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ORIGINAL RESEARCH

Latent Profile Analysis of Family Resilience and Its Associated Factors in Maintenance Hemodialysis Patients: A Cross-Sectional Study

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Purpose: This study aims to determine the latent categories of family resilience among patients undergoing maintenance hemodialysis (MHD) and to explore the influencing factors.

Patients and Methods: This cross-sectional study was conducted at two tertiary grade A hospitals affiliated with Jiangnan University from September 2025 to December 2025. The Family Resilience Assessment (FRAS-C) in its shortened version, Family Care Index Questionnaire, and the Medical Coping Modes Questionnaire (MCMQ) were utilized to assess the patients. Additionally, general information regarding the patients was collected. Latent Profile Analysis (LPA) was employed to identify potential subgroups of family resilience among MHD patients. Using these latent profile subgroups as the dependent variable, a multinomial logistic regression analysis was performed to investigate their influencing factors. The results of the multivariate logistic regression were visualized through a forest plot generated by GraphPad Prism version 10.1.2 software.

Results: The potential profile analysis revealed three distinct categories of family resilience: the Low Family Resilience – Insufficient Resource Utilization Group (n=72, 23.1%), the Moderate Family Resilience – Balanced Adaptation Group (n=139, 44.5%), and the High Family Resilience – Positive Interaction Group (n=101, 32.4%). The results of the multiple logistic regression analysis indicated that significant influencing factors for these categories of family resilience included marital status, the number of complications, dialysis vintage, family functioning, and medical coping.

Conclusion: This study employed LPA to categorize the family resilience of patients undergoing maintenance hemodialysis into three distinct profiles. The findings revealed significant heterogeneity in family resilience within this population. Hill's ABC-X family crisis model serves as a viable framework for exploring factors associated with family resilience among maintenance hemodialysis patients. The study demonstrated that family resilience in patients is significantly correlated with marital status, the number of complications, dialysis vintage, family functioning, and medical coping. In future treatment and care strategies for maintenance hemodialysis patients, implementing targeted interventions based on the identified profiles of family resilience holds important clinical significance.

Keywords: family function, family resilience, latent profile analysis, maintenance hemodialysis patients

Introduction

Chronic kidney disease (CKD) has emerged as a significant public health concern, posing a major global health threat. Its onset is often insidious, leading to most patients experiencing severely impaired kidney function by the time of diagnosis,

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frequently reaching or nearing end-stage renal disease (ESRD). For ESRD patients, hemodialysis serves as the primary renal replacement therapy to sustain life due to its proven safety and efficacy.[1] Epidemiological data indicate a steadily rising prevalence of maintenance hemodialysis (MHD) in China: the age-adjusted prevalence reaches 384.13 per million population, with hemodialysis accounting for 91.94% of all renal replacement modalities.[2] Furthermore, data from the National Blood Purification Case Information Registration System (CNRDS) show that the number of registered MHD patients increased from 582,000 in 2019 to 1,027,000 by the end of 2024, reflecting an annual compound growth rate of approximately 12.0%. This figure is projected to reach 1.23 million by 2026.[3] In the face of such a rapidly increasing population size, the long-term physical and psychological stress endured by patients and their families, as well as issues related to family adaptability, have become urgent clinical problems that require addressing.

The combined effects of chronic disease and long-term dialysis significantly impair the physical and mental health of patients undergoing MHD, rendering them vulnerable to both acute and chronic complications, as well as negative emotional disturbances such as helplessness, anxiety, and depression.[4] Furthermore, the chronic and irreversible nature of MHD necessitates long-term home-based care, with over 80% of caregivers reporting considerable caregiving burdens.[5,6] Continuous care demands, strict dietary restrictions, and frequent hospitalizations exacerbate caregivers' physical and psychological stress, hindering the development of adaptive family functioning. Relevant studies have shown that more than half of elderly MHD patients experience moderate to severe family dysfunction.[7] Optimal family functioning is closely associated with better adaptation to disease-related crises among MHD families, and family resilience serves as an essential protective factor for family adaptation.[8] Therefore, beyond focusing solely on individual patients, more attention should be paid to familial support and family resilience when addressing MHD-related challenges.[9]

Family resilience refers to a family's capacity to cope with crises. This capacity is fostered by stimulating internal driving forces that enable the family to actively utilize both internal and external resources to confront adversity.[10] In the context of nursing practice, it pertains to the family's ability to maintain stability, coordinate resources, and facilitate positive adaptation in the face of stress related to chronic diseases, encompassing mutual support and collaborative problem-solving.[11] The significance of family resilience has been extensively examined in patients with stroke, dementia, and cancer. Numerous studies[12,13] indicate that enhancing family resilience in patients with chronic diseases not only alleviates negative emotions, increases levels of hope and treatment confidence, and promotes the adoption of positive coping strategies, but also improves overall quality of life. For patients undergoing dialysis, family resilience is associated with the active mobilization of both internal and external resources by patients and their family members to adapt to the long-term treatment of the disease, daily caregiving needs, and associated health risks.[14,15]

Despite the well-recognized value of family resilience in chronic illness care, current studies focusing on MHD populations have notable methodological and theoretical limitations. Most existing research adopts a variable-centered perspective and relies solely on total family resilience scores to explore associated factors, thereby neglecting potential subgroup heterogeneity.[16,17] Furthermore, few studies incorporate established family theoretical frameworks to interpret variations in family resilience, resulting in an incomplete understanding of the interplay between MHD-related stressors and family adaptive outcomes. To address these gaps, the present study employs Hill's[18] ABC-X family crisis model as its theoretical framework.

The ABC-X family crisis model comprises four core elements: factors A, B, C, and X. Factor A refers to stressor events that are substantial enough to induce changes within the family system. Factor B pertains to the coping resources available to the family when confronting stressors, which may include familial support and other resources. Factor C encapsulates the family's perceptions and responses to these stressor events. Finally, factor X signifies the outcome of the family crisis or event. This model elucidates the mechanisms underlying family stress and crisis processes, illustrating that the combined effects of factors A, B, and C culminate in factor X. The ABC-X family crisis model has been extensively utilized in research on families dealing with chronic diseases, providing a structured framework for examining the interactions among stressors, resources, and coping strategies that influence family adaptability.[19,20]

Latent Profile Analysis (LPA) is an individual-centered statistical method that categorizes individuals into distinct subgroups based on complex patterns across multiple variables, thereby revealing potential heterogeneity among research subjects.[21,22] This method has been extensively utilized to study family resilience among patients with chronic diseases, effectively identifying various latent profiles and providing insights for personalized interventions.[23] However, to our knowledge, no research has utilized LPA to investigate the characteristic patterns of family resilience in patients with MHD

through the lens of the ABC-X family crisis model. Previous studies[24] have indicated that stressful events (Factor A) and response resources, such as family support and coping strategies (Factors B and C), are significantly related to family resilience (Factor X). Nonetheless, within the framework of the ABC-X family crisis model, the impact of these factors on the family resilience of MHD patients remains ambiguous.

This study employs LPA to identify potential family resilience profile types among patients with MHD. Guided by the ABC-X family crisis model, it explores the factors associated with these distinct profiles. The aim is to reveal the heterogeneous characteristics of family resilience within this population and to provide a theoretical basis and practical implications for developing targeted clinical interventions to enhance the family resilience of MHD patients.

Materials and Methods

Study Design

This cross-sectional study employed a convenience sampling method to collect data from patients diagnosed with chronic kidney disease (CKD) who were undergoing hemodialysis treatment at two tertiary grade A hospitals in Wuxi. The study was conducted from September 2025 to December 2025, and a total of 312 patients requiring maintenance hemodialysis were recruited. This study adhered to the STROBE reporting guidelines and received ethical approval from the Medical Ethics Committee of Jiangnan University Affiliated Hospital (Approval Number: LS2025291). All participants provided informed consent.

Participants

The inclusion criteria for participants in this study were as follows: (1) individuals aged 18 years or older; (2) those who meet the diagnostic criteria for end-stage renal disease as outlined in the "Chinese Guidelines for Early Evaluation and Management of Chronic Kidney Disease";[25] (3) patients undergoing regular long-term dialysis (2–3 times per week, 4 hours per session) for a minimum duration of three months; (4) individuals requiring caregivers; and (5) those capable of accurately reading and understanding the questionnaire content without any communication barriers. The exclusion criteria included: (1) individuals without a blood relationship to the caregiver who are compensating the caregiver; (2) individuals with life-threatening conditions confirmed by the attending physician through electronic medical records, including severe organ failure and advanced malignancies; and (3) individuals determined to have severe mental or cognitive disorders according to the "Diagnostic and Statistical Manual of Mental Disorders (Fifth Edition)". This study utilized G*Power 3.1 software to estimate the sample size. Through multiple regression analysis, the minimum sample size required for our study was determined to be 226, based on an effect size of 0.10, a significance level of 0.05, a power of 0.80, and the inclusion of 20 variables. To accommodate a 20% non-response rate, the target sample size was adjusted to 283. Furthermore, referencing the study by Ferguson et al,[26] it was suggested that a minimum sample size of 300 participants is required for latent profile analysis (LPA). Ultimately, we successfully recruited 312 patients undergoing maintenance hemodialysis.

Data Collection

After obtaining written informed consent from both the hospital and the patient, a cross-sectional survey was conducted by two researchers with standardized professional training in the blood purification center. Participants were initially screened individually based on inclusion and exclusion criteria through a review of medical records and face-to-face interviews. Eligible patients who provided informed consent were formally enrolled in the study. Prior to distributing the questionnaires, the researchers thoroughly explained the research purpose, significance, content, and completion instructions, emphasizing that participation was anonymous, voluntary, and could be withdrawn at any time. Participants completed the questionnaires anonymously during hemodialysis. For patients with visual impairments or other difficulties in independently completing the questionnaires, the researchers read the items neutrally without suggestive guidance and recorded answers strictly according to the patients' own intentions. The average completion time was approximately 10 to 15 minutes.

All questionnaires were collected on-site, followed by immediate quality checks. Items with missing or incomplete answers were promptly supplemented by reconfirmation with participants. Relevant clinical data were extracted from electronic medical records or supplemented through face-to-face inquiries. Questionnaires were excluded if they exhibited repetitive response patterns, fully consistent answers across all items, or an effective completion time of less than 5 minutes.

Measures

General Information Questionnaire

This study was designed by the researchers based on a comprehensive literature review and consists of three main parts: (1) demographic information, which includes variables such as gender, age, marital status, place of residence, educational level, occupational status, average monthly family income, and medical payment method; (2) family information, which primarily encompasses the relationship between the patient and the caregiver, whether the patient resides with the caregiver, and the number of the patient's children; (3) disease-related characteristics, which cover the type of primary disease, dialysis frequency, dialysis vintage, vascular access type, and the number of complications.

Family Resilience

The shortened Chinese version of the Family Resilience Assessment (FRAS-C) was developed in 2005 to evaluate the family resilience of the tested population. In 2016, Chinese scholars Li et al[27] introduced and revised it into FRAS-C, which comprises three dimensions: utilization of social resources (3 items), holding positive views (6 items), and family communication and problem-solving (23 items), resulting in a total of 32 items. This assessment employs a 4-point scoring method, ranging from "strongly disagree" to "strongly agree", with individual item scores ranging from 1 to 4, leading to a total score between 32 and 128. A higher score reflects a greater level of family resilience. This scale has demonstrated good applicability among Chinese patients undergoing maintenance hemodialysis, with a Cronbach's α coefficient of 0.799 in this study.

Family Functioning

The Family Care Index Questionnaire, also known as the Family APGAR Index, was developed by Dr. Smilkstein[28] in 1982, focusing on the characteristics of family functions. The Chinese version was revised by Lv Fan et al[29] It comprises five items: adaptability, cooperation, length, emotionality, and intimacy, with each item representing a distinct aspect of family functioning. The questionnaire employs a 3-point Likert scoring method, with scores ranging from "almost never" (0) to "often like this" (2). A total score of 7 to 10 indicates good family function, a score of 4 to 6 suggests moderate dysfunction, and a score of 0 to 3 indicates severe dysfunction. The Cronbach's α coefficient for this questionnaire is 0.861, demonstrating good reliability and validity.

Medical Coping

The Medical Coping Modes Questionnaire (MCMQ) was utilized in this study. This scale, developed by Feifel et al[30] was translated into Chinese by Shen Xiaohong.[31] The Chinese version of the scale comprises 20 items categorized into three dimensions: confrontation, avoidance, and acceptance-resignation. Specifically, the confrontation dimension contains 8 items, the avoidance dimension includes 7 items, and the acceptance-resignation dimension consists of 5 items. Each item is rated on a 4-point Likert scale, with scores ranging from 1 to 4; notably, 8 items employ reverse scoring. The individual with the highest score in each dimension is identified as having a propensity to adopt that particular medical coping strategy. The Cronbach's α coefficients for each dimension of this scale range from 0.724 to 0.779, indicating good internal consistency.

Data Analysis

A latent variable analysis was conducted using Mplus 8.3, with the average score of each item in the Family Resilience Scale treated as a continuous manifest variable. The initial model began with the variable "C1" and progressively increased the number of latent profiles until the optimal model fit index was achieved. The assessment indicators for latent profile adaptability comprise three types: (1) Information assessment indicators: Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC), and Sample Adjusted Bayesian Information Criterion (aBIC), where smaller values indicate better model fit; (2) Classification assessment indicators: Information Entropy (Entropy), with an entropy value of 0.8 indicates an accuracy rate exceeding 90%, and values closer to 1 signifying higher accuracy; (3) Proportion Ratio Tests: Log-Monte Carlo Test (LMRT) and Bootstrap-based Proportion Ratio Test (BLRT), where a p-value < 0.05 suggests that the k-category model is superior to the k-1 category model. Through a comprehensive evaluation of model fit indicators and practical interpretability, the optimal latent profile model was identified.

Data analysis was performed using SPSS version 27.0. The Kolmogorov–Smirnov test was employed to assess the normality of continuous data, while the Levene test evaluated the homogeneity of variance. Normally distributed continuous data were

presented as mean ± standard deviation, whereas non-normally distributed data were reported as median and interquartile range [M (P_{25}, P_{75})]. One-way analysis of variance was utilized for multi-group comparisons when the data met the assumptions of normality and homoscedasticity; otherwise, the Kruskal–Wallis *H*-test was applied. Categorical data were described using frequencies and percentages. The chi-square test or Fisher's exact test was used for unordered categorical variables, while the Kruskal–Wallis *H*-test was employed for ordered categorical variables. In the univariate analysis, variables with a P value < 0.05 were selected for subsequent multicollinearity assessment. A variance inflation factor (VIF) of ≥ 5 indicated severe multicollinearity.[32] Variables exhibiting high multicollinearity were excluded, and the remaining variables were included in the multinomial logistic regression model. This regression analysis was conducted to identify factors associated with family resilience among patients undergoing maintenance hemodialysis. A P-value < 0.05 was considered statistically significant.

Harman's single-factor test and unmeasured latent method factor analysis (ULMC) were utilized to evaluate common method bias among the scale items.[33] Furthermore, the outcomes of the multinomial logistic regression were illustrated as a forest plot using GraphPad Prism version 10.1.2.

Results

Participants Characteristics

In this study, a total of 337 questionnaires were collected. However, 25 were excluded from the analysis due to regular response formats, insufficient completion time, or missing items. Consequently, 312 questionnaires were deemed valid, resulting in a questionnaire recovery rate of 92.6%. (STROBE flowchart is shown in Supplementary Figure 1).

Among the 312 participants, 191 were male (61.2%) and 121 were female (38.8%), with an average age of 63.94 ± 9.83 years. The scores on the FRAS-C scale ranged from 61 to 109, with a mean score of 86.63 ± 9.74. Further details are provided in Table 1.

Table 1 Demographic and Clinical Characteristics of the Participants

Characteristics	Total (n = 312)	Classification of Latent Classes			$\chi^2/H/F$	P
		Class 1 (n = 72)	Class 2 (n = 139)	Class 3 (n = 101)		
Gender					1.137[a]	0.566
Male	191(61.2)	47(65.3)	86(61.9)	58(57.4)		
Female	121(38.8)	25(34.7)	53(38.1)	43(42.6)		
Age (years)					7.550[b]	0.023
18–<45	40(12.8)	7(9.7)	17(12.2)	16(15.8)		
45–<60	83(26.6)	15(20.8)	33(23.7)	35(34.7)		
≥60	189(60.6)	50(69.4)	89(64.0)	50(49.5)		
Employment status					6.245[a]	0.182
Employment	136(43.6)	24(33.3)	69(49.6)	43(42.6)		
Unemployment	33(10.6)	11(15.3)	13(9.4)	9(8.9)		
Retirement	143(45.8)	37(51.4)	57(41.0)	49(48.5)		
Marital status					11.234[a]	0.004
Married	223(71.5)	44(61.1)	95(68.3)	84(83.2)		
Unmarried or divorced or widowed	89(28.5)	28(38.9)	44(31.7)	17(16.8)		
Place of family residence					4.141[a]	0.126
A city or town	212(67.9)	42(58.3)	97(69.8)	73(72.3)		
Rural area	100(32.1)	30(41.7)	42(30.2)	28(27.7)		
Education level					0.123[b]	0.940
Primary school and below	81(26.0)	17(23.6)	34(24.5)	30(29.7)		
Junior high school	107(34.3)	28(38.9)	49(35.3)	30(29.7)		
High school or vocational school	55(17.6)	11(15.3)	26(18.7)	18(17.8)		
College degree or above	69(22.1)	16(22.2)	30(21.6)	23(22.8)		

(*Continued*)

Table 1 (Continued).

Characteristics	Total (n = 312)	Classification of Latent Classes			χ^2/H/F	P
		Class 1 (n = 72)	Class 2 (n = 139)	Class 3 (n = 101)		
Monthly household income (yuan)					3.605[b]	0.165
<3000	70(22.4)	19(26.4)	26(18.7)	25(24.8)		
3000–<5000	178(57.1)	38(52.8)	79(56.8)	61(60.4)		
≥5000	64(20.5)	15(20.8)	34(24.5)	15(14.9)		
Medical payment methods					5.526[a]	0.063
The medical insurance for urban residents	221(70.8)	46(63.8)	95(68.3)	80(79.2)		
Rural cooperative medical service	91(29.2)	26(36.1)	44(31.7)	21(20.8)		
Type of primary disease					2.551[c]	0.863
Chronic glomerulonephritis	145(46.5)	34(47.2)	60(43.2)	51(50.5)		
Diabetic nephropathy	103(33.0)	23(31.9)	50(36.0)	30(29.7)		
Hypertensive nephropathy	54(17.3)	13(18.1)	23(16.5)	18(17.8)		
Other	10(3.2)	2(2.8)	6(4.3)	2(2.0)		
The relationship between the patient and the caregiver					14.865[a]	0.021
Spouse	161(51.6)	47(65.3)	60(43.2)	54(52.5)		
Children	75(24.0)	17(23.6)	39(28.1)	19(18.8)		
Parents	29(9.3)	1(1.4)	17(12.2)	11(10.9)		
Others: such as brothers	47(15.1)	7(9.7)	23(16.5)	17(16.8)		
Number of children					3.817[b]	0.148
0	26(8.3)	8(11.1)	12(8.6)	5(5.9)		
1	190(60.9)	35(48.6)	81(58.3)	74(73.3)		
2	96(30.8)	29(40.3)	46(33.1)	21(20.8)		
Do you live with your caregiver?					1.075[a]	0.584
No	78(25.0)	15(20.8)	38(27.3)	25(24.8)		
Yes	234(75.0)	57(79.2)	101(72.7)	76(75.2)		
Dialysis frequency					2.083[a]	0.353
Three times a week	228(73.1)	50(69.4)	99(71.2)	79(78.2)		
Twice a week	84(26.9)	22(30.6)	40(22.8)	22(21.8)		
Number of complications*					20.942[b]	<0.001
No	41(13.1)	11(15.3)	11(7.9)	19(18.8)		
One	80(25.6)	14(19.4)	27(19.4)	39(38.6)		
Two	133(42.6)	29(40.3)	71(51.1)	33(32.7)		
Three or more	58(18.6)	18(25.0)	30(21.6)	10(9.9)		
Type of vascular access					0.013[a]	0.993
Internal arteriovenous fistula	287(92.0)	66(91.7)	128(92.1)	93(92.1)		
Central venous catheter	25(8.0)	6(8.3)	11(7.9)	8(7.9)		
Dialysis vintage(years)					14.308[b]	<0.001
<1	46(14.7)	21(29.2)	13(9.4)	12(11.9)		
1–<5	130(41.7)	29(40.3)	67(48.2)	34(33.7)		
5–<10	108(34.6)	20(27.8)	41(29.5)	47(46.5)		
≥10	28(9.0)	2(2.8)	18(12.9)	8(7.9)		
Family functioning	6.00 (5.00,7.00)	6.00 (5.00,6.00)	6.00 (5.00,6.00)	7.00 (6.00,8.00)	32.195[b]	<0.001
Confrontation	17.43±1.75	16.47±1.45	17.32±1.84	18.26±1.38	26.085[d]	<0.001
Avoidance	15.55±2.20	16.42±1.68	15.27±2.26	15.34±2.28	7.553[d]	<0.001
Acceptance-Resignation	9.99±1.28	10.81±1.20	9.82±1.24	9.63±1.24	22.359[d]	<0.001

Notes: Class 1 =Low Family Resilience – Insufficient Resource Utilization Group, Class 2 = Moderate Family Resilience – Balanced Adaptation Group, Class 3 = High Family Resilience – Positive Interaction Group. *Complications refer to the occurrence of one or more conditions, such as secondary hyperparathyroidism, renal anemia, hyperkalemia, etc. [a] χ^2 value; [b] Kruskal–Wallis *H* value; [c] Fisher's exact test, [d] One-way ANOVA.

Tests for Common Method Bias and Multicollinearity

Harman's single-factor test revealed the extraction of 22 common factors. The explanatory power of the first factor was 11.13%, which fell below the critical threshold of 40%. This finding indicates that there was no significant common method bias present in the data of this study.[34] Furthermore, this study utilized the ULMC approach to further assess common method bias. The results indicated that the fit indices for the three-factor measurement model were as follows: CFI = 0.885, TLI = 0.861, SRMR = 0.057, and RMSEA = 0.064. After introducing the method factor, the ULMC model yielded the following results: CFI = 0.892, TLI = 0.870, SRMR = 0.053, and RMSEA = 0.061. According to the ULMC method,[35] minimal changes in fit indices after adding the method factor ($\Delta CFI \leq 0.1$, $\Delta TLI \leq 0.1$, $\Delta RMSEA \leq 0.05$) suggest that common method bias is not severe. The variations in the fit indices for this study remained below the critical thresholds, indicating the absence of severe common method bias.

In the single-variable analysis, nine variables were identified as statistically significant. Following a multicollinearity test on these variables, it was observed that the tolerance of the independent variables ranged from 0.948 to 0.992, all exceeding 0.1. Furthermore, the variance inflation factor (VIF) ranged from 1.008 to 1.055, all below 5, which suggested that there was no serious multicollinearity issue among the independent variables, thereby indicating good stability of the regression model.

Family Resilience Latent Profiles in MHD Patients

The 32 items of the FRAS-C were employed as manifest variables for the LPA. The optimal number of class categories was determined by comparing the goodness-of-fit indices across various models. When the number of profiles increased to four, the results of the LMR test were not significant, and the categories were relatively small. We aimed to avoid subgroups with insufficient sample sizes, as this could lead to overfitting and potentially compromise the representativeness of the conclusions. Consequently, further grouping was discontinued, and the four-profile solution was rejected. Additionally, as the number of categories increased from one to three, the AIC, BIC, and aBIC exhibited a downward trend, indicating improved model fit with the increase in the number of categories. Comparisons between the three-profile and two-profile schemes revealed that the P-LMR and P-BLRT for the three-profile schemes were statistically significant, and the entropy values for the three-profile schemes surpassed those of the two-profile schemes. Furthermore, the category probability distribution of the three-category scheme was clearer than that of the two-category scheme. Therefore, the three-profile scheme aligned more closely with the actual clinical situation. Detailed model fit indices are presented in Table 2.

Naming Latent Categories of Family Resilience in MHD Patients

Based on our research results, we identified three distinct types of family resilience among the participants (Figure 1). Group C1 comprised 72 participants (23.1%), with FRAS-C item scores ranging from 1.236 to 2.447. This group exhibited significantly lower scores on items 6, 23, and 26, which pertained to the dimension of social resource utilization, reflecting limited access to and use of external support resources. Consequently, this group was designated as the "Low Family Resilience – Insufficient Resource Utilization Group". Group C2 included 139 participants (44.5%),

Table 2 Latent Class Model Fit Comparison

Model	*AIC*	*BIC*	*aBIC*	*Entropy*	*P*-value		Probability of Class
					LMR	*BLRT*	
1	25,069.775	25,309.122	25,106.137	–	–	–	–
2	23,921.012	24,283.772	23,976.123	0.916	<0.001	<0.001	0.569/0.431
3	23,423.871	23,910.044	23,497.730	0.924	<0.001	<0.001	0.231/0.445/0.324.
4	23,271.053	23,880.639	23,363.662	0.941	0.4765	<0.001	0.241/0.285/0.378/0.096

Notes: LMR (*P*) = *P* value for the Lo-Mendell-Rubin. BLRT (*P*) = *P* value for the Bootstrapped Likelihood Ratio Test.
Abbreviations: AIC, Akaike Information Criterion; BIC, Bayesian Information Criterion; aBIC, adjusted Bayesian Information Criterion.

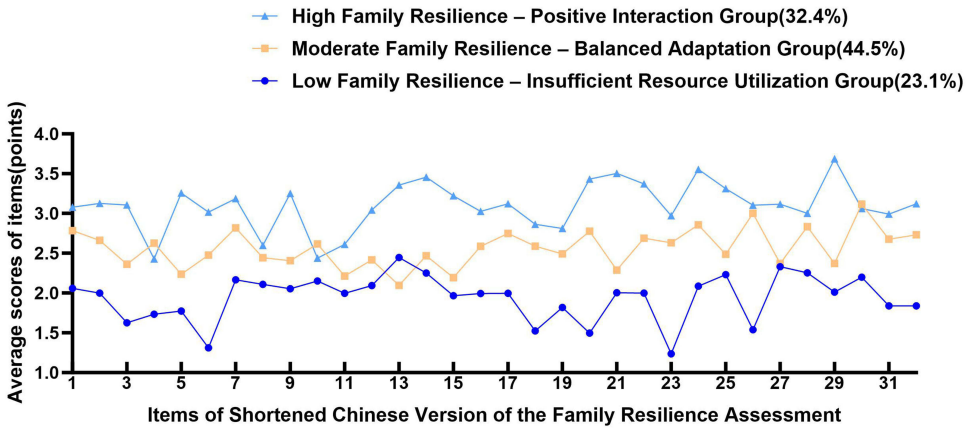

Figure 1 Characteristics of three latent profiles of family resilience in patients with MHD.

with item scores ranging from 2.095 to 3.001. This subgroup demonstrated a balanced response pattern across all FRAS-C items, with no significant differences in item scores across dimensions, and was therefore termed the "Moderate Family Resilience – Balanced Adaptation Group". Group C3 comprised 101 participants (32.4%), with item scores ranging from 2.429 to 3.686. This group exhibited markedly higher scores on items 14, 24, and 29, which were associated with the dimension of positive outlook. Individuals in this subgroup maintained an optimistic attitude toward family challenges and tended to engage in active communication and cooperation with family members to collaboratively address difficulties. As a result, this group was labeled the "High Family Resilience – Positive Interaction Group". These findings underscore the heterogeneity of family resilience among maintenance hemodialysis patients. Such heterogeneity suggests that targeted interventions tailored to each subgroup should be developed, focusing on resource mobilization, balanced adaptation, and positive cognitive regulation, rather than adopting a uniform intervention model.

Difference in Patient Characteristics Across Various Latent Categories

The chi-square test and Kruskal–Wallis *H*-test revealed significant differences among the three latent profile groups concerning age ($H = 7.550$, $p = 0.023$), marital status ($\chi^2 = 11.234$, p = 0.004), the relationship between patients and caregivers ($H = 14.865$, $p = 0.021$), the number of complications ($H = 20.942$, $p < 0.001$), and dialysis vintage ($H = 14.308$, $p < 0.001$). Additionally, the normality test results indicated that the scores of the three dimensions of the medical coping style scale were normally distributed across the three patient groups. Meanwhile, the homogeneity of variance test (Levene's test) confirmed that the p-values for the scores of the three dimensions exceeded 0.05, thereby validating the assumption of homogeneity of variance. However, the family function score failed to meet the criteria for normality and homogeneity of variance. Consequently, we opted for non-parametric tests. The results of the one-way analysis of variance and the Kruskal–Wallis *H*-test demonstrated significant differences in family function ($H = 32.195$, $p < 0.001$), confrontation coping style ($F = 26.085$, $p < 0.001$), avoidance coping style ($F = 7.556$, $p < 0.001$), and acceptance-resignation coping style ($F = 22.359$, $p < 0.001$) (see Table 1).

Multiple Logistic Regression Analysis of Factors Influencing Latent Categories of Family Resilience in MHD Patients

In the univariate analysis, nine variables were identified as statistically significant. Subsequent multicollinearity testing revealed no severe collinearity among these variables. All nine statistically significant variables were therefore entered as independent variables into the multinomial logistic regression model, with the latent family resilience subtypes set as the dependent variable. The parallel line test yielded $p = 0.023$, which failed to meet the criterion for ordered logistic regression ($p > 0.05$). Accordingly, unordered multinomial logistic regression was adopted for multivariate analysis. The allocation of independent variables is detailed in Supplementary Table 1. The results for Class 3 (Figure 2A) indicated that, in comparison to Class 1, Class 3 exhibited significant differences in married status (OR = 2.662, 95% CI:

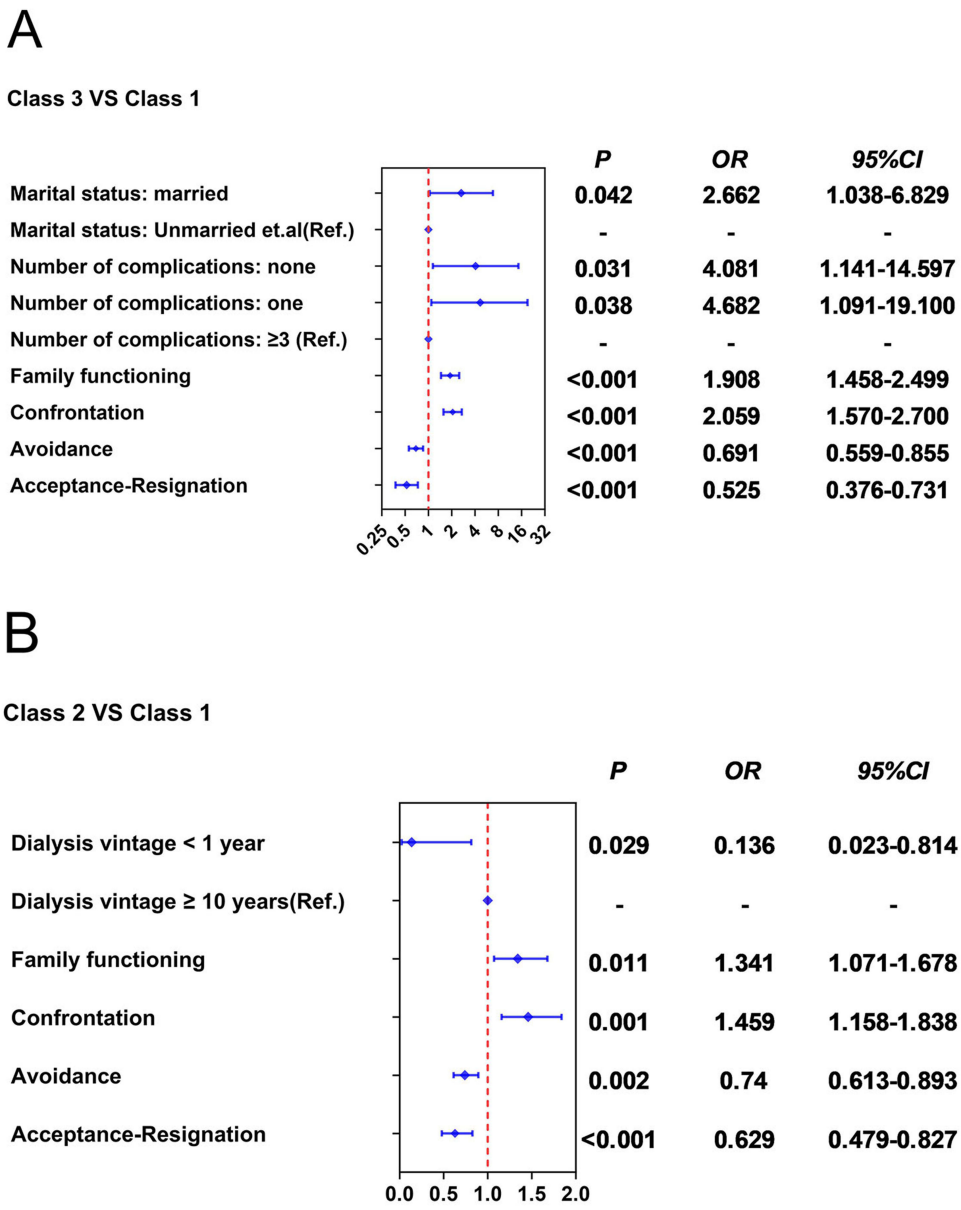

Figure 2 Multivariate analysis of family resilience in patients with MHD. (**A**) Comparisons between Class 3 and Class 1; (**B**) Comparisons between Class 2 and Class 1.
Abbreviations: OR, odds ratio; 95% CI, 95% confidence interval.

1.038–6.829), absence of complications (OR = 4.081, 95% CI: 1.414–14.597), and presence of one complication (OR = 4.682, 95% CI: 1.091–19.100). The results for Class 2 (Figure 2B) revealed statistical differences when compared to Class 1 in terms of dialysis vintage, specifically among patients with a dialysis duration of less than 1 year (OR = 0.136, 95% CI: 0.023–0.814). Furthermore, both Class 3 and Class 2 showed significant differences in family function compared to Class 1 (C3: OR = 1.908, 95% CI: 1.458–2.499; C2: OR = 1.341, 95% CI: 1.071–1.678). Differences were also noted in confrontation coping styles (C3: OR = 2.059, 95% CI: 1.570–2.700; C2: OR = 1.459, 95% CI: 1.158–1.838), avoidance coping styles (C3: OR = 0.691, 95% CI: 0.559–0.855; C2: OR = 0.740, 95% CI: 0.631–0.893), and acceptance-resignation coping styles (C3: OR = 0.525, 95% CI: 0.376–0.731; C2: OR = 0.629, 95% CI: 0.479–0.827). Detailed results are illustrated in Figure 2.

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Discussion

The Subgroups of Family Resilience Among Patients with Maintenance Hemodialysis

This study identified three distinct patterns of family resilience among MHD patients: the Low Family Resilience – Insufficient Resource Utilization Group (23.1%), the Moderate Family Resilience – Balanced Adaptation Group (44.5%), and the High Family Resilience – Positive Interaction Group (32.4%). These patterns highlight the significant heterogeneity of family resilience in MHD patients, which may serve as a foundation for guiding targeted nursing interventions for healthcare providers.

In this study, participants in the Low Family Resilience – Insufficient Resource Utilization Group were more likely to report poor family functioning, a tendency towards negative coping styles such as avoidance or acceptance-resignation, a higher proportion of unmarried, divorced, or widowed individuals, increased complications, and shorter dialysis vintage. Based on these observed concurrent profiles and the theoretical framework of the ABC-X family crisis model,[18] healthcare providers might consider interventions that target key components of family resilience. Specifically, enhancing family communication training could strengthen family resources (B), linking to social support resources could expand external support systems (B), and providing guidance on coping skills may help modify the family's cognitive appraisal of illness (C). Such multi-component strategies may improve family resilience in this patient group.[36] The Moderate Family Resilience – Balanced Adaptation Group exhibited a propensity to effectively utilize both internal and external resources to navigate the challenges associated with hemodialysis. However, participants in this group reported a higher incidence of multiple complications and demonstrated a tendency towards avoidance coping strategies. Consequently, their families may be at risk of experiencing functional imbalances. Drawing on Lazarus and Folkman's stress, appraisal, and coping theory,[37] it is suggested that healthcare providers regularly assess the psychological status of patients and their family members. Timely education on complication prevention should be provided, and patients might be encouraged to engage in medical decision-making and disease management, potentially fostering more active coping engagement and supporting adaptive adjustment to chronic illness. In contrast, the High Family Resilience – Positive Interaction Group was characterized by robust family functioning, a higher prevalence of positive confrontational coping styles, a higher proportion of married status, fewer complications, and longer dialysis vintage. Nevertheless, this group may still encounter challenges, such as sudden changes in disease condition or increased caregiving burdens, which may jeopardize the stability of family resilience. Based on the theoretical principles of Acceptance and Commitment Therapy (ACT), it may be beneficial to formulate flexible care plans to accommodate their evolving needs.[38] Implementing ACT-based stress reduction strategies, such as mindfulness training for caregivers, may cultivate psychological flexibility and facilitate acceptance of unforeseen disease-related stressors, which may help sustain family resilience in this subgroup.

The Influence of Demographic Data and Disease Characteristics on the Categories of Family Resilience in Maintenance Hemodialysis Patients

The findings of this study revealed an association between marital status and latent family resilience classification, which is consistent with prior evidence.[39] Differences in family resilience distribution across marital statuses were evident; specifically, married MHD patients were more likely to be categorized into the High Family Resilience – Positive Interaction Group compared to those in the Low Family Resilience – Insufficient Resource Utilization Group. Research indicated[40] that spouses served as the primary caregivers for MHD patients, sharing the negative stress associated with dialysis treatment. In contrast to unmarried, divorced, or widowed patients, married individuals tended to have more stable emotional companionship and practical support. Relevant studies[41] demonstrated that the positive coping strategies employed by spouses and family coping resources were correlated with lower illness-related stress. Although long-term dialysis treatment altered the family roles of patients, spousal collaboration may be linked to reduced adverse outcomes in family functioning. Additionally, Walsh's family resilience theory suggests that collective coping with disease challenges among couples and families may contribute to relational consolidation and family structure stability, potentially strengthening families' capacity to cope with future stressors.[13] Longitudinal research is needed to test this mechanism.

The number of complications and dialysis vintage were significantly associated with family resilience among MHD patients in the sample, consistent with the findings of González-Flores CJ.[42] Patients experiencing no or only one complication

were more likely to be categorized within the High Family Resilience – Positive Interaction Group compared to those in the Low Family Resilience – Insufficient Resource Utilization Group. Relevant studies[43] reported a positive correlation between symptom burden and the number of complications among MHD patients. In contrast to patients with more than three complications, those with fewer complications tended to experience less disease distress. At the same time, families reported a low complication-related burden and tended to adopt adaptive responses rather than crisis-oriented management approaches. Regarding dialysis vintage, patients with a duration of less than one year were more likely to be classified into the Low Family Resilience – Insufficient Resource Utilization Group compared to the Moderate Family Resilience – Balanced Adaptation Group. This pattern may reflect that, in contrast to patients with a dialysis vintage exceeding ten years, those with shorter dialysis exposure were generally less familiar with treatment procedures and held greater uncertainty about disease prognosis, factors that could be associated with passive and negative coping styles.[44] Relevant studies demonstrated[5] that the coping strategies adopted by MHD patients and their families in response to long-term dialysis challenges were closely linked to family resilience, with negative coping approaches associated with poorer family adaptability. Furthermore, it is plausible that an extended dialysis vintage may be associated with accumulated disease management experience, potentially reflecting more mature and positive coping strategies.[45]

These findings underscore that demographic and disease-related characteristics are significant correlates of family resilience, offering theoretical implications for clinical practice. Healthcare providers should evaluate the combined correlates of population and disease-related attributes when addressing family resilience. Targeted support and intervention measures can be customized for different subgroups of patients with MHD. For instance, providing family communication training for unmarried or widowed patients, enhancing guidance on complication management for individuals with multiple comorbidities, and delivering adaptive coping training for families with shorter dialysis vintage may help mitigate potential challenges associated with these correlates.[46,47]

The Impact of Family Functioning on the Family Resilience

Family function was strongly correlated with family resilience among patients undergoing MHD. This study identified significant differences in family function scores across three distinct groups characterized by varying levels of family resilience. Patients with higher family function scores were more likely to be classified into the Moderate Family Resilience – Balanced Adaptation Group or the High Family Resilience – Positive Interaction Group compared to those in the Low Family Resilience – Insufficient Resource Utilization Group, aligning with the findings of previous studies.[48] Within the context of Chinese culture, the family serves as the primary source of social support. Family care, which encompasses five core components — adaptability, cooperation, partnership, emotionality, and intimacy — serves as a crucial indicator for assessing family functioning. Enhanced performance in these dimensions may correlate with stronger emotional cohesion and adaptive capacity to disease-related stressors. Conversely, patients in the Low Family Resilience – Insufficient Resource Utilization Group exhibited ineffective intrafamilial communication and cooperation, which may be linked to poorer family coping capacity regarding chronic kidney disease. Studies showed that long-term dialysis treatment and the uncertainty surrounding the disease was associated with heightened levels of helplessness and anxiety among MHD patients.[49] In contrast, individuals with higher scores on the family care index tended to experience more favorable emotional and intimate dimensions of family functioning; these characteristics may facilitate positive family interaction and mutual understanding, potentially mitigating the negative emotional burden within the family. Furthermore, relevant studies reported that high family adaptability and cooperation are positively correlated with improved mobilization and allocation of both internal and external family resources.[50] Patients exhibiting higher family function scores were more likely to receive substantial care support, including companionship during dialysis, medication management, and dietary supervision. Accordingly, medical staff might consider routinely assessing the family function of patients undergoing MHD, encouraging open communication between patients and their family members, and guiding family members in providing support and care for patients. This approach might facilitate positive family adaptation.

The Impact of Medical Coping on the Family Resilience

The results of this study indicated a correlation between coping strategies and family resilience. Specifically, patients who employed a confrontation-type coping approach were more likely to be classified within the Moderate Family Resilience –

Balanced Adaptation Group or the High Family Resilience – Positive Interaction Group. Conversely, patients who utilized avoidance-type or acceptance-resignation-type strategies tended to fall within the Low Family Resilience – Insufficient Resource Utilization Group, which aligned with previous research findings.[5] Prior studies reported that positive coping styles were potential protective factors for family resilience, while negative coping styles may act as risk factors.[51] Among these, confrontation-type coping was categorized as a positive coping style, whereas avoidance-type and acceptance-resignation-type coping were classified as negative coping styles. Relevant research indicated that patients with MHD often experienced self-regulatory fatigue under prolonged physiological and psychological stress during long-term disease management. This fatigue may be associated with a reduced tendency to maintain an active treatment attitude, which could correlate with a greater likelihood of adopting negative coping strategies such as avoidance and acceptance-resignation.[52] For example, some patients tended to avoid communication with family members or refuse family participation in disease management and decision-making, rather than engaging in the active communication and collaborative participation characteristic of confrontation-type coping.[53] Relevant studies showed that effective coping strategies were correlated with reduced physical and psychological stress burden.[54] In comparison, negative coping strategies may be linked to poorer family stress regulation, weaker collaborative problem-solving capacity, and a higher risk of unfavorable family adaptation.

Therefore, guided by the stress and coping theory, clinical healthcare providers may consider integrating coping-oriented interventions into routine care, with a particular emphasis on strengthening patients' constructive coping patterns.[5] In clinical practice, it is recommended to provide targeted guidance to reduce maladaptive coping behaviors. In conjunction with Walsh's family resilience theory,[55] continuous family-centered psychological support, health education, and collaborative coping training can be offered to patients with MHD and their families. From a theoretical perspective, these supportive measures may assist families in developing adaptive coping patterns and fostering positive interaction modes, which are potentially correlated with a reduced susceptibility to poor family adaptation and enhanced family resilience.

Limitations

This study has several limitations. Firstly, due to constraints related to manpower and time, the survey subjects were exclusively drawn from the Wuxi City area of Jiangsu Province, utilizing a non-random sampling method, which may introduce selection bias. Secondly, data were collected solely from general hospitals, potentially failing to represent the full spectrum of dialysis patients, particularly those in community hospitals. This limitation may restrict the generalizability of the research findings. Thirdly, the cross-sectional design of this study precludes the exploration of causal relationships between various influencing factors and the categories of family resilience, as well as the dynamic tracking of changes in these potential categories over time. Future research should consider conducting multi-center, large-sample longitudinal studies to comprehensively and accurately identify the factors influencing the family resilience of MHD patients. Finally, family resilience is a construct that operates at the family system level. Due to resource limitations, this study evaluated family resilience solely from the patients' perspective, which may not fully capture the overall level and interaction characteristics of family resilience. This limitation may affect the representativeness of the potential profile analysis results. Future research could employ a paired design involving both patients and their primary caregivers to explore the characteristics of family resilience from a dual perspective, thereby enhancing the comprehensiveness and objectivity of the findings and enabling targeted intervention studies based on different profiles.

Conclusion

This study employed LPA to categorize the family resilience of patients undergoing maintenance hemodialysis into three distinct profiles. The findings revealed significant heterogeneity in family resilience within this population. Hill's ABC-X family crisis model serves as a viable framework for exploring factors associated with family resilience among maintenance hemodialysis patients. The study demonstrated that family resilience in patients is significantly correlated with marital status, the number of complications, dialysis vintage, family functioning, and medical coping. In future treatment and care strategies for maintenance hemodialysis patients, implementing targeted interventions based on the identified profiles of family resilience holds important clinical significance.

Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and received approval from the Research Ethics Committee of the Affiliated Hospital of Jiangnan University (LS2025291).

Data Sharing Statement

Upon reasonable request, communicating the correspondence author (Renjuan Sun) may present data in favor of the results of this research.

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Disclosure

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