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Latent Profiles of Perceived Social Support and Illness-Related Coping in Hospitalized Patients With Coexisting Hypertension and Diabetes: A Multicenter Cross-Sectional Study

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Abstract

Background

Hospitalized patients with coexisting hypertension and diabetes face substantial psychosocial and self-management demands, yet person-centered heterogeneity in perceived social support and illness-related coping remains poorly characterized. We aimed to identify latent support-coping profiles, compare depressive symptoms, anxiety symptoms, and sleep quality across profiles, and examine demographic and clinical correlates of profile membership.

Methods

This multicenter cross-sectional study enrolled 514 patients from 24 clinical departments across four hospitals in Hubei Province, China. Latent profile analysis used three Medical Coping Modes Questionnaire dimensions and three source-specific Multidimensional Scale of Perceived Social Support subscales as indicators. Between-profile differences in Patient Health Questionnaire-9, Generalized Anxiety Disorder-7, and Pittsburgh Sleep Quality Index scores were assessed using the Bolck-Croon-Hagenaars method with 1,000 nonparametric bootstrap resamples. Demographic and clinical correlates were examined using multinomial logistic regression with multiple pseudo-class draws and Holm correction.

Results

Five profiles were retained: very low support across sources (3.7%), low support across sources (42.8%), family-dominant support (8.4%), moderate-to-high support across sources (30.0%), and high support across sources (15.2%). Entropy was 0.940 and the mean maximum posterior membership probability was 0.963. Profiles differed primarily in the level and sources of perceived social support, whereas differences in coping dimensions were modest. Depressive and anxiety symptoms did not differ significantly across profiles. Sleep quality differed overall, but the pattern was nonmonotonic: the low-support profile had poorer sleep than the high-support profile, whereas the very-low-support profile had better sleep than the low-support and moderate-to-high-support profiles. Because the very-low-support profile included only 19 patients, these estimates warrant caution. After Holm adjustment, none of the measured demographic or clinical characteristics was associated with profile membership.

Conclusions

Psychosocial heterogeneity among hospitalized patients with coexisting hypertension and diabetes was characterized mainly by the level and sources of perceived social support. Sleep quality differed across profiles without a monotonic gradient, whereas depressive symptoms, anxiety symptoms, and measured demographic and clinical characteristics showed no consistent profile-specific differences. Source-specific social support and sleep quality should be assessed directly rather than inferred from routine characteristics.

Background

Hypertension and diabetes are common chronic noncommunicable diseases with a substantial and growing global burden. In 2019, an estimated 1.28 billion adults aged 30–79 years worldwide had hypertension [1]. In 2024, approximately 589 million adults aged 20–79 years were estimated to be living with diabetes globally, including approximately 148 million in China [2]. A systematic review and meta-analysis of patients with type 2 diabetes in China reported a pooled hypertension prevalence of 54%, increasing to 56% in populations recruited from healthcare settings [3]. Coexisting hypertension and diabetes further increase the risks of cardiovascular and renal complications and impose sustained self-management demands, including polypharmacy, blood pressure and glucose monitoring, lifestyle modification, and ongoing healthcare use [4, 5]. Current diabetes management guidelines therefore incorporate psychosocial status, family and social resources, coping capacity, and sleep health into comprehensive assessment [6]. These issues may be particularly salient during hospitalization, when changes in clinical status, treatment regimens, usual care routines, and the physical environment can increase support needs and make adaptation more difficult. Noise, light exposure, pain, anxiety, and nighttime nursing activities may further disrupt sleep [7]. Although biomedical indicators such as blood pressure, glycemia, and target-organ damage are essential for characterizing disease status, they do not capture patients' perceived support resources or responses to illness-related stress.

Lazarus and Folkman's stress–appraisal–coping framework provides a conceptual basis for understanding these psychosocial processes. Stress reflects an individual's appraisal of situational demands relative to available resources, whereas coping refers to the cognitive and behavioral efforts used to manage demands appraised as taxing or exceeding those resources [8]. Social support may be associated directly with health and psychological outcomes and may also buffer the effects of stress under specific circumstances [9]. Nursing research has similarly integrated health threats, psychosocial context, coping resources, coping responses, and health outcomes within a common framework [10]. We therefore viewed hospitalization in patients with coexisting hypertension and diabetes as a sustained context of health-related stress. Perceived social support was conceptualized as an external coping resource, whereas the MCMQ dimensions represented illness-related coping responses.

Depressive symptoms, anxiety symptoms, and sleep quality were used to describe psychological and sleep-related differences across the resulting support–coping profiles. Because primary and secondary appraisal were not measured directly, the framework was used to organize the study variables and guide interpretation rather than to test the complete theoretical process or a causal pathway.

Perceived social support refers to an individual's subjective appraisal of the availability and adequacy of interpersonal support. Support from different sources may serve distinct functions in emotional communication, information provision, and practical assistance. The Multidimensional Scale of Perceived Social Support (MSPSS) distinguishes support from family, friends, and significant others, allowing support from different sources to be examined separately rather than collapsed into a single overall score [11]. Meta-analytic evidence indicates that social support is associated with self-care among patients with diabetes, although the strength of this association varies by diabetes type, support measurement, and population characteristics [12]. The MCMQ captures three forms of illness-related coping—confrontation, avoidance, and acceptance-resignation—which are influenced by disease characteristics, psychological status, and available resources and should not be classified rigidly as inherently adaptive or maladaptive [13, 14]. Longitudinal research in patients with cardiac disease has suggested dynamic relationships among family and nonfamily social relationships, coping responses, and depressive symptoms [15]. Path analysis in hospitalized patients with type 2 diabetes has likewise shown complex associations among social support, coping, depression, and anxiety [16]. We therefore modeled source-specific perceived support and MCMQ coping dimensions jointly, without assuming a predetermined linear relationship between them.

Depressive and anxiety symptoms capture important dimensions of emotional distress in the context of illness-related threats, uncertainty, and long-term management demands, whereas sleep quality is also influenced by physical symptoms, treatment schedules, nursing activities, and the hospital environment [6, 7]. A meta-analysis estimated that approximately 39% of patients with type 2 diabetes had insomnia or insomnia symptoms, although substantial heterogeneity was observed across studies [17]. An umbrella review likewise reported a considerable burden of depression in type 2 diabetes, with prevalence estimates varying markedly by geographic region, measurement instrument, and study population [18]. Systematic review and meta-analytic evidence also supports associations between diabetes and anxiety symptoms or anxiety disorders [19]. A systematic review of sleep quality further suggested that depression, anxiety, disease characteristics, environmental factors, and social support may all be associated with sleep quality among patients with type 2 diabetes [20]. Structural equation modeling studies have also reported interrelations among stress, social support, coping, and sleep disturbance [21]. Together, these findings suggest that psychological symptoms and sleep quality may vary across distinct support–coping profiles, although such differences may depend on support source, disease stage, and hospitalization context and need not follow a simple dose–response gradient.

Previous studies have predominantly used correlational analyses, regression, path analysis, or structural equation modeling to examine average associations among social support, coping, and psychological or sleep-related outcomes [16, 21]. These variable-centered approaches are not designed primarily to identify subgroups of patients with distinct combinations of support sources and coping responses. For example, patients with similar overall levels of perceived social support may rely mainly on family or friends, potentially reflecting different coping characteristics and nursing needs. Person-centered studies have identified distinct profiles of knowledge, self-efficacy, psychological health, and physical health among patients with type 2 diabetes [22], multiple coping configurations among patients with chronic diseases [23], and different chronic disease self-management profiles among patients with coexisting hypertension and type 2 diabetes [24]. These findings suggest substantial between-patient psychosocial heterogeneity in chronic disease populations. However, few studies have examined latent profiles in hospitalized patients with coexisting hypertension and diabetes by jointly considering perceived support from family, friends, and significant others together with confrontation, avoidance, and acceptance-resignation. Evidence is particularly limited regarding differences in depressive symptoms, anxiety symptoms, and sleep quality across such profiles while accounting for uncertainty in profile membership.

Guided by the stress–appraisal–coping framework, we aimed to (1) identify latent profiles of perceived social support and illness-related coping among hospitalized patients with coexisting hypertension and diabetes; (2) compare depressive symptoms, anxiety symptoms, and sleep quality across profiles while accounting for classification uncertainty; and (3) examine demographic and clinical correlates of profile membership. The findings may help clarify psychosocial heterogeneity in this population and inform future stratified assessment and external validation. Given the cross-sectional design, the study addresses latent configurations and concurrent associations rather than temporal or causal relationships.

Methods

Study Design and Setting

We conducted a multicenter cross-sectional study of hospitalized patients with coexisting hypertension and diabetes. Data were collected from February to June 2024 at four tertiary or secondary hospitals in Hubei Province, China. Participating departments primarily included cardiology, endocrinology, and geriatric medicine. The study is reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement [25].

Participants

Patients hospitalized at participating institutions during the study period were recruited by convenience sampling. Inclusion criteria were: (1) age ≥18 years; (2) documented diagnoses of both hypertension and diabetes in the inpatient medical record, confirmed by the attending physician; (3)

ability to understand the study information and complete the questionnaire; and (4) provision of informed consent. Exclusion criteria were: (1) unstable vital signs, an emergency requiring resuscitation, or a judgment by the attending physician that questionnaire completion was inappropriate at the time of assessment; (2) severe cognitive impairment, impaired consciousness, or substantial language or communication difficulties; (3) duplicate participation; and (4) missing key study variables or a questionnaire judged invalid after quality-control review.

Diagnoses of hypertension and diabetes were ascertained from admission records and confirmed by the attending physician; diagnoses were not reclassified on the basis of self-reported questionnaire data. When duplicate submissions from the same patient were identified, the first completed questionnaire meeting the quality-control requirements was retained for analysis.

We did not perform an outcome-based a priori sample-size calculation because the estimation requirements for latent profile analysis (LPA) depend jointly on profile prevalence, profile separation, the number and distribution of indicators, and model parameterization [35–36]. Accordingly, all eligible patients who completed a valid survey during the prespecified data-collection period were included. Sample adequacy for model estimation was evaluated collectively from model convergence, replication of the best log-likelihood, profile size, average posterior membership probabilities, entropy, and sensitivity analyses. The final analytic sample comprised 514 participants; the smallest profile included 19 patients (3.7%). The implications of this small profile are addressed in the Results and Limitations.

Data Collection and Quality Control

At each hospital, the nursing department coordinated participating departments, data collectors, participant screening, and data collection. Before data collection, the research team trained all data collectors using a common survey protocol covering the study objectives, eligibility criteria, questionnaire administration, communication procedures, and protection of personal information.

Trained data collectors screened potential participants against the eligibility criteria. Questionnaires were administered when patients were clinically stable and participation would not interfere with diagnostic or therapeutic activities. After receiving information about the study objectives, survey content, and confidentiality measures, participants completed the questionnaire voluntarily. Electronic and paper questionnaires had identical content, item order, and scoring rules. Participants completed the questionnaires independently whenever possible. For patients unable to do so because of visual impairment, limited literacy, or difficulty using the survey device, a trained data collector read each item and the original response options aloud and recorded the selected response without prompting or interpretation. Paper questionnaires were checked for completeness before data entry, after which electronic and paper data were harmonized using a common variable dictionary.

Data collectors checked each questionnaire for completeness immediately after completion. The research team then processed the data using standardized variable definitions and scoring rules. Duplicate submissions were identified from hospital identifiers, inpatient numbers, and submission times. Hospital identifiers and inpatient numbers were used only for verification and deduplication and were removed before statistical analysis.

Quality-control procedures were applied throughout data collection, data entry, and analysis. Standardized survey procedures, administration instructions, and training requirements were used across sites. After data entry, paper questionnaires were checked item by item against the original forms, whereas electronic data were examined for permissible ranges, logical consistency, and unusual submission patterns. All questionnaires were assessed for completeness of key variables, duplicate submissions, correct reverse scoring, and adherence to the theoretical score ranges of the instruments. For electronic questionnaires with recorded completion times, potential insufficient-effort responding (IER) was screened using both completion time and invariant within-scale response patterns. A questionnaire was classified as low quality only when completion time was <180 s and the same response option had been selected for every item in at least three of the following five instruments: PHQ-9, GAD-7, MCMQ, MSPSS, and PSQI. No completion-time threshold was applied to paper questionnaires; these were evaluated primarily for completeness, logical consistency, and abnormal invariant response patterns across scales. Sensitivity analyses varied duplicate-retention rules and questionnaire-quality criteria to assess the stability of the main latent profiles.

Measures and Study Variables

Indicators for Latent Profiles of Perceived Social Support and Illness-Related Coping

The three MCMQ dimension scores and the three source-specific MSPSS subscale scores served as the six LPA indicators. The MCMQ assessed illness-related coping responses, whereas the MSPSS assessed perceived social support from different sources. The indicators were modeled jointly to identify patient-level support–coping profiles; they were not combined into a composite score or assumed to measure a single underlying construct.

The MCMQ was developed by Feifel et al. and subsequently adapted for use in Chinese populations and psychometrically evaluated by Shen and Jiang [13,26]. The Chinese version contains 20 items rated on a 4-point response scale and comprises three dimensions: confrontation, avoidance, and acceptance-resignation. Confrontation contains 8 items (score range, 8–32), avoidance 7 items (7–28), and acceptance-resignation 5 items

(5–20). Reverse-scored items were recoded according to the Chinese scoring rules. Dimension scores were calculated separately, with higher scores indicating greater use of the corresponding coping response.

The MSPSS was developed by Zimet et al., and its reliability and validity have been supported in mainland Chinese populations [11,27]. The 12-item scale uses a 7-point response format and assesses perceived support from three sources: significant others, family, and friends. Each source-specific subscale contains 4 items and ranges from 4 to 28, with higher scores indicating greater perceived support. The three subscale scores, rather than the total MSPSS score, were used as profile indicators to retain source-specific information.

All six dimension scores were calculated from the original item-level responses according to the corresponding scoring rules. Before LPA, each dimension was standardized to a z score using the mean and standard deviation of the primary analytic sample (N = 514). The same standardization parameters were applied in all sensitivity-analysis samples to preserve comparability.

Depressive Symptoms, Anxiety Symptoms, and Sleep Quality

Depressive symptoms were assessed with the Patient Health Questionnaire-9 (PHQ-9), developed by Kroenke et al.; the Chinese version has been validated in Chinese populations [28–29]. The PHQ-9 assesses symptoms over the preceding 2 weeks using 9 items scored from 0 to 3. Total scores range from 0 to 27, with higher scores indicating more severe depressive symptoms.

Anxiety symptoms were assessed with the Generalized Anxiety Disorder-7 (GAD-7), developed by Spitzer et al.; the Chinese version has been validated among inpatients in Chinese general hospitals [30–31]. The GAD-7 assesses symptoms over the preceding 2 weeks using 7 items scored from 0 to 3. Total scores range from 0 to 21, with higher scores indicating more severe anxiety symptoms.

Sleep quality was assessed with the Pittsburgh Sleep Quality Index (PSQI), developed by Buysse et al.; the Chinese version has demonstrated acceptable reliability and validity [32,33]. The PSQI assesses sleep quality and sleep-related disturbances over the preceding month across 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, yielding a total score of 0–21; higher scores indicate poorer sleep quality. The total score was analyzed continuously, and no sample-specific cutoff was applied.

The PHQ-9, GAD-7, and PSQI were administered in the same cross-sectional assessment as the profile indicators. Between-profile comparisons therefore describe concurrent differences in depressive symptoms, anxiety symptoms, and sleep quality and do not establish temporal order or causal direction.

Demographic and Clinical Covariates

The core model included age, sex, number of other chronic conditions, recorded disease severity, and Nutritional Risk Screening 2002 (NRS 2002) score. Age was modeled per 10-year increase, with male sex as the reference category. The number of other chronic conditions was obtained from inpatient records after excluding hypertension and diabetes, which were eligibility conditions. The source variable was coded as 0, 1, or ≥2 other chronic conditions. Because no participant had zero other chronic conditions, it was modeled as 1 versus ≥2 conditions, with 1 condition as the reference category. Thus, hypertension and diabetes were excluded from this count.

Diagnostic information was extracted from inpatient medical records, and both hypertension and diabetes were confirmed by the attending physician. However, the analytic dataset did not contain a diabetes-type variable coded reliably enough for analysis; participants were therefore not stratified or restricted by diabetes type. Evidence specific to type 2 diabetes is explicitly identified as such in the Introduction and Discussion.

Recorded disease severity was dichotomized as critical or severe versus neither critical nor severe, with the latter as the reference category. This variable reflected the documented severity classification and was distinct from the clinical assessment used to determine whether a patient was suitable to complete the questionnaire at the time of data collection. Patients recorded as having critical or severe disease could therefore be included if they were clinically stable at the time of the survey and the attending physician judged questionnaire completion appropriate.

Nutritional risk was assessed using the Nutritional Risk Screening 2002 (NRS 2002). The NRS 2002 integrates impaired nutritional status, disease severity, and age into a score ranging from 0 to 7; according to the instrument scoring rules, patients aged ≥70 years receive an additional 1 point. The NRS 2002 score was entered into the model as a continuous variable per 1-point increase. The original NRS 2002 method and European Society for Clinical Nutrition and Metabolism (ESPEN) nutritional screening guidelines have been reported previously [34].

Educational attainment and primary caregiver during hospitalization were included in prespecified extended models. Educational attainment was categorized as junior high school or below, senior high school or technical secondary school, and college or above. Primary caregiver was categorized as family caregiver, no primary caregiver, or paid or other caregiver. Because the MCMQ and MSPSS dimensions defined the latent profiles, they were not entered again as covariates in models of profile membership. Disease duration was excluded because special codes in the source data could not be mapped reliably to clinically interpretable values.

Scoring, Missing Data, and Psychometric Evaluation

All scale scores were reconstructed from item-level responses using a standardized data dictionary and the corresponding scoring rules. PHQ-9, GAD-7, MCMQ, MSPSS, and PSQI scores were calculated only when all required items were available; no item-level prorating or scale-score imputation was performed. Prespecified missing-value codes were identified and handled consistently before analysis. After scoring, permissible item ranges, reverse scoring, theoretical score ranges, data completeness, and reconstructed scores were verified. The PSQI sleep-efficiency component was recalculated from cleaned sleep-onset and wake times whenever these data could be interpreted reliably. When the original clock-time data did not permit reliable calculation, sleep efficiency was derived using a procedure prespecified before analysis.

Psychometric evaluation of the MCMQ and MSPSS included item distributions, response-category use, floor and ceiling effects, and internal consistency. In addition to Cronbach's α, ordinal α and McDonald's ω were estimated from polychoric correlation matrices to account for the ordinal nature of the items. The prespecified three-factor structures of the MCMQ and MSPSS were evaluated separately using the weighted least squares mean- and variance-adjusted (WLSMV) estimator. These analyses were used to inform profile labeling and interpretation, not to delete items or modify the standard scoring rules.

Latent Profile Analysis and Profile Enumeration

LPA was conducted using the six standardized dimension scores as continuous indicators. In the primary model, the residual variance of each indicator was constrained to be equal across profiles, and within-profile covariances among indicators were fixed at zero. Models with one through five profiles were fitted sequentially by maximum likelihood using tidySEM and OpenMx in R. A single set of starting values was used for the one-profile model. For each two- through five-profile model, 10 independent sets of starting values were used: the first initialized from k-means clustering (nstart = 50), the second from Ward.D2 hierarchical clustering, and the remainder from balanced random starts. Among admissible converged solutions, the solution with the highest log-likelihood was retained. Replication of the best log-likelihood across independent starts was examined to reduce the risk that local maxima affected parameter estimation or profile enumeration [35].

Candidate solutions were evaluated using the log-likelihood, Akaike information criterion (AIC), Bayesian information criterion (BIC), sample-size-adjusted Bayesian information criterion (saBIC), Lo–Mendell–Rubin likelihood ratio test (LMR), and bootstrap likelihood ratio test (BLRT) with 500 bootstrap replications. Lower AIC, BIC, and saBIC values indicated better relative fit, whereas the LMR and BLRT assessed whether a k-profile solution was favored over the corresponding k−1-profile solution. Entropy and profile-specific mean posterior membership probabilities were used to assess classification quality. Profile size, replication of the best log-likelihood, nonpositive variance estimates or boundary solutions, stability under alternative analytic specifications, and substantive and clinical interpretability were also considered. Because profile-enumeration criteria depend on sample size, the number of indicators, and profile separation, the final number of profiles was not determined by any single statistical criterion, entropy value, or fixed minimum profile-size threshold. The final solution was selected by integrating model fit, classification quality, estimation stability, and substantive interpretability [36–37].

After the final model was selected, profile order and labels were fixed before outcome comparisons and analyses of characteristics associated with profile membership. Labels were based primarily on the relative levels of the three source-specific MSPSS dimensions, with the MCMQ dimensions used as supplementary descriptors. The main text reports profile-specific standardized means and 95% Wald confidence intervals estimated directly from the final model. Maximum-posterior-probability assignment was used only for profile sizes, descriptive summaries, and sensitivity analyses.

Profile Description, BCH-Adjusted Outcome Comparisons, and Pseudo-Class Multinomial Regression

Demographic and clinical characteristics were summarized according to maximum-posterior-probability profile assignment. Continuous variables were summarized as medians and interquartile ranges and compared across profiles using the Kruskal–Wallis test, with ε^2 as the effect-size measure. Categorical variables were summarized as counts and percentages and compared using Pearson's χ^2 test, with Cramér's V as the effect-size measure. When any expected cell count was <1 or more than 20% of expected cell counts were <5, Monte Carlo-simulated P values based on 20,000 replicates were used. Holm adjustment was applied across eight global comparisons: age, NRS 2002 score, sex, number of other chronic conditions, recorded disease severity, educational attainment, primary caregiver, and department composition. Because maximum-posterior-probability assignment does not fully account for classification uncertainty, these analyses were considered descriptive rather than the primary inferential basis for between-profile differences [38].

Profile-specific means for the PHQ-9, GAD-7, and PSQI were estimated using the Bolck–Croon–Hagenaars (BCH) method. BCH weights derived from the classification-error matrix accounted for classification uncertainty rather than treating maximum-posterior-probability assignments as

error-free [38–39]. Standard errors and 95% percentile confidence intervals for BCH-weighted estimates were obtained from 1,000 nonparametric bootstrap resamples. Global Wald tests used the bootstrap covariance matrix. Holm adjustment was applied to the three global outcome P values. After each global test, pairwise between-profile differences were reported with Holm adjustment applied separately within each outcome.

Cross-sectional associations between demographic and clinical characteristics and latent profile membership were examined using multiple pseudo-class draws based on posterior class-membership probabilities. For each participant, profile membership was sampled independently from the individual posterior class-probability distribution to generate 200 pseudo-class datasets. The same multinomial logistic regression model was fitted to each dataset, and the resulting regression coefficients and covariance matrices were combined using multiple-imputation combining rules [40]. Profile 2 served as the reference category. The core model included age, sex, number of other chronic conditions, recorded disease severity, and NRS 2002 score simultaneously; no stepwise or other data-driven variable selection was used. Results are reported as odds ratios (ORs), 95% confidence intervals, unadjusted P values, and within-model Holm-adjusted P values. Prespecified extended models additionally included educational attainment and primary caregiver and were considered exploratory. Because multiple pseudo-class draws may not eliminate classification–analysis bias completely, these results were interpreted alongside sensitivity analyses using multinomial logistic regression based on maximum-posterior-probability profile assignment [40].

Multiple-Testing Adjustment, Robustness Analyses, and Statistical Software

All tests were two-sided, and Holm-adjusted P <0.05 was the primary criterion for statistical significance. Findings with unadjusted P <0.05 but Holm-adjusted P ≥0.05 were reported as nominal findings. Sensitivity to the classification approach was assessed by refitting the core multinomial logistic regression model using maximum-posterior-probability profile assignment. In extended models based on this assignment, inferential estimates were not reported when complete or quasi-complete separation, sparse cells, or nonfinite parameter estimates precluded reliable estimation.

Robustness of the smallest profile was evaluated by refitting five-profile models under alternative questionnaire-quality exclusion rules and in a more stringently defined quality-control sample. Three-, four-, and five-profile solutions were also examined to determine whether a similarly characterized low-support profile recurred. Additional analyses evaluated alternative indicator sets, profile-specific residual variances, and department fixed effects. Department fixed-effect models were fitted only when department-specific sample sizes and department-by-profile cell counts met prespecified requirements; otherwise, residual department-level heterogeneity was acknowledged in interpretation.

All analyses were conducted in R version 4.6.1. LPA was performed primarily with OpenMx version 2.22.11 and tidySEM version 0.2.10, and multinomial logistic regression with nnet version 7.3-20. Given the cross-sectional design, results were interpreted as concurrent associations rather than evidence of prediction or causality.

Ethical Considerations

The Ethics Committee of Renmin Hospital of Wuhan University approved the study (approval No. WDRY2022-K122). Before data collection, participants received information about the study objectives and procedures, potential risks, privacy and confidentiality protections, and their right to withdraw. Written informed consent was obtained from all participants. Data were de-identified before analysis and used only for this study. The study was conducted in accordance with the Declaration of Helsinki.

Results

Sample Selection, Data Completeness, and Overall Characteristics

We received 540 survey submissions from patients who met the age and diagnostic eligibility criteria, including 30 submissions representing 15 duplicate pairs. For each pair, the first completed questionnaire meeting the quality requirements was retained; 15 duplicate submissions were excluded, leaving 525 unique questionnaires. Twelve initially eligible submissions met the combined low-quality criteria, one of which had already been excluded as a duplicate. Excluding the remaining 11 low-quality questionnaires yielded a final analytic sample of 514 patients.

Complete data were available for all 514 patients on the six profile indicators, PHQ-9, GAD-7, PSQI, and all core and extended covariates; no scale-score imputation was required. Median age was 66 years (Q1, 57; Q3, 73), and 297 patients (57.8%) were men. A total of 461 patients (89.7%) had ≥2 other chronic conditions, 185 (36.0%) had critical or severe disease recorded in the medical record, and the median NRS 2002 score was 1 (Q1, 0; Q3, 2). All patients recorded as having critical or severe disease were clinically stable at the time of the survey and were judged by the attending physician to be able to complete the questionnaire. Overall characteristics and distributions by maximum-posterior-probability profile assignment are shown in Table 1.

Table 1. Overall and Profile-Stratified Demographic and Clinical Characteristics by Maximum-Posterior-Probability Assignment

Characteristic	Category	Overall (N = 514)	Profile 1 (n = 19)	Profile 2 (n = 220)	Profile 3 (n = 43)	Profile 4 (n = 154)	Profile 5 (n = 78)	Test statistic and effect size	Unadjusted P	Holm-adjusted P
Age, years	—	66.00 (57.00, 73.00)	68.00 (58.50, 73.00)	67.00 (58.75, 73.00)	67.00 (55.00, 73.00)	66.00 (58.00, 74.75)	61.50 (55.25, 68.75)	H(4)=5.52; ε²=0.003	0.238	1.000
NRS 2002 score	—	1.00 (0.00, 2.00)	1.00 (1.00, 2.00)	1.00 (0.00, 2.00)	1.00 (1.00, 2.00)	1.00 (0.00, 2.00)	1.00 (0.00, 2.75)	H(4)=2.67; ε²=0.000	0.614	1.000
Sex	Male	297 (57.8%)	15 (78.9%)	135 (61.4%)	22 (51.2%)	89 (57.8%)	36 (46.2%)	χ²(4)=9.74; V=0.138	0.045	0.328
	Female	217 (42.2%)	4 (21.1%)	85 (38.6%)	21 (48.8%)	65 (42.2%)	42 (53.8%)			
Other chronic conditions	1	53 (10.3%)	2 (10.5%)	22 (10.0%)	4 (9.3%)	20 (13.0%)	5 (6.4%)	χ²(4)=2.55; V=0.070	0.636	1.000
	≥2	461 (89.7%)	17 (89.5%)	198 (90.0%)	39 (90.7%)	134 (87.0%)	73 (93.6%)			
Recorded disease severity	Neither critical nor severe	329 (64.0%)	16 (84.2%)	137 (62.3%)	24 (55.8%)	98 (63.6%)	54 (69.2%)	χ²(4)=5.84; V=0.107	0.211	1.000
	Critical or severe	185 (36.0%)	3 (15.8%)	83 (37.7%)	19 (44.2%)	56 (36.4%)	24 (30.8%)			
Educational attainment	Junior high school or below	365 (71.0%)	10 (52.6%)	151 (68.6%)	30 (69.8%)	117 (76.0%)	57 (73.1%)	χ²(8)=9.56; V=0.096	0.298	1.000
	Senior high school or technical secondary school	93 (18.1%)	7 (36.8%)	43 (19.5%)	6 (14.0%)	22 (14.3%)	15 (19.2%)			
	College or above	56 (10.9%)	2 (10.5%)	26 (11.8%)	7 (16.3%)	15 (9.7%)	6 (7.7%)			
Primary caregiver	Family caregiver	353 (68.7%)	16 (84.2%)	158 (71.8%)	24 (55.8%)	100 (64.9%)	55 (70.5%)	χ²(8)=16.26; V=0.126; Monte Carlo	0.041	0.328
	No primary caregiver	136 (26.5%)	1 (5.3%)	50 (22.7%)	19 (44.2%)	46 (29.9%)	20 (25.6%)			
	Paid or other caregiver	25 (4.9%)	2 (10.5%)	12 (5.5%)	0 (0.0%)	8 (5.2%)	3 (3.8%)			

Note: Continuous variables are presented as median (Q1, Q3) and categorical variables as n (%). Maximum-posterior-probability assignment was used for descriptive purposes only. Continuous variables were compared using the Kruskal–Wallis test, with ε² as the effect size; categorical variables were compared using Pearson's χ² test, with Cramér's V as the effect size. The P value for primary caregiver was based on 20000 Monte Carlo simulations. The Holm family comprised the seven characteristics shown plus department composition (eight global comparisons); Holm-adjusted P values were the primary basis for inference.

Data Completeness and Psychometric Findings

PSQI total scores were available for all participants. The sleep-efficiency component was recalculated from cleaned raw clock-time data for 489 patients. For the remaining 25 patients, the original clock-time data did not permit reliable calculation, so the component was derived using the prespecified continuous sleep-efficiency procedure. This procedure yielded complete PSQI total scores and had been specified before the between-profile PSQI comparisons.

For the MCMQ, ordinal α values were 0.578 for confrontation, 0.454 for avoidance, and 0.836 for acceptance-resignation; corresponding McDonald's ω values were 0.616, 0.533, and 0.841. For the MSPSS, ordinal α values were 0.951 for significant-other support, 0.970 for family support, and 0.968 for friend support; corresponding ω values were 0.951, 0.970, and 0.968. The prespecified three-factor WLSMV model for the MCMQ converged, but the latent covariance matrix was not positive definite and overall model fit was poor (CFI = 0.412, TLI = 0.331, RMSEA = 0.194, SRMR = 0.185). The estimated latent correlation between confrontation and avoidance was −1.028. For the three-factor MSPSS model, post-

estimation diagnostics were CFI = 0.981, TLI = 0.975, SRMR = 0.029, and RMSEA = 0.202; CFI, TLI, and SRMR indicated good fit, whereas RMSEA indicated poor fit.

Accordingly, profile labels were driven primarily by the three source-specific MSPSS dimensions, and MCMQ dimensions were retained as secondary descriptive features. The prespecified scoring rules and final number of profiles were unchanged; the psychometric findings only limited the strength of interpretation assigned to between-profile MCMQ differences.

Comparison of Candidate Models and Selection of the Final Five-Profile Solution

All one- through five-profile models yielded admissible solutions, and AIC, BIC, and saBIC decreased as the number of profiles increased. Compared with the four-profile model, both the LMR (P = 0.0094) and BLRT (P = 0.0020; 500/500 valid bootstrap replications) favored the five-profile model. For the five-profile solution, the log-likelihood was −3496.94, AIC was 7073.88, BIC was 7243.57, saBIC was 7116.60, entropy was 0.940, and the mean maximum posterior profile-membership probability was 0.963. The best log-likelihood was replicated three times across independent starts, and no nonpositive or boundary variance estimates were observed. Fit statistics are shown in Table 2.

Profile-specific average posterior membership probabilities for the five-profile solution were 0.995, 0.982, 0.901, 0.947, and 0.966, respectively; the minimum was 0.901. The smallest profile included 19 patients (3.7%). Relative to the four-profile solution, the five-profile solution additionally distinguished a 43-patient family-dominant support profile, whereas the 19-patient very-low-support-across-sources profile was not further subdivided. Considering model fit, classification quality, replication of the best log-likelihood, profile size, and substantive and clinical interpretability, the five-profile solution was retained.

Table 2. Fit Indices and Classification Diagnostics for One- to Five-Profile Models

No. of profiles	LL	No. of parameters	AIC	BIC	saBIC	Entropy	Smallest profile, n (%)	LMR P	BLRT P	Valid bootstrap replications	Selected
1	-4373.00	12	8770.01	8820.91	8782.82	1.000	514 (100.0%)	—	—	—	—
2	-4028.54	19	8095.07	8175.67	8115.37	0.845	234 (45.5%)	<0.0001	0.0020	500	—
3	-3763.44	26	7578.88	7689.18	7606.65	0.935	19 (3.7%)	<0.0001	0.0029	340	—
4	-3576.08	33	7218.16	7358.15	7253.40	0.933	19 (3.7%)	0.0027	0.0020	498	—
5	**-3496.94**	**40**	**7073.88**	**7243.57**	**7116.60**	**0.940**	**19 (3.7%)**	**0.0094**	**0.0020**	**500**	Yes

Note: LL = log-likelihood; AIC = Akaike information criterion; BIC = Bayesian information criterion; saBIC = sample-size-adjusted BIC; LMR = Lo–Mendell–Rubin likelihood ratio test; BLRT = bootstrap likelihood ratio test. LMR and BLRT compare the k-profile solution with the k−1-profile solution. The five-profile solution was retained after considering model fit, classification quality, replication of the best log-likelihood, profile size, and clinical interpretability.

Characteristics of the Five Profiles of Perceived Social Support and Illness-Related Coping

Table 3 and Figure 1 show profile-specific standardized means estimated directly from the final five-profile model rather than means based on maximum-posterior-probability assignment or posterior-probability-weighted descriptive estimates.

Profile 1 included 19 patients (3.7%). Standardized means for family, friend, and significant-other support were −2.680, −2.542, and −2.539, respectively, indicating uniformly very low perceived support across all three sources. This profile was labeled “very low support across sources.” Given its small size, estimates for this profile should be interpreted cautiously. Profile 2 included 220 patients (42.8%) and showed below-average support across all three sources, with standardized means ranging from −0.745 to −0.556; it was labeled “low support across sources.” Profile 3 included 43 patients (8.4%) and was characterized by above-average family support (0.844) but below-average friend and significant-other support (−0.566 and −0.336, respectively); it was labeled “family-dominant support.”

Profile 4 included 154 patients (30.0%) and showed moderately above-average support across all three sources, with standardized means ranging from 0.471 to 0.523; it was labeled “moderate-to-high support across sources.” Profile 5 included 78 patients (15.2%) and showed markedly above-average support across all three sources, with standardized means ranging from 1.287 to 1.585; it was labeled “high support across sources.” Overall, profiles differed mainly in the level and sources of perceived social support. Between-profile variation in confrontation, avoidance, and acceptance-resignation was modest and was therefore treated as secondary descriptive information. Figure 2 shows the distribution of patients across profiles.

Table 3. Standardized Profile-Specific Estimates of the Six Indicators in the Final Five-Profile Model

Profile indicator	Profile 1 (n = 19)	Profile 2 (n = 220)	Profile 3 (n = 43)	Profile 4 (n = 154)	Profile 5 (n = 78)
Confrontation	0.281 (0.228) [-0.166, 0.728]	-0.014 (0.068) [-0.148, 0.119]	-0.050 (0.166) [-0.375, 0.276]	0.115 (0.084) [-0.049, 0.280]	-0.232 (0.116) [-0.459, -0.004]
Avoidance	0.151 (0.229) [-0.297, 0.600]	0.077 (0.068) [-0.056, 0.211]	0.076 (0.167) [-0.250, 0.403]	-0.124 (0.084) [-0.289, 0.042]	-0.053 (0.115) [-0.278, 0.173]
Acceptance–resignation	-0.446 (0.229) [-0.894, 0.003]	-0.027 (0.068) [-0.160, 0.107]	0.151 (0.163) [-0.168, 0.469]	0.050 (0.084) [-0.114, 0.214]	0.000 (0.115) [-0.225, 0.226]
Family support	-2.680 (0.078) [-2.832, -2.528]	-0.745 (0.025) [-0.794, -0.697]	0.844 (0.070) [0.708, 0.981]	0.507 (0.032) [0.445, 0.570]	1.287 (0.040) [1.209, 1.365]
Friend support	-2.542 (0.094) [-2.725, -2.358]	-0.556 (0.028) [-0.612, -0.501]	-0.566 (0.079) [-0.721, -0.411]	0.471 (0.039) [0.393, 0.548]	1.585 (0.049) [1.489, 1.681]
Significant-other support	-2.539 (0.094) [-2.723, -2.356]	-0.614 (0.028) [-0.670, -0.558]	-0.336 (0.080) [-0.492, -0.180]	0.523 (0.038) [0.447, 0.598]	1.514 (0.050) [1.416, 1.611]

Note: Cells report standardized profile-specific means (SEs) [95% Wald CIs] estimated directly from the final five-profile model. These are not descriptive means based on maximum-posterior-probability assignment or posterior-probability-weighted estimates. Profile 1 included only 19 patients; estimates for this profile should be interpreted cautiously.

Demographic and Clinical Characteristics Across Profiles

After Holm adjustment, we found no evidence of between-profile differences in age, sex, number of other chronic conditions, recorded disease severity, NRS 2002 score, educational attainment, or primary caregiver (Table 1). These analyses were descriptive and do not establish equivalence of the underlying populations.

Sex differed across profiles before adjustment ($\chi^2 = 9.742$, df = 4, unadjusted P = 0.045, Cramér's V = 0.138), but the difference was not significant after Holm correction (adjusted P = 0.328). Primary caregiver showed a similar pattern ($\chi^2 = 16.262$, df = 8, Monte Carlo P = 0.041, Cramér's V = 0.126; Holm-adjusted P = 0.328). These nominal findings were not interpreted as robust between-profile differences.

Depressive Symptoms, Anxiety Symptoms, and Sleep Quality Across Profiles

In BCH analyses accounting for classification uncertainty, neither PHQ-9 nor GAD-7 scores differed significantly across profiles after Holm correction. For PHQ-9, Wald $\chi^2 = 1.683$ (df = 4), with unadjusted P = 0.794 and Holm-adjusted P = 0.884; for GAD-7, Wald $\chi^2 = 3.741$ (df = 4), with unadjusted P = 0.442 and Holm-adjusted P = 0.884 (Table 4).

PSQI total scores differed significantly across profiles after Holm correction (Wald $\chi^2 = 37.899$, df = 4; unadjusted P = 1.18×10^{-7}; Holm-adjusted P = 3.53×10^{-7}). BCH-estimated means for Profiles 1–5 were 3.25, 6.19, 5.34, 5.53, and 4.64, respectively (Table 4).

Three of the 10 pairwise PSQI contrasts remained statistically significant after within-outcome Holm correction. Profile 1 had a lower mean PSQI score than Profile 2 (mean difference, −2.94 points; 95% CI, −3.91 to −1.84; unadjusted P = 0.002; Holm-adjusted P = 0.020) and Profile 4 (mean difference, −2.28 points; 95% CI, −3.21 to −1.19; unadjusted P = 0.004; Holm-adjusted P = 0.032). Profile 2 had a higher mean PSQI score than Profile 5 (mean difference, 1.55 points; 95% CI, 0.79 to 2.32; unadjusted P = 0.002; Holm-adjusted P = 0.020). Because the first two contrasts involved Profile 1, which included only 19 patients, these estimates warrant caution.

Higher PSQI scores indicate poorer sleep quality. The between-profile pattern was nonmonotonic and did not follow a simple gradient across levels of perceived support. Figure 3 shows the PSQI results.

Table 4. BCH-Adjusted Means of Depressive Symptoms, Anxiety Symptoms, and Sleep Quality Across the Five Latent Profiles

Outcome	Profile 1	Profile 2	Profile 3	Profile 4	Profile 5	Wald χ^2 (df)	Unadjusted P	Holm-adjusted P
PHQ-9 total score	4.79 (2.97, 6.79)	5.43 (4.76, 6.19)	6.21 (4.15, 8.31)	4.97 (4.12, 5.84)	5.09 (4.07, 6.19)	1.683 (4)	0.794	0.884
GAD-7 total score	2.36 (0.85, 4.05)	3.64 (3.08, 4.30)	4.55 (2.86, 6.31)	3.39 (2.72, 4.14)	3.46 (2.66, 4.32)	3.741 (4)	0.442	0.884
PSQI total score	3.25 (2.36, 4.25)	6.19 (5.76, 6.61)	5.34 (4.10, 6.63)	5.53 (5.06, 6.02)	4.64 (4.01, 5.23)	37.899 (4)	<0.001	**<0.001**

Note: Profile-specific values are BCH-adjusted means (95% nonparametric bootstrap percentile CIs) that account for uncertainty in latent profile membership. All 1000 bootstrap replications were valid for each outcome. Global tests are Wald tests with 4 df. Holm correction was applied across the three global outcome P values; adjusted P values were the primary basis for inference. Higher PSQI scores indicate poorer sleep quality.

Characteristics Associated With Profile Membership and Robustness Analyses

Using Profile 2 (“low support across sources”) as the reference category, we examined associations between prespecified demographic and clinical characteristics and profile membership using multinomial logistic regression pooled across 200 pseudo-class draws based on posterior class-membership probabilities. All 200 models converged. After Holm correction across the 20 non-intercept coefficients, no association met the prespecified criterion for statistical significance (Table 5). Two associations were nominally significant before correction. Per 10-year increase in age, the OR for Profile 5 versus Profile 2 was 0.77 (95% CI, 0.61–0.98; unadjusted P = 0.034; Holm-adjusted P = 0.651). For female versus male sex, the corresponding OR was 2.18 (95% CI, 1.25–3.77; unadjusted P = 0.006; Holm-adjusted P = 0.114). Confidence intervals involving Profile 1 were generally wide because this profile included only 19 patients. Figure 4 presents the core-model estimates.

All 20 non-intercept coefficients were directionally concordant between the maximum-posterior-probability core model and the pooled pseudo-class model; the maximum absolute difference in log-odds coefficients was 0.087. Neither approach yielded an association that remained significant after Holm correction. The extended pseudo-class model, which additionally included educational attainment and primary caregiver, likewise yielded no Holm-adjusted associations. The corresponding extended maximum-posterior-probability model was numerically unstable because of complete or quasi-complete separation and sparse cells; according to the prespecified analysis rules, inferential estimates were not reported.

For Profile 1, the mean maximum posterior membership probability was 0.995, and the lowest individual maximum posterior probability was 0.911. Across the three-, four-, and five-profile solutions, a 19-patient low-support profile recurred in which all three social support indicators were below −1.5 z. This recurrence indicates a similar pattern across solutions with different numbers of profiles but does not provide independent external validation or establish that the same 19 patients composed the profile in every solution. When the five-profile model was refitted in five sensitivity samples defined by alternative questionnaire-quality criteria, three specifications reproduced the rare profile relatively clearly. Interpretation of the remaining two specifications was less certain because the exclusion criteria may have overlapped structurally with the profile indicators.

Alternative parameterizations were less stable. Under a four-indicator equal-variance specification, BIC values for the four- and five-profile solutions were similar and the best log-likelihood was not consistently replicated. Under the six-indicator specification allowing residual variances to vary across profiles, models with more profiles showed numerical instability; in the two- versus three-profile comparison, only 340 of 500 BLRT replications were valid. Interpretation of the five-profile solution is therefore restricted to the primary specification used in this study: six indicators, residual variances constrained to be equal across profiles, and within-profile indicator covariances fixed at zero.

Sample sizes were unevenly distributed across the 24 participating departments in the four hospitals; the smallest department contributed one patient, and some department-by-profile cells were empty. The prespecified estimability requirements for department fixed-effect models were therefore not met. Department fixed-effect estimates were not reported, and residual clustering or confounding by department cannot be excluded.

Table 5. Demographic and Clinical Correlates of Latent Profile Membership in the Pooled Pseudo-Class Model

Profile contrast	Covariate	OR (95% CI)	Unadjusted P	Holm-adjusted P
Profile 1 vs Profile 2	Age (per 10-year increase)	1.22 (0.80, 1.85)	0.352	1.000
	Female (reference: male)	0.45 (0.14, 1.44)	0.180	1.000
	≥2 other chronic conditions (reference: 1)	0.94 (0.20, 4.44)	0.942	1.000
	Recorded critical or severe disease (reference: neither critical nor severe)	0.31 (0.08, 1.12)	0.074	1.000
	NRS 2002 score (per 1-point increase)	1.02 (0.76, 1.37)	0.902	1.000
Profile 3 vs Profile 2	Age (per 10-year increase)	0.96 (0.71, 1.30)	0.772	1.000
	Female (reference: male)	1.38 (0.67, 2.85)	0.386	1.000
	≥2 other chronic conditions (reference: 1)	1.22 (0.35, 4.30)	0.758	1.000
	Recorded critical or severe disease (reference: neither critical nor severe)	1.25 (0.60, 2.62)	0.554	1.000
	NRS 2002 score (per 1-point increase)	1.06 (0.86, 1.30)	0.587	1.000
Profile 4 vs Profile 2	Age (per 10-year increase)	1.01 (0.83, 1.22)	0.952	1.000
	Female (reference: male)	1.21 (0.78, 1.88)	0.395	1.000
	≥2 other chronic conditions (reference: 1)	0.82 (0.42, 1.62)	0.574	1.000
	Recorded critical or severe disease (reference: neither critical nor severe)	0.95 (0.60, 1.49)	0.809	1.000
	NRS 2002 score (per 1-point increase)	1.02 (0.89, 1.17)	0.776	1.000
Profile 5 vs Profile 2	Age (per 10-year increase)	0.77 (0.61, 0.98)	0.034	0.651
	Female (reference: male)	2.18 (1.25, 3.77)	0.006	0.114
	≥2 other chronic conditions (reference: 1)	1.82 (0.65, 5.08)	0.250	1.000
	Recorded critical or severe disease (reference: neither critical nor severe)	0.76 (0.42, 1.38)	0.363	1.000
	NRS 2002 score (per 1-point increase)	0.98 (0.82, 1.16)	0.790	1.000

Note: Multinomial logistic regression was fitted across 200 pseudo-class draws based on posterior class-membership probabilities; coefficients and covariance matrices were pooled using Rubin-type combining rules, and all 200 models converged. Profile 2 (“low support across sources”) was the reference category. The core model included the five covariates shown simultaneously. Holm correction was applied across 20 non-intercept tests, with adjusted P values used as the primary basis for inference. ORs represent relative odds of concurrent profile membership and should not be interpreted as predictive or causal. Profile 1 included only 19 patients.

Discussion

Main Findings and Overall Interpretation

This study identified five latent profiles among hospitalized patients with coexisting hypertension and diabetes: very low support across sources, low support across sources, family-dominant support, moderate-to-high support across sources, and high support across sources. Profiles differed mainly in the overall level and sources of perceived support from family, friends, and significant others, whereas differences in confrontation, avoidance, and acceptance-resignation were modest. Depressive and anxiety symptoms did not differ consistently across profiles. Sleep quality did

differ after accounting for classification uncertainty and multiple testing, but the pattern was nonmonotonic rather than showing progressively better sleep with greater perceived support. Measured demographic and clinical characteristics also did not consistently distinguish profile membership. Given the limited psychometric performance of the MCMQ in this sample, its dimensions were treated as supplementary descriptors rather than the principal basis for defining profiles.

Within the stress–appraisal–coping framework, perceived social support can be viewed as an external resource available to patients managing illness-related stress. Whether such resources are associated with more favorable outcomes may depend on stress appraisal, the fit between support and individual needs, coping responses, and the broader clinical context [8, 9]. Because this study did not assess primary or secondary appraisal or test a mediating pathway linking support, coping, and psychological or sleep outcomes, the findings do not test the full theoretical process. Rather, they show substantial variation in how hospitalized patients with coexisting hypertension and diabetes perceive the level and sources of social support. These support configurations were associated with differences in sleep quality but not with a clear gradient in depressive or anxiety symptoms.

Latent Heterogeneity in the Level and Sources of Perceived Social Support

The identified profiles captured heterogeneity in both the overall level and sources of perceived social support. Four profiles—very low support across sources, low support across sources, moderate-to-high support across sources, and high support across sources—formed a relatively clear gradient in overall support. The family-dominant support profile, however, showed that overall support level alone does not fully characterize patients' support resources. Meta-analytic evidence indicates that social support is associated with self-care among patients with diabetes, although the strength of this association varies by disease type, support measurement, and population characteristics [12]. Person-centered studies in patients with diabetes and in those with coexisting hypertension and diabetes have likewise identified multiple configurations of psychological resources, self-efficacy, disease-related distress, and self-management capacity [22, 24], suggesting that these characteristics may cluster in ways not captured by a single low-to-high continuum. Retaining family, friend, and significant-other support as separate dimensions may therefore provide more insight into patients' support networks than relying solely on the MSPSS total score.

The low-support profile accounted for the largest proportion of the sample, whereas the very-low-support profile was uncommon but showed markedly low perceived support from all three sources. Perceived social support reflects patients' subjective appraisal of the availability and adequacy of support and is not equivalent to the frequency of social contact, presence of a caregiver, or number of family members. Having a family caregiver therefore does not necessarily mean that emotional, informational, and practical support is available in a form that matches the patient's needs. Nursing assessment should extend beyond whether a caregiver is present to whether support is available when needed, perceived as adequate, aligned with patient expectations, and likely to continue after discharge.

The family-dominant support profile highlights the importance of considering support source as well as overall support level. Family support was above the overall mean, whereas friend and significant-other support were lower, suggesting that support was concentrated primarily within the family. Research in cardiovascular populations indicates that family and nonfamily social relationships may be associated with coping and psychological status through different pathways [15]. A systematic review of family support in chronic illness further suggests that family cohesion, autonomy support, and effective communication may facilitate disease management, whereas criticism, control, and overprotection may increase patient burden [41]. The family-dominant profile should therefore not be equated with uniformly adequate support. Family members may assist with inpatient care, treatment-related communication, and daily activities, whereas a relatively narrow support network may provide more limited access to peer experience, social participation, and emotional resources outside the family. Meta-analytic evidence on the MSPSS factor structure generally supports three correlated dimensions corresponding to family, friends, and significant others [42], providing conceptual and measurement support for source-specific assessment, although the exact structure requires further examination across cultural and clinical populations. Because this study did not directly assess support content, communication quality, or the match between support and patient needs, the functional significance of the family-dominant profile requires further study using longitudinal and qualitative approaches.

Although MCMQ dimensions contributed little to profile differentiation, coping remains clinically relevant to adaptation to chronic illness. Stress–coping theory conceptualizes coping as a dynamic process that varies with the nature of the illness threat, perceived controllability, and available resources [8]. The original MCMQ literature likewise indicates that these coping responses are influenced by disease characteristics and psychological status and should not be classified rigidly as universally adaptive or maladaptive [13]. Previous reviews and studies in hospitalized patients with diabetes support complex relationships among coping, social support, depression, and anxiety [14, 16], and LPA research in chronic disease populations suggests that different coping responses may coexist within the same individual [23]. In this study, internal consistency was limited for the confrontation and avoidance dimensions, and the prespecified three-factor model showed poor fit, potentially reducing the discriminative capacity of the coping indicators. The modest between-profile differences may therefore reflect genuine similarity in coping responses, limited measurement precision, or both. The MCMQ dimensions should therefore be interpreted as supplementary descriptors of the profiles rather than as strong determinants of profile structure.

Profile Differences in Depressive and Anxiety Symptoms and Sleep Quality

We found no evidence of consistent between-profile differences in depressive or anxiety symptoms. This does not contradict previous variable-centered evidence linking social support and coping with emotional symptoms. Systematic reviews and longitudinal studies have reported associations among the social environment, coping, and depression [14, 15], and path analysis in hospitalized patients with type 2 diabetes has identified direct and indirect associations of social support and coping with depression and anxiety [16]. Average associations between continuous variables, however, do not imply that latent profiles defined mainly by perceived support will differ in mean levels of depressive or anxiety symptoms. In this study, PHQ-9 and GAD-7 scores did not contribute to profile formation, and their means varied over a relatively narrow range across profiles. Depressive and anxiety symptoms may also be influenced by disease-related distress, pain, functional impairment, complications, financial strain, preexisting mental health status, and treatment burden, which were not comprehensively assessed. Adjustment for multiple testing reduced the risk of false-positive findings but may also have reduced sensitivity to small between-profile differences. These results should therefore be interpreted as a lack of evidence for profile-level differences rather than evidence of equivalence.

Sleep quality, by contrast, differed across profiles, with higher PSQI scores in the low-support profile than in the high-support profile. Meta-analytic evidence generally suggests that greater social support is associated with more favorable sleep outcomes, although the magnitude of this association varies by support type, sleep measurement, and population characteristics [43]. Among patients with diabetes, sleep quality has also been associated with depression, anxiety, disease status, nocturia, obstructive sleep apnea, treatment regimens, environmental factors, and social support [20]. Stress, social support, and coping may additionally operate within the same psychosocial process related to sleep disturbance [21]. During hospitalization, noise, light exposure, pain, anxiety, and nighttime nursing activities may further disrupt sleep [7]. Sleep quality may therefore be particularly sensitive to the combined influence of disease burden, psychological status, support resources, and environmental exposures rather than simply paralleling depressive or anxiety symptoms.

The lower mean PSQI score in the very-low-support profile than in some profiles with higher support warrants particular caution because this profile included only 19 patients. Although classification probabilities were high and similarly characterized patterns recurred across models with different numbers of profiles and in some questionnaire-quality sensitivity analyses, the small profile size may still have increased sampling variability in profile-specific means and confidence intervals. Unmeasured confounding may also have contributed, including pain, nocturia, obstructive sleep apnea, hypnotic medication use, length of hospital stay, ward type, and timing of assessment. Reverse temporal ordering is also plausible: in a cross-sectional setting, social support may be mobilized in response to increasing health needs, such that higher perceived support could reflect greater disease burden or worsening sleep rather than precede it. Moreover, the quantity and quality of support and the extent to which it matches patients' needs may have different implications; excessive involvement, controlling support, or nighttime caregiving activities do not necessarily improve sleep [9, 41]. The differing recall periods of the study instruments also warrant consideration. The PSQI assesses the preceding month, whereas the PHQ-9 and GAD-7 assess the preceding 2 weeks, so PSQI scores may reflect sleep experiences both before and during hospitalization. These findings therefore do not indicate that very low support benefits sleep or establish a causal or monotonic dose–response relationship between perceived support and sleep quality.

Implications of the Lack of Consistent Demographic and Clinical Correlates

After multiple-testing correction, none of the measured demographic or clinical characteristics was consistently associated with profile membership. This does not establish demographic or clinical equivalence across profiles; rather, the prespecified variables available in this sample did not reliably distinguish them. Primary caregiver, for example, identifies who assumed the main caregiving role during hospitalization but does not capture patients' perceptions of whether support from family, friends, or significant others is available and adequate. Likewise, NRS 2002 reflects nutritional risk and cannot substitute for direct assessment of psychosocial resources. Associations between social support and chronic disease self-management may also vary with support quality, patient needs, disease stage, and social context [12, 14]. Perceived support configurations therefore cannot be inferred reliably from a single demographic or clinical characteristic.

These findings have practical implications for nursing assessment. Restricting psychosocial assessment to patients selected by age, sex, disease severity, or caregiver presence may miss individuals who perceive insufficient support. The American Diabetes Association Standards of Care in Diabetes recommend assessment of psychosocial status, family and social resources, self-management capacity, and sleep health [6]. In light of the present findings, brief standardized screening of hospitalized patients with coexisting hypertension and diabetes may be more appropriate than selective assessment based mainly on demographic or routine clinical characteristics. Future studies should incorporate a broader range of potentially relevant factors, including marital and cohabitation status, family functioning, loneliness, social isolation, concordance between expected and received support, financial burden, disease-related distress, health literacy, self-efficacy, complications, and treatment complexity. Such data may help clarify factors associated with different psychosocial resource profiles.

Implications for Stratified Psychosocial Assessment and Nursing Practice

The findings support incorporating source-specific assessment of social support into comprehensive nursing care for hospitalized patients with coexisting hypertension and diabetes, but they do not justify treating the five latent profiles as fixed clinical categories. A two-component assessment framework may be useful. First, nurses can assess the forms of support available from family, friends, and significant others; whether patients can access such support when needed; whether it matches their needs and expectations; and whether it can be sustained after discharge. Second, all patients should also be assessed for depressive and anxiety symptoms, sleep problems, and illness-related coping. Higher perceived support should not be assumed to indicate the absence of emotional or sleep difficulties. For patients reporting low support, assessment should

extend beyond routine health education to identify barriers to social resources, continuity of support and care, and referral needs. Nurse-led interventions for people with multimorbidity commonly include case management, care coordination, transitional care, and self-management support. Systematic review evidence suggests that such approaches may improve selected aspects of patient experience and patient-reported outcomes, although effects vary across studies [44]. Assessment informed by psychosocial profiles should therefore be viewed as a stratified approach requiring prospective validation rather than as an intervention strategy with established effectiveness.

For patients in the very-low-support and low-support profiles, assessment may prioritize loneliness, unmet practical caregiving needs, financial and transportation barriers, and support for medication management and follow-up after discharge. When appropriate, patients may be referred to social work or community nursing services and linked with suitable peer-support resources. For those in the family-dominant profile, assessment should build on existing family resources while examining patient autonomy, family caregiving burden, and potential limitations in support outside the family. Patients in the moderate-to-high-support and high-support profiles should still undergo routine screening for psychological symptoms and sleep problems, together with assessment of whether available support is appropriately matched to their needs. For patients with prominent sleep problems, possible nursing measures include reducing nighttime noise and light exposure, clustering nonurgent care activities, optimizing pain and anxiety management, offering earplugs or eye masks, providing relaxation training and sleep-hygiene education, and screening for possible obstructive sleep apnea and medication-related contributors when clinically indicated [7]. These strategies should be individualized according to patient preferences, clinical status, and available hospital resources and should not be determined by profile membership alone.

Strengths, Limitations, and Future Directions

This study has several strengths. It included patients from four hospitals and 24 clinical departments and used systematic quality-control procedures addressing duplicate submissions, insufficient-effort responding, scale scoring, and anomalous response patterns. The profile indicators retained source-specific information on support from family, friends, and significant others, and psychometric evaluation of the MCMQ and MSPSS informed the degree of confidence placed in profile labeling and interpretation. Profile enumeration integrated information criteria, likelihood ratio tests, classification quality, replication of the best log-likelihood, profile size, and substantive interpretability rather than relying on a single statistical criterion. Outcome comparisons incorporated BCH adjustment and nonparametric bootstrap procedures, and sensitivity to classification uncertainty was evaluated using both multiple pseudo-class draws and maximum-posterior-probability analyses. Classification-error-adjusted approaches such as BCH can reduce bias in distal-outcome estimation and downstream analyses [39, 40]. Multiple-testing correction was also applied.

Several limitations should be considered. First, the cross-sectional design precludes determination of the temporal ordering of perceived support, illness-related coping, psychological symptoms, and sleep quality; reverse temporal relationships are possible because emotional distress or sleep problems may influence how support is perceived or mobilized. Second, we did not determine sample size using an a priori effect-size calculation for a single outcome; instead, the analytic sample comprised all eligible patients who completed a valid survey during the predefined study period. Although the final sample included 514 patients and classification indices were favorable, the smallest profile contained only 19 patients, increasing sampling variability, imprecision in profile-specific estimates, and limited statistical power for analyses involving this profile. Third, convenience sampling was restricted to selected hospitals in Hubei Province and included only patients who were clinically stable and able to complete the questionnaires. Generalizability to other regions, critically ill patients, and individuals with cognitive, language, or communication impairments is therefore limited. Fourth, all study instruments were self-reported, and use of both electronic and paper questionnaires may have introduced social-desirability or mode-of-administration bias. The PHQ-9, GAD-7, and PSQI also used different recall periods, and the PSQI could not distinguish sleep before admission from sleep during hospitalization. Fifth, the MCMQ confrontation and avoidance dimensions showed limited internal consistency, and the prespecified three-factor model fit poorly, potentially reducing differentiation based on coping. Fit evidence for the MSPSS was also not fully consistent, and its source-specific measurement structure requires further validation in the target population [42]. Sixth, although hypertension and diabetes were confirmed from inpatient records, the analytic dataset did not contain a diabetes-type variable coded reliably enough for analysis. The potential influence of type 1, type 2, and other forms of diabetes on profile structure could therefore not be evaluated. Future studies should systematically record disease type, duration, treatment regimens, and complications at the patient level.

The latent profile solution itself also has important limitations. The very-low-support profile comprised only 19 patients, making its outcome means, regression coefficients, and pairwise contrasts particularly susceptible to sampling variability. Although a similar low-support pattern recurred in some sensitivity analyses, alternative indicator sets and models allowing residual variances to vary across profiles did not consistently support the same structure. More generally, mixture-model solutions depend on indicator selection, distributional assumptions, variance–covariance parameterization, and sample composition; additional profiles may sometimes reflect departures from an underlying continuous distribution rather than discrete, naturally occurring subgroups [45]. The five profiles should therefore be interpreted as statistical representations specific to this sample and primary model specification rather than as fixed clinical subtypes. Unequal sample sizes across departments and sparse department-by-profile cells also limited the ability to control fully for hospital- and department-level clustering. Furthermore, potentially relevant factors—including pain, nocturia, obstructive sleep apnea, hypnotic medication use, length of hospital stay, disease-related distress, loneliness, family functioning, and the match between available support and patients' needs—were not comprehensively measured. Primary and secondary appraisal, central components of the stress–appraisal–coping framework, were also not assessed.

Future studies should examine whether the number, shape, and prevalence of these profiles can be reproduced in independent samples from different geographic regions and levels of healthcare. They should also evaluate the measurement structure of the underlying instruments and the reproducibility of the latent profile model. Longitudinal latent profile or latent transition analyses could assess the stability and transitions of support resources and coping configurations from hospitalization through discharge and follow-up and clarify their temporal relationships with emotional symptoms, sleep, self-management, and clinical outcomes. Sleep assessment could be strengthened by incorporating actigraphy, ward-environment monitoring, and screening for obstructive sleep apnea, while coping could be assessed with instruments showing stronger psychometric performance in people with multiple chronic conditions. Qualitative interviews with patients in the very-low-support and family-dominant profiles may help clarify differences among support sources, perceived support needs, and lived experiences. Profile-informed nursing assessment or intervention strategies should be evaluated prospectively only after the profile structure has been independently replicated.

Conclusions

Among 514 hospitalized patients with coexisting hypertension and diabetes, five latent profiles were identified that differed mainly in the level and sources of perceived social support. The family-dominant support profile further showed that source-specific support patterns cannot be represented adequately by overall support level alone. Depressive and anxiety symptoms did not differ consistently across profiles, whereas sleep quality differed significantly in a nonmonotonic pattern. Demographic and clinical characteristics, including NRS 2002 scores, were not consistently associated with profile membership.

These findings indicate that psychosocial needs should not be inferred solely from age, sex, disease severity, or the presence of a primary caregiver. Nursing assessment should directly evaluate perceived support from family, friends, and significant others and sleep quality, together with emotional symptoms and illness-related coping. Given the convenience sampling, cross-sectional design, small 19-patient profile, and psychometric limitations of the MCMQ, the identified profiles should be interpreted as statistical representations specific to this sample and model parameterization rather than as fixed clinical subtypes. Future studies should replicate the profile structure in independent multicenter samples and use longitudinal designs to examine profile transitions and their temporal relationships with psychological symptoms, sleep quality, and self-management outcomes.

Abbreviations

AIC, Akaike information criterion; BCH, Bolck-Croon-Hagenaars; BIC, Bayesian information criterion; BLRT, bootstrap likelihood ratio test; CFI, comparative fit index; CI, confidence interval; ESPEN, European Society for Clinical Nutrition and Metabolism; GAD-7, Generalized Anxiety Disorder-7; IER, insufficient-effort responding; LL, log-likelihood; LMR, Lo-Mendell-Rubin 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; OR, odds ratio; PHQ-9, Patient Health Questionnaire-9; PSQI, Pittsburgh Sleep Quality Index; RMSEA, root mean square error of approximation; saBIC, sample-size-adjusted Bayesian information criterion; SRMR, standardized root mean square residual; STROBE, Strengthening the Reporting of Observational Studies in Epidemiology; TLI, Tucker-Lewis index; WLSMV, weighted least squares mean- and variance-adjusted.

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.

Availability of data and materials

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 institutional and ethical requirements.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

ZW, TL, and TS contributed equally to this work and share first authorship. ZW, TL, TS, YX, and ZC contributed to the conception and design of the study. ZW, TL, TS, TC, YL, YW, and YS contributed to participant recruitment, data collection, and data management. ZW contributed to the statistical analysis, interpretation of the findings, and preparation of the initial manuscript draft. TL, TS, TC, YL, YW, and YS contributed to interpretation of the results and critical revision of the manuscript. YX and ZC supervised and coordinated the study, provided methodological and academic guidance, contributed to interpretation of the findings, and critically revised the manuscript for important intellectual content. YX and ZC jointly supervised the work and share corresponding authorship. All authors read and approved the final manuscript.

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Figures

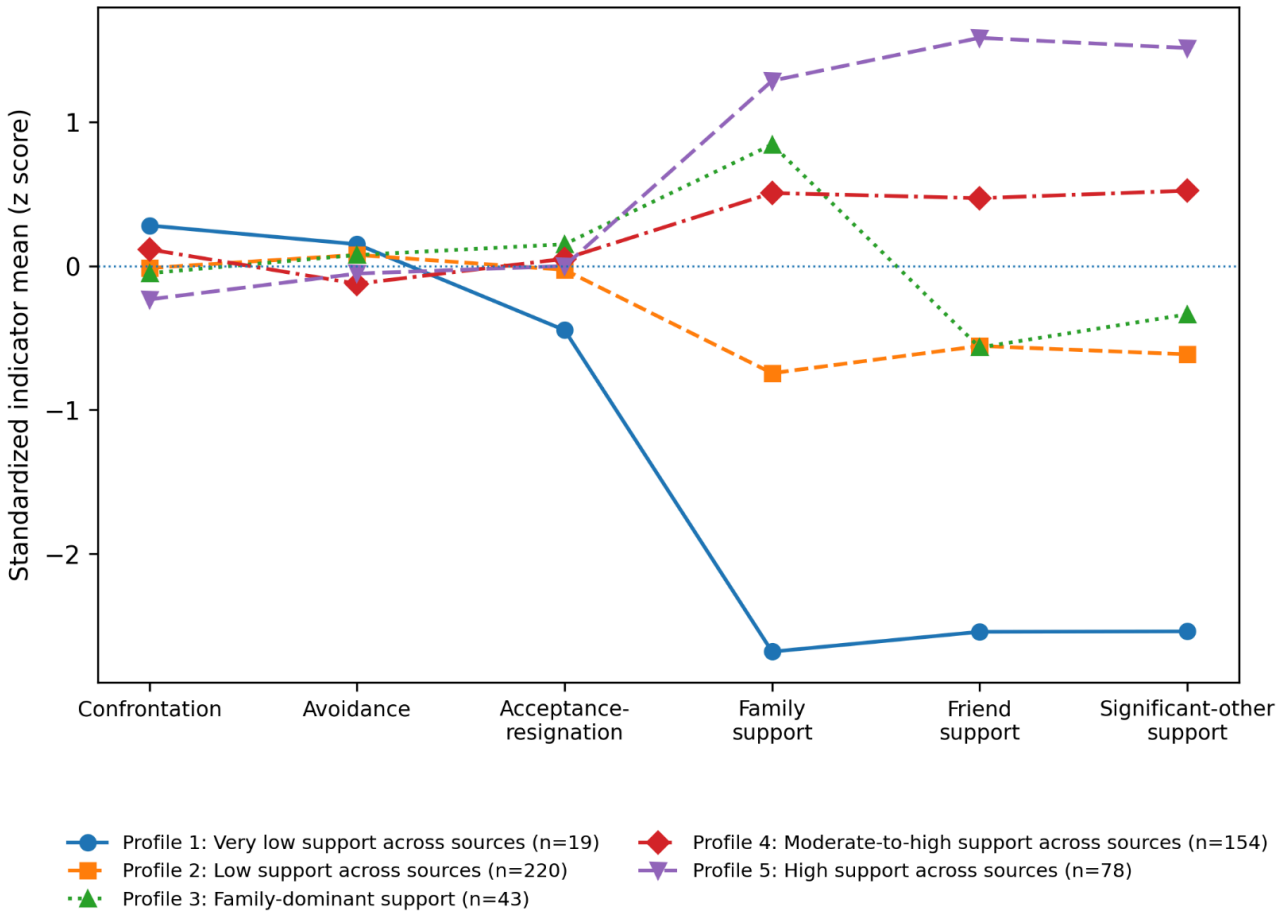


Figure 1

Standardized profile-specific means of the six indicators in the final five-profile model.

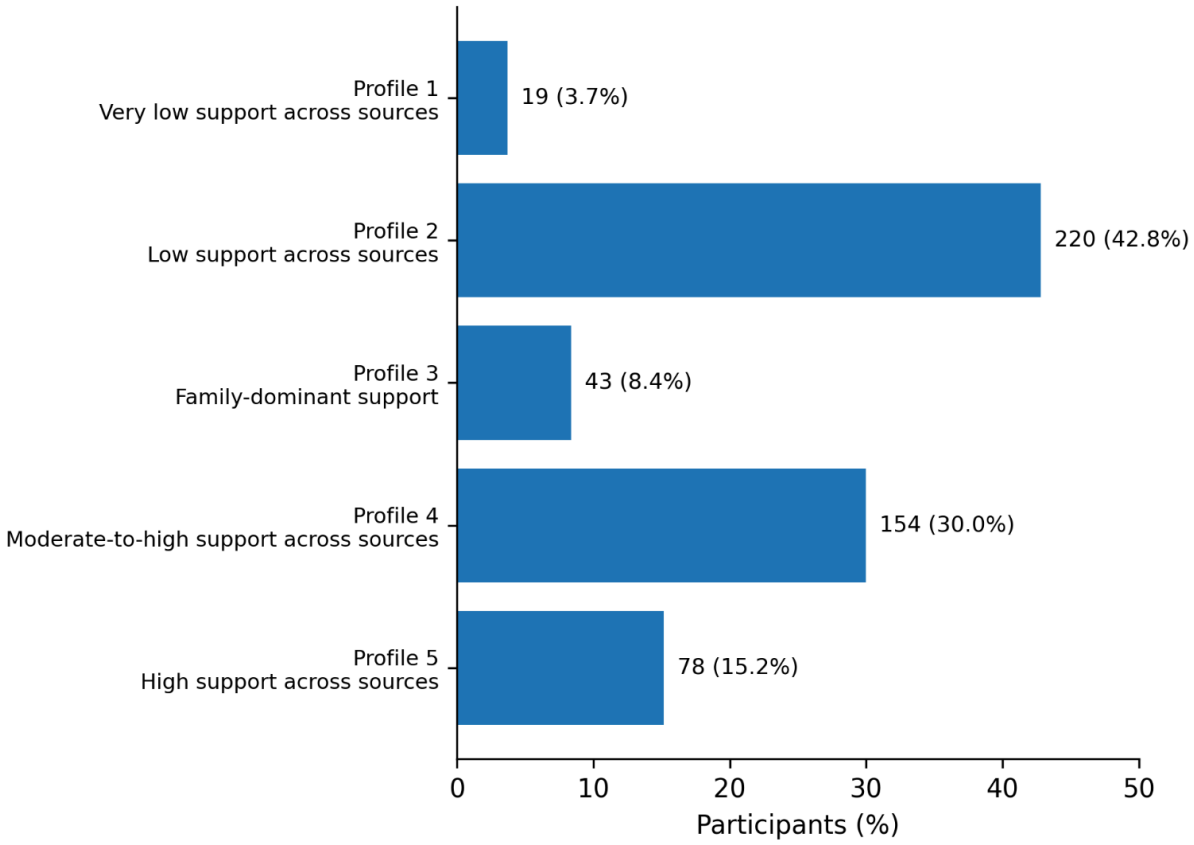


Figure 2

Distribution of patients across the five latent profiles based on maximum-posterior-probability assignment.

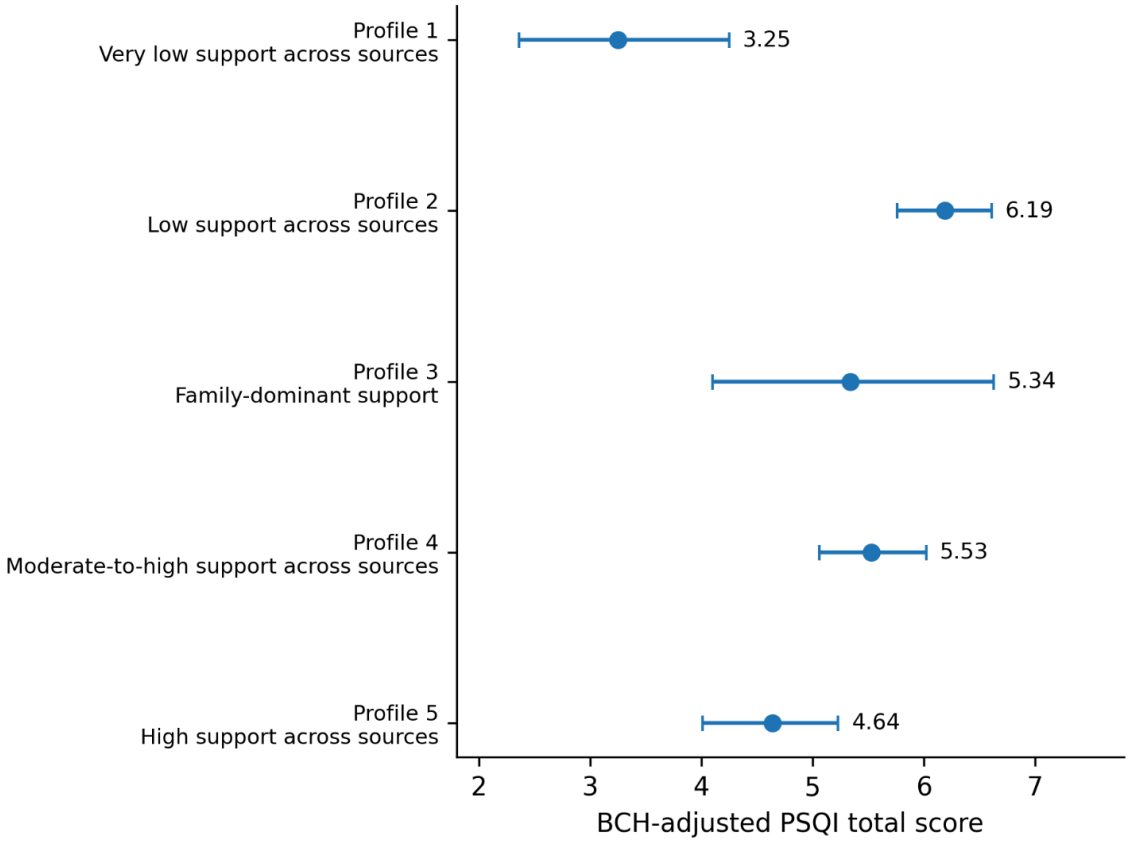


Figure 3

BCH-Adjusted PSQI Scores Across the Five Latent Profiles

Note: Higher PSQI scores indicate poorer sleep quality. Profile 1 included only 19 patients.

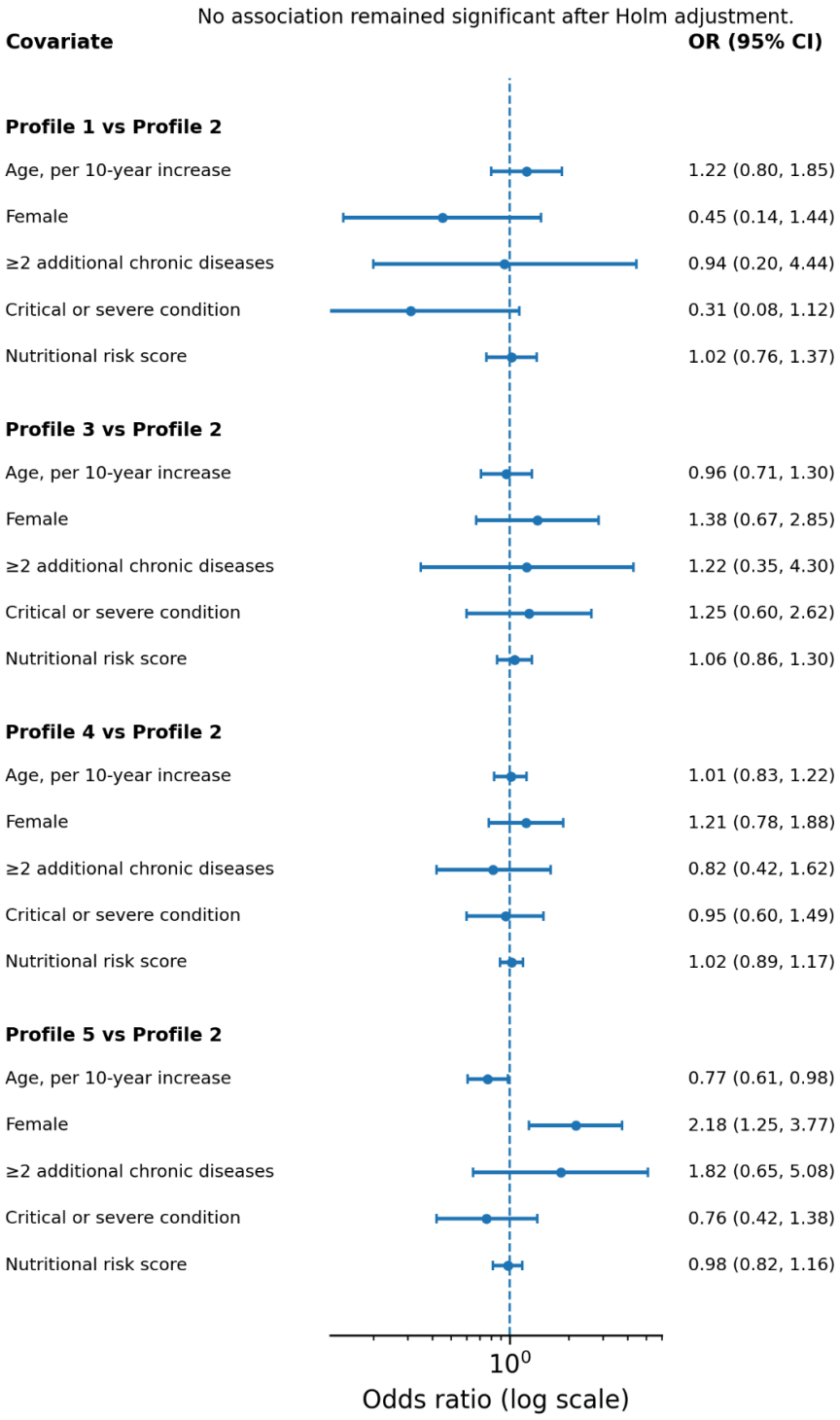


Figure 4

Core Multinomial Regression Estimates for Latent Profile Membership

Note: Profile 2 was the reference category. No association remained statistically significant after Holm correction.