afternoon and evening hemodialysis shifts to ensure consistency in data collection procedures.

Data Analysis

Data were analyzed with IBM SPSS Statistics version 27. Descriptive (univariate) analysis was conducted to summarize participant characteristics and the distribution of key variables, including sleep quality and blood pressure. Prior to bivariate analysis, test of normality was achieved using the Shapiro-Wilk test, which implied that the data were not normally distributed. Sleep quality was examined using the Pittsburgh Sleep Quality Index (PSQI) and analyzed both as a total score and as a categorical variable (good quality of sleep: PSQI $\leq$ 5; poor quality of sleep: PSQI $>$ 5). Blood pressure was assessed as systolic and diastolic values (mmHg) and further categorized based on hypertension classification. An analysis of

bivariate conducted using the Spearman Rank correlation test to examine the relationship between sleep quality and pre-hemodialysis blood pressure, as if the data were ordinal and not normally distributed. The correlation coefficient (r) was liable to determine the strength and direction of the relationship, and a p -value of < 0.05 was considered statistically significant.

Ethical Considerations

This research was implemented in adherence to the ethical principles set forth in the Declaration of Helsinki. Ethical approval was obtained from the Research Ethics Committee of Universitas Muhammadiyah Malang with approval number No. E.5.a./267/KEPK-UMM/X/2024. A comprehensive explanation was provided to all participants regarding the study aims, procedures, potential risks, and confidentiality of their data. Prior to participation, written informed consent was secured from all subjects, and respondents were assured of their right to discontinue participation at any time without consequences.

Results

This study involved 80 patients undergoing hemodialysis at the Universitas Muhammadiyah Malang Hospital. The baseline criterion of the respondents is shown in Table 1.

Table 1. Characteristics of Hemodialysis Patients

Variable	Category	Frequency (n)	Percentage (%)
Sex	Male	43	53.7%
	Female	37	46.3%
Age (years)	26-45	19	23.7%
	46-65	53	66.3%
	>65	8	10.0%
Comorbid	Yes	67	83.7%
	No	13	16.3%
Duration of Hemodialysis	<1 years	15	18.7%
	1-5 years	39	48.8%
	>5 years	26	32.5%
Sleep Quality	Good	42	52.5%
	Poor	38	47.5%
Blood Pressure	Normal	2	2.5%
	Elevated	19	23.8%
	Stage 1 Hypertension	38	47.5%
	Stage 2 Hypertension	21	26.2%
	Severe Hypertension	0	0.0%

According to Table 1, hemodialysis patients were predominantly male (53.7%), with a mean age of 53.14 ± 11.33 years, and most were in the 46–65 age group (66.3%). Most respondents had comorbidities (83.7%), especially hypertension, and had undergone hemodialysis for 1–5 years (48.8%). Based on sleep quality, more than half of respondents had good sleep quality (52.5%), but almost half experienced poor sleep quality (47.5%). Meanwhile, the distribution of blood pressure showed that most respondents were in

the stage 1 hypertension category (47.5%), followed by stage 2 hypertension (26.2%).

Analysis using the Spearman rank correlation test was conducted to assess the association between sleep quality and blood pressure in hemodialysis patients at the Universitas Muhammadiyah Malang Hospital, as presented in Table 2. The analysis results showed a p-value of 0.014 ($p < 0.05$), which indicates a statistically significant correlation between sleep quality and blood pressure.

Table 2. Correlation between Sleep Quality (PSQI Total Score) and Pre-Hemodialysis Blood Pressure in Hemodialysis Patients (n = 80)

Variables	Correlation Coefficient (r)	95% Confidence Interval (CI)	P value
Sleep Quality and Blood Pressure	0.274	0.033-0.484	0.014

The evaluation demonstrated a statistically significant relation between the quality of sleep and blood pressure ($p = 0.014$). The correlation coefficient ($r = 0.274$) indicates a weak positive correlation, recommending that elevated Pittsburgh Sleep Quality Index (PSQI) scores, indicating poorer sleep quality, are associated with higher blood pressure levels in patients undergoing hemodialysis.

Discussion

This research aimed to examine the association between quality of sleep and blood pressure amid the population of patients undergoing hemodialysis. The findings demonstrated a statistically significant but weak positive correlation, indicating diminished sleep quality is correlated with elevated blood pressure in this population. However, this finding should be interpreted cautiously, as the cross-sectional design only identifies associations at a single point in time and does not support causal inference. Therefore, this study cannot determine whether poor sleep quality contributes to elevated blood pressure or whether elevated blood pressure and related clinical conditions contribute to sleep disturbances. Moreover, the weak correlation coefficient ($r = 0.274$) suggests that sleep quality explains only a small proportion of blood pressure variability in this population, while many other physiological and clinical factors are likely involved.

From a pathophysiological perspective, several mechanisms may explain the observed association between sleep quality and blood pressure. Sleep disturbances are commonly associated with increased sympathetic nervous system activity and elevated secretion of stress hormones such as cortisol and catecholamines. These physiological responses may contribute to vasoconstriction, increased heart rate, and uplifted peripheral vascular resistance, which are frequently associated with hypertension. In addition, disruption of circadian rhythm and impaired nocturnal blood pressure dipping patterns have been reported among individuals with poor sleep quality (Husna et al., 2025). Nevertheless, these mechanisms should not be interpreted as evidence of a direct causal relationship in the recent study, as the temporal sequence between quality of sleep and blood pressure could not be established.

In the context of hemodialysis, blood pressure regulation is inherently complex and influenced by multiple interacting factors among physiological, behavioral, and treatment-related factors. Fluid overload during the interdialytic period remains a major contributor to elevated pre-hemodialysis blood pressure due to increased intravascular volume and cardiac workload. In addition, uremic symptoms such as pruritus, pain, muscle cramps, and restless leg syndrome, as well as psychological factors such as anxiety and stress, may impair sleep quality while simultaneously affecting hemodynamic stability (Kurniawan et al., 2025;

)Haliza et al., 2026) Psychological conditions, including stress and anxiety, may also influence both cardiovascular responses and sleep disturbances. These findings suggest that the observed association between sleep quality and blood pressure may reflect shared underlying clinical conditions rather than a simple one-directional relationship.

The findings of this study are consistent with prior studies reporting an association between sleep quality and blood pressure among patients receiving hemodialysis (Kusumaningrum et al., 2021). Nevertheless, the correlation observed in the present study was relatively weak. This indicates that although sleep quality may be related to blood pressure, its contribution is likely limited compared with other determinants such as fluid balance, antihypertensive therapy, dietary adherence, duration of hemodialysis, and comorbid conditions including hypertension and diabetes mellitus. Furthermore, findings across previous studies remain inconsistent, which may be related to differences in patient characteristics, measurement methods, dialysis adequacy, and control of confounding variables.

An important consideration in interpreting these findings is the possibility of reverse causality. Elevated blood pressure, fluid retention, and uremic symptoms may lead to physical discomfort, dyspnea, nocturnal awakening, and psychological distress, which can subsequently worsen sleep quality (Widiyastuti et al., 2024). Consequently, the relationship of sleep quality and blood pressure may be bidirectional rather than unidirectional. This interpretation is particularly relevant in hemodialysis patients, whose clinical conditions fluctuate over time and are influenced by multiple interconnected factors. Therefore, the weak association identified in this study should not be interpreted as evidence that sleep quality independently determines blood pressure levels.

From a clinical perspective, routine assessment of sleep quality may still be valuable as part of comprehensive and holistic care for patients undergoing hemodialysis. Although the observed relationship was weak, sleep disturbances remain clinically pivotal because they may affect overall well-being, treatment adherence, and quality of life. Interventions such as sleep hygiene education, symptom management, psychological support, and counseling may therefore serve as supportive

strategies alongside standard blood pressure management and dialysis care (Rahman et al., 2024;)Mahdalena & Hasibuan, 2023). However, blood pressure control in hemodialysis patients should continue to prioritize broader clinical management, including fluid balance regulation, medication adherence, and management of comorbidities.

This research is subject to several constraints. Initially, the cross-sectional methodology prevents conclusions regarding temporal or causal relationships through sleep quality and blood pressure. Second, sleep quality was assessed using a self-reported questionnaire, which may be impacted by recall bias and subjective interpretation. Third, blood pressure was measured only once before hemodialysis, which may not fully represent blood pressure variability over time. Finally, several potential confounding variables, including interdialytic weight gain, medication adherence, psychological status, and dialysis adequacy, were not comprehensively controlled. These limitations, together with the weak correlation observed, indicate the need for longitudinal or prospective studies to clarify the direction, magnitude, and clinical significance of the association between sleep quality and pressure of blood in patients undergoing hemodialysis.

Conclusion and Recommendation

This study shows a statistically significant, albeit weak, association between sleep quality and pre-hemodialysis blood pressure among patients undergoing hemodialysis. Poorer quality of sleep was associated with higher blood pressure, suggesting that sleep disturbances may contribute to blood pressure variability in this population. The findings of this research highlight the critical role of incorporating sleep quality assessment into routine clinical care for hemodialysis patients. Interventions aimed at improving sleep quality, including patient education and symptom management, may serve as complementary strategies to support optimal blood pressure control.

However, given the cross-sectional design of this study and the modest strength of the association, the results should be considered with caution. Future studies employing the use of bigger sample sizes and longitudinal designs is recommended to improve the understanding the causal relationship and to explore additional factors influencing both

sleep quality and blood pressure in hemodialysis patients.

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Declaration of conflict of interest

The authors declare no competing interests.

Declaration on the Use of AI

No AI tools were used in the preparation of this manuscript.

Data Availability Statement

Data sharing is not applicable to this article.

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