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Risk factors affecting the sleep quality of patients on dialysis

A single-center cross-sectional study

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Abstract

Sleep quality is among the common complication in patients on dialysis and serious affect their health and quality of life; however, other associated risk factors are unclear. This study aimed to investigate the risk factors affecting sleep quality in patients on dialysis. Data were collected from 260 patients who met the inclusion criteria at out hospital from May 2023 to October 2023. Questionnaires were completed by patients, and biochemical indicators were obtained from past medical records. Univariate and multifactor analyses were used to find factors influencing sleep quality in patients on dialysis. Simple linear regression results showed that female, type of kidney primary disease, high systolic blood pressure (SBP), pruritus, pruritus frequency, restless legs syndrome (RLS), anxiety, and depression were associated with poor sleep quality. Blood biochemical parameters showed that low sodium and calcium levels and high ferritin levels were associated with poor sleep quality. Multiple linear regression statistics showed that female, pruritus, RLS, high SBP, depression, and high ferritin levels were associated with poor sleep quality. This study showed that female, chronic nephritis syndrome, high SBP, pruritus, RLS, low mood. and high ferritin levels were associated with poor sleep quality. Future development of individual nursing and targeted therapies is key to improving sleep quality in patients on dialysis.

Abbreviations: CKD = chronic kidney disease, eGFR = estimated glomerular filtration rate, HADS = Hospital Anxiety and Depression Scale, PSQI = Pittsburgh sleep quality index, RLS = restless legs syndrome, SBP = systolic blood pressure, SD = standard deviation.

Keywords: chronic kidney disease, dialysis, pruritus, sleep quality

1. Introduction

Sleep is an important biological process that involves the voluntary suspension of bodily functions and consciousness, and is crucial for maintaining normal physiological functions in living organisms. However, poor sleep quality often occurs in patients on dialysis, leading to a significant reduction in their quality of life and overall health.[1,2] Dialysis is a vital blood purification technique used to treat advanced chronic kidney disease (CKD) and end-stage kidney disease.[3,4] As the aging population continues to increase, the number of patients on dialysis is also growing annually. Addressing sleep quality in these patients is therefore a crucial challenge for clinical care.

Previous studies have indicated that poor sleep quality is highly prevalent (11%–97.5%) in both patients on dialysis and patients with CKD. This condition is associated with poor physiological indicators, as well as depression, smoking, and arousal behavior. The question of whether dialysis improves or exacerbates poor sleep quality has been studied extensively, and evidence suggests that a switch in dialysis modality to intensive dialysis or transplantation can significantly improve sleep quality, sleep apnea, and restless legs syndrome (RLS) in patients with advanced CKD and end-stage kidney disease.[5] This suggests that poor sleep quality in patients on dialysis may be associated with kidney failure and poor sleep quality can be improved. Therefore, identifying and addressing risk factors for sleep quality in patients on dialysis can be crucial for improving their overall quality of life.

This study aims to examine the sleep quality of patients on dialysis at a single center, as well as to identify the various

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factors that influence the sleep quality. Therefore, we hope to provide the necessary insights that can inform clinical care strategies and ultimately improve the patient's overall quality of life. For this purpose, we gathered data from 260 preselected patients on dialysis and conducted both univariate and multifactor analyses to assess the various factors that impact their sleep quality.

2. Methods

2.1. Ethics

This single-center cross-sectional study was conducted with ethical consideration and did not involve any content that could be harmful to the participants. The Ethics Committee of Peking University Shenzhen Hospital reviewed all methods used in the study (No. 2023-066). In addition, all study plans and questionnaires need to be reviewed by the Clinical Research Institute of our hospital before execution to ensure the rigor and scientific validity of the study. Before participation, all participants were fully informed of the study purpose and significance; and their consent was obtained. The Strengthening the Reporting of Observational Studies in Epidemiology statement was followed in the planning, implementation, and reporting of the present work.[6]

2.2. Patients information

The study population consisted of patients on dialysis at the dialysis center of Peking University Shenzhen Hospital from May 2023 to October 2023. Inclusion criteria included regular hemodialysis and peritoneal dialysis treatment time of >3 months, age between 18 and 90 years, ability to communicate with the investigators in local language or text, and voluntarily participation in the study after signing the informed consent. Exclusion criteria included previous or current mental disorders, such as cognitive impairment, or dementia disease that prevented communication with the investigators, and acute complications within 1 month, such as heart failure and cerebrovascular accidents that prevented outpatient follow-up. Two hundred sixty study subjects were ultimately included, with 130 each in patients on peritoneal dialysis or hemodialysis.

Additional information: all patients included in this study were free from coronavirus disease 2019 infection, patients undergoing peritoneal dialysis received continuous ambulatory peritoneal dialysis during the day, personal information and lifestyle habits of the patients were obtained from medical records or self-reported by the patients themselves after providing informed consent, missing data were either excluded from the statistical analysis or included after repeated sampling, the diagnostic criteria for CKD were based on the 2022 Kidney Disease Improving Global Outcome guidelines, the classification of the primary disease was determined based on outpatient reports. If there were changes in the diagnostic criteria at the time of treatment, the corresponding data were excluded from the analysis. After the screening of all the above steps, the formal study was started. The final steps of the study are shown in Figure 1.

2.3. Blood indicators

This study involved the admission of patients in the hospital and the collection of venous blood from their elbows for testing. Routine blood index testing samples were collected using anticoagulation tubes (#101680720, EDTA-K2-2.0 mg/mL, Ivory, China), while procoagulation tubes (Separation Gel Coagulation Tube 3.5 mL, Ivory) were used to store blood samples for other assays. The collected samples were sent to the Department of Laboratory Medicine for testing. The Macon SYSMEX series hematocrit analyzer, Japan, was used to perform routine blood tests, while the Beckmann AU5800 fully automated biochemical analyzer was used for blood biochemistry. Beckmann DXI800 automatic chemiluminescence analyzer was used to determine parathyroid function based on the most recent routine monitoring record.

2.4. Sleep

The Pittsburgh sleep quality index (PSQI) was used to measure the patients' sleep.[7] This scale is reliable and valid, and the

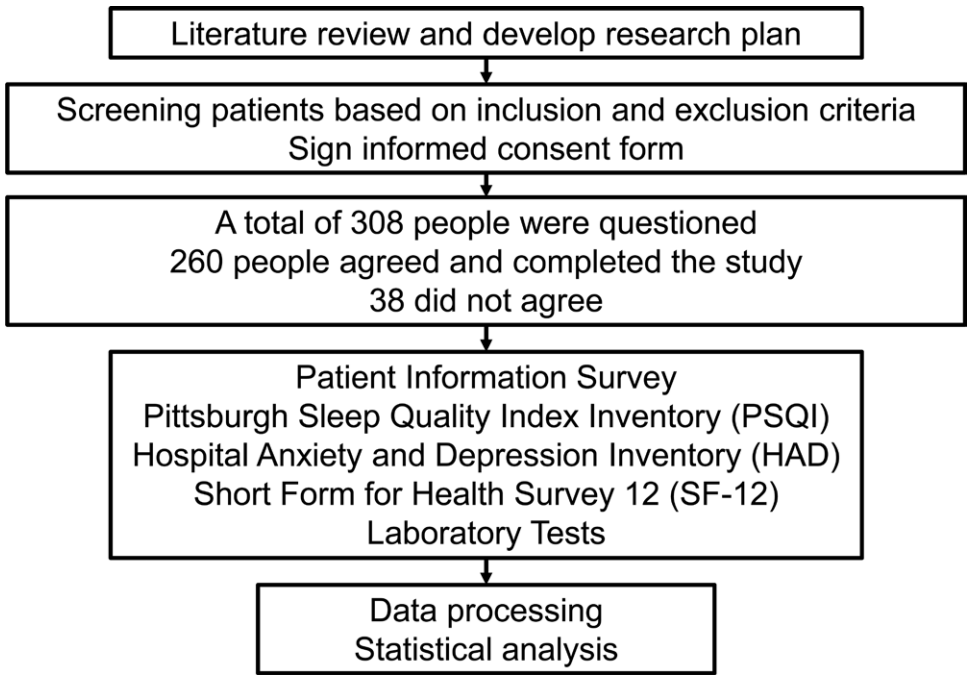

Figure 1. Schematic diagram of the research steps.

study selected the 7 factors on this PSQI scale, including subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, used sleep medication, and daytime dysfunction. Each factor is scored on a 4-point scale from 0 to 3, and the total PSQI score is the sum of each factor score. Higher total scores indicate worse sleep quality. A total PSQI score >5 is used as the threshold for abnormal sleep quality.

2.5. Lifestyle

The lifestyle habits were categorized into alcohol intake, tea and coffee consumption, and exercise. Alcohol, tea, and coffee intake were evaluated based on weekly frequency and single intake. A score of −3 was assigned for no intake, 1 for no more than once per week, 2 for 2 to 3 times per week, and 3 for 4 to 7 times per week. Additionally, alcohol, tea, and coffee were scored as 4 when intake exceeded 50, 500, and 200 mL per day, respectively. Exercise was classified as walking, jogging, fast running, swimming, and cycling. It was evaluated with a score of 0 for no exercise, 1 for once per week, 2 for 2 to 3 times per week, and 3 for 4 to 7 times per week, with a single exercise session lasting more than 20 minutes (waling should last more than 40 minutes). If the patient has never enjoyed exercise and has not exercised in the last year, mark it as a −3.

2.6. Patients' family background

The family background of patients, encompassing education, marital status, employment status, and economic circumstances, was gathered. In China, CKD is closely associated with these factors. The low-income families often experience substandard hygiene and are more susceptible to CKD resulting from infections. Furthermore, the level of education is linked to patient adherence, with those having lower adherence often failing to comply with essential care standards, leading to potential dialysis-related complications. Similarly, marital status can impact mood and consequently affect sleep quality. Therefore, these demographic factors were integrated into this study.

2.7. Anxiety and depression

Anxiety and depression can be effectively measured using the Hospital Anxiety and Depression Scale (HADS), which was developed by Zigmond et al in 1983.[8,9] The self-assessment scale is highly reliable and valid, making it a valuable tool for screening hospital patients. Comprised of 14 items, the HADS provides separate scores for anxiety (HAD-A) and depression (HAD-D), with scores ranging from 0 to 7 indicating no symptoms, 8 to 10 indicating possible symptoms, and 11 to 21 indicating definite anxiety or depression.

2.8. Health

The health status of the study participants was evaluated using the Short Form for Health Survey 12,[10] which required approximately 15 minutes to complete. To ensure uniformity, participants were given a uniform guideline and were allowed to self-assess only after fully comprehending the meaning of each entry. Each patient completed the questionnaire independently, and any omissions or logical errors were corrected upon detection. The accuracy of the completed questionnaires was verified through re-checking before retrieval.

2.9. Statistics

Statistical analysis was conducted using R Studio 4.2.2. Descriptive statistics were used to summarize the measurement data, with mean ± standard deviation reported, while frequency and composition ratios were used to describe the count data. Simple linear regression was employed to analyze the factors influencing the sleep quality of patients on dialysis. Given the small sample size, a P value ≤.05 was deemed statistically significant. Variables with P values ≤.05 from univariate analysis were further analyzed using multifactor analysis, with variable screening performed using the stepwise regression method. Ultimately, a multiple linear regression model was established to identify factors affecting the sleep quality of patients on dialysis. A difference of $P \leq .05$ was considered statistically significant.

3. Results

3.1. Univariate analysis of patients' basic conditions and sleep quality

To understand the effect of basic patient profile on sleep, 260 patients on dialysis were analyzed for age, gender, education, marital status, work status, and economic status. The results revealed that females had higher PSQI scores than males (Table 1). In addition, other factors were not associated with sleep quality.

3.2. Univariate analysis of lifestyle habits and sleep quality

To understand the effect of patients' lifestyle habits on sleep, alcohol consumption, tea and coffee consumption and exercise were analyzed. Our results showed that these factors are not related to sleep quality (Table 2).

3.3. Univariate analysis of physiological status and sleep quality

To understand the effect of patients' physiological status on sleep. The kidney primary disease, dialysis modality, pruritic skin, blood pressure and pulse were analyzed and correlate with the sleep quality. The results showed that the patients' kidney primary disease, systolic blood pressure, presence of pruritus in the last month, frequency of pruritus, and RLS may affect sleep quality (Table 3). Interestingly, the PSQI scores varied among different types of kidney diseases. Lupus nephritis and diabetic nephropathy exhibiting the highest PSQI scores.

3.4. Univariate analysis of mood and sleep quality

To understand the effect of patients' mood on sleep, their anxiety and depression status was assessed. After grouping by scoring criteria, the results showed that emotional anxiety or depression was positively associated with sleep disorders (Table 4).

3.5. Univariate analysis of blood biochemical indicators and sleep quality

To understand the effect of blood biochemical indicators on sleep, the results of the patients' examinations during the last three months were retrieved and analyzed. The results showed that patients with poor sleep quality had low levels of sodium and calcium and high levels of ferritin in their blood biochemistry (Table 5).

3.6. Multifactor analysis of sleep quality affecting patients on dialysis

Based on the univariate results, a multiple linear regression model was constructed incorporating 15 statistically significant variables. The model was refined using the Akaike information criterion and stepwise regression for variable selection, ultimately including seven variables. Age was included as a

Table 1

Univariate analysis of patients' basic conditions and sleep quality.

Influence factor	$\bar{x}$ (SD)/n (%)	PSQI score (SD)	*F*	*P*
Age (yr)	51.49 (13.14)	7.57 (3.92)	3.280	.0713
Gender			9.464	.0023*
Male	151 (58.1)	6.95 (3.63)		
Female	109 (41.9)	8.44 (4.16)		
Education			1.702	.1208
Junior high school and below	103 (39.6)	7.92 (4.08)		
High school/junior college	77 (29.6)	7.75 (3.86)		
College and above	80 (30.8)	6.95 (3.76)		
Marital status			1.847	.1390
Unmarried	16 (6.2)	6.06 (3.40)		
Married	229 (88.1)	7.67 (3.98)		
Divorced	10 (3.8)	8.90 (3.31)		
Widowed	5 (1.9)	5.20 (2.49)		
Working condition			1.255	.2882
Full-time	53 (20.4)	6.70 (3.15)		
Half position	44 (16.9)	7.36 (3.69)		
Retire	83 (31.9)	8.22 (4.35)		
Retirement of cadre	20 (7.7)	7.65 (3.56)		
Unemployed	60 (23.1)	7.58 (4.16)		
Economic situation			1.012	.3878
1000–3000 CNY	99 (38.1)	7.73 (4.45)		
3000–5000 CNY	78 (30.0)	7.76 (3.68)		
5000–10,000 CNY	54 (20.7)	7.67 (3.54)		
>10,000 CNY	29 (11.2)	6.38 (3.24)		

*$P \leq .05$ is considered statistically significant. CNY is an abbreviation for Renminbi, a Chinese monetary unit.
PSQI = Pittsburgh sleep quality index, SD = standard deviation.

Table 2

Univariate analysis of lifestyle habits and sleep quality.

Influence factor	$\bar{x}$ (SD)/n (%)	PSQI score (SD)	*F*	*P*
Alcohol			3.577	.0597
Yes	3 (1.2)	3.33 (3.06)		
No	257 (98.8)	7.62 (3.91)		
Tea			0.283	.5954
Yes	102 (39.2)	7.41 (3.92)		
No	158 (60.8)	7.68 (3.93)		
Coffee			0.260	.6104
Yes	23 (8.8)	7.17 (3.33)		
No	237 (91.2)	7.61 (3.98)		
Exercise			0.506	.4775
Yes	202 (77.7)	7.48 (3.85)		
No	58 (22.3)	7.90 (4.19)		

$P \leq .05$ is considered statistically significant.
PSQI = Pittsburgh sleep quality index, SD = standard deviation.

correction factor, and patients were categorized by depression score and age. Continuous variables, such as SBP and serum ferritin levels were also included in the equation. The *F* test demonstrated that the model was statistically significant ($F = 6.871$, $P < .001$). The final analysis results are presented in Table 6. The findings suggest that female patients were more likely to experience poor sleep quality compared to males. Other factors, such as pruritus in the last month, RLS, and high SBP, were also associated with poor sleep quality. Notably, depression and poor sleep quality were positively correlated, and high ferritin levels were also found to be linked with poor sleep quality.

4. Discussion

Improving the sleep quality of patients on dialysis is a crucial aspect in clinical care; and to identify the relevant factors that affect it may greatly improve our nursing care and interventions. This study has revealed several significant findings, including the fact that kidney primary disease, high SBP, pruritus, RLS, high ferritin levels, anxiety, and depression are strong predictors of poor sleep quality in patients on dialysis (Fig. 2). Furthermore, women have higher odds of developing the poor sleep quality. Hence, these findings provide valuable insights that can inform targeted treatments to enhance the sleep quality of patients on dialysis.

The key finding of this study is that the correlation between different types of kidney disease and sleep quality varies. Specifically, chronic nephritis syndrome had the highest incidence of comorbid poor sleep quality, while patients with lupus nephritis and diabetic nephropathy were more prone to falciparous poor sleep quality. Despite the prevalence of sleep quality in patients with nephropathy, few studies focus on a single nephropathy type and its subtypes. For instance, 1 case report showed a patient with IgA nephropathy with obstructive sleep apnea,[11] while a survey of pediatric patients with nephrotic syndrome found that they commonly experienced sleep disturbances and depression.[12] Although studies have examined the association between the type of nephropathy and depressed mood; fewer studies have explored the relationship between nephropathy and sleep quality. It is worth noting that depressed mood is a manifestation of neurological dysfunction in the brain, which suggests that both types of kidney disease can impact neurological function. Hence, we think that CKD is closely linked to sleep quality, and further research is needed to investigate the effect of different types of kidney diseases on sleep quality.

In addition, gender also has a role in sleep quality, with a higher proportion of men being affected, while women had poor quality of sleep. This may be due to the fact that men are more susceptible to developing kidney and cardiovascular diseases, resulting in more male patients.[13] Our findings are in consistent with a meta-analysis of sleep, which shows that women are at a greater risk of developing poor sleep quality than men,[14] potentially due to hormonal levels.

Moreover, our observations indicate a strong correlation between poor sleep quality and SBP. Previous research has demonstrated the prevalence of poor sleep quality in various

Table 3

Univariate analysis of physiological status and sleep quality.

Influence factor	$\bar{x}$ (SD)/n (%)	PSQI score (SD)	F	P
Kidney primary disease			1.837	.0305*
Chronic nephritis syndrome	139 (53.5)	7.46 (3.72)		
Diabetes nephropathy	41 (15.8)	9.05 (4.42)		
Hypertensive nephropathy	34 (13.1)	6.56 (3.29)		
Nephrotic syndrome	20 (7.7)	7.05 (4.20)		
Polycystic kidney	8 (3.1)	5.75 (3.49)		
Obstructive nephropathy	6 (2.3)	8.17 (3.49)		
Lupus nephritis	3 (1.2)	11.67 (5.13)		
Others	9 (3.5)			
Dialysis method			0.599	.4398
Peritoneal dialysis	130 (50.0)	7.38 (3.55)		
Hemodialysis	130 (50.0)	7.76 (4.27)		
Skin itch			7.489	.0066*
Yes	149 (57.3)	8.14 (3.81)		
No	111 (42.7)	6.81 (3.96)		
The frequency of itching			3.712	.0059*
Frequent (almost daily)	29 (19.9)	9.59 (3.64)		
Frequent (≥ 3 times/wk)	42 (28.8)	8.40 (3.86)		
Occasionally (1–2 times/wk)	71 (48.6)	7.45 (3.67)		
Rarely	4 (2.7)	8.5 (5.92)		
Restless leg syndrome			9.577	.0022*
Yes	78 (30.0)	8.71 (4.33)		
No	182 (70.0)	7.09 (3.64)		
Systolic blood pressure (mm Hg)	138.68 (18.2)	7.57 (3.92)	8.598	.0037*
Diastolic blood pressure (mm Hg)	83.04 (11.6)	7.57 (3.92)	0.719	.3974
Pulse (times/min)	75.02 (9.6)	7.57 (3.92)	0.249	.6182

*$P \leq .05$ is considered statistically significant.

PSQI = Pittsburgh sleep quality index, SD = standard deviation.

Table 4

Univariate analysis of mood and sleep quality.

Influence factor	$\bar{x}$ (SD)/n (%)	PSQI score (SD)	F	P
Anxiety score			7.669	.0006*
Asymptomatic	220 (84.6)	7.19 (3.76)		
Suspicious symptoms	29 (11.2)	9.38 (3.92)		
Definitely exists	11 (4.2)	10.55 (4.91)		
Depression score			7.489	.0007*
Asymptomatic	206 (79.2)	7.18 (3.65)		
Suspicious symptoms	32 (12.3)	8.16 (4.21)		
Definitely exists	22 (8.5)	10.41 (4.81)		

*$P \leq .05$ is considered statistically significant.

PSQI = Pittsburgh sleep quality index, SD = standard deviation.

forms of hypertension, including idiopathic intracranial hypertension, metabolic syndrome-associated hypertension, and aldosterone-induced hypertension.[15–18] However, the causality between hypertension and poor sleep quality remains unclear, and further interventional studies may be required to elucidate this relationship.

There is a strong correlation between poor sleep quality and pruritus and RLS. These conditions are linked to the central nervous system and can cause significant discomfort, often prompting patients to constantly move or walk around, resulting in poor sleep quality.[19,20] Numerous studies have reported similar findings.[21–25] Additionally, it has been noted that if RLS is left untreated, it may lead to more serious central nervous disorders such as Alzheimer disease.[26] Due to the diverse etiology of these disorders, treatment must be tailored to each individual case.

It is widely acknowledged that depression can lead to poor sleep quality. In fact, a meta-analysis revealed that poor sleep quality is associated with an increased risk of all-cause dementia, Alzheimer syndrome, and vascular dementia.[27] The subtype analysis of poor sleep quality further revealed that insomnia increases the likelihood of Alzheimer syndrome, while sleep breathing disorders are linked to all-cause dementia, Alzheimer syndrome, and vascular dementia. These findings suggest a strong correlation between poor sleep quality and central nervous system disorders. Similarly, our study found a close relationship between anxiety, depression, and poor sleep quality, though the exact cause and effect remains unknown. These conditions may exacerbate each other, making it all the more important to prioritize improving sleep quality as a means of calming patients and preventing central nervous system dysfunction.

An intriguing finding was revealed through the examination of blood biochemical markers, indicating that individuals with lower levels of sodium and calcium in their blood were more likely to experience poor sleep quality. These essential ions play a crucial role in maintaining proper fluid-electrolyte balance and regulating neural activity.[28–31] CKD patients typically exhibit decreased levels of these ions, which could ultimately lead to central or peripheral nerve dysfunction, including poor sleep quality and RLS. Appropriate electrolyte supplementation may be an easy and effective solution for improving poor sleep quality.

Furthermore, patients may experience poor sleep quality due to elevated levels of serum ferritin. The kidneys normally produce erythropoietin, a hormone that stimulates the production of red blood cells containing iron ions. In healthy individuals, excess iron ions are filtered and excreted by the kidneys to prevent accumulation in the body. However, CKD patients may experience impaired iron homeostasis regulation, leading to excess iron ions and elevated ferritin levels. Ferritin is a protein that stores iron, and high levels in the blood may indicate an excess of iron in the body. This phenomenon is known as functional iron deficiency.[32] Moreover, it can also be caused by chronic inflammation common in CKD.[33] Inflammatory cytokines can stimulate ferritin synthesis and lead to elevated levels even in the absence of iron ion overload. Recent studies have linked CKD-related RLS to age, gender, iron ions, ferritin,

lipids, electrolytes, and parathyroid hormone abnormalities.[34] Another study found that ferritin levels were proportional to the severity of obstructive sleep apnea.[35] All of the results suggesting that high ferritin levels may trigger RLS and poor sleep quality by causing neurological dysfunction.

As the CKD progresses, patients may develop hypocalcemia, hyperphosphatemia, and a decrease in vitamin D3, leading to secondary hyperparathyroidism.[36] This condition may result in a range of physiological and pathological changes, including disruptions in bone metabolism, skin and soft tissue calcification, pruritus, and lipid metabolism disorders.[37] Consequently, patients with severe hyperparathyroidism may necessitate surgical intervention to reduce parathyroid hormone levels.[38] Furthermore, previous studies have indicated an association between hyperparathyroidism and cognitive impairment,[39,40] prompting relevant tests in this study. However, no significant difference was observed. Our result is also consistent with their results that parathyroidectomy may reduce parathyroid levels and improve cognition, but may not improve poor sleep quality in patients with hyperparathyroidism.[39]

Many of the discussed risk factors can be mitigated through simple interventions. For instance, hemodialysis can improve their sleep quality by limiting their dietary fiber intake.[41] Additionally, melatonin supplementation has been shown to significantly improve poor sleep quality, depression, anxiety, and overall quality of life in hemodialysis.[42] Patients undergoing peritoneal dialysis have also benefited from video-based exercise interventions, which have been found to enhance sleep quality and reduce depression.[43] These findings suggest that interventions such as pharmacological treatment, nutrition, hormone modulation, and exercise can effectively enhance the quality of life of patients on dialysis.[44]

While this study was focused on sleep quality in patients on dialysis, but there are some limitations that need to be addressed. Firstly, the underlying mechanism of poor sleep quality in these patients remains unclear. Although various factors have been identified as contributing factors, such as age, gender, psychological factors, comorbidities, and dialysis treatment modality; there is still no consensus on the impact of dialysis adequacy and scheduling. Other factors such as obesity, recent dry weight changes, and blood pressure changes in dialysis require further investigation. Secondly, this study was conducted at a single location and focused primarily on demographic data, dialysis-related factors, and biochemical indicators, with less attention paid to psychological status, comorbidities, and lifestyle. Thirdly, the prevalence of poor sleep quality in patients on dialysis varies widely across different regions, which may be attributed to differences in study instruments, ethnicity, and cultural factors. Therefore, further research is needed to explore the prevalence and influencing factors of poor sleep quality in maintenance hemodialysis in different regions. Fourthly, gender differences in sleep quality have not been analyzed in this study. Lastly, the neurological effects of different kidney primary conditions require further investigation.

Table 5

Univariate analysis of blood biochemical indicators and sleep quality.

Indicators	$\bar{x}$ (SD)/n (%)	*F*	*P*
Uric acid (mmol/L)	138.68 (18.2)	0.185	.6675
Urea (mmol/L)	21.23 (6.74)	0.717	.3981
Creatinine (μmol/L)	1070.04 (289.96)	0.741	.3903
eGFR (mL/min/1.73 m^2)	4.44 (1.68)	0.277	.5990
Total protein (g/L)	66.31 (6.71)	0.026	.08723
Albumin (g/L)	36.57 (4.75)	0.583	.4459
Pre-albumin (g/L)	303.52 (75.53)	0.254	.6150
Phosphorus (mmol/L)	1.90 (0.55)	0.921	.3380
Potassium (mmol/L)	4.28 (0.78)	0.500	.4801
Sodium (mmol/L)	139.40 (2.80)	7.350	.0072*
Chlorine (mmol/L)	98.29 (3.73)	3.735	.0544
Calcium (mmol/L)	2.23 (0.21)	4.367	.0376*
β 2-Microglobulin	34.63 (30.36)	0.417	.5192
Parathyroid hormone (pg/mL)	52.01 (58.94)	0.555	.4570
Adequacy of dialysis (Kt/v)	1.57 (0.35)	0.396	.5296
Ferritin (ng/mL)	215.37(195.57)	9.862	.0019*
Hemoglobin (g/L)	113.38 (16.23)	1.842	.1759

*$P \leq .05$ is considered statistically significant.

eGFR = estimated glomerular filtration rate, SD = standard deviation.

Table 6

Multiple linear regression analysis of factors affecting sleep quality.

Variable factor	β	SE	*t*	Confidence interval (95% CI)	*P*
Gender					
Male					
Female	1.184	0.447	2.651	(0.304–2.064)	.0085**
Age group					
≤30					
31–50	−2.285	1.807	−1.264	(−5.845 to 1.275)	.2073
51–70	−0.676	1.869	−0.362	(−4.357 to 3.004)	.7178
71–90	−2.137	1.991	−1.073	(−6.059 to 1.784)	.2841
Skin itching (in 1 mo)					
No					
Yes	1.569	0.442	3.553	(0.699–2.439)	.0005***
Restless leg syndrome					
No					
Yes	1.07	0.479	2.227	(0.123–2.010)	.0269*
Systolic blood pressure	0.035	0.0121	2.850	(0.011–0.059)	.0047**
Depression score					
Asymptomatic					
Suspicious symptoms	1.093	0.669	1.633	(−0.225 to 2.412)	.1037
Definitely exists	2.897	0.792	3.660	(1.338–4.457)	.0003***
Ferritin (ng/mL)	0.003	0.001	3.060	(0.001–0.006)	.0025**

$P \leq .05$ is considered statistically significant.

SE = standard error.

*$P \leq .05$;

**$P \leq .01$;

***$P \leq .001$.

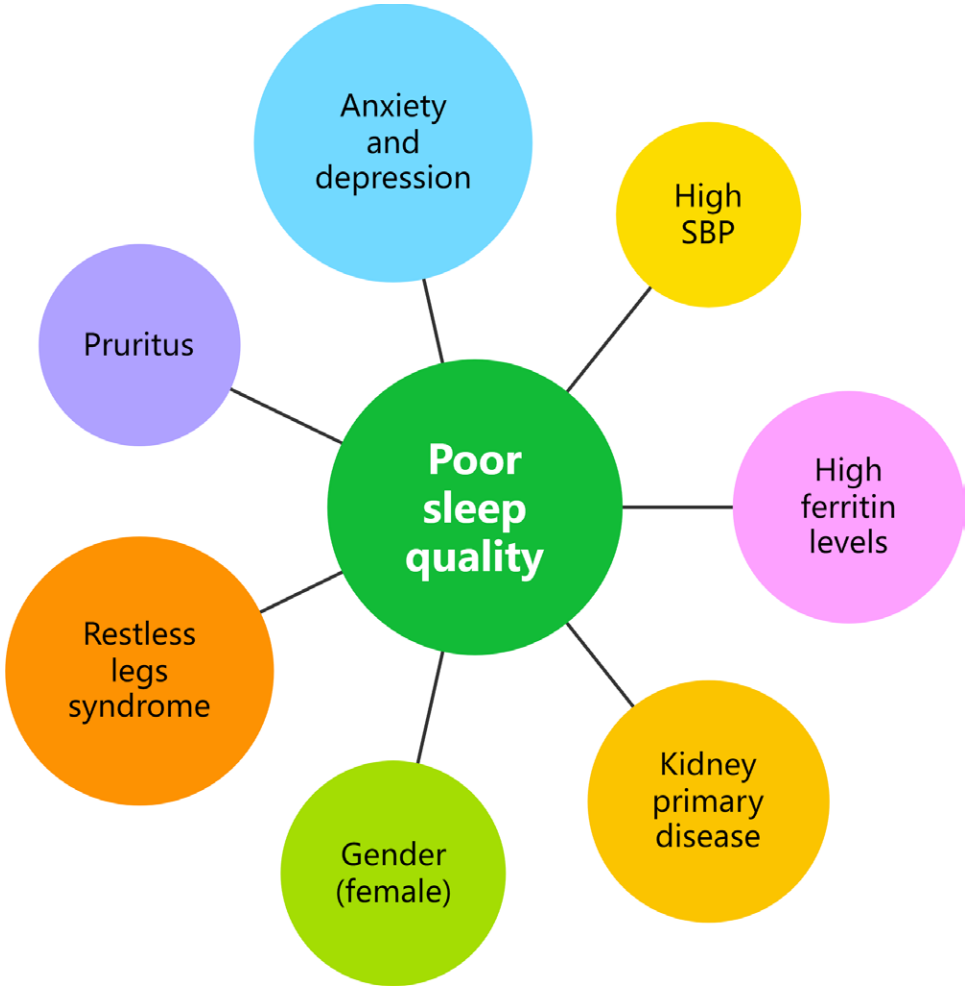

Figure 2. Schematic diagram of the high-risk factors for developing poor sleep quality in CKD patients. CKD = chronic kidney disease, SBP = systolic blood pressure.

5. Conclusions

In conclusion, this study has identified several high-risk factors for poor sleep quality in patients on dialysis, including having a certain type of kidney primary disease, high SBP, pruritus, RLS, low mood, and high ferritin levels. Additionally, female patients appear to have a higher likelihood of experiencing poor sleep quality compared to males. Moving forward, it is imperative that further research is conducted to develop targeted treatments and personalized care aimed at improving the quality of sleep for patients on dialysis.

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