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Abstract

Background Frailty, as a common geriatric health syndrome, has attracted widespread attention because it is associated with multiple adverse health outcomes; however, the heterogeneous characteristics of frailty among community-dwelling older adults and its related psychosocial factors remain insufficiently studied. Objective To identify latent classes of frailty among community-dwelling older adults and, based on conservation of resources theory, to explore the relationships of resource loss factors and resource gain factors with different frailty classes. Methods From May to October 2024, a multistage stratified sampling method was used to select 480 community-dwelling older adults in Shijiazhuang as study participants. The Tilburg Frailty Indicator (TFI) was used to assess frailty status, and the Generalized Anxiety Disorder Scale (GAD-7), the 15-item Geriatric Depression Scale (GDS-15), the short-form 6-item UCLA Loneliness Scale (ULS-6), and the Social Support Rating Scale (SSRS) were used to assess levels of anxiety, depression, loneliness, and social support, respectively. Latent profile analysis was used to identify frailty classes, and a generalized structural equation model was applied to examine the relationships between gain/loss factors and different frailty classes. Results A total of 479 valid questionnaires were recovered, with an effective response rate of 99.79%. Latent profile analysis identified 3 latent frailty classes. The "high physical-social frailty type" (13.15%) was predominantly female, with higher proportions of living alone and being unmarried, lower levels of social support, and higher levels of depression and loneliness; the "moderate frailty-robust type" (59.71%) was the main group among community-dwelling older adults, mostly married, with the highest level of social support and relatively stable overall functioning; the "low psychological-social frailty type" (27.14%) was predominantly male, with better economic status, social support, and psychological status. The generalized structural equation model showed that the relationships between gain/loss factors and different frailty classes differed significantly. Resource loss factors were positively associated with the "high physical-social frailty type" (β=0.246, P<0.001); resource gain factors were negatively associated with the "high physical-social frailty type" (β=-0.404, P<0.001) and positively associated with the "moderate frailty-robust type" (β=0.605, P<0.001). Social support did not show a significant moderating effect between resource loss factors and frailty classes (P>0.05), supporting the "independent dual-path model of resource loss and gain." Conclusion Frailty among community-dwelling older adults shows marked heterogeneity, and different frailty classes differ in their associations with resource loss factors and resource gain factors. Community health management can adopt targeted strategies to promote and maintain gain resources and reduce loss resources according to the characteristics of different frailty classes, thereby improving the health and quality of life of frail older adults.

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Full Text

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Heterogeneity of Frailty and Its Psychosocial Factors among Community-Dwelling Older Adults: Based on Conservation of Resources Theory

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Abstract Background Frailty, as a common geriatric health syndrome, has attracted extensive attention because of its association with multiple adverse health outcomes. However, the heterogeneity of frailty among community-dwelling older adults and its related psychosocial factors remain insufficiently studied. **Objective** To identify latent profiles of frailty among community-dwelling older adults and, based on Conservation of Resources Theory, to explore the relationships of resource loss factors and resource gain factors with different frailty profiles. **Methods** From May to October 2024, a multistage stratified sampling method was used to select 480 community-dwelling older adults in Shijiazhuang as study participants. The Tilburg Frailty Indicator (TFI) was used to assess frailty status; the Generalized Anxiety Disorder Scale (GAD-7), the Short Form Geriatric Depression Scale (GDS-15), the 6-item Short Form of the UCLA Loneliness Scale (ULS-6), and the Social Support Rating Scale (SSRS) were used to assess anxiety, depression, loneliness, and social support, respectively. Latent profile analysis was used to identify frailty profiles, and generalized structural equation modeling was applied to examine the relationships between gain/loss factors and different frailty profiles. **Results** A total of 479 valid questionnaires were collected, with an effective response rate of 99.79%. Latent profile analysis identified three latent frailty profiles. The "high physical-social frailty profile" (13.15%) was dominated by women, had higher proportions of older adults living alone and not currently married, lower social support, and higher levels of depression and loneliness. The "moderate frailty-robust profile" (59.71%) was the main group among community-dwelling older adults; most were currently married, had the highest level of social support, and showed relatively stable overall functioning. The "low psychological-social frailty profile" (27.14%) was dominated by men and showed better economic status, social support, and psychological status. Generalized structural equation modeling showed significant differences in the relationships between gain/loss factors and different frailty profiles. Resource loss factors were positively asso-

ciated with the "high physical-social frailty profile" ($\beta = 0.246$, $P < 0.001$); resource gain factors were negatively associated with the "high physical-social frailty profile" ($\beta = -0.404$, $P < 0.001$) and positively associated with the "moderate frailty-robust profile" ($\beta = 0.605$, $P < 0.001$). Social support did not show a significant moderating effect between resource loss factors and frailty profiles ($P > 0.05$), supporting the "resource loss-gain dual-pathway independent model." **Conclusion** Frailty among community-dwelling older adults shows marked heterogeneity, and the association patterns between different frailty profiles and resource loss and resource gain factors differ. Community health management may incorporate the characteristics of different frailty profiles and adopt targeted strategies to promote and maintain gain resources and reduce loss resources, thereby improving the health and quality of life of frail older adults.

[**Keywords**] frailty; older adults; latent profile analysis; resource loss factors; resource gain factors; community health management

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Heterogeneity of Frailty and Its Psychosocial Factors among Community-dwelling Older Adults: Based on Conservation of Resources Theory

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Abstract Background Frailty, as a common geriatric health syndrome, has attracted extensive attention due to its association with multiple adverse health outcomes. However, the heterogeneity of frailty and its related psychosocial factors among community-dwelling older adults remain insufficiently explored. **Objective** To identify the potential latent profiles of frailty among community-dwelling older adults and, based on the Conservation of Resources Theory, to examine the relationships between resource loss and resource gain factors and different frailty profiles. **Methods** From May to October 2024, a multi-stage stratified

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sampling method was employed to select 480 community-dwelling older adults from Shijiazhuang as participants. Frailty was assessed using the Tilburg Frailty Indicator (TFI). Anxiety, depression, loneliness, and social support levels were measured using the Generalized Anxiety Disorder Scale (GAD-7), the Geriatric Depression Scale-15 (GDS-15), the 6-item University of California at Los Angeles (UCLA) Loneliness Scale (ULS-6), and the Social Support Rating Scale (SSRS), respectively. Latent profile analysis was used to identify frailty categories, and the generalized structural equation model was applied to examine the effects of resource loss and gain factors on these different profiles. **Results** A total of 479 valid questionnaires were collected, resulting in an effective response rate of 99.79%. Latent profile analysis identified three latent profiles of frailty: (1) The “High Physical-Social Frailty” profile (13.15%) was characterized by a higher proportion of women, a higher proportion of individuals living alone or not married, lower social support, and higher levels of depression and loneliness. (2) The “Moderate but Stable Frailty” profile (59.71%) represented the largest group, mainly consisting of married individuals, with the highest level of social support and relatively stable overall functioning. (3) The “Low Psychological-Social Frailty” profile (27.14%) was predominantly male and showed better economic status, social support, and psychological well-being. Generalized structural equation model revealed significant differences in the associations between resource factors and frailty profiles. For the “High Physical-Social Frailty”profile, resource loss was positively associated with frailty profile ($\beta = 0.246, P < 0.001$), whereas resource gain was negatively associated ($\beta = -0.404, P < 0.001$). For the “Moderate but Stable Frailty” profile, only resource gain was positively associated with frailty profile ($\beta = 0.605, P < 0.001$). Social support did not show a significant moderating effect between resource loss and frailty profiles ($P > 0.05$), supporting the “Independent Dual-Path Model of Resource Loss and Gain” . **Conclusion** Frailty among community-dwelling older adults is heterogeneous, and different frailty profiles exhibit distinct associations with resource loss and resource gain factors. Community health management strategies should be tailored to specific frailty profiles, focusing on enhancing resource

gains and reducing resource losses to improve health outcomes and quality of life among older adults.

【Key words】 Frailty; Aged; Latent profile analysis; Resource loss factors; Resource gain factors; Community health management

Frailty is a dynamic and reversible state between health and disability [1], and is one of the most representative geriatric health syndromes. Its main characteristics include reduced physiological reserve, impaired stress-response capacity, and increased vulnerability [2]. Frailty significantly increases the risk of adverse health outcomes among older adults, such as falls, disability, hospitalization, and death, imposing a heavy health and economic burden on families and society [3]. Previous studies have shown that early identification and intervention can effectively delay, or even reverse, the progression of frailty and reduce the risk of disability [4]. Therefore, against the global backdrop of increasingly severe population aging, the prevention and control of frailty has become an important public health issue [5].

Amid the global trend of "aging in place," the community, as the primary living environment for older adults, has become a key setting for frailty prevention and control. Notably, the prevalence of frailty among community-dwelling older adults is relatively high [6], and this population shows marked heterogeneity in health status, functional level, and social resources [7]. This means that if community-dwelling older adults are treated as a homogeneous group and provided with undifferentiated interventions, the effectiveness and efficiency of such interventions may be limited. However, existing studies on frailty heterogeneity have mostly focused on clinical populations with specific diseases, such as cancer and diabetes [8–9], while the identification of latent frailty classes and analysis of their characteristics among community-dwelling older adults remain insufficient.

Further exploration of the influencing factors of different latent frailty classes is an important foundation for achieving precise health management. Existing studies have largely focused on listing psychological and social factors associated with frailty [1,10], but how these factors act synergistically on different frailty classes, and what the underlying mechanisms are, remain insufficiently and unsystematically explained. Conservation of resources theory (COR) posits that individuals have an intrinsic motivation to preserve, acquire, and consolidate important resources, including material, psychological, and social resources; when facing the threat of resource loss or actual resource loss, individuals are prone to adverse states such as psychological stress; resource gain, by contrast, helps replenish or strengthen resource reserves, thereby improving psychological adaptation and resilience [11]. Among older adults, anxiety, depression, and loneliness are typical psychological resource-loss factors, while social support is a key social resource-gain factor [12]. However, few existing studies have placed the dual pathways of resource "loss" and "gain" within the same framework to examine their relationships with different latent frailty classes—specifically, whether resource-gain factors buffer the negative effects of resource loss (the

resource-gain buffering model), or instead exert an independent protective effect (the independent dual-path model of resource loss and gain). Empirical evidence remains lacking. Clarifying these issues will help realize classified management and precise intervention at the community level.

1 Objects and Methods

1.1 Study Participants

This study used a multistage stratified sampling method to select survey participants in Shijiazhuang, Hebei Province, from May to October 2024. The specific sampling procedure consisted of three stages: in the first stage, four main urban districts were selected according to administrative divisions; in the second stage, convenience sampling was used to select a total of seven communities from the above districts, with the numbers being 3, 1, 1, and 2, respectively; in the third stage, in places where older adults were relatively concentrated—such as Party-mass service centers, community health service centers, senior activity centers, and residents' activity squares in each community—the survey was conducted by uniformly trained [[unclear: text continues on next page]].

Investigators conducted on-site recruitment with the assistance of community staff and invited older adults who met the inclusion criteria to participate in the survey by convenience sampling. Before the survey, the study purpose and content were explained to participants. After informed consent was obtained, data were collected through face-to-face questionnaire interviews; for those who had difficulty reading or completing the questionnaire, investigators used standardized instructions to assist them in completing it. Inclusion criteria were: (1) age $ $60 years; (2) continuous residence in the community for $ $12 months; and (3) clear consciousness and no communication barriers. Those unable to cooperate with the survey were excluded.

The sample size was calculated according to the requirements of latent profile analysis (LPA). The minimum sample size was set at 300 cases, with at least 30 participants ensured in each latent class[13]. Considering an approximately 20% rate of invalid questionnaires, the final required sample size was determined to be at least 360 cases. In practice, 480 questionnaires were distributed, and 479 valid questionnaires were recovered, yielding an effective response rate of 99.79%. This study was approved by the Medical Ethics Committee of Hebei Medical University (2025029), and all participants signed informed consent forms.

1.2 Measurement Tools and Scales

The data collection instruments in this study included a general information questionnaire and scales assessing five domains: anxiety, depression, loneliness, social support, and frailty.

1.2.1 General Information

A self-designed general information questionnaire was used, including 9 items: age, sex, ethnicity, education level, marital status, number of children, mode of residence, retirement status, and average monthly income.

1.2.2 Frailty Assessment

The Chinese version of the Tilburg Frailty Indicator (TFI), translated by Xi Xing et al.[14], was used, primarily to assess the degree of frailty among community-dwelling older adults. The scale consists of 15 items across 3 dimensions: physical (8 items), psychological (4 items), and social (3 items). Items are scored as "yes" (1 point) or "no" (0 points), with a total score range of 0–15; higher scores indicate more severe frailty. In this study, the Cronbach' s α coefficient of the scale was 0.513. Because the scale contains highly heterogeneous dichotomous items, the α coefficient may be low; however, its internal consistency reliability and validity have been widely verified, and it is suitable for use among Chinese older adults[14].

1.2.3 Anxiety Assessment

The Chinese version of the Generalized Anxiety Disorder-7 (GAD-7), translated and validated by Cai Chengjun[15], was used. The scale contains 7 items and assesses anxiety symptoms over the past two weeks. It uses a 4-point scoring system from 0 ("not at all") to 3 ("nearly every day"), with a total score range of 0–21; higher scores indicate more severe anxiety symptoms. The scale has good reliability and validity among older adults in China[16]. In this study, the Cronbach' s α coefficient of the scale was 0.893.

1.2.4 Depression Assessment

The short-form Geriatric Depression Scale-15 (GDS-15), developed by Yesavage and Sheikh[17], was used. The scale contains 15 items and assesses depressive status over the past week. Items are scored as "yes" (1 point) or "no" (0 points), with a total score range of 0–15; higher scores indicate more severe depressive symptoms. In this study, the Cronbach' s α coefficient of the scale was 0.527. Similar to the TFI, item heterogeneity may have led to a low α coefficient[18]; however, the scale has good reliability and validity among older adults in China and has been widely used[19].

1.2.5 Loneliness Assessment

The Chinese version[20] of the 6-Item UCLA Loneliness Scale (ULS-6), a shortened version of the University of California at Los Angeles Loneliness Scale (UCLA), was used. The scale contains 6 items and uses a 4-point scoring system from 1 ("never") to 4 ("often"), with a total score range of 6–24; higher scores indicate stronger loneliness. The scale removes reverse-scored items, making it

more concise for use among older adults in China, and it has good reliability and validity[21]. In this study, the Cronbach' s α coefficient of the scale was 0.907.

1.2.6 Social Support Assessment

The Social Support Rating Scale (SSRS), developed by Xiao Shuiyuan[22], was used. The scale contains 10 items and includes 3 dimensions: objective support (3 items), subjective support (4 items), and utilization of support (3 items). Scoring methods differ across items; higher total scores indicate higher levels of social support. The scale has been widely used among older adults in China and has good reliability and validity[23]. In this study, the Cronbach' s α coefficient of the scale was 0.803.

1.3 Data Collection and Quality Control

This study adopted a cross-sectional survey design. The data collection process was carried out by investigators. All investigators participated in the formal survey only after receiving unified training. The training covered the study purpose and procedures, questionnaire survey methods, standards for completing the scales, communication skills, and quality-control requirements. The training was organized and implemented uniformly by the project leader, and surveys were conducted only after investigators passed the training assessment. Survey sites included community Party-mass service centers, community health service centers, older adult activity centers, residents' activity squares, and other places where older adults were relatively concentrated. With the assistance of community staff, investigators used standardized instructions to introduce the study purpose and content to older adults who met the inclusion criteria, and the survey was conducted after informed consent was obtained.

Data were collected using paper questionnaires. Questionnaires were distributed one-on-one by investigators and, in principle, were completed independently by older participants. For older adults with lower educational levels, limited reading ability, or difficulty understanding individual items, investigators provided standardized and neutral explanations according to the unified training content, without giving any leading prompts, to ensure consistency in the survey process and standardization of data collection. After completion of the questionnaire, investigators checked the completeness and logical consistency of the questionnaire on site and promptly asked participants to supplement missing items, thereby improving data quality.

1.4 Statistical Methods

SPSS 27.0 was used for data processing and statistical analysis. Measurement data conforming to a normal distribution were expressed as $(\bar{x} \pm s)$, and those not conforming to a normal distribution were expressed as $M(P_{25}, P_{75})$; count data were expressed as frequencies and percentages (rates). Mplus 8.7 was

used to conduct LPA[24]. Model fit evaluation indicators included the Akaike information criterion (AIC), Bayesian information criterion (BIC),

adjusted Bayesian information criterion (aBIC), where smaller values indicate better model fit; Entropy ranges from 0 to 1, with values closer to 1 indicating clearer classification. The Lo–Mendell–Rubin adjusted likelihood ratio test (LMRT) and the Bootstrap-based likelihood ratio test (BLRT) were also used to compare the merits of adjacent class models; if $P < 0.05$, the k-class model was considered superior to the $k-1$-class model [25]. Chi-square tests, independent-samples t tests, and one-way analysis of variance were used to compare differences among older adults in different frailty classes in terms of demographic characteristics, anxiety, depression, loneliness, and social support. Pearson correlation analysis was used to explore correlations among variables. Mplus 8.7 was used to construct a generalized structural equation model (GSEM) [26], with the latent frailty class as the dependent variable; resource-loss factors composed of anxiety, depression, and loneliness as independent variables; and resource-gain factors composed of the three dimensions of social support as independent or moderating variables. Demographic variables that were statistically significant in the one-way analyses were controlled for. The maximum likelihood estimation method was adopted to systematically examine the relationships between resource-loss and gain factors and different frailty classes. Differences were considered statistically significant at $P < 0.05$.

2 Results

2.1 General demographic information

A total of 479 community-dwelling older adults were included in this study, including 206 men (43.01%) and 273 women (56.99%). The mean age was (71.32 ± 6.91) years. Most participants were Han Chinese (98.12%), married (82.46%), and not living alone (88.10%). Other general information is shown in Table 1.

2.2 Scores for psychological status, social support, and frailty among community-dwelling older adults

The scores of each variable showed that the anxiety score of community-dwelling older adults was (2.50 ± 3.54) points, depression was (6.40 ± 2.22) points, loneliness was (9.83 ± 3.91) points, the total social support score was (38.29 ± 8.38) points, objective support was (9.72 ± 3.75) points, subjective support was (21.25 ± 4.36) points, utilization of support was (7.31 ± 2.51) points, and frailty was (5.24 ± 2.10) points. The results showed that there were certain degrees of individual differences in all variables in the sample. Among them, anxiety, loneliness, and social-support-related indicators showed relatively high dispersion, whereas depression and frailty showed relatively low dispersion.

2.3 Distribution of latent classes of frailty among community-dwelling older adults

Using the physical, psychological, and social dimensions of frailty as observed variables, LPA was performed. The results showed that as the number of latent classes increased, AIC, BIC, and aBIC all showed a continuous decreasing trend. Taking into account fit indices, class interpretability, and class probabilities, the 3-class model was determined to be optimal: AIC = 3 800.260, BIC = 3 858.664, aBIC = 3 814.229, Entropy = 1.000, and BLRT was significant ($P < 0.001$), as shown in Table 2. Further calculation of the average posterior probabilities showed that the average posterior probabilities of the three classes were all 1.000, indicating extremely high classification accuracy.

Based on the scores of the three dimensions of frailty among the three classes of community-dwelling older adults, a latent profile plot was drawn (Figure 1). Class 1 had the highest physical and social frailty scores and was named the "high physical–social frailty type," accounting for 13.15% (63/479), with an average frailty level of (6.44 ± 1.97). Class 2 had moderate and relatively stable scores across all dimensions and was named the "moderate-frailty stable type," accounting for 59.71% (286/479), with an average frailty level of (5.56 ± 1.87). Class 3 had relatively low psychological and social dimensions and was named the "low psychological–social frailty type," accounting for 27.14% (130/479), with an average frailty level of (3.95 ± 2.02).

Table 1 General information of community-dwelling older adults (n = 479)

Item	Gender: Female	Gender: Male	Ethnicity: Han	Ethnicity: Ethnic minority	Educational level: Primary school or below	Educational level: Junior high school	Educational level: Senior high school or technical secondary school	Educational level: Junior college or above	Marital status: Married	Marital status: Unmarried, divorced, or widowed
Number of cases (%)	273 (57.99)	206 (43.01)	470 (98.12)	9 (1.88)	197 (41.13)	142 (29.65)	88 (18.37)	52 (10.85)	395 (82.46)	84 (17.54)

Item	Number of children: 0	Number of children: 1	Number of children: 2	Number of children: 3 or more	Living arrangement: Living alone	Living arrangement: Not living alone	Retired: No	Retired: Yes	Average monthly income: <1000 yuan	Average monthly income: 1000–2999 yuan	Average monthly income: $ $3000 yuan
Number of cases (%)	20 (4.18)	92 (19.20)	239 (49.90)	128 (26.72)	57 (11.90)	422 (88.10)	144 (30.06)	335 (69.94)	243 (50.73)	110 (22.96)	126 (26.31)

Table 2 Fit indices for latent profiles of frailty among community-dwelling older adults ($n = 479$)

Model	AIC	BIC	aBIC	Entropy	PLMRT value	PBLRT value	Class probability (%)
1	4103.300	4128.330	4109.287				
2	3909.135	3950.852	3919.114	0.926	<0.001	<0.001	0.8476/0.1524
3	3800.260	3858.664	3814.229	1.000	0.220	<0.001	0.1315/0.5971/0.2714
4	3766.973	3842.064	3784.934	0.957	0.152	<0.001	0.2714/0.5449/0.0522/0.1315
5	3681.929	3773.706	3703.880	0.97	0.229	<0.001	0.2484/0.1065/0.4990/0.1232/0.0230
6	3478.734	3587.199	3504.677	0.973	0.301	0.667	0.0042/0.0689/0.3570/0.1002/0.0459/

Note: AIC = Akaike information criterion; BIC = Bayesian information criterion; aBIC = adjusted Bayesian information criterion; LMRT = Lo-Mendell-Rubin adjusted likelihood ratio test; BLRT = Bootstrap-based likelihood ratio test; Entropy = information entropy; LMRT = Lo-Mendell-Rubin adjusted likelihood ratio test; BLRT = Bootstrap-based likelihood ratio test.

The difference in total frailty scores among the three categories was statistically significant ($F = 45.665,\ P < 0.001$).

Figure 1. Characteristics distribution of three categories of frailty among community-dwelling older adults
Visible plot labels: high physical–social frailty type (13.15%); moderate frailty/robust type (59.71%); low psychological–social frailty type (27.14%). Y-axis: mean score for each dimension (points). X-axis: dimensions of the

Tilburg Frailty Assessment Scale—physical frailty, psychological frailty, social frailty.

2.4 Univariate analysis of factors influencing latent frailty categories among community-dwelling older adults

The univariate analysis results showed that, taking the different latent frailty categories of community-dwelling older adults as the dependent variable, and taking sex, ethnicity, educational level, marital status, number of children, living arrangement, retirement status, average monthly income, age, anxiety, depression, loneliness, social support, and its dimensions as independent variables for univariate analysis (variable assignments are shown in Table 3), sex, marital status, living arrangement, retirement status, average monthly income, depression, social support, and its dimensions were influencing factors for the latent frailty categories of community-dwelling older adults ($P < 0.05$), as shown in Table 4.

Table 3. Variable assignment

Variable	Assignment
Latent frailty category	High physical-social frailty type = 1; moderate frailty/robust type = 2; low psychological-social frailty type = 3
Sex	Female = 0; male = 1
Ethnicity	Han = 0; ethnic minority = 1
Educational level	Primary school or below = 0; junior high school = 1; senior high school or technical secondary school = 2; junior college or above = 3
Marital status	Married = 0; unmarried, divorced, or widowed = 1
Number of children	0 = 0; 1 = 1; 2 = 2; 3 or more = 3
Living arrangement	Living alone = 0; not living alone = 1
Retirement status	No = 0; yes = 1
Average monthly income	<1 000 yuan = 0; 1 000–2 999 yuan = 1; $ $3 000 yuan = 2
Age	Measured value
Anxiety	Measured value
Depression	Measured value
Loneliness	Measured value
Social support	Measured value

2.5 Mechanisms by which resource loss and gain factors influence community-dwelling older adults

2.5.1 Correlation analysis of resource loss and gain factors with frailty

Pearson correlation analysis was used to preliminarily determine the relationship between resource loss and gain factors and frailty among community-dwelling older adults. The results showed that frailty was positively correlated with anxiety ($r = 0.426,\ P < 0.001$), depression ($r = 0.289,\ P < 0.001$), and loneliness ($r = 0.230,\ P < 0.001$); it was not correlated with the total social support score ($r = 0.077,\ P > 0.05$); and it was positively correlated with the utilization of support dimension of social support ($r = 0.225,\ P < 0.001$), as shown in Table 5.

2.5.2 Test of the "resource gain buffering model"

To test whether the resource gain factor (social support) had a buffering effect between resource loss factors and latent frailty categories, this study constructed a GSEM. In the model, latent frailty category, with the "low psychological-social frailty type" as the reference, was used as the dependent variable; the resource loss factors comprising anxiety, depression, and loneliness were used as independent variables; the resource gain factors comprising the three dimensions of social support were used as moderating variables; and variables that were statistically significant in the univariate analysis were controlled for (sex, marital status, living arrangement, retirement status, and average monthly income). The results showed that resource loss factors were not correlated with the "high physical-social frailty type" ($\beta = 0.203,\ P = 0.412$) or the "moderate frailty/robust type" ($\beta = 0.100,\ P = 0.432$). Resource gain factors were negatively correlated with the "high physical-social frailty type" ($\beta = -0.787,\ P < 0.001$), and positively correlated with the "moderate frailty/robust type"($\beta = 0.395,\ P < 0.001$). Among them, the moderating effects of resource gain factors were not significant (interaction terms: "high physical-social frailty type," $\beta = -0.262,\ P = 0.322$; "moderate frailty/robust type," $\beta = -0.031,\ P = 0.825$), as shown in Table 6 and Figure 2. This indicates that social support did not significantly buffer the relationships of anxiety, depression, and loneliness with different latent frailty categories, and the "resource gain buffering model" was not supported.

2.5.3 Test of the "resource loss-gain dual-path independent model"

A dual-path GSEM was further constructed. The results showed that resource loss factors were positively correlated with the "high physical-social frailty type" ($\beta = 0.246,\ P < 0.001$), and not correlated with the "moderate frailty/robust type" ($\beta = 0.145,\ P = 0.460$); resource gain factors were negatively correlated with the "high physical-social frailty type" ($\beta = -0.404,\ P < 0.001$), and positively correlated with the "moderate frailty/robust type"($\beta = 0.605,\ P < 0.001$), as shown in Table 7 and Figure 3. This indicates that the relationships of resource loss and gain factors with different frailty categories differed significantly,

supporting the "resource loss–gain dual-path independent model."

3 Discussion

Based on COR and using a "person-centered" LPA, this study explored the heterogeneity of frailty among community-dwelling older adults and its relationship with psychosocial resources. The results showed that: (1) frailty among community-dwelling older adults is heterogeneous and can be divided into three latent categories: "high physical–social frailty type," "moderate frailty/robust type,"and "low psychological–social frailty type"; (2) the relationships of resource loss factors (anxiety, depression, loneliness) and gain factors (social support) with different frailty categories differ significantly.

3.1 Latent frailty categories and characteristics among community-dwelling older adults

In this study, the mean frailty score of community-dwelling older adults was (5.24 ± 2.10)

Table 4 Results of univariate analysis on the latent profiles of frailty among community-dwelling older adults

Group	Cases	Gender: Female [n (%)]	Gender: Male [n (%)]	Ethnicity: Han [n (%)]	Ethnicity: Ethnic minority [n (%)]	Education: Primary school or below [n (%)]	Education: Junior middle school [n (%)]	Education: High school or technical secondary school [n (%)]	Education: College or above [n (%)]	Marital status: Married [n (%)]	Marital status: Unmarried, divorced, or widowed [n (%)]
High physical–social frailty type	63	42 (66.67)	21 (33.33)	62 (98.41)	1 (1.59)	33 (52.38)	16 (25.40)	10 (15.87)	4 (6.35)	27 (42.86)	36 (57.14)

Group	Cases	Gender: Female [n (%)]	Gender: Male [n (%)]	Ethnicity: Han [n (%)]	Ethnicity: Ethnic minority [n (%)]	Education: Primary school or below [n (%)]	Education: Junior middle school [n (%)]	Education: High school or technical secondary school [n (%)]	Education: College or above [n (%)]	Marital status: Married [n (%)]	Marital status: Unmarried, divorced, or widowed [n (%)]
Moderately frail–robust type	286	169 (59.09)	117 (40.91)	281 (98.25)	5 (1.75)	106 (37.06)	91 (31.82)	54 (18.88)	35 (12.24)	252 (88.11)	34 (11.89)
Low psychological–social frailty type	130	62 (47.69)	68 (52.31)	127 (97.69)	3 (2.31)	58 (44.62)	35 (26.92)	24 (18.46)	13 (10.00)	116 (89.23)	14 (10.77)
χ^2 (F) value		7.507	7.507	0.185	0.185	6.662	6.662	6.662	6.662	78.765	78.765
P value		0.023	0.023	0.912	0.912	0.353	0.353	0.353	0.353	<0.001	<0.001

Group	Number of children: 0 [n (%)]	Number of children: 1 [n (%)]	Number of children: 2 [n (%)]	Number of children: $ $3 [n (%)]	Living arrangement: Living alone [n (%)]	Living arrangement: Not living alone [n (%)]	Retired: No [n (%)]	Retired: Yes [n (%)]	Average monthly income: <1 000 yuan [n (%)]	Average monthly income: 1 000–2 999 yuan [n (%)]	Average monthly income: $ $3 000 yuan [n (%)]
High physical-social frailty type	4 (6.35)	9 (14.29)	32 (50.79)	18 (28.57)	39 (61.91)	24 (38.09)	23 (36.51)	40 (63.49)	35 (55.56)	15 (23.81)	13 (20.63)
Moderately frail-robust type	8 (2.80)	53 (18.53)	146 (51.05)	79 (27.62)	10 (3.50)	276 (96.50)	100 (34.97)	186 (65.03)	159 (55.59)	51 (17.83)	76 (26.58)
Low psychological-social frailty type	8 (6.15)	30 (23.08)	61 (46.92)	31 (23.85)	8 (6.15)	122 (93.85)	21 (16.15)	109 (83.85)	49 (37.69)	44 (33.85)	37 (28.46)
χ^2 (F) value	5.995	5.995	5.995	5.995	173.621	173.621	16.476	16.476	16.990	16.990	16.990
P value	0.424	0.424	0.424	0.424	<0.001	<0.001	<0.001	<0.001	0.002	0.002	0.002

Group	Age ($\bar{x} \pm s$, years)	Anxiety ($\bar{x} \pm s$, points)	Depression ($\bar{x} \pm s$, points)	Loneliness ($\bar{x} \pm s$, points)	Social support ($\bar{x} \pm s$, points)	Objective support ($\bar{x} \pm s$, points)	Subjective support ($\bar{x} \pm s$, points)	Utilization of support ($\bar{x} \pm s$, points)
High physical–social frailty type	72.67 ± 6.60	2.78 ± 3.56	7.08 ± 2.18	10.86 ± 3.86	30.84 ± 8.68	6.35 ± 4.73	17.40 ± 4.98	7.10 ± 2.00
Moderately frail–robust type	71.24 ± 7.16	2.67 ± 3.68	6.25 ± 1.95	9.75 ± 3.99	40.29 ± 7.67	10.52 ± 3.32	22.14 ± 3.86	7.63 ± 2.55
Low psychological–social frailty type	70.85 ± 6.44	1.99 ± 3.15	6.41 ± 2.71	9.51 ± 3.72	37.49 ± 7.58	9.59 ± 3.16	21.170 ± 4.10	6.73 ± 2.55
χ^2 (F) value	1.528^a	1.919^a	3.645^a	2.695^a	38.920^a	36.853^a	34.911^a	6.080^a
P value	0.218	0.148	0.027	0.069	<0.001	<0.001	<0.001	0.002

Note: ^a indicates an F value.

Table 5 Correlation results of anxiety, depression, loneliness, social support, and frailty among community-dwelling older adults

Item	Physical frailty	Psychological frailty	Social frailty	Frailty	Anxiety	Depression	Loneliness	Objective support	Subjective support	Utilization of support	Social support
Physical frailty	1.000										

Item	Physical frailty	Psychological frailty	Social frailty	Frailty	Anxiety	Depression	Loneliness	Objective support	Subjective support	Utilization of support	Social support
Psychological frailty	0.153^c	1.000									
Social frailty	0.053	0.039	1.000								
Frailty	0.834^c	0.552^c	0.403^c	1.000							
Anxiety	0.408^c	0.195^c	0.106^a	0.426^c	1.000						
Depression	0.195^c	0.290^c	0.055	0.289^c	0.292^c	1.000					
Loneliness	0.212^c	0.093^a	0.090^a	0.230^c	0.399^c	0.277^c	1.000				
Objective support	−0.110^a	−0.070	−0.138^b	−0.064	0.139^b	−0.072	−0.102^a	1.000			
Subjective support	−0.007	−0.030	−0.127^b	−0.037	−0.056	−0.080	−0.188^c	0.536^c	1.000		
Utilization of support	−0.247^c	−0.000	0.116^a	−0.225^c	−0.236^c	−0.002	−0.173^c	0.372^c	0.288^c	1.000	
Social support	−0.119^b	−0.047	−0.093^a	−0.077	−0.162^c	−0.073	−0.092^a	0.838^c	0.847^c	0.616^c	1.000

Note: ^a indicates $P < 0.05$, ^b indicates $P < 0.01$, and ^c indicates $P < 0.001$.

points. According to the TFI scale criteria[1], frailty is relatively common in this population, consistent with previous research findings[2]. In this study, LPA was used to divide community-dwelling older adults into three latent classes, confirming marked heterogeneity within the frail older population in the community.

3.1.1 Characteristics of the "high physical-social frailty type"

This class is characterized mainly by impairment of physical and social functioning and represents a group in which resource deficits are relatively concentrated. In this class, the proportion of women was relatively high (66.67%)[3], as were the proportions of those not currently married (57.14%) and those living alone (61.90%)[4]; those with a monthly income of <1 000 yuan accounted for 55.56%,

[1] 14
[2] 1,27
[3] 6
[4] 28-29

and those not retired accounted for 36.51%[5]. At the psychosocial-resource level, this class had higher depression and loneliness scores and the lowest social support scores, consistent with previous studies[6]. According to COR, when individuals simultaneously face resource losses such as absence of marriage, living alone, and economic pressure, their coping capacity declines, making them more prone to negative emotions and impaired social functioning, thereby forming a vicious cycle of continuous resource depletion[7]. This study found that this class had higher levels of depression and loneliness, whereas psychological frailty was not the most severe, suggesting that negative emotions may be resource loss

Table 6. Test Results of the "Resource Gain Buffering Model" ($n = 479$)

Item	High Physical-Social Frailty Type: β	High Physical-Social Frailty Type: SE	High Physical-Social Frailty Type: 95% CI	High Physical-Social Frailty Type: P value	Moderate Frailty Robust Type: β	Moderate Frailty Robust Type: SE	Moderate-Frailty Robust Type: 95% CI	Moderate-Frailty Robust Type: P value
Control variables								
Gender	−0.347	0.203	−0.744~0.050	0.087	−0.235	0.111	−0.452~−0.018	0.034
Marital status	0.890	0.176	0.545~1.234	0.000	0.056	0.136	−0.210~0.322	0.680
Living arrangement	−1.236	0.237	−1.700~−0.772	0.000	−0.199	0.118	−0.431~0.033	0.092
Retired or not	−0.370	0.212	−0.784~0.045	0.081	−0.462	0.133	−0.722~−0.201	0.001
Average monthly income	−0.335	0.221	−0.768~0.099	0.130	−0.046	0.118	−0.276~0.185	0.698
Resource loss factor	0.203	0.248	−0.282~0.689	0.412	0.100	0.127	−0.149~0.348	0.432

[5] 30
[6] 31-33
[7] 11

Item	High Physical–Social Frailty Type: β	High Physical–Social Frailty Type: SE	High Physical–Social Frailty Type: 95% CI	High Physical–Social Frailty Type: P value	Moderate Frailty Robust Type: β	Moderate Frailty Robust Type: SE	Moderate Frailty Robust Type: 95% CI	Moderate-Frailty Robust Type: P value
Resource-gain factor	−0.787	0.259	−1.295~−0.279	0.002	0.395	0.151	0.099~0.690	0.009
Resource-loss factor * resource gain factor	−0.262	0.265	−0.781~0.257	0.322	−0.031	0.142	−0.309~0.247	0.825

Figure 2. Test results diagram of the "Resource Gain Buffering Model"

Table 7. Test Results of the "Independent Dual-Path Model of Resource Loss and Gain" ($n = 479$)

Item	High Physical–Social Frailty Type: β	High Physical–Social Frailty Type: SE	High Physical–Social Frailty Type: 95% CI	High Physical–Social Frailty Type: P value	Moderate Frailty Robust Type: β	Moderate Frailty Robust Type: SE	Moderate Frailty Robust Type: 95% CI	Moderate-Frailty Robust Type: P value
Control variables								
Gender	−0.181	0.100	−0.378~0.016	0.072	−0.317	0.143	−0.598~−0.037	0.027
Marital status	0.446	0.079	0.292~0.600	0.001	0.087	0.180	−0.266~0.440	0.629

Item	High Physical-Social Frailty Type: β	High Physical-Social Frailty Type: SE	High Physical-Social Frailty Type: 95% CI	High Physical-Social Frailty Type: P value	Moderate Frailty Robust Type: β	Moderate Frailty Robust Type: SE	Moderate Frailty Robust Type: 95% CI	Moderate-Frailty Robust Type: P value
Living arrangement	−0.614	0.087	−0.784~−0.444	<0.001	−0.267	0.150	−0.561~0.028	0.076
Retired or not	−0.198	0.105	−0.403~0.007	0.059	−0.617	0.143	−0.897~−0.338	<0.001
Average monthly income	−0.141	0.107	−0.351~0.069	0.188	−0.049	0.157	−0.357~0.258	0.755
Resource loss factor	0.246	0.120	0.012~0.480	0.040	0.145	0.196	−0.240~0.530	0.460
Resource-gain factor	−0.404	0.118	−0.635~−0.173	0.001	0.605	0.149	0.314~0.896	<0.001

an early warning signal that appears relatively early in this context, preceding the occurrence of overall psychological-function decline

. Therefore, in community health management, for older adults whose physical and social functions have already become impaired, emotional screening and social-support interventions should be carried out in a timely manner to prevent further progression of frailty.

3.1.2 Characteristics of the "Moderate-Frailty Robust Type"

The frailty levels of this category are moderate across all dimensions; this is a group whose functioning is relatively stable but who remain at risk of further decline. The most prominent feature of this category is a relatively high level of social support: most are married (88.11%) and the rate of living alone is

extremely low (3.50%), forming a relatively stable family support network

28–29

. Correspondingly, their social support is significantly higher than that of the other categories. Previous studies have shown that family support is an important source through which older adults obtain emotional support and instrumental support

33

. However, this study found that this category presents a pattern of "high support,

Figure 3 Test results diagram of the "Independent Dual-Path Model of Resource Loss and Gain"

These "moderate frailty" characteristics suggest that social support helps maintain functional stability, but it is difficult for it to completely offset the adverse effects brought about by increasing age and the accumulation of chronic diseases[35]. Therefore, in community health management, for this large and critical older population, efforts should, on the basis of consolidating their support resources, further promote social participation, stimulate intrinsic agency, and delay the progression of frailty.

3.1.3 Characteristics of "low psychological-social frailty"

This class had relatively low frailty scores across the physical, psychological, and social dimensions, and represents a group with comparatively better health status. In this class, the proportion of men was relatively high (52.3%), and most were married (89.2%) and retired (83.8%); their economic status was better than that of the other classes[6, 28–30]. At the psychosocial resource level, this class had lower levels of depression and loneliness, and social support was significantly higher than in the "high physical-social frailty" type[31–33], suggesting a relatively good psychological adaptation status and foundation of social support. According to COR, individuals with abundant resources are more likely to acquire and utilize new resources, thereby forming a resource-gain cycle[11]. Good social relationships, a positive psychological state, and stable living resources promote one another and jointly maintain their relatively low level of frailty. Therefore, in community health management, for older adults whose health status is relatively good, attention should be paid to cultivating and accumulating positive resources so as to further consolidate their health advantages.

3.2 Relationship between resource-loss/gain factors and latent classes of frailty among community-dwelling older adults

The GSEM constructed in this study based on COR revealed significant differences in the relationships of resource-loss factors (anxiety, depression, loneliness)

and gain factors (social support) with different latent classes of frailty among community-dwelling older adults.

First, the correlation analysis showed that frailty was positively correlated with anxiety ($r = 0.426,\ P < 0.001$), depression ($r = 0.289,\ P < 0.001$), and loneliness ($r = 0.230,\ P < 0.001$), consistent with previous findings[16, 31-32], suggesting that psychological resource loss is closely related to frailty. Frailty was not correlated with the total social support score ($r = 0.077,\ P > 0.05$), but was positively correlated with the utilization of support dimension ($r = 0.225,\ P < 0.001$), which is inconsistent with previous research findings[36]. This result suggests that, as frailty worsens, older adults' need or behavior of actively seeking and using external support may instead increase.

Second, the "resource-gain buffering model" showed that social support did not exert a significant moderating effect between resource-loss factors and frailty classes ($P > 0.05$). This result does not support the hypothesis that social support can buffer the negative effects of resource-loss factors, indicating that alleviating resource-loss factors and enhancing resource-gain factors are two relatively independent tasks.

The further constructed "resource loss-gain independent dual-path model" showed differentiated relationships between the two types of factors and different frailty classes. For the "high physical-social frailty" type, frailty was positively correlated with resource-loss factors ($\beta = 0.246,\ P < 0.001$) and negatively correlated with resource-gain factors ($\beta = -0.404,\ P < 0.001$). This indicates that intensified negative emotions and insufficient social support are associated with belonging to this high-risk class[16, 31-32]. Therefore, interventions for this group should aim at "remediation," requiring simultaneous psychological counseling and reconstruction of substantive social-support networks. For the "moderate-frailty robust" type, only resource-gain factors were positively correlated with this class ($\beta = 0.605,\ P < 0.001$). This result suggests that social support plays an important role in the formation and maintenance of this class. Although, theoretically, higher levels of social support may be more conducive to maintaining optimal health status, this study found that individuals with relatively high levels of social support did not all belong to the class with the lowest degree of frailty. Considering the characteristics of this class— "high support, moderate frailty" —social support may play a greater role in maintaining functional stability and delaying frailty progression, but it is difficult for it to completely offset the adverse effects of increasing age and the accumulation of chronic diseases[35]. Therefore, interventions for this group should aim at "empowerment," further leveraging the role of family and community support networks.

3.3 Study limitations and future prospects

This study has the following limitations. First, the study participants were community-dwelling older adults from a single region; regional culture, socioe-

conomic level, and community

Differences in service provision may limit the external generalizability of the study conclusions. Second, this study used a cross-sectional design, making it difficult to rigorously infer causal relationships between frailty status and its influencing factors. In addition, the relevant indicators in this study were mainly measured by self-rating scales, which may involve recall bias and subjective reporting bias. Finally, in the LPA results, the LMRT test for the three-class model did not reach statistical significance. Although the BLRT test was significant, and previous studies have suggested that BLRT has better stability under limited sample conditions, the model classification results still have a certain degree of uncertainty.

Future studies may conduct multicenter, large-sample longitudinal follow-up research, combining objective health indicators with dynamic data analysis methods to further explore the developmental trajectories and influencing mechanisms of different frailty types among community-dwelling older adults. Meanwhile, sample size may be expanded and methods such as theoretical justification and cross-validation may be combined to improve the stability of potential class-identification results. In addition, given that this study found that the social dimension has a relatively good discriminating role in frailty classification, future research may further examine whether a simplified social frailty screening tool can effectively capture the heterogeneity of frailty among community-dwelling older adults.

4 Conclusion

This study confirms that frailty among community-dwelling older adults has marked heterogeneity, and that resource loss and resource gain factors differ significantly in their associations with different latent classes. This suggests that community health management should implement a precision, classification-based management model according to frailty class: for high-risk individuals of the "high physical-social frailty type," a management model aimed at "remediation" should be implemented, providing systematic support through integrated "medical-psychological-social" interventions, inclusion in follow-up for key populations, connection with professional psychological services, and reconstruction of social support networks; for the medium-risk and stable group of the "moderate-frailty-robust type," a management model aimed at "empowerment" should be implemented, making use of their favorable social support foundation and promoting the transformation of social capital into healthy behaviors through health activities; for the low-risk group of the "low psychological-social frailty type," a management model aimed at "maintenance and development" should be implemented, encouraging them to participate in community building through volunteer services and other forms, and to play a demonstrative and leading role while consolidating their own health.

Author contributions: Lü Huicong was responsible for the study design, sta-

tistical analysis, and manuscript drafting; Chen Yetian and Yao Jiasi were responsible for preliminary data collection and data organization; Qi Weijing was responsible for study conception and manuscript revision; Hu Jie was responsible for research guidance, manuscript quality control, and overall responsibility for the article.

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