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INTERACTION OF SLEEP DISRUPTION AND VITAL SIGN FLUCTUATIONS: A COMPREHENSIVE ANALYSIS OF BLOOD PRESSURE, PULSE, AND RESPIRATORY RATE IN HEMODIALYSIS PATIENTS

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ABSTRACT

Sleep disruption is highly prevalent among patients undergoing maintenance haemodialysis and has been associated with autonomic dysfunction and haemodynamic instability. However, previous studies have primarily examined individual haemodynamic parameters, providing limited understanding of the relationship between sleep quality and fluctuations in vital signs. To examine the association between sleep quality and fluctuations in blood pressure, pulse rate, and respiratory rate among patients undergoing maintenance haemodialysis. An analytical observational study with a cross-sectional design was conducted among 100 patients with end-stage kidney disease undergoing routine haemodialysis. Participants were selected using total sampling. Sleep quality was assessed using a structured questionnaire that had been tested for validity and reliability. The validity test demonstrated that all questionnaire items were valid, while the reliability test showed good internal consistency, with a Cronbach's alpha coefficient of $\geqslant$ 0.70. Haemodynamic parameters, including blood pressure, pulse rate, and respiratory rate, were measured using standard clinical equipment and classified as normal or abnormal according to established clinical criteria. Data were analysed using descriptive statistics and the Chi-square test, with statistical significance set at $p < 0.05$. Poor sleep quality was identified in 58.0% of participants. Significant associations were observed between sleep quality and all assessed haemodynamic parameters. Participants with good sleep quality were more likely to have normal blood pressure (76.2% vs. 39.7%; $p < 0.001$), normal pulse rate (81.0% vs. 50.0%; $p = 0.002$), and normal respiratory rate (83.3% vs. 56.9%; $p = 0.006$) compared with those reporting poor sleep quality. Sleep quality was significantly associated with blood pressure, pulse rate, and respiratory rate among patients undergoing maintenance haemodialysis. Participants with poor sleep quality had a higher proportion of abnormal haemodynamic parameters.

Keywords: blood pressure; haemodialysis; haemodynamic stability; pulse rate; respiratory rate; sleep quality

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INTRODUCTION

End-stage kidney disease has become an increasing global health concern, with millions of patients relying on maintenance haemodialysis to sustain life (Shi et al., 2026; Mohtashami et al., 2022). Haemodialysis may be accompanied by changes in haemodynamic status, including fluctuations in blood pressure, pulse rate, and other vital signs (Habas et al., 2025; Faitatzidou et al., 2022). These haemodynamic changes are clinically relevant because patients with kidney failure have a high burden of cardiovascular complications (Yang et al., 2024; Habas et al., 2025). During haemodialysis, changes in fluid volume, vascular resistance, and cardiovascular responses may contribute to fluctuations in vital signs (Faitatzidou et al., 2022; Yang et al., 2024). Therefore, identifying patient-related factors associated with haemodynamic changes may support more comprehensive monitoring and management during haemodialysis (Jia et al., 2025; Shi et al., 2026). Sleep disturbance is also frequently reported among patients undergoing maintenance haemodialysis. Previous studies have demonstrated a high prevalence of poor sleep quality and sleep disorders among patients with kidney failure (Davydov et al., 2023; Shi et al., 2026). Poor sleep quality may be associated with alterations in autonomic nervous system activity, including increased sympathetic activity and reduced autonomic balance (Greenlund & Carter, 2022; Carneiro

et al., 2022). Changes in autonomic regulation may subsequently be related to cardiovascular responses, including blood pressure and pulse rate, while respiratory patterns may also be affected by sleep-related physiological changes (Carneiro et al., 2022; Faitatzidou et al., 2022). These interactions suggest that sleep quality may be one of the factors associated with haemodynamic status among patients receiving haemodialysis.

Previous studies have examined the relationship between sleep quality and individual physiological or haemodynamic parameters. However, studies assessing the relationship between sleep quality and multiple vital-sign parameters, including blood pressure, pulse rate, and respiratory rate, remain limited. Examining these parameters together may provide a more comprehensive description of the relationship between sleep quality and haemodynamic status in patients undergoing haemodialysis. This is particularly relevant because changes in one physiological parameter may occur alongside changes in other vital signs during haemodialysis.

Based on this background, the present study aimed to examine the association between sleep quality and haemodynamic parameters among patients undergoing maintenance haemodialysis. Specifically, the study evaluated the association between sleep quality and blood pressure, pulse rate, and respiratory rate. The study hypothesised that sleep quality would be significantly associated with these haemodynamic parameters among patients undergoing maintenance haemodialysis. This study provides an integrated assessment of sleep quality and several vital-sign parameters in patients undergoing maintenance haemodialysis. By examining blood pressure, pulse rate, and respiratory rate simultaneously, the study is expected to contribute additional evidence regarding the relationship between sleep quality and haemodynamic status in this population.

METHOD

Research Design:

This study applies an analytical observational design with a *cross-sectional approach*. This approach was chosen because it allows for simultaneous evaluation between independent and dependent variables at one specific point in time. Cross-sectional designs have proven to be highly efficient for mapping the prevalence of health problems while testing associations between clinical variables directly. This method specifically answers the formulation of problems related to the relationship between sleep quality and hemodynamic status without the need for follow-up intervention.

Research Participants:

The target population includes patients with end-stage kidney disease undergoing routine hemodialysis therapy. This study involved a total sample of 100 respondents. The demographic characteristics of the sample show the dominance of the age group of 55 to 64 years with a proportion of 48.0%. Male patients dominated this cohort with a percentage of 52.0%. Based on the duration of therapy, 44.0% of respondents had undergone hemodialysis for 1 to 3 years. Comorbidity analysis showed hypertension as the main comorbidity experienced by 52.0% of patients. The majority of patients used vascular access in the form of an *Arteriovenous Fistula* (AVF), as much as 82.0%. This characteristic provides a strong justification that the samples used are highly representative of the real conditions in the dialysis unit.

Measurement Instruments:

Variable assessment uses specific and measurable instruments. Independent variables focus on the quality of the patient's sleep. Sleep quality is evaluated and classified into two main categories, which are good and bad. The dependent variables include three objective hemodynamic parameters. These parameters include blood pressure, pulse frequency, and *respiratory rate*. Vital signs measurement uses standard medical equipment that has been calibrated to ensure data accuracy. The

results of the hemodynamic measurement were then dichotomously categorized into normal and abnormal states for each indicator.

Data Collection Procedure
Primary data were collected directly from the haemodialysis unit. Before data collection, the researcher explained the purpose, procedures, potential benefits, and participants' rights, after which each respondent who agreed to participate signed an *informed consent* form. Data collection was performed when the patient was in a stable condition to minimize the influence of acute clinical changes on the assessment.

Sleep quality was assessed using a structured sleep quality questionnaire. The questionnaire consisted of items measuring the respondents' sleep-related conditions and was completed directly by the respondents with assistance from the researcher when necessary. The questionnaire had undergone validity and reliability testing before being used for data collection. Item validity was assessed by examining the correlation between each item score and the total questionnaire score. Items were considered valid when the calculated correlation coefficient exceeded the predetermined critical value. Reliability was assessed using Cronbach's alpha to determine the internal consistency of the questionnaire, with a coefficient of ≥ 0.70 considered indicative of acceptable reliability.

Haemodynamic parameters, including blood pressure, pulse rate, and respiratory rate, were measured observationally by trained medical personnel using standard clinical equipment and according to standard measurement procedures. Blood pressure was measured using a calibrated sphygmomanometer or digital blood pressure monitor, while pulse rate and respiratory rate were assessed according to standard clinical procedures. The results of the measurements were recorded on the research data collection sheet and subsequently classified into normal and abnormal categories based on the clinical criteria specified in the study.

The use of a validated and reliable questionnaire and standardised clinical measurement procedures was intended to improve the consistency and accuracy of the collected data. Data collection was conducted under the same procedures for all respondents to minimise measurement bias and ensure comparability between participants.

Data Analysis Techniques:
All data are processed using computer statistical software. The analysis process is divided into two main stages. The first stage is univariate analysis. Univariate analysis functions to present the distribution of data on respondent characteristics and research variables in the form of frequency (n) and percentage (%). The second stage involves bivariate analysis to test the research hypothesis. This study used *the Chi-Square* () statistical test to evaluate the relationship between sleep quality and blood pressure, pulse frequency, and *respiratory rate*. The selection of *the Chi-Square* test has a strong statistical justification because all variables analyzed are categorically scaled. This study set the threshold of statistical significance at a $p<$ value of 0.05.

RESULT
This section presents the output of observational data analysis from one hundred hemodialysis patients. The researchers divided the findings into two main stages of analysis. The univariate analysis described the demographic characteristics and distribution of the respondents' clinical variables. Bivariate analysis tested the significance of the interaction between sleep quality and specific hemodynamic parameters.

Demographic and Clinical Characteristics of Patients
Table 1 presents the frequency distribution of demographic characteristics and clinical history of one hundred study respondents. The researchers detailed patient profiles based on age, gender,

education level, and employment status. This section also maps the duration of hemodialysis, the frequency of weekly therapy, comorbidities, and the type of vascular access.

Table 1.
Demographic Characteristics and Clinical Profile of Hemodialysis Patients (n = 100)

Features	Category	F	%
Gender	Male	52	52.0
	Women	48	48.0
Age	18–44 years old	30	30.0
	45–54 years old	22	22.0
	55–64 years old	48	48.0
Education	Elementary/Equivalent	23	23.0
	Junior High School/Equivalent	25	25.0
	High School/Equivalent	29	29.0
	Diploma/Bachelor's	23	23.0
Jobs	Not working	47	47.0
	Housewives	17	17.0
	Self-employed	22	22.0
	Private Employees	3	3.0
	Farmer	3	3.0
	Daily laborer	3	3.0
	PNS	5	5.0
Long Undergoing Hemodialysis	<1 year	25	25.0
	1–3 years	44	44.0
	>3 years	31	31.0
Komorbid	Hypertension	52	52.0
	Diabetes Mellitus	21	21.0
	Hypertension + Diabetes	18	18.0
	Others	9	9.0
Akses Vaskular	AV Fistula	82	82.0
	Double Lumen Catheter (DLC)	18	18.0

Statistical analysis using the Chi-Square (χ^2) test. The data are presented in n (%). P value < 0.05

Most of the respondents occupy the age group of 55 to 64 years with a proportion of 48.0%. Male patients dominated this sample by 52.0%. The highest level of education for the majority of patients is high school or equivalent, which reaches 29.0%. The group of non-working patients recorded the highest percentage of 47.0%. Analysis of hemodialysis history showed that 44.0% of patients had undergone therapy for 1 to 3 years. Hypertension is the most dominant comorbidity affecting 52.0% of patients. As many as 82.0% of patients use an *Arteriovenous Fistula* (AVF) vascular access.

Distribution of Research Variables

Table 2 describes the proportion of classification of the main variables in the sample population. Researchers categorized sleep quality status into good and bad groups. This section also divides the parameters of blood pressure, pulse, and respiratory rate into normal and abnormal states.

Table 2.
Distribution of Sleep Quality and Basic Hemodynamic Parameters of Patients (n = 100)

Variabel	f	%
Sleep Quality		
Good	42	42,0
Bad	58	58,0
Blood Pressure		
Normal	55	55,0
Abnormal	45	45,0
Nadi		
Normal	63	63,0
Abnormal	37	37,0
Breathing		
Normal	68	68,0
Abnormal	32	32,0

Statistical analysis using the Chi-Square (χ^2) test. The data is presented in n (%). P value < 0.05

Sleep quality analysis showed that 58.0% of patients experienced disruption or poor sleep quality. The first evaluation of hemodynamic parameters noted that 55.0% of respondents were able to maintain normal blood pressure. The assessment of the second indicator showed that 63.0% of respondents had a normal pulse frequency. The measurement of the third indicator proved that the majority of patients recorded a normal breathing rate with a percentage of 68.0%.

The Relationship between Sleep Quality and Blood Pressure

Table 3 presents the results of testing the bivariate hypothesis between sleep quality and blood pressure stability. The researcher applied *the Chi-Square* test to measure the significance of the interaction of the two variables. This cross-matrix shows the distribution of patients' blood pressure by sleep quality category.

Table 3.
Analysis of the Association of Sleep Quality with Blood Pressure Fluctuations

Sleep Quality	TD Normal n (%)	Abnormal TD n (%)	Total	p-value
Good	32 (76,2)	10 (23,8)	42	
Bad	23 (39,7)	35 (60,3)	58	
Total	55	45	100	<0.001

Statistical analysis using the Chi-Square (χ^2) test. The data is presented in n (%). P value < 0.05

Statistical tests proved a very strong interaction between these two variables with a p-value of less than 0.001. As many as 76.2% of patients with good sleep quality succeeded in keeping blood pressure within normal limits. In contrast, 60.3% of patients with poor sleep quality experienced blood pressure abnormalities during therapy. Sleep quality has been shown to predict blood pressure stability directly.

The Relationship between Sleep Quality and Pulse Frequency

Table 4 shows the output of statistical analysis related to the relationship between sleep quality and patient pulse frequency. The researchers evaluated the strength of associations between variables using strict significance thresholds. This data compared the proportions of normal and abnormal pulses in the two sleep quality groups.

Table 4.
Analysis of the Association of Sleep Quality with Pulse Rate

Sleep Quality	Pulse Normal n (%)	Abnormal Pulse n (%)	Total	p-value
Good	34 (81,0)	8 (19,0)	42	
Bad	29 (50,0)	29 (50,0)	58	
Total	63	37	100	0,002

Statistical analysis using the Chi-Square (χ^2) test. The data is presented in n (%). P value < 0.05

The results of data processing showed a significant statistical relationship with a p-value of 0.002. As many as 81.0% of patients with good sleep quality managed to record normal pulse frequency. Patients with poor sleep quality showed a balanced distribution between normal and abnormal pulse rates at 50.0%. Sleep disruption empirically disrupts the pulse rhythm of hemodialysis patients.

The Relationship between Sleep Quality and Breathing Rate

Table 5 outlines the empirical interaction between sleep quality and respiratory rate of hemodialysis patients. The researcher displays the cross-distribution along with the statistical probability value. The numbers in this table represent the respiratory rate as a physiological response to the patient's sleep architecture.

Table 5.
Analysis of the Association of Sleep Quality with Respiratory Rate

Sleep Quality	RR Normal n (%)	Abnormal RR n (%)	Total	p-value
Good	35 (83,3)	7 (16,7)	42	
Bad	33 (56,9)	25 (43,1)	58	

Statistical analysis using the Chi-Square (χ^2) test. The data is presented in n (%). P value < 0.05

Statistical testing yielded a p-value of 0.006, which definitively confirmed the meaningful relationship. The group of patients with good quality sleep recorded the highest percentage of normal breathing rate at 83.3%. Although 56.9% of patients with poor sleep still had normal breathing, the percentage of abnormalities in this group jumped significantly to 43.1%. This data proves that sleep quality also modulates patients' respiratory function.

DISCUSSION

This study proves that poor sleep quality predicts the absolute instability of all hemodynamic parameters in hemodialysis patients. The results of clinical measurements recorded that 58.0 percent of the sample population experienced sleep disruption. This pathological condition triggers the most dominant impact on blood pressure fluctuations in patients with a probability value of less than 0.001. Subsequent statistical testing found a significant correlation in pulse frequency with a significance level of 0.002. The analysis of the latter variable validated a strong pathological relationship between sleep architecture and changes in respiratory rate with a probability value of 0.006. These empirical findings confirm the direct influence of the patient's resting status in modulating the stability of the cardiovascular system during the dialysis machine operation.

These empirical findings confirm the pathological impact of sleep disruption on cardiovascular autonomic regulatory function. Lack of rest directly triggers sympathetic nervous system activation in hemodialysis patients. These results definitively close gaps in the previous clinical literature. Previous researchers generally partially separated the analysis of blood pressure, pulse, and respiratory rate. This study successfully proves that hemodynamic compensation failure occurs as a systemic unit due to poor sleep architecture. Our observational data specifically expand the theory of physiological stress in a population of chronic kidney failure. The old literature has focused too much on changes in intravascular fluid volume as the main cause of vital sign instability. This research proves that intrinsic neurobiological factors have a very crucial role. Chronic sympathetic activation due to poor sleep quality significantly impairs cardiovascular stabilization mechanisms during dialysis procedures.

These empirical findings confirm the pathological impact of sleep disruption on cardiovascular autonomic regulatory function. Lack of rest may contribute to sympathetic nervous system activation and impaired physiological adaptation in patients with chronic kidney disease. Recent work by Hudiyawati and colleagues has also highlighted the clinical importance of sleep-related problems and supportive nursing interventions in chronic and hemodialysis populations (Pambudiarto et al., 2024; Murwani et al., 2026).

The results of this study fundamentally expand the scope of clinical pathophysiology theory. Sleep assessment should be considered alongside other patient-centered aspects of hemodialysis care. Recent research from the Faculty of Health Sciences, Universitas Muhammadiyah Surakarta, has demonstrated the relevance of supportive nursing approaches in hemodialysis patients, including intradialytic mindfulness and self-care interventions (Murwani et al., 2026; Rosyid et al., 2025). These findings support the integration of sleep assessment and non-pharmacological supportive care into routine dialysis nursing practice.

This preventive education is independent for patients and their families to practice sleep hygiene consistently at home. National policymakers can apply comprehensive assessment instruments through the public health empowerment index to evaluate patient adaptation capacity. This integration of clinical care and community intervention directly reduces the morbidity rate of kidney failure patients.

CONCLUSION

This study concludes that sleep quality was significantly associated with haemodynamic parameters among patients undergoing maintenance haemodialysis. Participants with poor sleep quality had a higher proportion of abnormal blood pressure, pulse rate, and respiratory rate compared with those with good sleep quality. Significant associations were identified between sleep quality and blood pressure, pulse rate, and respiratory rate. These findings indicate that sleep quality is related to haemodynamic status among patients undergoing maintenance haemodialysis.

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