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ORIGINAL RESEARCH

Distinct Sleep Quality Profiles and Their Varying Levels of Stigma Among Patients Undergoing Maintenance Hemodialysis: A Cross-Sectional Study

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Objective: To identify distinct sleep quality profiles among patients undergoing maintenance hemodialysis (MHD) using latent profile analysis (LPA), and examine differences in perceived stigma across these sleep quality subtypes.

Methods: From December 2024 to March 2025, a total of 334 MHD patients were recruited via convenience sampling from the nephrology departments of two tertiary hospitals in Xinjiang, China. Data were collected using structured questionnaires, including the Pittsburgh Sleep Quality Index (PSQI), the Self-Rating Depression Scale (SDS), and the Social Impact Scale (SIS), along with sociodemographic and clinical information. LPA was employed to identify latent subgroups of sleep quality based on PSQI components. Multinomial logistic regression was used to determine predictors of sleep profile membership. Differences in stigma scores across sleep profiles were analyzed using non-parametric equivalents.

Results: Three distinct sleep profiles were identified: Class 1 – "overall better sleep", Class 2 – "short sleep duration and low efficiency", and Class 3 – "poor sleep quality with high medication use". Multinomial logistic regression identified comorbid heart failure (OR=2.867, P=0.001 for Class 2), pruritus (OR=2.715, P<0.001 for Class 2), depressive symptoms (OR=2.568, P=0.001 for Class 2; OR=4.823, P<0.001 for Class 3), and elevated C-reactive protein (OR=1.044, P<0.001 for Class 2; OR=1.035, P=0.008 for Class 3) as significant predictors of poorer sleep profiles. Stigma scores differed significantly across all sleep profiles (Class 1 vs 2: P=0.039; Class 1 vs 3: P<0.001; Class 2 vs 3: P=0.005), with Class 3 exhibiting the highest median SIS score.

Conclusion: Patients with MHD exhibit heterogeneous patterns of sleep disturbance, which are associated with varying levels of perceived stigma. Those with the poorest sleep quality and highest reliance on medication experience the most pronounced stigma. Tailored interventions addressing sleep-related issues and psychosocial factors may help reduce stigma and improve patient well-being.

Keywords: maintenance hemodialysis, sleep quality, stigma, latent profile analysis, depression, cross-sectional study

Introduction

Chronic kidney disease (CKD), characterized by persistent renal impairment lasting over three months, is a growing global health concern. The 2020 United States Renal Data System Annual Data Report[1] revealed a persistent rise in end-stage renal disease (ESRD) prevalence, with approximately 550,000 documented cases in the United States by the end of 2018. For the majority of ESRD patients, maintenance hemodialysis (MHD) is the primary life-sustaining treatment, chosen by 86.9% of such patients in the US[2] and up to 92% in China.[3]

Sleep disorders are highly prevalent among MHD patients,[4] clinically manifesting as abnormalities in sleep quality/quantity or aberrant nocturnal behaviors.[5] Epidemiological studies demonstrate striking prevalence rates of 40–85% in this cohort.[6,7] Through polysomnographic analysis, Ezza[8] identified significant sleep impairments in MHD patients compared to healthy controls, including reduced total sleep time, prolonged sleep latency, decreased sleep efficiency, frequent periodic limb movements, and increased nocturnal awakenings. Sleep disorders have been demonstrated to be closely associated with elevated cardiometabolic risk,[9] accelerated disease progression,[10] and impaired quality of life and survival.

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Psychological factors are well-established determinants of sleep quality across diverse patient populations, where excessive mental stress predicts poorer sleep outcomes.[11] A Lasso-Nomogram predictive model developed for MHD patients indicates that depressive mood exacerbates psychological distress, thereby further impairing sleep quality.[12]

Stigma, a psychological process involving self-stigmatization and internalization of social discrimination,[13] is commonly experienced by MHD patients. These individuals face not only the irreversible nature of their condition (requiring lifelong dialysis), but also visible treatment-related effects such as skin hyperpigmentation and ammoniacal breath odor.[14] Such traits often lead to social rejection in daily interactions, which compounds psychological distress and intensifies stigma. Qualitative research by Manookian[15] illustrated that ESRD patients frequently encounter stigmatizing behaviors, including verbal aggression and exclusion from social activities like shared meals. Zhang reported moderate stigma levels among young and middle-aged MHD patients,[16] which was consistent with the findings of a previous study.[17] Beyond ESRD, stigma has been linked to broader health outcomes. For example, research[18] among HIV patients indicates that stigma may contribute to loneliness and depression, which in turn correlate with poor sleep quality and daytime dysfunction. A systematic review also confirms an association between stigma and insufficient sleep.[19]

Latent profile analysis (LPA) is a person-centered method that identifies distinct subpopulations within heterogeneous data. Although sleep quality heterogeneity in MHD patients has been well-documented,[20,21] the determinants of these latent classes, particularly the role of biochemical markers, remain poorly understood. To address this, this study incorporated biochemical indicators associated with sleep disorders alongside questionnaire-based assessments of sleep disorders. This approach aims to validate the biological plausibility of distinct sleep quality categories identified through LPA at a physiological level, thereby enhancing the scientific rigor of the classification. Furthermore, it remains unclear whether different sleep disorder categories are associated with varying levels of stigma. Therefore, our research tackles this limitation by applying LPA to a unique combination of biochemical and clinical data. Simultaneously, it definitively links these specific profiles to differing levels of stigma, offering a novel perspective on their interrelatedness.

This study aimed to explore three principal hypotheses: (1) Potential sleep quality classes exist in MHD patients, demonstrating novel patterns compared to prior classifications; (2) The latent classes are significantly predicted by both baseline characteristics and biochemical markers; (3) Patients in different sleep quality categories showed significant differences in stigma levels. The main objective of this study was to identify the latent classes and predictors of sleep quality in MHD patients and analyze stigma manifestations across classes. These findings will inform the development of stratified sleep management protocols and stigma-reduction strategies, ultimately aiming to enhance quality of life and clinical outcomes in MHD populations.

Methods

Study Design

A descriptive cross-sectional design was adopted.

Participants

From December 2024 to March 2025, we recruited 350 hemodialysis patients through convenience sampling at two tertiary hospitals in Xinjiang, China. Inclusion Criteria: (1) Be aged ≥18 years; (2) Have undergone MHD for >3 months; (3) Medically stable with stable vital signs, and sufficiently alert and communicative; (4) Provide informed consent and voluntary participation. Exclusion criteria: (1) Diagnosed cognitive impairment or psychiatric disorders; (2) Comorbidities involving multiorgan failure, severe infections, or acute systemic illnesses.

Sample Size

A convenience sampling method was employed for participant recruitment. The sample size was calculated using the formula for estimating a population mean with a specified margin of error: $n = (u_{\alpha/2})^2 \cdot \sigma^2/\delta^2$. Where $u_{\alpha/2} = 1.96$ (corresponding to a 95% confidence level), $\sigma = 3.4$ (the standard deviation of the primary sleep disorder score from

a previous study[22]), and δ=0.5 (the desired margin of error). This calculation yielded a minimum required sample size of 178 participants. Accounting for a 20% attrition rate, the target sample size was adjusted to 200.

Furthermore, to ensure sufficient statistical power for the multivariate analyses, we adhered to the rule of 5–10 participants per predictor variable.[23] This study included a total of 39 independent variables. Considering a 20% attrition rate, the minimum sample size required was 244–488 cases.

A total of 350 questionnaires were distributed. After excluding 16 invalid responses, 334 valid questionnaires were included, yielding an effective recovery rate of 95.4%, meeting all sample size criteria.

Measures

Socio-Demographic Information

Includes gender, age, ethnicity, employment status, marital status, Place of residence, education level, dialysis vintage, regular exercise, whether smoking and drinking, comorbid conditions, and so on.

Biochemical Indicator Data

Includes Hemoglobin, C-reactive protein, Serum calcium, Serum phosphate, B-type natriuretic peptide, Parathyroid hormone, 25-Hydroxyvitamin D, Blood urea nitrogen, Creatinine, and Uric acid.

Self-Rating Depression Scale (SDS)

SDS was developed by Zung,[24] is a unidimensional psychometric instrument containing 20 items rated on a 4-point Likert scale (1="never" to 4="always"). Standardized scores are derived by multiplying raw total scores by 1.25, with elevated scores indicating increased depressive severity, where clinical thresholds classify ≤53 as normal, 53–62 as mild depression, 63–72 as moderate depression, and ≥72 as severe depression. Therefore, SDS scores ≤53 indicate the absence of depression, and scores>53 indicate the presence of depression. In this study, the Cronbach's α was 0.903. The SDS was employed specifically to examine whether depressive status influences classification into sleep disorder categories. The dichotomization enhanced clinical applicability by facilitating the identification of sleep subgroups that may require prioritized depression screening.

The Pittsburgh Sleep Quality Index (PSQI)

PSQI was developed by Buysse,[25] is a validated psychometric instrument containing 18 items in 7 dimensions (subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, daytime dysfunction, and use of sleep medication). Each dimension is scored on a scale of 0–3, with total scores ranging from 0 to 21. Elevated total scores indicate poorer sleep quality, with a clinically validated cutoff score>7 distinguishing individuals with sleep disorders.[26] In this study, the Cronbach's α was 0.839.

Social Impact Scale (SIS)

SIS was developed by Wright and Fife[27] and translated into Chinese by Taiwanese scholars PAN[28] in 2007. Currently, the scale has been utilized in the study of stigma in MHD patients.[29] The scale contains 24 items in 4 dimensions (social rejection, economic hardship, internalized shame, and social isolation). The scale uses a 4-point Likert rating system, with scores from 1 to 4 for "strongly disagree" to "strongly agree", with a total score of 24 to 96. In this study, the Cronbach's α was 0.810. This study used the SIS to determine whether sleep disorder categories are associated with different levels of stigma. Analyzing SIS scores as a continuous variable allowed for comparison of overall stigma severity and identification of differing specific dimensions across these categories, highlighting key aspects of psychosocial heterogeneity in MHD patients.

Data Collection

Participants were recruited from the nephrology departments of two medical centers. Potential participants were pre-screened against the inclusion and exclusion criteria using the electronic medical record system. Eligible patients were approached, and the study's purpose, procedures, and significance were explained in detail. Written informed consent was obtained before any data collection. To ensure questionnaire quality and validity, distribution was deliberately avoided immediately following dialysis sessions to minimize fatigue-related impacts. All questionnaires were anonymous

and paper-based. Each participant's questionnaire session was designed to be completed within 30 minutes. For participants unable to complete the questionnaire independently, trained researchers administered the survey by verbally reading each question and recording responses. Upon collection, all questionnaires were immediately checked for completeness. Concurrently, relevant supplementary biochemical data for the corresponding period were extracted from the EMR system. The questionnaire data and clinical biochemical data were then linked and integrated to form the final analysis dataset.

Statistical Analysis

LPA was conducted in Mplus 8.3 to identify heterogeneous subgroups based on the 7-dimensional PSQI profile, with model selection guided by a comprehensive evaluation framework incorporating the Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and sample-adjusted BIC (aBIC), where lower values indicated superior model parsimony. Classification accuracy was quantified through entropy values, where values approaching 1 indicate higher classification precision in the latent profile model. Model selection was performed using the Lo-Mendell-Rubin adjusted likelihood ratio test (LMR) and bootstrap likelihood ratio test (BLRT), with statistical significance ($P<0.05$) indicating that the K-class model provided a superior fit compared to the (K-1)-class model. Following identification of the optimal latent profile model, the derived latent class variable was exported to SPSS (version 23.0) for subsequent analyses. Categorical variables were expressed as frequencies and percentages, while continuous variables were expressed as medians and quartiles (M [P25, P75]). Comparisons between multiple groups were analyzed using the chi-square test and the Kruskal–Wallis test. Multivariable analysis employed multinomial logistic regression to identify factors associated with sleep quality. $P<0.05$ indicates statistical significance.

Patient and Public Involvement

This study did not involve patients or the public in its design, conduct, reporting or dissemination plans.

Results

Socio-Demographic Information and Sleep Quality Status of MHD Patients

A total of 350 patients with MHD participated. After excluding 16 questionnaires with either >20% missing data or patterned responses, 334 valid questionnaires were retained for analysis. The final sample comprised 229 males (68.56%) and 105 females (31.44%), with age distribution predominating in the 45–60 year range. A large proportion of the participants were unemployed (77.75%). Among the respondents, 64.07% (n=214) had sleep disorders. Detailed demographic and clinical information is presented in Table 1.

LPA of Sleep Quality in MHD Patients

Based on the LPA of the 7 dimensions of PSQI in MHD patients, the fit metrics of the models of 1-class to 5-class were compared. The 3-class model was identified as the best model, as shown in Table 2. As the number of latent profiles increased, AIC, BIC, and aBIC exhibited a significant decreasing trend, with the highest decreases in AIC and BIC for the 2-class to 3-class models, suggesting a significant improvement in model fit. The Entropy value of the 3-class model reached 0.986, demonstrating superior classification accuracy compared to the 2-class model, and both LMR and BLRT P-values were < 0.05. However, when the model was extended to 4-class and 5-class, LMR values were > 0.05. Therefore, the three latent profiles identified were:

Class 1: the overall better sleep group

This category includes 159 patients (47.6% of the sample). These patients had the lowest scores on all dimensions and relatively better sleep quality.

Class 2: the insufficient sleep duration-low sleep efficiency group

This category includes 134 patients (40.1% of the sample). These patients scored high on both the sleep duration and sleep efficacy.

Class 3: the poor subjective sleep quality-high medication use group

Table 1 Univariate Analysis of Latent Categories of Sleep Quality in Patients on MHD (n=334)

Items	Class 1 (159)	Class 2 (134)	Class 3 (41)	*X2/H*	*P*	Total (334)
Dialysis vintage [month, n (%)]				6.535	**0.038***	
<60	138(86.79)	119(88.81)	30(73.17)			287(85.93)
≥60	21(13.21)	15(11.19)	11(26.83)			47(14.07)
Sex [n (%)]				4.645	0.098	
Male	118(74.21)	86(67.18)	25(60.98)			229(68.56)
Female	41(25.79)	48(35.82)	16(39.02)			105(31.44)
Age [year, n (%)]				15.308	**0.004****	
≥18~45	60(37.74)	25(18.66)	8(19.51)			93(27.84)
≥45~60	52(32.70)	55(41.04)	15(36.59)			122(36.53)
≥60	47(29.56)	54(42.30)	18(43.90)			119(35.63)
Place of residence [n (%)]				7.568	**0.023***	
Rural areas	68(42.77)	43(32.09)	9(21.95)			120(35.93)
Urban areas	91(57.23)	91(67.91)	32(78.05)			214(64.07)
Education level [n (%)]				3.474	0.901	
No formal schooling	6(3.77)	8(5.97)	1(2.44)			15(4.49)
Primary School	36(22.64)	34(25.37)	9(21.95)			79(23.65)
Middle School	45(28.30)	43(32.09)	12(29.27)			100(29.94)
High School	36(22.64)	25(18.66)	9(21.95)			70(20.96)
College diploma or higher	36(22.64)	24(17.91)	10(24.39)			70(20.96)
Marital status [n (%)]				8.924	0.148	
Single	17(10.69)	7(5.22)	2(4.88)			26(7.78)
Married	133(83.65)	112(83.58)	35(85.37)			280(83.83)
Divorced	2(1.26)	6(4.48)	3(7.32)			11(3.29)
Widowed	7(4.40)	9(6.72)	1(2.44)			17(5.09)
Employment status [n (%)]				4.977	0.083	
Unemployed	113(71.07)	110(82.09)	30(73.17)			253(75.75)
Employed	46(28.93)	24(17.91)	11(26.83)			81(24.25)
Monthly household incomeper capita [RMB, n (%)]				6.163	0.405	
≤1000	37(23.27)	33(24.63)	4(9.76)			74(22.16)
>1000~3000	42(26.42)	40(29.85)	15(36.59)			97(29.04)
≥3000~5000	46(28.93)	38(28.36)	11(26.83)			95(28.44)
≥5000	34(21.38)	23(17.16)	11(26.83)			68(20.36)
Smoking [n (%)]				1.167	0.558	
Yes	30(18.87)	26(19.40)	5(12.20)			61(18.26)
No	129(81.13)	108(80.60)	36(87.80)			273(81.74)
Alcohol drinking [n (%)]				1.621	0.445	
Yes	14(8.81)	11(8.21)	6(14.63)			31(9.28)
No	145(91.19)	123(91.79)	35(85.37)			303(90.72)

(*Continued*)

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Table 1 (Continued).

Items	Class 1 (159)	Class 2 (134)	Class 3 (41)	*X2/H*	*P*	Total (334)
Drink tea/coffee [n (%)]				0.746	0.689	
Yes	41(25.79)	39(29.10)	13(31.71)			93(27.84)
No	118(74.21)	95(70.90)	28(68.29)			241(72.16)
Regular exercise [n (%)]				8.290	**0.016***	
Yes	81(50.94)	46(34.33)	19(46.34)			146(43.71)
No	78(49.06)	88(65.67)	22(53.66)			188(56.29)
Comorbid heart failure [n (%)]				15.414	**< 0.001****	
Yes	24(15.09)	46(34.33)	8(19.51)			78(23.35)
No	135(84.91)	88(65.67)	33(80.49)			256(76.65)
Comorbid coronary heart disease [n (%)]				4.250	0.119	
Yes	39(24.53)	47(35.07)	14(34.15)			100(29.94)
No	120(75.47)	87(64.93)	27(65.85)			234(70.06)
Comorbid diabetes [n (%)]				2.957	0.228	
Yes	65(40.88)	65(48.51)	22(53.66)			152(45.51)
No	94(59.12)	69(51.49)	19(46.34)			182(54.49)
Pruritus [n (%)]				20.677	**< 0.001****	
Yes	55(34.59)	82(61.19)	19(46.34)			156(46.71)
No	104(65.41)	52(38.81)	22(53.66)			178(53.29)
Depression [n (%)]				40.079	**< 0.001****	
Yes	56(35.22)	92(68.66)	30(73.17)			178(53.29)
No	103(64.78)	42(31.34)	11(26.83)			156(46.71)
Hemoglobin [g/L,M (P25, P75)]	97.00(82.00, 115.00)	92.00(80.00, 105.00)	101.50(82.50, 116.50)	6.423	**0.040***	94.00(81.75, 110.00)
C-reactive protein [mg/L,M (P25, P75)]	5.67(4.80, 13.00)	10.90(5.30, 22.35)	12.18(7.68, 24.47)	30.888	**< 0.001****	8.05(4.80, 17.92)
Serum calcium [mmol/L,M (P25, P75)]	2.07(1.94, 2.26)	2.10(1.98, 2.23)	2.14(1.98, 2.26)	1.483	0.476	2.10(1.95, 2.25)
Serum phosphate [mmol/L,M (P25, P75)]	1.59(1.24, 1.95)	1.52(1.24, 1.89)	1.60(1.17, 2.28)	0.641	0.726	1.59(1.23, 1.94)
B-type natriuretic peptide [pg/mL,M (P25, P75)]	3228.70(728.00, 13900.00)	4451.85(1223.68, 16450.00)	3101.00(955.50, 18050.00)	2.457	0.293	3629.00(956.90, 14700.00)
Parathyroid hormone [pmol/L,M (P25, P75)]	32.08(13.82, 173.70)	26.62(11.42, 131.62)	29.95(11.48, 260.70)	1.109	0.574	31.35(13.06, 167.00)
25-Hydroxyvitamin D [ng/mL,M (P25, P75)]	17.07(11.23, 22.17)	15.76(10.05, 23.94)	17.30(13.25, 23.58)	0.937	0.626	16.90(10.88, 23.83)
Blood urea nitrogen [mmol/L,M (P25, P75)]	20.60(17.19, 26.98)	19.91(14.18, 26.71)	19.08(12.77, 29.60)	1.662	0.436	20.36(15.64, 27.03)
Creatinine [mg/dL,M (P25, P75)]	8.34(5.94, 10.40)	6.88(4.91, 8.92)	7.57(4.64, 10.05)	11.097	**0.004****	7.83(5.29, 9.84)
Uric acid [μmol/L,M (P25, P75)]	352.89(276.07, 442.71)	350.70(288.41, 422.29)	323.76(219.55, 379.58)	3.800	0.150	350.29(276.10, 436.99)

Notes: Bold indicates statistical significance; *indicates $P < 0.05$; **indicates $P < 0.01$. Class 1: "overall better sleep"; Class 2: "short sleep duration and low efficiency"; Class 3: "poor sleep quality with high medication use".

Table 2 Fitting Results of Latent Profile Analysis of Sleep Quality in Patients on Hemodialysis

Model	AIC	BIC	aBIC	Entropy	LMR	BLRT	Class Probability
1	6810.151	6863.507	6819.098	/	/	/	/
2	5629.024	5712.869	5643.083	0.978	< 0.001	< 0.001	0.482/0.518
3	4864.356	4978.69	4883.527	0.986	0.011	< 0.001	0.476/0.401/0.123
4	4435.773	4580.597	4460.058	0.989	0.686	< 0.001	0.467/0.045/0.401/0.087
5	4306.794	4482.106	4336.191	0.967	0.500	< 0.001	0.308/0.186/0.383/0.087/0.036

This category includes 41 patients (12.3% of the sample). These patients scored higher on two dimensions, subjective sleep quality and use of hypnotic medication.

Mean values of the scores of each category on each dimension of the PSQI as shown in Figure 1. Figure 2 shows the comparison of each dimension of PSQI for each category. Detailed data are provided in Supplementary Table S1.

Factors Associated with Sleep Quality in MHD Patients

The univariate analysis revealed statistically significant differences (all $P<0.05$) among the three potential categories across multiple parameters, including dialysis vintage, age, residential area, comorbid heart failure, exercise regularity, pruritus, depression, hemoglobin levels, C-reactive protein concentrations, and serum creatinine values, as shown in Table 1.

Subsequently, we conducted multinomial logistic regression using the latent categories of sleep quality in MHD patients as the dependent variable and incorporating all variables with statistical significance ($P<0.05$) from univariate analyses as independent variables. The results showed that comorbid heart failure, pruritus, depression, and C-reactive protein level served as significant independent predictors of sleep quality subtypes ($P<0.05$), as shown in Table 3.

Comparison of Stigma by Sleep Quality Profiles

The comparison of the SIS scores among MHD patients in the three potential categories of sleep quality is presented in Figure 3, with detailed data available in Supplementary Table S2. Analyses revealed statistically significant differences between categories: Class1 vs Class2 ($P=0.039$), Class1 vs Class3 ($P<0.001$), and Class2 vs Class3 ($P=0.005$).

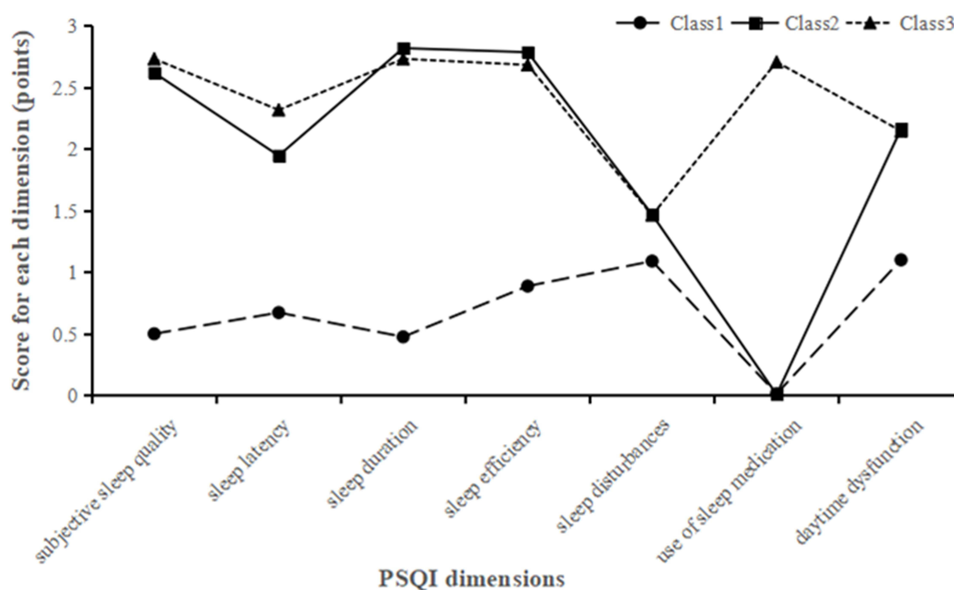

Figure 1 Comparison of PSQI component scores across the three identified latent classes. Class 1 (n=159): "Overall better sleep". Class 2 (n=134): "Insufficient sleep duration - low sleep efficiency". Class 3 (n=41): "Poor subjective sleep quality - high medication use". The seven PSQI components are: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction.

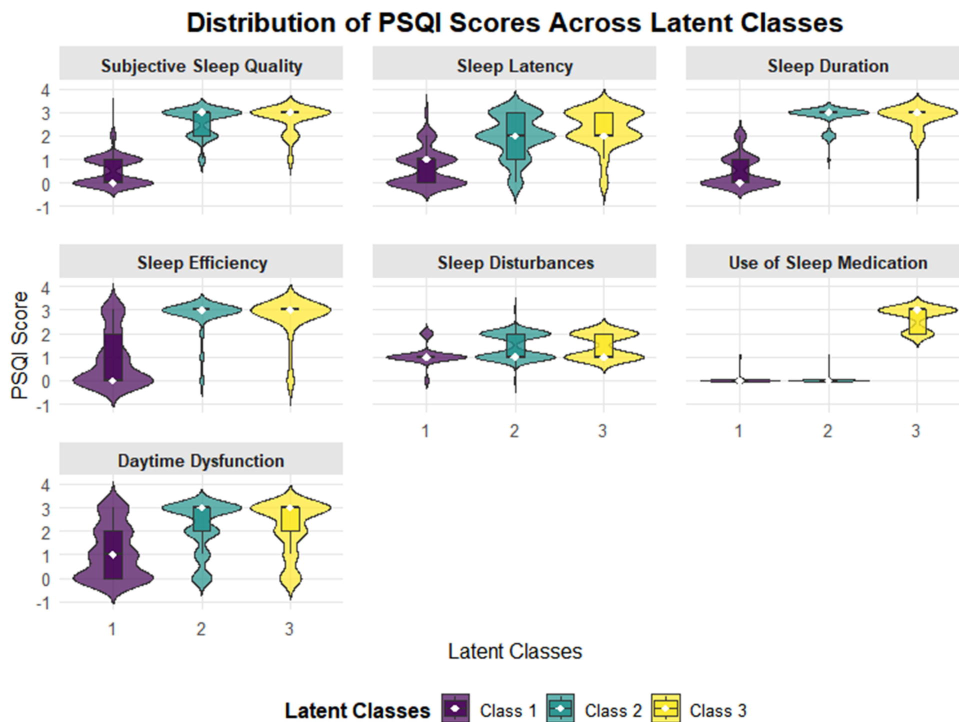

Figure 2 Comparison of the seven PSQI component scores among the three latent sleep quality classes. The profiles visually represent the distinct patterns of sleep disturbances: Class 1 ("Overall better sleep") shows consistently low scores, Class 2 ("Short sleep duration and low efficiency") shows peaks in sleep duration and sleep efficiency, while Class 3 ("Poor sleep quality with high medication use") shows high scores in subjective sleep quality and especially the use of sleep medication.

Discussion

Sleep Quality in MHD Patients Can Be Categorized into 3 Potential Categories

Class 1 (47.6%) demonstrated better sleep quality along with more favorable health profiles, including the lowest rates of heart failure and pruritus, the highest proportion of younger patients, and regular exercise habits. Therefore, clinicians should prioritize preventive sleep management strategies for this subgroup, such as physical activity within functional limitations.[30] Patients experiencing complications like heart failure or uremic pruritus should seek medical attention to prevent exacerbation of sleep quality.

Class 2 (40.1%) displayed high scores in most sleep disorders dimensions, particularly in sleep duration and efficiency, despite reporting little use of hypnotic medication. This group exhibited the highest prevalence of comorbid heart failure and pruritus. Previous studies have found that comorbidities, including heart failure[31] and pruritus,[32] may be significant contributors to their sleep disorders. To improve sleep quality, healthcare providers are advised to conduct a thorough clinical assessment of heart failure severity and the cause of pruritus, develop personalized treatment strategies.

Class 3 (12.3%) showed high scores across all dimensions except sleep disturbances, most notably in subjective sleep quality and hypnotic medication use. Research has found that individuals experiencing depression often exhibit an inaccurate perception of their sleep quality.[33] This subgroup exhibits the highest prevalence of depression, leading us to hypothesize that negative emotions such as depression may distort patients' sleep perceptions, thereby increasing their dependence on hypnotic medications. Therefore, implementing multidimensional interventions, including cognitive behavioral therapy for maladaptive thoughts and sleep hygiene education, is crucial.

Factors Influencing Potential Categories of Sleep Quality in MHD Patients

Patients with comorbid heart failure were more likely to fall into the insufficient sleep duration–low efficiency group. A related study[34] has confirmed that concomitant heart failure is an independent predictor of elevated PSQI scores in this population. This may stem from physiological mechanisms such as nocturnal pulmonary congestion and bronchoconstriction induced by vagal excitation when recumbent,[35] leading to frequent awakenings and sleep fragmentation.

Table 3 Unordered Multicategorical Logistic Regression Analysis of the Latent Profile of Sleep Quality in Patients on MHD

Items	Attributes	Class1 vs Class2					Class1 vs Class3				
		β	SE	*P*	OR	95% CI	β	SE	*P*	OR	95% CI
Age(year)	≥18~45	−0.701	0.368	0.057	0.496	(0.241, 1.020)	−0.731	0.522	0.161	0.482	(0.173, 1.339)
	≥45~60	0.137	0.317	0.665	1.147	(0.616, 2.136)	−0.287	0.436	0.510	0.750	(0.319, 1.765)
	≥60										
Dialysis vintage(month)	<60	−0.015	0.445	0.972	0.985	(0.411, 2.357)	−0.81	0.496	0.103	0.445	(0.168, 1.177)
	≥60										
Place of residence	Rural areas	−0.051	0.296	0.864	0.951	(0.533, 1.697)	−0.771	0.454	0.089	0.463	(0.190, 1.125)
	Urban areas										
Regular exercise	No	0.231	0.284	0.415	1.260	(0.722, 2.198)	−0.130	0.395	0.743	0.878	(0.405, 1.906)
	Yes										
Comorbid heart failure	Yes	1.053	0.323	**0.001****	2.867	(1.523, 5.398)	0.158	0.487	0.745	1.172	(0.451, 3.046)
	No										
Pruritus	Yes	0.999	0.284	**<0.001****	2.715	(1.557, 4.734)	0.362	0.394	0.358	1.436	(0.664, 3.109)
	No										
Depression	Yes	0.943	0.281	**0.001****	2.568	(1.481, 4.452)	1.537	0.423	**<0.001****	4.823	(2.107, 11.042)
	No										
Hemoglobin		0.002	0.007	0.707	1.002	(0.990, 1.016)	0.015	0.009	0.112	1.015	(0.997, 1.033)
C-reactive protein		0.043	0.011	**<0.001****	1.044	(1.022, 1.067)	0.034	0.013	**0.008****	1.035	(1.009, 1.061)
Creatinine		−0.002	0.004	0.510	0.998	(0.990, 1.005)	−0.002	0.007	0.770	0.998	(0.985, 1.011)

Notes: Bold indicates statistical significance; **indicates $P < 0.01$; Class 1: "overall better sleep"; Class 2: "short sleep duration and low efficiency"; Class 3: "poor sleep quality with high medication use".

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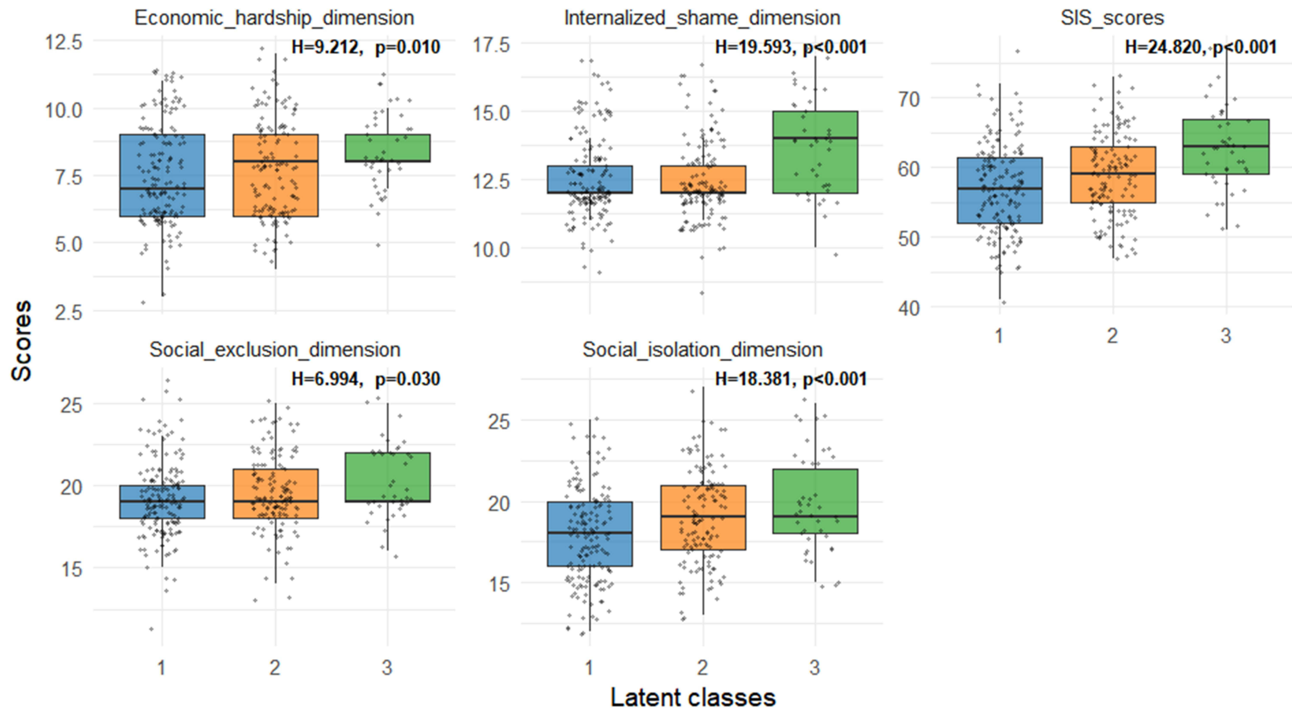

Figure 3 Comparison of total stigma scores, as measured by the SIS, among the three latent sleep quality classes. Stigma levels differed significantly across all pairs of classes. Class 3 ("Poor subjective sleep quality - high medication use") reported the highest level of perceived stigma, followed by Class 2 ("Insufficient sleep duration - low sleep efficiency"), while Class 1 ("Overall better sleep") had the lowest stigma score. Data are presented as box plots showing medians and interquartile ranges. Statistical test results are labeled in each legend.

Elevated NT-proBNP, a marker of left ventricular stress, is more common in individuals sleeping <5 hours,[36] suggesting a link between short sleep and heart failure severity. Additionally, a meta-analysis[37] revealed that patients with heart failure exhibit reduced sleep efficiency compared to those without heart failure. Combining these findings with previous studies reveals that concomitant heart failure significantly impacts sleep duration and efficiency, which is consistent with the present study.

Pruritus substantially increases the risk of insufficient sleep duration and low sleep efficiency in MHD patients. The Pathophysiological basis involves uremic toxin accumulation, calcium-phosphate dysregulation, and neurological dysfunction.[38] Clinical evidence indicates that pruritus is a persistent issue,[39] with over 50% of MHD patients experiencing pruritus-related sleep disruption.[40] One study[41] found that 50.1% of 2978 MHD patients experienced pruritus, and over half of those with pruritus reported insufficient sleep. A multicenter study of 555 Chinese MHD patients further demonstrated that each 1-point increase in Pruritus VAS score raised insomnia risk by 7.7%, primarily through prolonged sleep latency.[42] This prolonged latency period can directly lead to a reduction in total sleep time relative to time spent in bed, thereby decreasing sleep efficiency.

In this study, 178 individuals exhibited depressive symptoms, accounting for 53.29% of the total sample, consistent with previous research.[43] Furthermore, depressed patients were more likely to be concurrently classified into both the insufficient sleep duration-low sleep efficiency group and the poor subjective sleep quality-high medication usage group. A related study[44] showed that more severe depressive symptoms predicted poorer sleep quality and medication adherence, a relationship likely mediated by impaired emotional regulation and cognitive hyperarousal. Polysomnographic studies confirm that major depression is associated with abnormal sleep architecture, including prolonged sleep latency and frequent nocturnal awakenings, resulting in sleep fragmentation and reduced efficiency.[45] Depressive states also amplify perceptual distortions, such as overestimating sleep onset latency and underestimating sleep duration.[46] Given the widespread long-term use of hypnotic medications among individuals with depression,[47] this

study hypothesizes that MHD patients with comorbid depression are more prone to developing medication dependence when experiencing sleep disorders.

Patients with elevated C-reactive protein (CRP) levels exhibited a higher probability of being classified into both the insufficient sleep duration-low sleep efficiency group and the poor subjective sleep quality-high medication use group. As a biomarker of systemic inflammation, elevated CRP has been clinically associated with poor sleep outcomes. A cross-sectional study[48] found that short sleep duration (≤5.5 hours) was positively associated with increased CRP levels. Notably, anti-inflammatory dietary interventions have been shown to improve both sleep duration and efficiency in adults,[49] suggesting that inflammatory markers may be closely linked to sleep duration and efficiency. A prospective study indicated that 70% of individuals with high CRP reported poor subjective sleep quality.[50] Although no direct causal link between CRP and hypnotic use has been established, our finding that patients with high CRP levels were observed the poor subjective sleep quality-high medication use group suggests that systemic inflammation may indirectly increase hypnotic use through its detrimental effect on sleep quality. Future longitudinal studies could be conducted to examine whether this potential mediating pathway exists.

Differences in SIS Scores in MHD Patients with Different Potential Categories of Sleep Quality

The analysis revealed significantly different levels of stigma across the latent sleep quality classes in MHD patients (all $P<0.05$). Class 3 patients exhibited the highest scores for stigma, and Class 1 patients had the lowest levels of stigma. Stigma is a psychogenic stress response that stems from the patient's negative emotions due to the disease.[51] Patients in Class 3 exhibit pronounced depressive characteristics, and we hypothesize that this may account for the high levels of stigma experienced by this group. A previous study[52] found that perceived stigma and depressive symptoms are both independent and interrelated concepts in their relationship. Negative emotions can significantly intensify patients' experience of stigma.[53] Furthermore, a Japanese study[54] found that among 7461 patients with mental health disorders, 18.2% experienced stigma, 47.4% exhibited depressive symptoms, and stigma exerted a direct positive influence on depression. However, due to the cross-sectional design of this study, it is not possible to establish a definitive causal relationship between the variables. We hypothesize that depression may worsen perceived sleep quality and exacerbate feelings of stigmatization. Therefore, future longitudinal studies could be conducted to clarify the temporal sequence and directionality of this association.

Clinical Implications

Identifying three potential categories emphasizes the necessity for personalized, stratified management in MHD patients. Clinicians should integrate routine sleep screening, using tools like the PSQI, to proactively identify at-risk patients. For those in the "overall better sleep" group, preventive strategies such as reinforcing physical activity and sleep hygiene are paramount. Patients characterized by "short sleep duration – low sleep efficiency" warrant comprehensive management of comorbidities like heart failure and pruritus, which are key drivers of their sleep fragmentation. Meanwhile, the "poor subjective sleep quality - high medication use" group demands a multidisciplinary approach, including psychological support, depression screening, and a careful review of hypnotic medication to mitigate overreliance. Furthermore, monitoring inflammatory markers like CRP could help identify patients at risk for severe sleep disturbances. Finally, addressing the elevated stigma levels through patient education and destigmatizing clinical communication is crucial to improving both psychological well-being and overall sleep outcomes.

Strengths and Limitations

This study explores LPA to identify sleep quality subgroups in MHD patients and examine their association with stigma, further incorporating key biochemical indicators into the analysis of influencing factors. However, there are some limitations. First, the two-center convenience sampling method may introduce selection bias and limit the sample's representativeness, potentially restricting the generalizability of our findings to the broader MHD population.

Additionally, the cross-sectional design precludes assessment of causality. Future multicenter longitudinal studies with robust sampling are needed to track the trajectory of sleep disorders and identify key determinants across patient subgroups.

Conclusion

This study identified three distinct sleep quality profiles among MHD patients and highlighted that the presence of heart failure, pruritus, depression, and elevated CRP levels were all identified as key determinants influencing sleep quality categories in MHD patients. Critically, the data firmly show that stigma levels significantly differ across these profiles, being highest in the "poor subjective sleep quality - high medication use" group, which also had the highest depression prevalence. However, the cross-sectional nature of our study means the causal relationship between depression and stigma remains speculative. We hypothesize that depression may both worsen perceived sleep quality and amplify feelings of stigma, but longitudinal studies are essential to confirm whether depression leads to stigmatization, or vice versa. Clarifying this interplay is vital for developing effective interventions.

Abbreviations

MHD, Maintenance hemodialysis; LPA, Latent profile analysis; PSQI, Pittsburgh Sleep Quality Index; SDS, Self-Rating Depression Scale; SIS, Social Impact Scale; CKD, Chronic kidney disease; ESRD, End-stage renal disease; AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion; LMR, Lo-Mendell-Rubin adjusted likelihood ratio test; BLRT, Bootstrap likelihood ratio test; CRP, C-reactive protein.

Ethics Approval

The study was reviewed by the Ethics Committee of the First Affiliated Hospital of Xinjiang Medical University (K202412-77). All procedures were conducted following the rules and regulations of the Declaration of Helsinki. After obtaining permission from the hospital, study questionnaires were distributed, and anonymous surveys were conducted. All participants voluntarily provided written informed consent before participation in the study.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors have no conflicts of interest for this work.

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