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Associations of multidimensional frailty with life satisfaction in older men: a latent class approach

Sangyoon Han[1], Sunghee Kim[2,]*, Heeran J Cho[3]

[1] Department of Social Welfare, Semyung University, 27136 Jecheon, Republic of Korea
[2] Institute of Social Welfare, Jeonbuk National University, 54896 Jeonju, Republic of Korea
[3] School of Glocal Studies, Kyungwoon University, 39160 Gumi, Republic of Korea

*Correspondence
kim_sh@jbnu.ac.kr
(Sunghee Kim)

Abstract

Background: Frailty, encompassing physical, psychological and social vulnerabilities, significantly affects life satisfaction in older men. However, intra-gender differences in frailty remain underexplored. This study aims to classify frailty subtypes among older men and examine their associations with life satisfaction. **Methods**: This cross-sectional study analyzed data from the 2023 National Survey of Older Koreans (N = 3824 men aged 65+). Latent Class Analysis (LCA) identified frailty subtypes, and multiple regression analysis examined their associations with life satisfaction while controlling for key demographic factors. **Results**: Four frailty subtypes were identified: Physically Frail and Socially Discontent (PFSD), Robust and Socially Satisfied (RSS), Robust but Socially Isolated (RSI), and Moderately Frail and Socially Adequate (MFSA). The RSS group reported the highest level of life satisfaction, while all other subtypes showed significantly lower levels. Notably, the RSI group, despite good physical health, reported lower life satisfaction than the MFSA group, highlighting that social isolation may outweigh physical health advantages in determining life satisfaction. **Conclusions**: This study highlights the need for integrated interventions that address physical, psychological and social well-being to enhance life satisfaction among older men.

Keywords

Frailty; Older men; Life satisfaction; Social isolation; Interventions

1. Introduction

The rapid progression of global population aging has brought the physical, mental and environmental well-being of older adults to the forefront of policy discussions, extending beyond individual concerns to national and international priorities [1]. The United Nations projects that the proportion of individuals aged 65 and older worldwide will increase from 17% in 2024 to over 33% in the next 30 years, nearly doubling [2]. This phenomenon, often referred to as the "longevity revolution", indicates a substantial rise in healthcare and caregiving demands [1]. As a result, research on maintaining health and enhancing the quality of life for older adults has gained increasing significance.

Frailty, in particular, is a distinct concept from disability and refers to a state of heightened vulnerability caused by accumulated deficits across multiple physiological systems [3, 4]. It has been recognized as a key predictor of health deterioration and mortality in older adults [5, 6]. Given its significant implications, the urgency of preventing and managing frailty has grown [7]. Traditionally, frailty has been primarily understood as a physical decline characterized by factors such as weight loss, muscle weakness, fatigue, reduced walking speed and decreased physical activity [4]. However,

recent studies have expanded the concept by incorporating psychological and social dimensions into a multidimensional framework [8–10]. This expanded framework enables a more holistic assessment of older adults' overall health and life satisfaction, while also serving as a foundation for more effective interventions targeting frailty.

While frailty research has traditionally focused on older adults as a general population, recent scholarship has begun to emphasize the distinct experiences of older men. These emerging perspectives suggest that older men may face unique patterns of frailty and psychosocial vulnerabilities that warrant gender-specific investigation. Gender differences must also be considered when examining the relationship between frailty and life satisfaction in older adults. Men and women exhibit distinct health and psychosocial experiences related to frailty. Studies suggest that, even under similar health conditions, frailty progresses more rapidly in men than in women and is associated with higher mortality rates in men [11, 12]. Additionally, older men often experience a sharp reduction in social networks after retirement, increasing their risk of social isolation and depression [13]. Moreover, compared to older women, they may be less likely to recognize or express psychological and social difficulties, making older men less inclined to seek help and more vulnerable to inadequate social support

[14–16]. Despite these differences, many existing studies have overlooked the specific needs of older men, broadly examined the relationship between frailty and quality of life without disaggregating by gender [17]. Although some studies have taken gender-specific characteristics into account, they have often focused on frailty prevalence, specific subpopulations [18–20] or isolated aspects of frailty [21, 22], limiting a more nuanced understanding of gender-sensitive approaches. Developing effective prevention and management strategies that reflect the unique characteristics of frailty in older men requires a more refined approach.

To address this gap, the present study focuses on older men and investigates the relationship between frailty and life satisfaction based on the conceptual framework of the Integral Conceptual Model of Frailty proposed by Han *et al.* [9]. This framework, developed through a synthesis of empirical findings, integrates life course determinants and disease-related factors with Gobbens *et al.*'s [23] three dimensions of frailty: physical frailty, psychological frailty and social frailty. In this model, frailty encompasses three distinct but interconnected dimensions: increased vulnerability in physical health (physical frailty), age-related psychological and cognitive changes (psychological frailty), and the decline of social functioning and networks (social frailty). A decline in one of these dimensions can negatively affect the others, ultimately leading to a deterioration in overall quality of life.

Based on this framework, the present study employs latent class analysis (LCA) to identify distinct subgroups of older men based on their multidimensional frailty profiles and examines their association with life satisfaction. Unlike traditional methods that focus on correlations between variables, LCA identifies underlying subgroups based on response patterns, enabling a more nuanced understanding of individual characteristics. By analyzing the relationship between the identified frailty subtypes and life satisfaction, this study aims to identify at-risk groups and explore tailored intervention strategies that account for the specific characteristics of frailty in older men, ultimately contributing to efforts to improve their quality of life.

2. Methods

2.1 Research data and participants

This study utilized data from the 2023 National Survey of Older Koreans, conducted by the Ministry of Health and Welfare and the Korea Institute for Health and Social Affairs. As a legally mandated, nationwide survey, the National Survey of Older Koreans serves as a fundamental resource for developing policies aimed at improving the quality of life for older adults and addressing the challenges of an aging society. By comprehensively assessing the health, welfare and overall needs of older adults, this dataset is particularly well-suited for studying multidimensional frailty and quality of life among community-dwelling older individuals.

The target population of the 2023 National Survey of Older Koreans includes individuals aged 65 and older residing in general households in South Korea at the time of the survey. The survey adopts a multistage stratified sampling method, ensuring representativeness across urban and rural regions. In Korea, urban areas (dong districts) typically consist of high-density housing, such as apartment complexes, and are characterized by more extensive infrastructure and public services. In contrast, rural areas (eup/myeon districts) often feature more dispersed households with a higher proportion of older residents and limited access to healthcare and welfare services. Furthermore, the household structure among older men in South Korea has also been shifting due to demographic and cultural shifts. In particular, there has been a growing prevalence of single-person households, especially among older men who are widowed or have never married.

Cases with missing responses for key variables were excluded using listwise deletion. As a result, the final analysis in this study was based on data from 3824 older men. This study was approved by the Institutional Review Board of Semyung University (IRB No. SMU-EX-2025-03-001). The data were originally collected by Statistics Korea and the Ministry of Health and Welfare, following all applicable ethical guidelines and regulations. Informed consent was obtained from all participants or their legal guardians prior to data collection.

2.2 Measurement

This study selected multidimensional frailty indicators based on the Integral Conceptual Model of Frailty proposed by Han *et al.* [9]. This model integrates findings from multiple empirical studies on frailty and suggests that multidimensional frailty—including physical frailty, psychological frailty and social frailty—influences quality of life alongside life course determinants and disease-related factors. Based on this framework, the study classified frailty into three domains—physical, psychological and social frailty—and applied 10 specific indicators to conduct the LCA.

For physical frailty, the study included nutrition, resistance, ambulation, ADL (Activities of Daily Living) and IADL (Instrumental Activities of Daily Living) as key indicators. Nutritional status was measured using the Determine Your Nutrition Health Checklist from the Nutrition Screening Initiative (NSI). This checklist consists of 10 items, with each item assigned a specific weight. The total score ranges up to 21 points, and individuals scoring 0–2 points were classified as nutritionally adequate (0), whereas those scoring 3 or higher, indicating a need for nutritional monitoring and improvement, were classified as at risk (1). Resistance and ambulation were assessed using the Korean version of the FRAIL scale (K-FRAIL) [24], which was adapted from the original FRAIL scale developed by Morley *et al.* [25]. The K-FRAIL is a culturally and linguistically validated tool for evaluating frailty among older Korean adults. Resistance was assessed by asking, "*Do you have difficulty climbing 10 stairs without assistance or rest?*" (Response options: No = 0, Yes = 1). Ambulation was measured with the question, "*Do you have difficulty walking 300 meters alone without assistance?*" (Response option: No = 0, Yes = 1). To assess functional impairment and independence, this study utilized ADL and IADL scales. The Korean version of the Activities of Daily Living (K-ADL) and the Korean Instrumental Activities of Daily Living (K-IADL) [26], which were adapted to the Korean context from

the original instruments respectively developed by Katz *et al.* [27] and Lawton and Brody [28], were used. The ADL scale consists of 7 items, and the IADL scale includes 10 items. If a respondent required partial or full assistance with at least one item from either scale, they were classified as functionally impaired (1); otherwise, they were classified as functionally intact (0).

For psychological frailty, the study included cognition and mood as indicators. Cognitive function was measured using the validated Korean version of the Mini-Mental State Examination-2 (K-MMSE-2), an extensively validated instrument originally developed by Folstein *et al.* [29] and standardized for the Korean population by Song *et al.* [30]. Scores were adjusted for age and educational level based on conversion criteria proposed by Kang *et al.* [31]. Respondents with scores of 24 or above were classified as cognitively intact (0), while those scoring 23 or lower were considered cognitively impaired (1). Mood was measured using the Short Form of the Geriatric Depression Scale (SGDS-K), which consists of 15 items. The total score ranges from 0 to 15, with scores of 8 or higher indicating depressive symptoms [31]. Respondents scoring 0–7 points were classified as non-depressed (0), while those scoring 8 or higher were classified as depressed (1).

For social frailty, the study included three indicators: satisfaction with social relationships, satisfaction with leisure and cultural activities, and social adaptation. Each indicator was assessed using a single item and dichotomized as either satisfied (0) or dissatisfied (1). Satisfaction with social relationships was measured by evaluating satisfaction with interactions with neighbors and friends. Satisfaction with leisure and cultural activities was assessed based on self-reported satisfaction with leisure and cultural participation. Social adaptation was measured by assessing whether respondents experienced difficulties adapting to a rapidly advancing information society. Those who reported no difficulties were categorized as adapted (0), while those experiencing difficulties were classified as socially maladapted (1).

The dependent variable, life satisfaction, was assessed using a single-item measure that asked respondents to rate their overall satisfaction with life. The item was measured on a 5-point scale, with higher scores indicating greater life satisfaction. Additionally, this study included covariates that could influence life satisfaction based on Han *et al.*'s [9] Integral Conceptual Model of Frailty. These covariates, classified under life course determinants and disease-related factors, included age, educational attainment, household composition, residential area, poverty status and chronic disease burden. Age was categorized as "65–74 years" and "75 years or older". Educational attainment was classified as "middle school or lower" and "high school or higher". Household composition was categorized as "living alone" or "living with others". Residential area was defined based on official administrative divisions, classifying respondents into "urban areas" (dong districts) and "rural areas" (eup/myeon districts). Poverty status was determined using the relative poverty threshold, defined as a household income below 50% of the national median income. Respondents were categorized as "low-income" if they met this criterion and "middle or higher income" if otherwise. Chronic disease burden was assessed using the Illness item from the K-FRAIL scale [24]. Respondents were classified based on the number of chronic diseases they reported, including hypertension, diabetes, cancer, chronic lung disease, myocardial infarction, heart failure, angina, asthma, arthritis, stroke and kidney disease. In accordance with the original criteria of the K-FRAIL scale, they were categorized into two groups: "0–4 diseases" and "5 or more diseases".

2.3 Method of analysis

This study aimed to classify multidimensional frailty among older men and examine its impact on life satisfaction. The data analysis was conducted using SPSS v.27.0 (IBM Corp., Armonk, NY, USA) and Mplus v.7.4 (Muthén & Muthén, Los Angeles, CA, USA).

First, LCA was performed to identify distinct subgroups of older men based on multidimensional frailty profiles. The best-fitting model was determined by evaluating model fit indices. Subsequently, multiple regression analysis was conducted to examine the effects of frailty subtypes, controlling for covariates, on life satisfaction.

LCA is a statistical method that classifies individuals into latent subgroups based on the probability of belonging to each class, allowing for a more nuanced analysis of response patterns [32]. The selection of the optimal number of latent classes was guided by several model fit indices, including Akaike Information Criterion (AIC), Bayesian Information Criterion (BIC) and Sample Size Adjusted BIC (SSABIC). Lower values of these indices indicate better model fit [33].

To assess classification quality, entropy values were examined. Entropy ranges from 0 to 1, with values closer to 1 indicating a more accurate classification of latent classes [34]. Finally, model comparison tests, including the Lo-Mendell-Rubin adjusted likelihood ratio test (LMR-LRT) and the Bootstrapped Likelihood Ratio Test (BLRT), were conducted to evaluate model significance.

3. Results

3.1 Descriptive characteristics of the study sample

The sociodemographic and health characteristics of the study sample are as follows (Table 1, Ref. [25]). In terms of age distribution, 2207 participants (57.7%) were early-old adults (65–74 years), while 1617 participants (42.3%) were late-old adults (75 years or older). Regarding educational attainment, 2004 participants (52.4%) had completed middle school or lower, which was higher than the 1820 participants (47.6%) who had completed high school or higher, indicating that a slightly larger proportion of older men had lower educational attainment.

For household composition, the majority of participants lived alone (3058 participants, 80.0%), whereas 766 participants (20.0%) lived with others, showing a significant predominance of single-person households. In terms of residential area, a larger proportion of older men resided in urban areas (dong districts) (2735 participants, 71.5%), compared to rural areas (eup/myeon districts) (1089 participants, 28.5%).

Regarding poverty status, 1266 participants (33.1%) were

T A B L E 1. Descriptive characteristics of the study sample (N = 3824).

Variables	N	%
Age (yr)		
65–74	2207	57.7
75+	1617	42.3
Educational attainment		
Middle school or lower	2004	52.4
High school or higher	1820	47.6
Household composition		
Living alone	3058	80.0
Living with others	766	20.0
Residential area		
Rural (eup/myeon district)	1089	28.5
Urban (dong district)	2735	71.5
Poverty status+		
Low-income	1266	33.1
Middle or higher income	2558	66.9
Chronic diseases++		
4 or fewer	3818	99.8
5 or more	6	0.2

Note. +Poverty status was determined based on the relative poverty threshold, where households with an income below 50% of the national median income were classified as "low-income", while those above this threshold were classified as "middle or higher income". ++Chronic disease classification was based on the Illness component of the FRAIL scale (Fatigue, Resistance, Ambulation, Illness, Loss of weight) by Morley et al. [25], which includes a list of 11 conditions.

classified as low-income, meaning their household income was below 50% of the national median income, while 2558 participants (66.9%) were classified as middle or higher income.

In terms of health status, most participants (3818 participants, 99.8%) reported having four or fewer chronic diseases from the list of 11 conditions, whereas only six participants (0.2%) had five or more chronic diseases.

3.2 Latent class analysis on multidimensional frailty in older men

This study utilized LCA to identify distinct subgroups of multidimensional frailty among older men and compared model fit indices across different numbers of latent classes to determine the optimal classification model (Table 2).

A comparison of model fit indices from Model 2 (two latent classes) to Model 5 (five latent classes) showed a decreasing trend in the Akaike Information Criterion (AIC), the Bayesian Information Criterion (BIC), and the adjusted BIC (aBIC) values as the number of latent classes increased. The Lo-Mendell-Rubin likelihood ratio test (LMR-LRT) and the Bootstrapped

Likelihood Ratio Test (BLRT) results indicated $p < 0.001$ up to Model 4, while for Model 5, the p-values were 0.0004 and 0.0005, respectively.

Additionally, entropy values were above 0.7 across all models, indicating stable classification quality. Based on a comprehensive evaluation of these fit indices, the four-class model (Class 4) was selected as the final model for this study.

3.3 Construct of the latent class model of multidimensional frailty in older men

After testing the model fit of the latent class model, four distinct groups were identified, as shown in Table 3. Group 1 consisted of older men who exhibited vulnerabilities in physical frailty, particularly in nutrition and functional ability, along with overall low social satisfaction and poor social adaptation. Given these characteristics, this group was classified as the Physically Frail and Socially Discontent (PFSD) group, comprising 10.3% (n = 393) of the study sample. Group 2 exhibited favorable conditions across all frailty dimensions, indicating robust conditions across all domains and high social satisfaction. Therefore, this group was categorized as the Robust and Socially Satisfied (RSS) group, accounting for 44.6% (n = 1707) of the total sample.

Group 3 demonstrated high functional ability in the physical frailty domain but reported significant dissatisfaction in social frailty, particularly regarding social relationship satisfaction and leisure and cultural activities. Accordingly, this group was classified as the Robust but Socially Isolated (RSI) group, with 30.5% (n = 1168) of the participants falling into this subtype. Lastly, Group 4 exhibited moderate levels of physical frailty, with adequate ADL and IADL function but reduced resistance in physical activity, indicating an overall moderate level of frailty. Furthermore, psychological and social frailty levels were also moderate. Based on these characteristics, this group was categorized as the Moderately Frail and Socially Adequate (MFSA) group, representing 14.5% (n = 556) of the sample.

3.4 Effect of latent classes of multidimensional frailty on life satisfaction in older men

To examine the impact of multidimensional frailty subtypes on life satisfaction among older men, a multiple regression analysis was conducted. The overall regression model was statistically robust, yielding a significant F-statistic ($F = 183.850$, $p < 0.001$), explaining 30.3% of the variance in life satisfaction ($R^2 = 0.303$, adjusted $R^2 = 0.301$). The Variance Inflation Factor (VIF) values for all variables were below 10, indicating no issues with multicollinearity.

Using the Robust and Socially Satisfied (RSS) group as the reference category, the analysis revealed that life satisfaction was significantly lower in all three other groups compared to the RSS group. A comparison of standardized coefficients indicated that, relative to the RSS group, the Physically Frail and Socially Discontent (PFSD) group exhibited the greatest reduction in life satisfaction ($B = -0.762$, $p < 0.01$), followed by the Robust but Socially Isolated (RSI) group ($B = -0.657$, $p < 0.01$) and the Moderately Frail and Socially Adequate (MFSA) group ($B = -0.548$, $p < 0.01$).

T A B L E 2. Model fit of latent class analysis on multidimensional frailty in older men.

Class	AIC	BIC	aBIC	Entropy	LMR (p)	BLRT (p)
2	35,658.981	35,790.211	35,723.483	0.835	<0.0001	<0.0001
3	35,041.671	35,241.641	35,139.960	0.889	<0.0001	<0.0001
4	34,441.362	34,710.071	34,573.437	0.778	<0.0001	<0.0001
5	34,208.997	34,546.446	34,374.859	0.797	0.0004	0.0005

AIC: Akaike Information Criterion; BIC: Bayesian Information Criterion; aBIC: adjusted BIC; LMR: Lo-Mendell-Rubin; BLRT: Bootstrapped Likelihood Ratio Test.

T A B L E 3. Construct of the latent classes of multidimensional frailty in older men (N = 3824).

Multidimensional Frailty		Group 1. PFSD (n = 393)	Group 2. RSS (n = 1707)	Group 3. RSI (n = 1168)	Group 4. MFSA (n = 556)
Physical frailty					
Nutrition	Adequate (0)	0.377	0.796	0.741	0.675
	At risk (1)	0.623	0.204	0.259	0.325
Resistance	Adequate (0)	0.376	0.960	0.956	0.090
	At risk (1)	0.624	0.040	0.044	0.910
Ambulation	Adequate (0)	0.411	0.993	0.999	0.349
	At risk (1)	0.589	0.007	0.001	0.651
ADL	Adequate (0)	0.289	1.000	1.000	1.000
	At risk (1)	0.711	0.000	0.000	0.000
IADL	Adequate (0)	0.000	0.958	0.915	0.862
	At risk (1)	1.000	0.042	0.085	0.138
Psychological frailty					
Cognition (MMSE)	Adequate (0)	0.600	0.877	0.753	0.704
	At risk (1)	0.400	0.123	0.247	0.296
Mood (GDS)	Non-depressed (0)	0.635	0.984	0.892	0.840
	Depressed (1)	0.365	0.016	0.108	0.160
Social frailty					
Social relations	Satisfied (0)	0.251	0.812	0.050	0.352
	Dissatisfied (1)	0.749	0.188	0.950	0.648
Leisure and Cultural Satisfaction	Satisfied (0)	0.136	0.581	0.062	0.238
	Dissatisfied (1)	0.864	0.419	0.938	0.762
Social adaptation	adapted (0)	0.203	0.451	0.326	0.255
	maladapted (1)	0.797	0.549	0.674	0.745

Note. PFSD: Physically Frail and Socially Discontent Group; RSS: Robust and Socially Satisfied Group; RSI: Robust but Socially Isolated Group; MFSA: Moderately Frail and Socially Adequate Group; ADL: Activities of Daily Living; IADL: Instrumental Activities of Daily Living; MMSE: Mini-Mental State Examination; GDS: Geriatric Depression Scale.

Based on the analysis of covariates corresponding to life course determinants and diseases within the framework, it was found that higher educational attainment, living alone, and not being in poverty were significantly associated with higher life satisfaction. In contrast, age, residential area and the presence of chronic diseases did not show significant associations with life satisfaction (Table 4).

4. Discussion

This study, based on Han *et al.*'s [9] Integral Conceptual Model of Frailty, classified multidimensional frailty subtypes among older men by integrating physical, psychological and social factors and examined their associations with the derived frailty subtypes, life course determinants, disease-related factors and life satisfaction. The analysis utilized data from the 2023 National Survey of Older Koreans, targeting a sample of 3824 Korean men aged 65 and older.

T A B L E 4. The effect of latent classes of multidimensional frailty in older men on life satisfaction (N = 3824).

Predictor	B	SE	β	t	VIF
Constant	3.610	0.028		130.062***	
Covariate					
Age	0.022	0.020	0.016	1.098	1.213
Educational Attainment	0.107	0.019	0.081	5.507***	1.187
Household Composition	−0.080	0.022	−0.049	−3.589***	1.012
Residential Area	−0.021	0.020	0.109	7.508	1.065
Poverty Status	0.152	0.020	0.109	7.508***	1.151
Chronic Diseases	0.304	0.226	0.018	1.346	1.009
Independent Variable					
(Reference Category = RSS)					
PFSD	−0.762	0.032	−0.352	−23.867***	1.189
RSI	−0.657	0.021	−0.460	−31.095***	1.198
MFSA	−0.548	0.028	−0.294	−19.768***	1.210

$R^2 = 0.303$; adj. $R^2 = 0.301$; $F = 183.850$***

*Note. RSS: Robust and Socially Satisfied Group; PFSD: Physically Frail and Socially Discontent Group; RSI: Robust but Socially Isolated Group; MFSA: Moderately Frail and Socially Adequate Group; B: Unstandardized regression coefficient; SE: Standard Error; VIF: Variance Inflation Factor; ***p < 0.001.*

First, to identify multidimensional frailty subtypes among older men, the LCA was conducted, resulting in the identification of four distinct frailty subtypes: Physically Frail and Socially Discontent (PFSD), Robust and Socially Satisfied (RSS), Robust but Socially Isolated (RSI) and Moderately Frail and Socially Adequate (MFSA). The subsequent multiple regression analysis revealed that all three frailty subtypes, compared to the RSS group, exhibited significantly lower life satisfaction. The fact that the RSS group, which demonstrated the most favorable conditions across all frailty dimensions, had the highest life satisfaction underscores the importance of the interaction between physical, psychological and social factors in determining well-being. This finding supports previous arguments that frailty should not be viewed solely through a physical lens, but rather through an integrated framework that also considers psychological and social vulnerabilities [8–10]. Additionally, this study's findings align with existing research indicating that frailty significantly impacts life satisfaction and overall quality of life [9, 17].

Among the frailty subtypes, the PFSD and RSI groups reported the lowest levels of life satisfaction. Notably, the RSI group, characterized by good physical health but experiencing social isolation, exhibited lower life satisfaction than the MFSA group, which had moderate levels of physical, psychological and social vulnerabilities. This finding underscores the central role of social engagement and connectedness as key determinants of life satisfaction in older men. It suggests that maintaining physical health alone does not guarantee a high quality of life, reinforcing the need for social connection and psychological well-being. This finding is consistent with previous research emphasizing that social networks and adaptation are major determinants of well-being in later life [35, 36].

Additionally, this study examined variables corresponding to "life course determinants" and "disease-related factors" within the framework, including age, educational attainment, household composition, residential area, poverty status and chronic disease burden. Educational attainment, poverty status and household composition emerged as significant predictors of life satisfaction. Specifically, lower educational attainment, poverty and living with others were associated with lower life satisfaction among older men. These findings underscore the role of socioeconomic factors in shaping subjective well-being in later life. Interestingly, living with others was associated with lower life satisfaction among older men. This finding contrasts with much of the previous literature, which tends to emphasize the disadvantages of living alone in later life [37]. However, some studies have indicated that co-residence may reduce life satisfaction depending on who the co-resident is and the reasons for living together, as such arrangements can potentially infringe upon older adults' autonomy and emotional intimacy [38, 39]. Furthermore, studies have shown that older adults with higher income and better functional health are more likely to maintain independent living [40, 41], which may, in turn, contribute to greater life satisfaction. These findings may help explain the pattern observed in this study and underscore the importance of considering the broader context of living arrangements in later life.

Based on these results, several practical and policy implications emerge. Since life satisfaction in older men is shaped not only by physical health but also by psychological and social factors, intervention strategies must adopt an integrated, multidimensional approach. The high life satisfaction observed in the RSS group, which exhibited favorable conditions across all frailty dimensions and the notably lower life satisfaction in the RSI group—despite their good physical health but experiencing social isolation—compared to the MFSA group, which had moderate levels of physical

and social frailty, indicate that addressing social isolation and enhancing psychological well-being are just as important as promoting physical health. Accordingly, case management models—which integrate healthcare and social support services tailored to individual needs—should be considered as an effective intervention strategy. Case management is a representative integrated treatment model wherein healthcare or welfare professionals lead the development of treatment plans and coordinate service provision based on individual needs. For case management to function effectively, it is essential to overcome the limitations of fragmented healthcare and social welfare systems and to conduct precise effectiveness analyses [42]. A community-based integrated care model implemented in Hong Kong demonstrated that a coordinated approach involving nurses and social workers effectively reduced frailty levels among older adults by providing personalized services at elderly care centers [43]. Despite the growing recognition of the need for multidimensional frailty interventions, there is currently a lack of well-established integrated treatment models, which highlights the necessity for continued development and validation [44].

Interventions should also be tailored to the specific frailty subtypes identified in older men in this study. For the PFSD group, which exhibited both physical and social frailty, interventions should focus on simultaneously improving physical health and enhancing social connectedness. A community-based approach that combines exercise programs with group activities may be effective in this regard [45, 46]. For the RSI group, which was physically healthy but socially isolated, enhancing social support should be prioritized. A systematic review by Tong *et al.* [47] found that group-based and hybrid interventions were effective in reducing social isolation among older adults, and that technology-based solutions, such as telehealth services, could also be beneficial. Meanwhile, the MFSA group, which exhibited moderate frailty, should be considered a high-risk population for further frailty progression, necessitating preventive interventions and continuous monitoring [48].

Frailty prevention policies should also be developed through a multidisciplinary approach. Many existing frailty prevention policies remain primarily medical-centered [49], yet the findings of this study suggest that psychological and social aspects must also be incorporated. Therefore, policy frameworks should integrate screenings for social and psychological vulnerabilities to ensure that interventions address frailty comprehensively.

Finally, beyond frailty prevention, efforts should target structural inequalities, particularly low educational attainment and poverty, which significantly undermine life satisfaction in later life. Expanding lifelong learning opportunities, strengthening targeted financial assistance programs for low-income older adults, and implementing welfare policies aimed at improving economic security are crucial for reducing socioeconomic vulnerabilities among older men in later life. Additionally, considering that living with others was associated with lower life satisfaction, future housing welfare policies for older adults should be designed to ensure their autonomy and freedom of choice. Given previous studies indicating that non-voluntary cohabitation or family conflicts can reduce the quality of life for older adults [38, 39], it is necessary to create residential environments that support independent living and to develop programs that promote the formation of social networks regardless of cohabitation status. Further research should explore the nuanced effects of living arrangements on life satisfaction among older men.

This study has several limitations. First, since it relied on cross-sectional data, it is unable to establish causal relationships. Future longitudinal studies should examine frailty transitions over time and explore causal links with life satisfaction. Given that frailty is a cumulative and evolving condition, analyzing longitudinal patterns would provide deeper insights into frailty progression and its long-term impact on well-being. Second, this study utilized a single-item measure of life satisfaction due to the constraints of the secondary data source. Although widely used in large-scale aging studies for practicality, single-item measures may fall short in capturing the nuanced and multidimensional aspects of subjective well-being. Future studies are encouraged to utilize validated multi-item scales to enhance measurement reliability. Third, although this study focused on the direct relationship between frailty subtypes and life satisfaction, it did not examine potential mediating or moderating variables that may influence this relationship. Future research could adopt structural equation modeling (SEM) to enable a more comprehensive exploration of the complex pathways and mechanisms linking frailty and life satisfaction. Lastly, the study sample was limited to older adults in South Korea, and this study focused solely on Korean older men. While South Korea presents a meaningful case study due to its rapidly aging population and unique cultural characteristics, the generalizability of findings to other populations may be limited. Future studies should incorporate more diverse samples across genders, regions and sociocultural contexts to enhance external validity.

Despite these limitations, this study contributes to the literature by identifying multidimensional frailty subtypes among older men and examining their effects on life satisfaction. The findings provide important insights for frailty prevention, intervention and policy development. As aging populations continue to grow worldwide, addressing frailty through holistic and evidence-based approaches will be essential in ensuring well-being and quality of life in later life. In particular, the results underscore the importance of developing integrated intervention strategies that not only target physical health, but also actively support psychological well-being and social engagement. These multidimensional interventions will be essential in promoting resilience and life satisfaction among older adults.

5. Conclusions

This study highlights the importance of classifying multidimensional frailty and understanding its impact on life satisfaction among older men. The results underscore that physical health alone does not ensure well-being—psychological and social factors are equally critical. Accordingly, integrated, evidence-based interventions and supportive policies must target all dimensions of frailty, alongside addressing structural inequalities. Such integrative efforts are essential to enhancing

quality of life across the rapidly aging populations in diverse sociocultural contexts worldwide. Implementing multidimensional interventions that address all aspects of frailty is vital to promoting resilience and life satisfaction, particularly among older men.

AVAILABILITY OF DATA AND MATERIALS

The data presented in this study are available on reasonable request from the corresponding author.

AUTHOR CONTRIBUTIONS

SH and SK—conceptualized and designed the study. SH—developed the methodological framework and conducted the data analysis. SK—contributed to the theoretical framework and manuscript drafting. HJC—critically reviewed and revised the manuscript to enhance its conceptual coherence, clarity and academic rigor. All authors contributed to revising the manuscript and approved the final version for submission.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

This study was conducted according to the guidelines of the Declaration of Helsinki and approved by the Institutional Review Board of Semyung University in Korea (SMU-EX-2025-03-001). Informed consent was obtained from all participants.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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