

Latent Profiles of Emotional Distress and Sleep and Their Correlates Among Hospitalized Patients With Hypertension and Diabetes: A Multicenter Cross-Sectional Study

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Abstract

Background

Depressive symptoms, anxiety symptoms, and sleep problems are common among hospitalized patients with hypertension and diabetes, but their patterns of co-occurrence and associated factors remain poorly understood. Guided by the Theory of Unpleasant Symptoms, we aimed to identify latent profiles of emotional distress and sleep characteristics and examine clinical and psychosocial factors associated with profile membership.

Methods

This multicenter cross-sectional study included 529 hospitalized patients with medical-record-confirmed hypertension and diabetes. Latent profile analysis (LPA) was performed using the Patient Health Questionnaire-9 (PHQ-9) total score, Generalized Anxiety Disorder-7 (GAD-7) total score, and the seven Pittsburgh Sleep Quality Index (PSQI) component scores as profile indicators. Associations with profile membership were examined using mean bias-reduced multinomial logistic regression to mitigate sparse-data bias.

Results

Three profiles were identified: low emotional distress–low sleep burden ($n = 327$, 61.81%), emotional distress–predominant ($n = 164$, 31.00%), and sleep medication use–daytime dysfunction ($n = 38$, 7.18%). The three-profile solution showed high classification quality (entropy = 0.918; average maximum posterior probability = 0.967). Serious or critical clinical status (adjusted odds ratio [aOR] = 1.60, 95% CI: 1.04–2.47), higher Nutritional Risk Screening 2002 (NRS 2002) scores (per 1-point increase: aOR = 1.24, 95% CI: 1.09–1.40), avoidance coping (per 1-point increase: aOR = 1.27, 95% CI: 1.17–1.37), and acceptance-resignation coping (per 1-point increase: aOR = 1.19, 95% CI: 1.11–1.26) were associated with higher odds of membership in the emotional distress–predominant profile.

Conclusions

Hospitalized patients with hypertension and diabetes showed distinct configurations of emotional distress and sleep characteristics. Nursing assessment may benefit from considering joint emotional and sleep symptom patterns alongside clinical status, nutritional risk, and illness-related coping. These findings may inform stratified assessment and symptom management during hospitalization.

Background

Hypertension and diabetes are major chronic cardiometabolic conditions in China. In 2024, approximately 148 million adults aged 20–79 years in China were living with diabetes. National surveillance data for 2018 showed an age-standardized hypertension prevalence of 24.7% among adults aged 18–69 years, corresponding to approximately 274 million people, whereas the hypertension control rate was only 12.0% [1, 2]. Their coexistence increases cardiovascular and renal risk, complicates treatment, and adds to the burden of long-term self-management. Current diabetes guidelines incorporate psychosocial care and sleep health into routine management [3], highlighting the importance of outcomes beyond conventional cardiometabolic indicators.

Depressive symptoms, anxiety, and sleep problems are common but often underrecognized among people with hypertension or diabetes. Previous studies have reported depressive symptoms in approximately 35% of people with diabetes and 25.9% of Chinese patients with type 2 diabetes, while the prevalence of comorbid anxiety disorders is approximately 28% [4–6]. The pooled prevalence of sleep disturbances among people with diabetes is approximately 52%, and impaired sleep has been associated with poor glycemic control, diabetes-related complications, and reduced quality of life [7, 8]. People with hypertension also experience substantial burdens of depressive symptoms and sleep disturbance, particularly at older ages, and subjective sleep quality is closely associated with blood pressure status [9, 10]. These symptoms may impair treatment engagement, coping, and daytime functioning and are interrelated through shared behavioral and physiological pathways, including stress responses and circadian disruption [3, 11–13]. However, they do not necessarily occur at comparable levels within the same individual. Analyses based solely on individual scale scores or average effects may therefore obscure clinically relevant symptom patterns.

The Theory of Unpleasant Symptoms provides a conceptual framework for understanding this heterogeneity. The theory proposes that multiple symptoms may coexist and interact, that symptom experiences are jointly shaped by physiological, psychological, and situational

factors, and that these experiences may subsequently influence functional performance [14–16]. Accordingly, we conceptualized depressive symptoms, anxiety symptoms, and the seven PSQI components as an interrelated configuration of emotional distress and sleep characteristics. Clinical status and nutritional risk were conceptualized as physiological factors, medical coping styles as psychological factors, and perceived social support as a situational factor. Previous studies have linked coping styles and social support with sleep, psychological distress, and glycemic management in people with diabetes, and lower social support with a greater likelihood of depression [17, 18]. A person-centered approach may therefore help characterize multisymptom configurations within the physiological, psychological, and situational framework proposed by the theory.

Latent profile analysis (LPA) is a person-centered method that identifies subgroups with distinct patterns across multiple continuous indicators [19, 20]. Previous person-centered studies have identified subgroups characterized by different combinations of diabetes distress, depression, anxiety, sleep characteristics, and other psychological and somatic features [21–23]. However, few studies in hospitalized patients with hypertension and diabetes have simultaneously examined depressive symptoms, anxiety symptoms, and multidimensional sleep characteristics. In addition, limited research has used a nursing theoretical framework to integrate factors across physiological, psychological, and situational domains, including clinical status, nutritional risk, coping styles, and social support. Further characterization of emotional distress and sleep configurations and their associated factors is therefore warranted in this population.

Guided by the Theory of Unpleasant Symptoms, we performed LPA using depressive symptoms, anxiety symptoms, and seven sleep components to identify latent profiles of emotional distress and sleep characteristics among hospitalized patients with hypertension and diabetes. We then compared demographic, clinical, and psychosocial characteristics across profiles and examined physiological, psychological, and situational factors associated with profile membership. By identifying heterogeneity that may be obscured by aggregate scale scores, this study aimed to inform stratified nursing assessment, focused reassessment, and symptom management.

Methods

Study Design and Participants

We conducted a multicenter cross-sectional study from February to June 2024 at four healthcare institutions in Hubei Province, China. Participants were recruited from endocrinology, cardiology, respiratory medicine, nephrology, psychiatry, and other clinical departments involved in chronic disease care. Hospitalized patients with medical-record-confirmed hypertension and diabetes were screened using prespecified eligibility criteria. The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement [24].

Convenience sampling was used. Patients were eligible if they: (1) were aged ≥ 18 years; (2) had medical-record-confirmed diagnoses of both hypertension and diabetes during hospitalization; (3) were able to understand the study information and questionnaire items and communicate their responses; (4) could complete the questionnaire independently or with non-directive investigator assistance; and (5) voluntarily participated and provided written informed consent.

Patients were excluded if they: (1) were unable to complete the survey because of impaired consciousness, severe cognitive impairment, an acute psychiatric disorder, or clinical instability; (2) had hypertension or diabetes diagnoses that could not be verified from the medical record; (3) had missing data on core LPA indicators that precluded model inclusion; or (4) had substantial internal inconsistencies in their data that could not be resolved through source-data verification. Patients documented as having serious or critical clinical status were not excluded solely on that basis if they remained able to complete the survey.

A total of 540 hospitalized patients with hypertension and diabetes were enrolled. Eleven had missing data for the habitual sleep efficiency component of the Pittsburgh Sleep Quality Index (PSQI), leaving 529 participants in the LPA analytic sample.

Theoretical Framework

The Theory of Unpleasant Symptoms provided the conceptual framework for this study. Within this framework, clinical status and nutritional risk assessed using Nutritional Risk Screening 2002 (NRS 2002) were conceptualized as physiological factors, medical coping styles as psychological factors, and perceived social support as a situational factor. The PHQ-9 total score, GAD-7 total score, and seven PSQI component scores were jointly specified as indicators of emotional distress and sleep characteristics. LPA was used to identify latent configurations of these indicators, and the theoretical framework guided the organization and interpretation of factors associated with profile membership [14–16].

Sample Size Considerations

Sample-size requirements for LPA depend on the number of indicators, degree of profile separation, number and size of latent profiles, and model specification. Given the absence of a single conventional sample-size formula applicable to all LPA settings, all eligible participants recruited during the study period were included, yielding an analytic sample of 529. Sample adequacy was evaluated in conjunction with model convergence, profile size, entropy, and posterior classification probabilities rather than a single conventional power calculation.

Study Measures

Demographic and Clinical Characteristics

The research team developed a demographic and clinical data-collection form based on the study objectives and clinical context. Demographic variables included age, sex, ethnicity, marital status, educational attainment, health insurance type, occupation, monthly per capita household income, area of residence, and living arrangement. Clinical variables included height, weight, number of additional chronic conditions other than hypertension and diabetes, level of nursing care, clinical status, primary caregiver during hospitalization, NRS 2002 score, diagnoses, and hospital tier. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2).

Additional chronic conditions were defined as chronic diseases other than hypertension and diabetes that were self-reported by patients and verified against their medical records. For presentation in Table 1, the number of additional chronic conditions was categorized as 1, 2, or ≥ 3 .

Nutritional risk was assessed using NRS 2002, with higher scores indicating greater nutritional risk. The total score was used both descriptively and as a continuous variable in the analyses. NRS 2002 is a nutritional risk-screening instrument and does not constitute a clinical diagnosis of malnutrition. Clinical status was recorded from routine clinical documentation as neither serious nor critical, serious, or critical. For regression analyses, the serious and critical categories were combined, yielding a binary variable contrasting neither serious nor critical with serious/critical clinical status.

Depressive and Anxiety Symptoms

Depressive symptoms were assessed using the 9-item Patient Health Questionnaire (PHQ-9), developed by Kroenke et al. The PHQ-9 assesses the frequency of nine depressive symptoms during the previous 2 weeks. Each item is rated from 0 to 3, yielding a total score of 0–27; higher scores indicate greater depressive symptom severity [25]. The Chinese version has demonstrated good reliability and validity [26]. The PHQ-9 total score was used as an LPA indicator; Cronbach's α was 0.915 in this sample.

Anxiety symptoms were assessed using the 7-item Generalized Anxiety Disorder scale (GAD-7). Its seven items are rated from 0 to 3, yielding a total score of 0–21; higher scores indicate greater anxiety symptom severity [27]. The Chinese version has demonstrated good reliability and validity among general-hospital patients [28]. The GAD-7 total score was used as an LPA indicator; Cronbach's α was 0.949 in this sample.

Sleep Quality

Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI), which evaluates sleep during the previous month. The PSQI comprises seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction. Each component is scored from 0 to 3, and component scores are summed to produce a global score of 0–21; higher scores indicate poorer sleep quality [29]. The Chinese version has demonstrated good reliability and validity [30].

The seven PSQI component scores were entered separately as LPA indicators to preserve multidimensional sleep patterns. To avoid redundancy between the component scores and global score, the PSQI global score was not included as an additional profile indicator; instead, it was used descriptively to characterize overall sleep burden within each profile. Cronbach's α across the seven PSQI components was 0.857 in this sample.

Medical Coping Styles and Perceived Social Support

Medical coping styles were assessed using the Medical Coping Modes Questionnaire (MCMQ), originally developed by Feifel et al. to assess illness-related coping across three dimensions: confrontation, avoidance, and acceptance-resignation [31]. The Chinese version comprises 20 items: 8 assessing confrontation, 7 avoidance, and 5 acceptance-resignation. Items are rated on a 4-point scale, with reverse-scored items recoded according to the Chinese scoring protocol. Subscale scores are calculated separately; higher scores indicate greater use of the corresponding coping style [32]. Cronbach's α values for confrontation, avoidance, and acceptance-resignation were 0.821, 0.847, and 0.879, respectively.

Perceived social support was assessed using the Multidimensional Scale of Perceived Social Support (MSPSS), developed by Zimet et al. The MSPSS comprises 12 items across three subscales: Family, Friends, and Significant Other. Each item is rated from 1 to 7, yielding a total score of 12–84; higher scores indicate greater perceived social support [33]. The MSPSS has demonstrated good psychometric properties in clinical samples from mainland China [34]. The total score was used in the analyses. Cronbach's α was 0.976 for the total scale and 0.940, 0.964, and 0.963 for the Significant Other, Family, and Friends subscales, respectively. For regression analyses, the MSPSS total score was divided by 10 so that effect estimates corresponded to a 10-point increase on the original scale.

Data Collection and Quality Control

The coordinating research team developed a standardized protocol covering eligibility assessment, questionnaire administration, variable definitions, source-data verification, data coding, and quality control. Investigators at all centers received standardized training on eligibility criteria, non-directive questionnaire administration, permissible clarification of scale items, verification of clinical information, informed consent, and protection of participant privacy.

Trained clinical nurses at each center screened patients using uniform eligibility criteria and administered paper-based questionnaires. Eligible patients received information about the study purpose, procedures, voluntary participation, and confidentiality before providing written informed consent. Participants completed questionnaires independently whenever possible. For participants with reading or writing difficulties but adequate comprehension and communication, investigators read items aloud and recorded responses without leading explanations. Demographic and psychosocial information was primarily self-reported, whereas diagnoses, level of nursing care, clinical status, NRS 2002 score, and other clinical information were verified against medical records and nursing documentation.

Completed questionnaires underwent a two-stage review for completeness and internal consistency at each center. When responses were missing, internally inconsistent, or discrepant across data sources, investigators reviewed the original questionnaire, medical records, and nursing documentation to resolve the discrepancy when possible. Each center used standardized variable names, coding conventions, and scale-scoring rules. Two trained data-entry personnel independently entered and cross-checked the data, resolving discrepancies against the source documents.

Before analysis, the research team checked variable ranges, scale-scoring accuracy, internal consistency, outliers, duplicate records, and missing values. PHQ-9 and GAD-7 items were scored from 0 to 3, and the seven PSQI components were derived on the standard 0–3 scale. BMI was recalculated from height and weight whenever possible. Values outside prespecified plausible ranges were set to missing if they could not be verified against source records. Additional chronic conditions were coded using uniform criteria. Before LPA, the PHQ-9 total score, GAD-7 total score, and seven PSQI component scores were standardized as z scores to reduce the influence of differing indicator scales on profile estimation.

Statistical Analysis

Descriptive Analyses and Missing Data

Continuous-variable distributions were assessed using histograms, Q-Q plots, skewness, and kurtosis. Variables with approximately normal distributions were summarized as mean $\pm$ standard deviation (SD), whereas skewed variables were summarized as median (25th, 75th percentiles). Categorical variables were summarized as counts and percentages. Continuous variables were compared across latent profiles using Welch's one-way analysis of variance (ANOVA) or the Kruskal–Wallis test, as appropriate. Categorical variables were compared using Pearson's chi-square (χ^2) test; when expected-cell assumptions were not met, Fisher's exact test with 20,000 Monte Carlo simulations was used. When an overall test was significant, post hoc pairwise comparisons were performed with Holm adjustment for multiple testing. Effect sizes were reported as η^2 for Welch's ANOVA, Kruskal–Wallis ε^2 for the Kruskal–Wallis test, and Cramér's V for categorical comparisons.

Complete-case analysis was used for the LPA indicators; missing core profile indicators were not imputed. Descriptive analyses used all available data for each variable, with the corresponding valid sample size reported. No covariate data were missing for the primary

multinomial logistic regression within the LPA analytic sample. All statistical tests were two-sided, with $P < 0.05$ considered statistically significant.

Exploratory Assessment of Common Method Variance

Because several key psychometric measures were self-reported, Harman's single-factor test was used as a supplementary exploratory check for a dominant common factor across the 48 PHQ-9, GAD-7, MCMQ, and MSPSS items [35]. An unrotated exploratory factor analysis (EFA) was conducted, retaining factors with eigenvalues > 1 , and the proportion of variance explained by the first factor was examined. The analysis was repeated using a polychoric correlation matrix, with an additional sensitivity analysis including the seven PSQI component scores.

Latent Profile Analysis

LPA was conducted in R version 4.6.1 using the tidySEM and OpenMx packages. The PHQ-9 total score, GAD-7 total score, and seven PSQI component scores were included as nine continuous profile indicators and standardized as z scores before model estimation.

Models with one to six latent profiles were fitted sequentially. In the primary specification, indicator variances were constrained to equality across profiles, and within-profile indicator covariances were fixed to zero. Parameters were estimated by maximum likelihood, with OpenMx providing the computational framework for finite-mixture model estimation [36].

Model selection considered statistical fit and substantive interpretability, including log-likelihood, Akaike information criterion (AIC), Bayesian information criterion (BIC), sample-size-adjusted BIC (aBIC), entropy, Lo–Mendell–Rubin likelihood ratio test (LMR-LRT), profile size, average posterior probabilities, parsimony, and clinical interpretability [19, 20, 37]. Lower AIC, BIC, and aBIC values indicated better relative fit. Entropy ≥ 0.80 and average posterior probabilities ≥ 0.70 were treated as supportive indicators of classification quality rather than absolute decision rules. Solutions containing profiles representing $< 5\%$ of the sample were interpreted cautiously because of potential instability and limited interpretability. The retained solution was selected by jointly considering model fit, classification quality, profile size, parsimony, and substantive interpretability rather than any single fit index. For descriptive and external-variable analyses, participants were assigned to the profile with the highest posterior probability.

Comparison of Characteristics Across Latent Profiles

To facilitate clinical interpretation, raw means and SDs of the nine profile indicators were calculated within each modally assigned profile, and posterior-probability-weighted standardized profile plots were generated. Because the PHQ-9 total score, GAD-7 total score, and seven PSQI component scores were used to derive the profiles, between-profile differences in these indicators were interpreted descriptively rather than as independent confirmatory tests. Demographic characteristics, clinical variables, MCMQ subscale scores, and MSPSS total score were treated as external variables and compared across modal profiles using the procedures described above. Because modal assignment does not fully account for classification uncertainty, these comparisons were interpreted primarily as descriptive profile characteristics.

Factors Associated With Latent Profile Membership

Modal profile membership was modeled as a three-category outcome, with the low emotional distress–low sleep burden profile as the reference category. Associations of demographic, clinical, and psychosocial characteristics with profile membership were examined using baseline-category multinomial logistic regression with mean bias reduction. This approach was used to mitigate sparse-data bias and reduce the risk of infinite estimates from complete or quasi-complete separation, given the small size of the smallest profile [38]. Results were reported as adjusted odds ratios (aORs) with 95% confidence intervals (CIs).

Covariates for the primary model were selected on the basis of theoretical and clinical relevance, potential confounding, data completeness, sparse-cell patterns, and model complexity supported by the size of the smallest profile. The model included sex, clinical status, NRS 2002 score, MCMQ avoidance score, MCMQ acceptance-resignation score, and MSPSS total score. Effects for NRS 2002, MCMQ avoidance, and MCMQ acceptance-resignation were expressed per 1-point increase, whereas the MSPSS effect was expressed per 10-point increase on the original scale. Before model fitting, categorical variables were examined for sparse cells, and variance inflation factors (VIFs) were assessed from the design matrix. As a sensitivity analysis, conventional maximum-likelihood multinomial logistic regression was fitted using the same reference category and covariates, and the direction and magnitude of estimates were compared with those from the primary model.

Ethical Considerations

The study protocol was reviewed and approved by the Ethics Committee of Renmin Hospital of Wuhan University (approval no. WDRY2022-K122). Before data collection, participants were informed about the study objectives and procedures, potential risks, privacy protections, and their right to withdraw. All participants provided written informed consent. Data were de-identified before analysis and used solely for this study. The study was conducted in accordance with the Declaration of Helsinki.

Results

Participant Characteristics and Scale Scores

Of 540 enrolled participants, 529 (98.0%) had complete data on all nine profile indicators; 11 had missing data for the PSQI habitual sleep efficiency component. Thus, 529 participants were included in the LPA. Mean age was 64.82 ± 11.98 years, and 307 participants (58.0%) were men. Median BMI was 23.73 (21.22, 26.04) kg/m², and median NRS 2002 score was 1.00 (0.00, 2.00). Overall, 480 participants (90.7%) were married, and 189 (35.7%) had serious or critical clinical status.

Median PHQ-9 and GAD-7 total scores were 4.00 (0.00, 9.00) and 2.00 (0.00, 7.00), respectively. Mean MCMQ scores were 19.29 ± 3.41 for confrontation, 15.22 ± 2.75 for avoidance, and 10.34 ± 3.61 for acceptance-resignation. Mean PSQI global score was 5.36 ± 3.19 , and mean MSPSS total score was 58.50 ± 15.49 . Detailed demographic, clinical, and scale-score characteristics are presented in Table 1.

Table 1
Participant Demographic and Clinical Characteristics and Scale Scores (N = 529)

Variable	Category	Overall (N = 529)
Demographic characteristics		
Age, years		64.82 ± 11.98
Sex	Male	307 (58.0)
	Female	222 (42.0)
Ethnicity	Han Chinese	528 (99.8)
	Other	1 (0.2)
Marital status	Married	480 (90.7)
	Unmarried/widowed/divorced	49 (9.3)
Educational attainment	Junior high school or below	380 (71.8)
	Senior high school or technical secondary school	94 (17.8)
	College or above	55 (10.4)
Health insurance type	Resident medical insurance	372 (70.3)
	Employee medical insurance	140 (26.5)
	Other	17 (3.2)
Occupation	Farmer	149 (28.2)
	Worker	69 (13.0)
	Enterprise, public institution, or public-sector employee	67 (12.7)
	Self-employed	53 (10.0)
	Unemployed	73 (13.8)
	Retired	118 (22.3)
Monthly per capita household income, CNY	< 3000	213 (40.3)
	3000 to < 5000	213 (40.3)
	≥ 5000	103 (19.5)
Area of residence	Rural area	244 (46.1)
	City	184 (34.8)
	Town	101 (19.1)
Living arrangement	With spouse	288 (54.4)
	With children or with spouse and children	182 (34.4)
	Alone or with parents	59 (11.2)
Clinical characteristics		
BMI, kg/m ²		23.73 (21.22, 26.04)
NRS 2002 score		1.00 (0.00, 2.00)
Additional chronic conditions	1	54 (10.2)

Note: Continuous variables are presented as mean ± SD or median (25th, 75th percentiles), as appropriate; categorical variables are presented as n (%). The valid sample size was 520 for BMI and 529 for all other variables. BMI, body mass index; NRS 2002, Nutritional Risk Screening 2002; PHQ-9, Patient Health Questionnaire-9; GAD-7, Generalized Anxiety Disorder-7; MCMQ, Medical Coping Modes Questionnaire; PSQI, Pittsburgh Sleep Quality Index; MSPSS, Multidimensional Scale of Perceived Social Support.

Variable	Category	Overall (N = 529)
Demographic characteristics		
(excluding hypertension and diabetes)		
	2	266 (50.3)
	≥ 3	209 (39.5)
Level of nursing care	Level I	284 (53.7)
	Level II or III	245 (46.3)
Clinical status	Neither serious nor critical	340 (64.3)
	Serious or critical	189 (35.7)
Primary caregiver during hospitalization	None	134 (25.3)
	Spouse	185 (35.0)
	Children	155 (29.3)
	Other	55 (10.4)
Hospital tier	Tertiary Grade A	476 (90.0)
	Other	53 (10.0)
Major scale and subscale scores		
PHQ-9 total score		4.00 (0.00, 9.00)
GAD-7 total score		2.00 (0.00, 7.00)
MCMQ confrontation		19.29 ± 3.41
MCMQ avoidance		15.22 ± 2.75
MCMQ acceptance-resignation		10.34 ± 3.61
PSQI global score		5.36 ± 3.19
MSPSS total score		58.50 ± 15.49
Note: Continuous variables are presented as mean ± SD or median (25th, 75th percentiles), as appropriate; categorical variables are presented as n (%). The valid sample size was 520 for BMI and 529 for all other variables. BMI, body mass index; NRS 2002, Nutritional Risk Screening 2002; PHQ-9, Patient Health Questionnaire-9; GAD-7, Generalized Anxiety Disorder-7; MCMQ, Medical Coping Modes Questionnaire; PSQI, Pittsburgh Sleep Quality Index; MSPSS, Multidimensional Scale of Perceived Social Support.		

Exploratory Assessment of Common Method Variance

Harman's single-factor analysis was used as a supplementary exploratory assessment of common method variance. Unrotated EFA of the 48 self-reported PHQ-9, GAD-7, MCMQ, and MSPSS items yielded seven factors with eigenvalues > 1; the first factor explained 23.43% of the total variance. The Kaiser–Meyer–Olkin (KMO) measure was 0.924, and Bartlett's test of sphericity was significant ($\chi^2 = 21,026.13$, $df = 1,128$, $P < 0.001$). Using a polychoric correlation matrix, the first factor explained 28.85% of the variance; after inclusion of the seven PSQI component scores, the corresponding proportion was 20.63%. These supplementary analyses did not indicate a single dominant factor.

Latent Profile Model Fit and Profile Selection

Models with one to six profiles were fitted sequentially, and all solutions converged. AIC, BIC, and aBIC decreased as the number of profiles increased, and the LMR-LRT was significant for all two- through six-profile solutions (all $P < 0.001$). The three-profile solution had an entropy of 0.918, a minimum profile-specific average posterior probability of 0.944, and a smallest profile comprising 7.18% of the sample. Although the four-profile solution had lower AIC, BIC, and aBIC values, classification quality was lower (entropy = 0.855; minimum average posterior probability = 0.880). The five- and six-profile solutions each contained a 12-participant profile (2.27%), raising concerns about stability and interpretability.

Inspection of profile shapes showed that the four-profile solution primarily subdivided the low-burden group from the three-profile solution, whereas the emotional distress–predominant and sleep medication use–daytime dysfunction profiles remained broadly similar. Thus, although the four-profile solution improved the information criteria, this improvement was accompanied by poorer classification quality and greater complexity without identifying a clearly distinct, clinically informative profile beyond further subdivision of the low-burden group. Considering relative fit, classification quality, profile size, parsimony, and clinical interpretability, the three-profile solution was retained. Fit indices for all candidate models are presented in Table 2.

Table 2
Fit Indices for One- to Six-Profile Latent Profile Models

No. of profiles	LL	Parameters	AIC	BIC	aBIC	Entropy	LMR-LRT P value	Smallest profile, n (%)	Minimum APP	Profile sizes
1	-6761.808	18	13559.616	13636.494	13579.357	—	—	529 (100.00)	1.000	C1 = 529
2	-6503.790	28	13063.579	13183.167	13094.287	0.887	< 0.001	176 (33.27)	0.959	C1 = 353; C2 = 176
3	-6208.739	38	12493.478	12655.776	12535.153	0.918	< 0.001	38 (7.18)	0.944	C1 = 327; C2 = 164; C3 = 38
4	-6081.337	48	12258.673	12463.681	12311.315	0.855	< 0.001	39 (7.37)	0.880	C1 = 229; C2 = 105; C3 = 156; C4 = 39
5	-5934.666	58	11985.333	12233.050	12048.942	0.951	< 0.001	12 (2.27)	0.964	C1 = 293; C2 = 139; C3 = 35; C4 = 50; C5 = 12
6	-5846.474	68	11828.948	12119.375	11903.524	0.891	< 0.001	12 (2.27)	0.872	C1 = 195; C2 = 100; C3 = 138; C4 = 49; C5 = 35; C6 = 12

Note: LL, log-likelihood; AIC, Akaike information criterion; BIC, Bayesian information criterion; aBIC, sample-size-adjusted Bayesian information criterion; LMR-LRT, Lo–Mendell–Rubin likelihood ratio test; APP, average posterior probability. Higher entropy indicates greater classification precision. The final solution was selected by jointly considering statistical fit, classification quality, profile size, parsimony, and clinical interpretability.

Classification Quality and Profile Characteristics of the Three-Profile Solution

The three-profile solution had an entropy of 0.9182 and an average maximum posterior probability of 0.9673. Fourteen participants (2.65%) had maximum posterior probabilities below 0.70, and 23 (4.35%) had probabilities below 0.80. Diagonal entries of the average posterior probability matrix were 0.9754, 0.9437, and 0.9994 for the low emotional distress–low sleep burden, emotional distress–

predominant, and sleep medication use–daytime dysfunction profiles, respectively, indicating good separation and low classification uncertainty (Table 3).

The low emotional distress–low sleep burden profile comprised 327 participants (61.81%), with standardized means for the nine indicators generally below the overall sample mean. Mean PHQ-9, GAD-7, and PSQI global scores were 2.30 ± 2.70 , 0.95 ± 1.61 , and 4.66 ± 2.67 , respectively. The emotional distress–predominant profile comprised 164 participants (31.00%) and was characterized by elevated depressive and anxiety symptoms (mean PHQ-9, 11.08 ± 4.40 ; mean GAD-7, 8.77 ± 3.77), while most sleep components were only modestly elevated. The sleep medication use–daytime dysfunction profile comprised 38 participants (7.18%). PHQ-9 and GAD-7 scores were comparatively low, whereas the mean PSQI global score was 10.55 ± 2.59 . Its most pronounced elevations involved use of sleeping medication, daytime dysfunction, subjective sleep quality, and sleep disturbances (Fig. 1 and Table 4).

Note

The y-axis shows posterior-probability-weighted standardized means of the profile indicators. Error bars indicate approximate 95% CIs calculated using posterior-probability-weighted effective sample sizes. Profile labels reflect the shape and clinically distinctive features of each profile.

Table 3
Average Posterior Probability Matrix for the Three-Profile Solution

Modal profile	Profile 1	Profile 2	Profile 3	n	%
Low emotional distress–low sleep burden	0.9754	0.0229	0.0017	327	61.81
Emotional distress–predominant	0.0561	0.9437	0.0002	164	31.00
Sleep medication use–daytime dysfunction	0.0000	0.0006	0.9994	38	7.18
Note: Rows indicate modal profile assignment and columns show the average posterior probability of membership in each profile. Higher diagonal values indicate greater classification precision. Profile 1, low emotional distress–low sleep burden; Profile 2, emotional distress–predominant; Profile 3, sleep medication use–daytime dysfunction.					

Table 4
Raw Emotional Distress and Sleep Indicator Scores Across Latent Profiles

Indicator	Overall (n = 529)	Profile 1	Profile 2	Profile 3
PHQ-9 total score	5.19 ± 5.29	2.30 ± 2.70	11.08 ± 4.40	4.61 ± 4.72
GAD-7 total score	3.51 ± 4.42	0.95 ± 1.61	8.77 ± 3.77	2.76 ± 3.52
Subjective sleep quality	0.87 ± 0.77	0.79 ± 0.71	0.80 ± 0.74	1.82 ± 0.80
Sleep latency	1.11 ± 0.67	1.04 ± 0.64	1.16 ± 0.72	1.45 ± 0.60
Sleep duration	0.50 ± 0.82	0.40 ± 0.73	0.68 ± 0.96	0.47 ± 0.83
Habitual sleep efficiency	1.02 ± 1.08	0.85 ± 1.03	1.35 ± 1.10	1.08 ± 1.12
Sleep disturbances	0.87 ± 0.66	0.81 ± 0.64	0.85 ± 0.61	1.47 ± 0.73
Use of sleeping medication	0.26 ± 0.64	0.13 ± 0.34	0.07 ± 0.27	2.24 ± 0.43
Daytime dysfunction	0.73 ± 0.84	0.64 ± 0.76	0.62 ± 0.75	2.03 ± 0.75
PSQI global score	5.36 ± 3.19	4.66 ± 2.67	5.55 ± 3.13	10.55 ± 2.59
Note: Data are presented as mean $\pm$ SD. Values in Table 4 are raw within-profile means based on modal assignment, whereas Fig. 1 shows posterior-probability-weighted standardized means; the two displays therefore use different estimation approaches. Because the nine indicators were used to derive the profiles, between-profile values are presented descriptively rather than as independent inferential comparisons. The PSQI global score was not used as a profile indicator and is shown only to aid clinical interpretation. Profile 1, low emotional distress–low sleep burden; Profile 2, emotional distress–predominant; Profile 3, sleep medication use–daytime dysfunction.				

Demographic, Clinical, and Psychosocial Characteristics Across Latent Profiles

The three profiles differed in sex, marital status, educational attainment, health insurance type, clinical status, and NRS 2002 score (all $P < 0.05$); other demographic and clinical variables did not differ significantly (Table 5). Holm-adjusted pairwise comparisons showed that,

relative to the low emotional distress–low sleep burden profile, the emotional distress–predominant profile included higher proportions of women (51.2% vs 37.0%), participants who were unmarried, widowed, or divorced (15.2% vs 5.8%), and participants with serious or critical clinical status (45.7% vs 30.3%), but a lower proportion with college-level education or higher (3.7% vs 13.1%). These comparisons are descriptive because they are based on modal profile assignment.

The profiles also differed in MCMQ avoidance and acceptance-resignation scores and MSPSS total score, whereas MCMQ confrontation scores did not differ significantly. Mean avoidance and acceptance-resignation scores were higher in the emotional distress–predominant profile than in the low emotional distress–low sleep burden profile (16.4 ± 2.4 vs 14.7 ± 2.8 and 11.9 ± 2.3 vs 9.5 ± 3.9 , respectively). Mean MSPSS total score was lower in the sleep medication use–daytime dysfunction profile than in the emotional distress–predominant profile (53.7 ± 11.8 vs 59.9 ± 15.2).

Table 5
Demographic, Clinical, and Psychosocial Characteristics Across Latent Profiles

Variable	Overall (n = 529)	Profile 1	Profile 2	Profile 3	Test	P value	Effect size
Age, years	64.8 ± 12.0	64.7 ± 11.8	65.2 ± 12.2	64.7 ± 12.9	Welch ANOVA	0.899	η²=0.000
Sex					Pearson χ²	0.010	V = 0.132
Male	307 (58.0)	206 (63.0)	80 (48.8)	21 (55.3)			
Female	222 (42.0)	121 (37.0)	84 (51.2)	17 (44.7)			
BMI, kg/m²	23.73 (21.22, 26.04)	23.78 (21.61, 26.03)	23.44 (20.81, 26.12)	24.12 (21.09, 26.67)	Kruskal–Wallis	0.543	ε²=0.000
Marital status					Pearson χ²	0.002	V = 0.153
Married	480 (90.7)	308 (94.2)	139 (84.8)	33 (86.8)			
Unmarried/widowed/divorced	49 (9.3)	19 (5.8)	25 (15.2)	5 (13.2)			
Educational attainment					Pearson χ²	0.018	V = 0.106
Junior high school or below	380 (71.8)	229 (70.0)	126 (76.8)	25 (65.8)			
Senior high school or technical secondary school	94 (17.8)	55 (16.8)	32 (19.5)	7 (18.4)			
College or above	55 (10.4)	43 (13.1)	6 (3.7)	6 (15.8)			
Health insurance type					Pearson χ²	0.003	V = 0.123
Resident medical insurance	372 (70.3)	226 (69.1)	125 (76.2)	21 (55.3)			
Employee medical insurance	140 (26.5)	93 (28.4)	30 (18.3)	17 (44.7)			
Other	17 (3.2)	8 (2.4)	9 (5.5)	0 (0.0)			
Occupation					Pearson χ²	0.124	V = 0.120
Farmer	149 (28.2)	94 (28.7)	44 (26.8)	11 (28.9)			
Worker	69 (13.0)	36 (11.0)	29 (17.7)	4 (10.5)			
Enterprise, public institution, or public-sector employee	67 (12.7)	47 (14.4)	13 (7.9)	7 (18.4)			
Self-employed	53 (10.0)	30 (9.2)	17 (10.4)	6 (15.8)			
Unemployed	73 (13.8)	42 (12.8)	29 (17.7)	2 (5.3)			
Retired	118 (22.3)	78 (23.9)	32 (19.5)	8 (21.1)			
Monthly per capita household income, CNY					Pearson χ²	0.055	V = 0.094
< 3000	213 (40.3)	123 (37.6)	80 (48.8)	10 (26.3)			
3000 to < 5000	213 (40.3)	137 (41.9)	56 (34.1)	20 (52.6)			

Note: Continuous variables are presented as mean ± SD or median (25th, 75th percentiles), as appropriate; categorical variables are presented as n (%). Continuous variables were compared using Welch's ANOVA or the Kruskal–Wallis test, and categorical variables using Pearson's χ² test or Fisher's exact test, as appropriate. η², ε², and V denote effect sizes for ANOVA, the Kruskal–Wallis test, and Cramér's V, respectively. BMI data were available for 520 participants. NRS 2002, Nutritional Risk Screening 2002. Profile 1, low emotional distress–low sleep burden; Profile 2, emotional distress–predominant; Profile 3, sleep medication use–daytime dysfunction.

Variable	Overall (n = 529)	Profile 1	Profile 2	Profile 3	Test	P value	Effect size
≥ 5000	103 (19.5)	67 (20.5)	28 (17.1)	8 (21.1)			
Area of residence					Pearson χ^2	0.174	V = 0.077
Rural area	244 (46.1)	155 (47.4)	74 (45.1)	15 (39.5)			
City	184 (34.8)	120 (36.7)	50 (30.5)	14 (36.8)			
Town	101 (19.1)	52 (15.9)	40 (24.4)	9 (23.7)			
Living arrangement					Pearson χ^2	0.659	V = 0.048
With spouse	288 (54.4)	184 (56.3)	82 (50.0)	22 (57.9)			
With children or with spouse and children	182 (34.4)	106 (32.4)	63 (38.4)	13 (34.2)			
Alone or with parents	59 (11.2)	37 (11.3)	19 (11.6)	3 (7.9)			
Additional chronic conditions (excluding hypertension and diabetes)					Pearson χ^2	0.831	V = 0.037
1	54 (10.2)	35 (10.7)	16 (9.8)	3 (7.9)			
2	266 (50.3)	165 (50.5)	79 (48.2)	22 (57.9)			
≥ 3	209 (39.5)	127 (38.8)	69 (42.1)	13 (34.2)			
Level of nursing care					Pearson χ^2	0.076	V = 0.099
Level I	284 (53.7)	164 (50.2)	100 (61.0)	20 (52.6)			
Level II or III	245 (46.3)	163 (49.8)	64 (39.0)	18 (47.4)			
Clinical status					Pearson χ^2	0.003	V = 0.148
Neither serious nor critical	340 (64.3)	228 (69.7)	89 (54.3)	23 (60.5)			
Serious or critical	189 (35.7)	99 (30.3)	75 (45.7)	15 (39.5)			
Primary caregiver during hospitalization					Pearson χ^2	0.127	V = 0.097
None	134 (25.3)	91 (27.8)	33 (20.1)	10 (26.3)			
Spouse	185 (35.0)	122 (37.3)	53 (32.3)	10 (26.3)			
Children	155 (29.3)	82 (25.1)	60 (36.6)	13 (34.2)			
Other	55 (10.4)	32 (9.8)	18 (11.0)	5 (13.2)			
NRS 2002 score	1.0 (0.0, 2.0)	1.0 (0.0, 2.0)	2.0 (0.0, 3.0)	1.0 (0.0, 2.0)	Kruskal–Wallis	< 0.001	$\epsilon^2=0.031$
Hospital tier					Pearson χ^2	0.103	V = 0.093
Tertiary Grade A	476 (90.0)	300 (91.7)	145 (88.4)	31 (81.6)			

Note: Continuous variables are presented as mean $\pm$ SD or median (25th, 75th percentiles), as appropriate; categorical variables are presented as n (%). Continuous variables were compared using Welch's ANOVA or the Kruskal–Wallis test, and categorical variables using Pearson's χ^2 test or Fisher's exact test, as appropriate. η^2 , ϵ^2 , and V denote effect sizes for ANOVA, the Kruskal–Wallis test, and Cramér's V, respectively. BMI data were available for 520 participants. NRS 2002, Nutritional Risk Screening 2002. Profile 1, low emotional distress–low sleep burden; Profile 2, emotional distress–predominant; Profile 3, sleep medication use–daytime dysfunction.

Variable	Overall (n = 529)	Profile 1	Profile 2	Profile 3	Test	P value	Effect size
Other	53 (10.0)	27 (8.3)	19 (11.6)	7 (18.4)			
MCMQ confrontation score	19.3 ± 3.4	19.3 ± 3.8	19.3 ± 2.6	18.8 ± 3.3	Welch ANOVA	0.589	$\eta^2=0.002$
MCMQ avoidance score	15.2 ± 2.8	14.7 ± 2.8	16.4 ± 2.4	14.8 ± 2.7	Welch ANOVA	< 0.001	$\eta^2=0.078$
MCMQ acceptance-resignation score	10.3 ± 3.6	9.5 ± 3.9	11.9 ± 2.3	10.4 ± 3.7	Welch ANOVA	< 0.001	$\eta^2=0.091$
MSPSS total score	58.5 ± 15.5	58.4 ± 15.9	59.9 ± 15.2	53.7 ± 11.8	Welch ANOVA	0.025	$\eta^2=0.010$
Note: Continuous variables are presented as mean ± SD or median (25th, 75th percentiles), as appropriate; categorical variables are presented as n (%). Continuous variables were compared using Welch's ANOVA or the Kruskal–Wallis test, and categorical variables using Pearson's χ^2 test or Fisher's exact test, as appropriate. η^2 , ϵ^2 , and V denote effect sizes for ANOVA, the Kruskal–Wallis test, and Cramér's V, respectively. BMI data were available for 520 participants. NRS 2002, Nutritional Risk Screening 2002. Profile 1, low emotional distress–low sleep burden; Profile 2, emotional distress–predominant; Profile 3, sleep medication use–daytime dysfunction.							

Factors Associated With Latent Profile Membership

With the low emotional distress–low sleep burden profile as the reference category, mean bias-reduced multinomial logistic regression showed that serious or critical clinical status was associated with higher odds of membership in the emotional distress–predominant profile (aOR = 1.60, 95% CI: 1.04–2.47, $P = 0.033$). Higher NRS 2002 scores were also associated with higher odds of membership (per 1-point increase: aOR = 1.24, 95% CI: 1.09–1.40, $P < 0.001$), as were higher MCMQ avoidance scores (per 1-point increase: aOR = 1.27, 95% CI: 1.17–1.37, $P < 0.001$) and acceptance-resignation scores (per 1-point increase: aOR = 1.19, 95% CI: 1.11–1.26, $P < 0.001$). For female sex, the estimated association was aOR = 1.51 (95% CI: 0.99–2.32, $P = 0.057$). No clear independent association was observed for the MSPSS total score.

For the sleep medication use–daytime dysfunction profile, no modeled covariate showed a clear association with profile membership relative to the low emotional distress–low sleep burden profile. For the MSPSS total score, the aOR per 10-point increase was 0.81 (95% CI: 0.66–1.00, $P = 0.052$). Results of the primary model are presented in Table 6 and Fig. 2.

Table 6
Factors Associated With Latent Profile Membership

Variable	Profile 2 vs Profile 1, aOR (95% CI)	P value	Profile 3 vs Profile 1, aOR (95% CI)	P value
Female (ref: male)	1.51 (0.99–2.32)	0.057	1.39 (0.71–2.73)	0.339
Serious/critical clinical status (ref: neither)	1.60 (1.04–2.47)	0.033	1.45 (0.73–2.87)	0.289
NRS 2002 score (per 1-point increase)	1.24 (1.09–1.40)	< 0.001	1.00 (0.80–1.25)	0.972
MCMQ avoidance (per 1-point increase)	1.27 (1.17–1.37)	< 0.001	1.01 (0.89–1.15)	0.866
MCMQ acceptance-resignation (per 1-point increase)	1.19 (1.11–1.26)	< 0.001	1.06 (0.97–1.17)	0.193
MSPSS total score (per 10-point increase)	1.05 (0.92–1.21)	0.458	0.81 (0.66–1.00)	0.052
Note: Estimates are from mean bias-reduced multinomial logistic regression, with Profile 1 as the reference outcome category. All variables shown were included simultaneously in the model. Profile 1, low emotional distress–low sleep burden; Profile 2, emotional distress–predominant; Profile 3, sleep medication use–daytime dysfunction. aOR, adjusted odds ratio; CI, confidence interval; NRS 2002, Nutritional Risk Screening 2002; MCMQ, Medical Coping Modes Questionnaire; MSPSS, Multidimensional Scale of Perceived Social Support.				

Note

Points represent adjusted odds ratios, and horizontal lines represent 95% CIs; the dashed vertical line indicates aOR = 1. Estimates are from mean bias-reduced multinomial logistic regression, with the low emotional distress–low sleep burden profile as the reference outcome category. Male sex and neither serious nor critical clinical status were the reference categories.

Discussion

Heterogeneity in Emotional Distress and Sleep Characteristics

We identified three latent profiles: low emotional distress–low sleep burden (61.81%), emotional distress–predominant (31.00%), and sleep medication use–daytime dysfunction (7.18%). The three-profile solution showed high classification quality (entropy = 0.9182; average maximum posterior probability = 0.9673). The profiles did not form a simple severity continuum. Rather, emotional and sleep indicators showed different configurations: the emotional distress–predominant profile was marked by elevated depressive and anxiety symptoms with only modest sleep elevations, whereas the sleep medication use–daytime dysfunction profile showed pronounced abnormalities in selected sleep components despite comparatively lower emotional symptom levels. Previous person-centered studies in type 2 diabetes have likewise identified subgroups defined by different combinations of diabetes distress, depression, anxiety, sleep problems, and other psychological or somatic symptoms, while latent class studies in coronary heart disease have shown heterogeneity in the composition of sleep problems [21–23, 39]. Together, these findings highlight how analyses based solely on mean values or global scale scores can obscure clinically relevant symptom configurations in chronic cardiometabolic disease.

The three-profile solution also offered greater substantive parsimony than more complex solutions. Although information criteria continued to improve as profiles were added, the four-profile solution mainly subdivided the low-burden group, retained broadly similar emotional distress–predominant and sleep medication use–daytime dysfunction profiles, and had lower entropy than the three-profile solution. The five- and six-profile solutions each produced a 12-participant profile. The retained three-profile solution therefore reflects a balance among relative fit, classification quality, profile size, parsimony, and clinical interpretability rather than selection on the basis of a single statistical index [37].

Emotional Distress–Predominant Profile and Associated Physiological and Psychological Characteristics

The emotional distress–predominant profile comprised 31.00% of the sample and was characterized by elevated depressive and anxiety symptoms (mean PHQ-9, 11.08 ± 4.40 ; mean GAD-7, 8.77 ± 3.77) despite only modest elevations in most sleep components. Similar person-centered studies in type 2 diabetes have identified subgroups dominated by emotional distress that are distinct from low-symptom or broadly high-symptom groups [21, 23]. Symptom-network research in populations with hypertension and diabetes has also suggested that chronic disease status may be associated with differences in the organization of depressive and anxiety symptoms, although demographic composition may partly explain between-group variation [40]. Our findings extend this evidence by showing that, among hospitalized patients with both conditions, substantial emotional distress can occur without a parallel increase across all dimensions of sleep disturbance. This pattern supports assessment of emotional and sleep domains as related but non-interchangeable aspects of the inpatient symptom experience.

Within the Theory of Unpleasant Symptoms, clinical status and nutritional risk represent physiological factors that can shape symptom experience. In the adjusted model, serious or critical clinical status and higher NRS 2002 scores were associated with greater odds of membership in the emotional distress–predominant profile. These cross-sectional associations do not establish directionality, but they may reflect the psychological burden accompanying greater illness severity, treatment uncertainty, concern about complications, activity restriction, or reduced perceived control. Higher NRS 2002 scores indicate greater nutritional risk and may also capture reduced intake, disease burden, dietary restrictions, or diminished physiological reserve. Previous work in hospitalized patients with diabetes has linked nutritional intake, anthropometric measures, treatment adherence, and physical activity with depressive and anxiety symptoms while acknowledging potentially bidirectional relationships [41]. Clinical status and nutritional risk may therefore provide useful context when psychological symptoms are assessed during hospitalization.

Higher avoidance and acceptance-resignation coping scores were also independently associated with membership in the emotional distress–predominant profile, and conventional maximum-likelihood sensitivity analysis yielded broadly similar effect directions and magnitudes. Avoidance may temporarily reduce exposure to illness-related threat while limiting problem solving, symptom communication, or active help-seeking; acceptance-resignation may reflect helplessness and diminished perceived control. Previous structural equation and path analyses have described interrelationships among stress, coping, social support, sleep, depression, and anxiety [17, 42], and lower social support has been associated with a greater likelihood of depression in type 2 diabetes [18]. In contrast, MSPSS total score showed no clear independent association with emotional distress–predominant profile membership after multivariable adjustment. This discrepancy may reflect differences in patient characteristics, the dimensions or quality of support captured, or adjustment for correlated psychosocial factors rather than evidence that social support is unimportant. Women, participants who were

not married, and those with lower educational attainment were more frequently represented in this profile in descriptive between-profile comparisons; these differences should not be interpreted as independent correlates established by the adjusted model.

Sleep Medication Use–Daytime Dysfunction Profile: Characteristics and Associated Factors

The sleep medication use–daytime dysfunction profile comprised 7.18% of the sample and showed particularly high classification certainty. Its mean PSQI global score was 10.55 ± 2.59 , with marked elevations in use of sleeping medication (2.24 ± 0.43) and daytime dysfunction (2.03 ± 0.75). Subjective sleep quality and sleep disturbances were also elevated, whereas sleep duration and habitual sleep efficiency were less prominent. The profile label therefore reflects its most distinctive component pattern rather than overall sleep severity alone. Previous studies in patients with hypertension and type 2 diabetes have reported poor sleep quality in nearly 60% of patients and associations with age, stroke history, and anxiety [43]. A systematic review identified nocturia, diabetes-related complications, glycemic control, risk of obstructive sleep apnea, psychological factors, environmental factors, and social support as correlates of sleep quality [44]. Higher perceived stress has also been associated with poorer subjective sleep quality, greater use of sleeping medication, and greater daytime dysfunction in type 2 diabetes [45]. These observations are consistent with the multidimensional nature of the sleep pattern identified here.

Although MSPSS total score was lower in the sleep medication use–daytime dysfunction profile than in the emotional distress–predominant profile in descriptive comparisons, it showed no clear independent association with membership in the adjusted model (aOR = 0.81, 95% CI: 0.66–1.00). This difference between unadjusted profile characterization and multivariable estimates underscores the need to distinguish descriptive group differences from independent associations. Previous research suggests complex relationships among coping, social support, stress, sleep, and glycemic control [17, 44], and sleep problems have also been associated with glycemic control, diabetes-related complications, and quality of life [7]. The pattern identified here may additionally reflect factors not measured in this study, including medication type, dose, frequency, and duration of use; nocturia; pain; sleep-disordered breathing; sleep disruption related to the hospital environment; and low daytime activity. Future studies incorporating sleep diaries, detailed medication data, and objective sleep monitoring could help clarify factors underlying this profile and the care needs of patients within it.

Implications for Nursing Assessment Within the Theory of Unpleasant Symptoms

The findings are compatible with the Theory of Unpleasant Symptoms, which emphasizes multisymptom experience and the joint influence of physiological, psychological, and situational factors. In this study, physiological factors (clinical status and nutritional risk) and psychological factors (avoidance and acceptance-resignation coping) were associated primarily with membership in the emotional distress–predominant profile. By contrast, none of the measured physiological, psychological, or situational factors showed a clear independent association with membership in the sleep medication use–daytime dysfunction profile. The factors associated with profile membership therefore appeared to differ across symptom configurations, while depressive symptoms, anxiety symptoms, and sleep characteristics did not vary in parallel. These data are consistent with the theoretical framework [15, 16] but, given the cross-sectional design, do not test its causal propositions.

For nursing practice, assessment may extend beyond isolated scale thresholds to consider joint patterns of emotional and sleep symptoms and the clinical context in which they occur. The profiles identified here are exploratory subgroup descriptions rather than diagnostic categories, but they may provide a framework for prioritizing further assessment. Patients in the low emotional distress–low sleep burden profile may require routine rescreening, self-management support, and ongoing symptom monitoring. For those in the emotional distress–predominant profile, nurses may interpret PHQ-9 and GAD-7 results alongside clinical assessment of self-harm risk, nutritional risk, and illness-related coping, with psychological or psychiatric consultation when clinically indicated. For patients in the sleep medication use–daytime dysfunction profile, further assessment may focus on medication type, dose, frequency, and duration of use, together with nocturia, pain, risk of obstructive sleep apnea, environmental sleep disruption during hospitalization, and daytime functioning. Current diabetes standards incorporate psychosocial care and sleep health into routine management [3], and systematic reviews suggest that cognitive behavioral therapy, collaborative care, and health education can improve depressive symptoms in people with diabetes, with some interventions also benefiting anxiety or metabolic outcomes [46]. These profiles may therefore help clinicians recognize distinct symptom configurations and prioritize psychological assessment, sleep evaluation, and specialist referral when indicated.

Strengths and Limitations

This study has several strengths. First, depressive symptoms, anxiety symptoms, and the seven PSQI component scores were modeled simultaneously, allowing multidimensional sleep patterns to be examined without relying solely on the PSQI global score. Second, the Theory of Unpleasant Symptoms provided a coherent framework for organizing physiological, psychological, and situational factors and interpreting their associations with profile membership. Third, profile selection incorporated multiple statistical and substantive criteria, including information criteria, entropy, average posterior probabilities, profile size, correspondence between the three- and four-profile solutions, and clinical interpretability. Finally, mean bias-reduced multinomial logistic regression was used to mitigate sparse-data bias and estimation instability associated with the small third profile; conventional maximum-likelihood sensitivity analysis yielded broadly similar effect directions and magnitudes.

Several limitations should be considered. First, the cross-sectional design precludes inference about temporal ordering or the direction of associations between the examined factors and profile membership. Second, the sleep medication use–daytime dysfunction profile was small, and external-variable analyses relied on modal profile assignment. Because modal assignment does not fully account for classification uncertainty, misclassification may have affected between-profile comparisons and regression estimates; these findings should therefore be interpreted as exploratory associations rather than definitive profile-specific effects. Third, the study relied primarily on self-report measures and lacked potentially relevant clinical information, including glycated hemoglobin (HbA1c), measured blood pressure, detailed medication data, and objective sleep measures. Future studies incorporating more comprehensive clinical and sleep assessments could clarify factors underlying the observed profiles. Finally, participants were recruited predominantly from Tertiary Grade A hospitals within the Chinese hospital classification system, which may limit generalizability to primary care, outpatient populations, and other healthcare settings.

Conclusions

Three distinct latent profiles of emotional distress and sleep characteristics were identified among hospitalized patients with hypertension and diabetes: low emotional distress–low sleep burden, emotional distress–predominant, and sleep medication use–daytime dysfunction. Serious or critical clinical status, greater nutritional risk as reflected by higher NRS 2002 scores, and higher avoidance and acceptance-resignation coping scores were associated with greater odds of membership in the emotional distress–predominant profile. These findings suggest that emotional and sleep symptoms do not necessarily vary in parallel. Nursing assessment may therefore benefit from considering joint symptom configurations alongside relevant clinical and psychological characteristics.

Abbreviations

aBIC
sample-size-adjusted Bayesian information criterion
AIC
Akaike information criterion
ANOVA
analysis of variance
APP
average posterior probability
aOR
adjusted odds ratio
BIC
Bayesian information criterion
BMI
body mass index
CI
confidence interval
EFA
exploratory factor analysis
GAD-7
Generalized Anxiety Disorder-7
LL
log-likelihood
LMR-LRT

Lo–Mendell–Rubin adjusted likelihood ratio test
LPA
latent profile analysis
MCMQ
Medical Coping Modes Questionnaire
MSPSS
Multidimensional Scale of Perceived Social Support
NRS 2002
Nutritional Risk Screening 2002
PHQ-9
Patient Health Questionnaire-9
PSQI
Pittsburgh Sleep Quality Index
SD
standard deviation
STROBE
Strengthening the Reporting of Observational Studies in Epidemiology.

Declarations

Ethics approval and consent to participate

The study protocol was reviewed and approved by the Ethics Committee of Renmin Hospital of Wuhan University (approval no. WDRY2022-K122). Before data collection, participants were informed about the study objectives and procedures, potential risks, privacy protections, and their right to withdraw. All participants provided written informed consent. Data were de-identified before analysis and used solely for this study. The study was conducted in accordance with the Declaration of Helsinki. Clinical trial number: not applicable.

Consent for publication

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Author Contribution

ZW, TL, and WL contributed equally to the conception and design of the study, participant recruitment, data collection, data interpretation, and preparation of the manuscript. YL, YW, YS, and ZX contributed to participant recruitment, data collection, data management, and critical revision of the manuscript. ZC and YX contributed to the conception and design of the study, supervised and coordinated the research, interpreted the findings, and critically revised the manuscript for important intellectual content. ZW, TL, and WL contributed equally to this work. ZC and YX jointly supervised the work and share corresponding authorship. All authors read and approved the final manuscript.

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The datasets generated and/or analyzed during the current study are not publicly available because they contain potentially sensitive clinical information. De-identified data are available from the corresponding authors on reasonable request and subject to applicable

Data Availability

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Figures

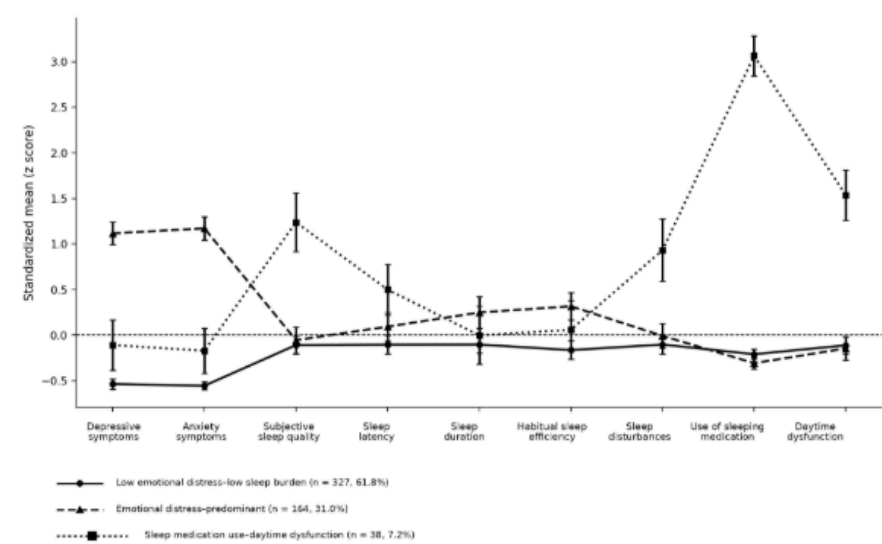


Figure 1

Three Latent Profiles of Emotional Distress and Sleep Among Hospitalized Patients With Hypertension and Diabetes

Note: The y-axis shows posterior-probability-weighted standardized means of the profile indicators. Error bars indicate approximate 95% CIs calculated using posterior-probability-weighted effective sample sizes. Profile labels reflect the shape and clinically distinctive features of each profile.

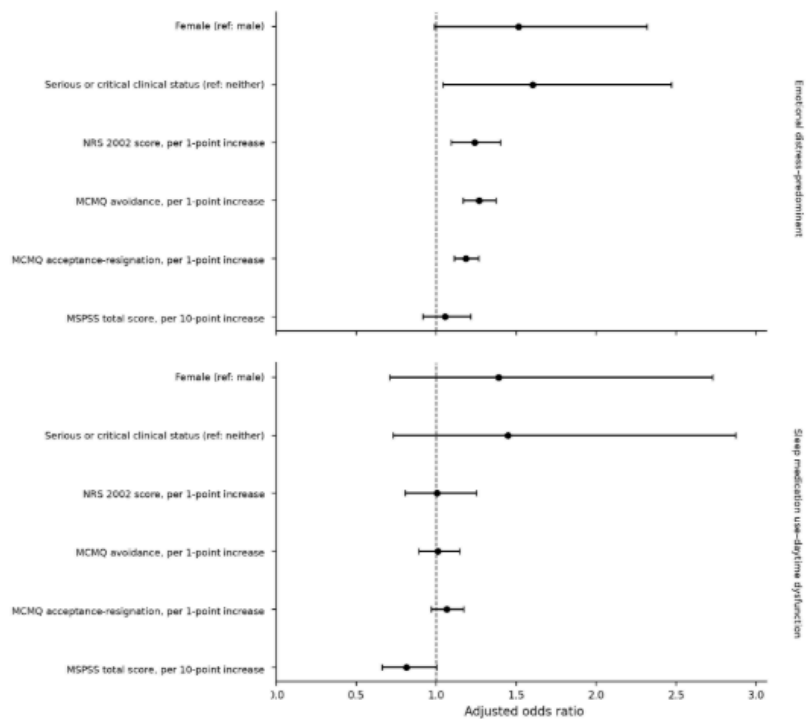


Figure 2

Factors Associated With Latent Profile Membership Among Hospitalized Patients With Hypertension and Diabetes

Note: Points represent adjusted odds ratios, and horizontal lines represent 95% CIs; the dashed vertical line indicates aOR = 1. Estimates are from mean bias-reduced multinomial logistic regression, with the low emotional distress–low sleep burden profile as the reference outcome category. Male sex and neither serious nor critical clinical status were the reference categories.