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Prevalence of Multidimensional Frailty and Related Factors Among Community-Dwelling Older Adults in Shahroud, Northeastern Iran: A Cross-Sectional Study

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Abstract

Background: *Most frailty studies focus on physical aspects, with limited data on other dimensions, particularly environmental. This study estimated frailty prevalence and related risk factors across five dimensions (physical, psychological, cognitive, social, and environmental) among Iranian community-dwelling older adults.*

Methods: *This cross-sectional study was performed on 413 older adults referred to health centers in Shahroud, northeastern Iran. Participants were selected via cluster random sampling. Persian-speaking adults aged ≥60 years, able to communicate and provide informed consent, were included in the study; those with severe mental or cognitive disorders diagnosed by physicians or severe physical disorders were excluded. Multidimensional frailty was assessed using the Comprehensive Frailty Assessment Instrument Plus (CFAI-Plus). Multinomial logistic regression identified risk factors associated with frailty.*

Results: *In physical, psychological, cognitive, social, and environmental dimensions, the prevalence of mild to high frailty was 9.2%, 13.6%, 59.6%, 26.4%, and 28.3%, respectively. Advanced age was the only variable associated with frailty in all dimensions (physical, psychological, and cognitive dimensions: P-value<0.001; environmental: P-value=0.023, and social: P-value=0.013). Also, female gender, low education, dependence on Instrumental Activities of Daily Living (IADL), current smoking, joint disease, hypertension, insufficient income, physical inactivity, living alone, having less than two children, depressive symptoms, poor cognition, comorbidity, and poor self-reported health were each differentially associated with one of the frailty dimensions.*

Conclusions: *A multidimensional approach to frailty highlights distinct risk factors across physical, psychological, cognitive, social, and environmental domains, supporting health professionals and policymakers in developing targeted interventions to prevent or delay frailty in older adults.*

Keywords: Multidimensional frailty, Older adults, Prevalence, Risk factors.
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Introduction

With the increase in life expectancy and the growing population of older adults in recent years, greater attention has been directed toward addressing the health problems and care needs of this population, particularly those experiencing frailty[1]. Frailty is a common geriatric syndrome characterized by a reduced ability to adapt to stressors, resulting from impairments across multiple physiological systems[2,3]. In recent years, frailty has been reconceptualized as a multidimensional phenomenon, and many scholars have emphasized the need for operational definitions that extend beyond the physical domain to include other key dimensions of functioning[4]. Consequently, the reported prevalence of frailty varies substantially depending on the assessment tool employed[3,5,6]. A systematic review estimated the global prevalence of physical frailty at 9.9% and multidimensional frailty at 13.6% among community-dwelling older adults[7]. Physical frailty is typically defined by the presence of features such as unintentional weight loss, slow gait speed, self-reported fatigue, low physical activity, and muscular weakness[8]. A unidimensional focus on physical frailty alone may result in fragmented or inadequate care. In contrast, the multidimensional approach provides a holistic understanding of frailty by addressing the person as a whole[4]. Multidimensional frailty encompasses a dynamic interaction among physical, psychological, social, cognitive, and environmental components[9]. In the Middle East countries, the combined prevalence of unidimensional and multidimensional frailty and pre-frailty has been reported to be 35% and 39%, respectively[10]. In Iran, according to several previous studies, the prevalence of multidimensional frailty was 33-47%[11,12]. However, these studies did not assess the individual domains of frailty separately. The present study seeks to address this gap by examining each domain of frailty independently. Such domain-specific analysis facilitates the identification of areas in which an individual may be frail and supports the development of targeted interventions to reduce frailty and improve health outcomes within those specific domains[13].

Older adults who are frail experience more adverse outcomes such as falls, disability, hospitalization, admission to care homes, death, and higher care costs [8,14-16]. Additionally, frailty is considered a pre-disability condition and overlaps with aging, disability, and comorbidity[1]; however, unlike these conditions, it is a dynamic state that can be prevented or mitigated through appropriate interventions such as exercise, proper nutrition, and health education [2,16]. Therefore, identifying frailty and the factors associated with it allows for effective planning to reduce its negative impacts[17].

Previous studies conducted in both developed and developing countries have identified several factors that contribute to the progression of frailty syndrome. The prevalence of frailty increases with age, and among individuals over 85 years old, it has been reported to range from 25% to as high as 80% in some studies[16,18,19]. According to previous studies, frailty is more prevalent among women, individuals with lower levels of education and income, single persons, and those living alone [20-22]. Other determinants of frailty include the presence of multiple chronic conditions, polypharmacy, poor self-rated health, and unhealthy lifestyles such as poor nutrition, smoking, alcohol consumption, and physical inactivity[22-24]. In addition, several common geriatric syndromes are also associated with frailty, including depression, cognitive impairment, and functional disability[18,19,25]. In general, factors related to frailty can be categorized into sociodemographic, health-related, and lifestyle-related factors[21]. Evaluation the factors that influence the development of frailty is essential for identifying high-risk groups[6]. So far, very few studies have investigated the prevalence of multidimensional frailty and its associated factors in each dimension separately, both in Iran and around the world. Therefore, the current study was conducted with the aim of determining the prevalence of frailty across five domains: physical, psychological, cognitive, social, and environmental. In addition, the associations between demographic characteristics, clinical factors, health-related variables, and lifestyle-related factors were examined separately for each domain of frailty among community-dwelling older adults.

Materials and Methods

This cross-sectional study, conducted from January to October 2021, assessed the prevalence of multidimensional frailty and associated risk factors among community-dwelling older adults aged ≥60 years in Shahroud, northeastern Iran. The sample size was calculated as 385 individuals based on an estimated frailty prevalence of 50% in previous studies[11], with a 95% confidence level and a 5% margin of error. Considering a potential 10% non-response rate, the final target sample size was set at 425 participants. A multi-stage random sampling method was used. In the first stage, out of 11 healthcare centers in the city, five centers were randomly selected and the records of the older adults covered by these five centers were extracted based on household numbers. In the second stage, 5% of the population covered by each center was selected as a systematic random sampling with an interval of 20 (K=20). In this way, the older adults files of each center are numbered in order, a random number among 1 and 20 was selected and then the next people were selected with a distance of 20 from the previous one. The purpose of the study and the method of conducting it were explained to each of the participants**.** Individuals aged 60 years or older who were able to understand and speak the Persian language and who provided informed consent were included in the study. Exclusion criteria included severe mental or cognitive disorders diagnosed by a physician or severe physical disability. Out of the 425 participants, four were excluded from the study due to cognitive impairment, one due to psychotic disorder, and six due to extensive missing data, leaving 413 participants for the final analysis. The study was approved by the Ethics Council of Shahroud University of Medical Sciences, with the code IR.SHMU.REC.1398.163, and written informed consent was obtained from the participants.

Data were collected through face-to-face interviews by trained health professionals in health centers using structured questionnaires. These measures were implemented to ensure consistency across interviews and minimize potential sources of interviewer or measurement bias. Variables included sociodemographic characteristics (age, sex, marital status, living arrangement (alone vs. with others), years of education, monthly income adequacy (self-reported as sufficient or insufficient), housing situation (own vs. rented), occupation (employed vs. unemployed), number of children (<2 vs. ≥2), retirement insurance (yes vs. no), history of falls in the past 12 months, and Body Mass Index (BMI)), lifestyle factors (smoking status (non-smoker, ex-smoker, current smoker), regular physical activity), and health-related factors (comorbidity, polypharmacy, self-perceived health (poor, moderate, good), functional status, cognitive and mental status, self-reported medical diagnoses (such as hypertension, diabetes, respiratory disease, kidney disease, liver disease, cancer, stroke, Parkinson, arthrosis/arthritis, osteoporosis, hyperlipidemia, heart disease, and thyroid disease). Comorbidity was defined as having two chronic diseases or more. Polypharmacy was defined as the use of five or more drugs during the day. Regular physical activity was defined by the world health organization as having at least 150 minutes of moderate activity or 75 minutes of vigorous activity per week[26]. BMI was calculated as weight (kg) divided by height squared (m^2).

Functional status was assessed using the Persian version of the Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL). Katz et al. (1963) developed and validated the ADL scale in different versions of 8, 7 and 6 items. Each activity is scored dichotomously (1 point for independent performance, 0 points for dependence), with higher total scores indicating greater functional independence[27]. The IADL scale was developed by Lawton and Brody (1970) and consists of eight items assessing more complex daily activities, using the same scoring method[28]. The Persian version of these tools was validated by Taheri Tanjani et al. (2016). The ADL scale demonstrated sensitivity of 0.75 and specificity of 0.96, while the IADL scale showed sensitivity of 0.71 and specificity of 0.77. Both scales exhibited significant discriminative validity across age and cognitive function groups (P-value<0.01). Internal consistency was good for both measures (ADL: Cronbach's α=0.80; IADL: Cronbach's α=0.75)[29]. In the current study, the 8-item ADL version (total score range: 0-16) uses a cutoff score >11 to indicate independence, and the 7-item IADL version (total score range: 0-14) uses a cutoff score >10 to indicate independence.

The cognitive status was assessed by the Persian version of the Mini-Cog. This instrument, developed by Borson et al. (2000), consists of two components: a three-word recall test and a clock-drawing test. The participants are asked to listen carefully to three unrelated words spoken by the examiner and recall them later. They were then asked to draw a clock showing 11:10. The word recall section is scored out of 3 points, while the clock-drawing test is scored out of 2 points, yielding a total possible score of 5 (cut-off point ≤3). The Mini-Cog demonstrates high sensitivity (99%) and specificity (93%) compared to the Mini-Mental State Examination (MMSE) and Cognitive Abilities Screening Instrument

(CASI)[30]. Its Persian version was validated by Rezaei et al. (2018), showing good reliability (Cronbach's α=0.83, inter-rater reliability=0.76, test-retest reliability=0.86) and acceptable criterion and known-group validity. The sensitivity and specificity were 0.88 and 0.63, respectively, and the cut-off point was 2[31].

Depression was assessed by the Persian version of the Geriatric Depression Scale-4 Item (GDS-4). the GDS is a self-report questionnaire originally developed as a 30-item questionnaire, and Subsequent validation studies produced shorter versions, including 15, 10, and 4-item scales[32]. The GDS-4 demonstrates 91% agreement with the GDS-15, with Cronbach's α=0.55, sensitivity of 89%, and specificity of 65% at the 0/1 cutoff point. The GDS-4 comprises four yes/no questions: Are you basically satisfied with your life? Do you feel that your life is empty? Are you afraid something bad will happen to you? Do you feel happy most of the time? The total score is four. Norouzi et al. (2013) validated the Persian versions of the GDS in 30, 15, 10, 5, and 4-item formats, reporting agreement rates of 75% (GDS-30), 79% (GDS-15), and 82% (GDS-5) with the GDS-4. At a cutoff score of 2, the GDS-4 showed sensitivity of 0.43 and specificity of 0.92. The scale showed a correlation 0.31 with DSM-IV depression criteria and achieved Cronbach's α=0.89[33].

Multidimensional frailty was assessed by the Persian version of the Comprehensive Frailty Assessment Instrument Plus (CFAI-Plus). This tool includes five dimensions (physical, psychological, cognitive, social and environmental). The physical frailty includes four items about daily performance capacity, whose answers are on a 3-point Likert scale from 0-2 points. The scores of the psychological frailty are obtained from the sum of the scores of the two factors of mood and emotion. The mood factor includes five items about depression and anxiety disorders with a 4-point Likert response from 0-3 points, and the emotion factor includes three items about feelings of loneliness and rejection by others with a 5-point Likert response from 0-4 points. The responses of the cognitive frailty with four items about memory and learning disorders and the environmental frailty with five items about housing and neighborhood are also on a 5-point Likert scale as above. The social frailty includes two factors: social isolation (three items with a 5-point Likert response) and social support (10 items with yes /no response). The total score of each dimension is calculated separately, and higher scores indicate greater frailty. According to the obtained score, people are divided into three categories; "No to Low", "Low to Mild", and "Mild to High" frailty. The initial version of this tool was developed and validated by De Witte et al**.** (2013)[34], and then De Roeck et al. (2018) added a cognitive dimension to it[9]. Imani et al. (2021) translated and validated the Persian version of the CFAI-Plus. The internal consistency of the entire tool was adequate, with a Cronbach's alpha of 0.79, while individual factors showed Cronbach's alpha values ranging from 0.47 to 0.88. The total extracted variance was 62.89%, and test-retest reliability was acceptable, with intra-class correlation coefficients ranging from 0.76 to 0.92. In confirmatory factor analysis, the model fit indices were acceptable (RMSEA=0.045, CFI=0.93, TLI=0.92)[35].

Baseline characteristics and multidimensional frailty prevalence were analyzed using descriptive statistics. Associations between frailty levels in each of the dimensions and categorical variables were examined using χ^2 tests or Fisher's exact tests, as appropriate. Continuous variables were analyzed using one-way ANOVA for each frailty dimension. Variables demonstrating significant associations (P-value<0.05) in univariate analyses were entered into backward elimination multinomial logistic regression models to identify independent predictors for each frailty dimension. All analyses were conducted using IBM SPSS Statistics 26.0 (SPSS Inc., Chicago, IL, USA). Results are presented as adjusted odds ratios (aOR) with 95% confidence intervals, with statistical significance set at α=0.05.

Results

The mean age of study population (N=413) was 69.4±6.6 years and most of them (n=229, 55.4%) were men. The education level of 190 participants (46%) was less than five years. Most of the participants were married (n=299, 72.4%), most of them did not have regular physical activity (n=254, 61.5%), less often lived alone (n=60, 14.6%), most of them believed that they did not have enough monthly income (n=246, 59.9%), most of them lived in their own house (n=362, 88.1%) and only 89 people were employed (21.5%). In 46 (11.2%) older adults, there was a history of falling in the last year, and most of them did not have a history of smoking (n=297, 72.3%). Hypertension (n=205, 49.6%) and diabetes (n=120, 29.1%) were the most common chronic conditions. Other details of the participants are presented in Table 1.

Participants with older age, lower education, comorbidity, IADL dependence, and depressive symptoms showed significantly higher frailty across all dimensions (P-value<0.05 for all dimensions). No significant associations were found between any frailty dimension and lack of retirement or complementary insurance and conditions such as diabetes, hyperlipidemia, liver disease, thyroid problems, cancer, and poor vision (P-value>0.05 for all dimensions). Other variables were each associated with one or more specific dimensions of frailty. Gender (P-value=0.683), physical activity (P-value=0.079), and occupational status (P-value=0.961) were unrelated to environmental frailty, while housing situation (P-value=0.047) and BMI (P-value=0.047) were only associated with environmental frailty. The number of children was uniquely associated with social frailty (P-value=0.009). However, cognitive status (P-value=0.053) and self-reported health (P-value=0.080) were significantly associated with all dimensions except social frailty. Smoking (P-value=0.045), kidney disease (P-value=0.021), stroke (P-value=0.007) and osteoporosis (P-value<0.001) were exclusively associated with physical frailty. Results of the univariate analyses, showing associations between frailty dimensions and demographic characteristics or health-related factors, are presented in Table 1. Associations with self-reported medical conditions are presented in Table 2.

Table 1. Baseline characteristics of the participants according to frailty levels in all of dimension (N=413)

Baseline characteristics	Total N (%)	Physical frailty P-value	Psychological frailty P-value	Cognitive frailty P-value	Environmental frailty P-value	Social frailty P-value
Age †† (y), Mean (SD)	69.4 (6.6)	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**<0.001**
Gender † Female	184 (44.6)	**0.003**	**<0.001**	**<0.001**	0.683	**<0.001**
Education †† (y), Mean (SD)	7.1 (5.0)	**<0.001**	**<0.001**	**<0.001**	**0.004**	**0.027**
Marital status †, Single	114 (27.6)	**<0.001**	**0.002**	**0.001**	0.574	0.428
Living arrangement †, Alone	60 (14.6)	**0.006**	**0.001**	**0.026**	0.322	0.376
Number of children †, <2	30 (7.3)	0.335	0.074	0.772	0.095	**0.009**
Source of income, Others †	58 (14.1)	**0.027**	**0.021**	0.272	**0.042**	**0.049**
Housing situation, Rent †	49 (11.9)	0.286	0.531	0.087	**0.047**	0.082
Retirement insurance, No †	31 (7.5)	0.149	0.294	0.335	0.915	0.261
Occupation, Unemployed †	324 (78.5)	**<0.001**	**0.002**	**0.003**	0.961	**<0.001**
Income, Inadequacy †	246 (59.9)	0.545	**<0.001**	**0.002**	**<0.001**	**0.003**
BMI †† (kg/m2), Mean (SD)	26.1 (3.9)	0.071	0.668	0.527	**0.047**	0.632
Falls in last 12 months, Yes †	46 (11.2)	**<0.001**	**<0.001**	0.188	0.786	0.170
Physical inactivity †	254 (61.5)	**0.022**	**<0.001**	**<0.001**	0.079	**<0.001**
Smoking ††						
Non-smoker	297 (72.3)					
Ex-smoker	46 (11.2)	**0.045**	0.073	0.872	0.200	0.110
Current-smoker	68 (16.5)					
ADL, Dependent †	36 (8.8)	**<0.001**	**<0.001**	**0.002**	**0.022**	0.139
IADL, Dependent †	116 (28.1)	**<0.001**	**<0.001**	**<0.001**	**<0.001**	**0.002**
Mini-Cog score, Mean (SD) ††	3.1 (1.4)	**<0.001**	**<0.001**	**<0.001**	**<0.001**	0.053
Depressive disorder †	117 (28.4)	**0.001**	**<0.001**	**<0.001**	**0.012**	**<0.001**
Comorbidity†	214 (51.8)	**<0.001**	**<0.001**	**0.002**	**0.001**	**0.009**
Polypharmacy †	65 (15.7)	**<0.001**	**<0.001**	**0.006**	0.062	0.073

Note: SD=Standard Deviation; BMI: Body Mass Index

††The P-values were calculated based on the ANOVA test; P-values<0.05 indicated in bold.

† The P-values were calculated based on the Chi-square test; P-values<0.05 indicated in bold.

Table 2. Self-reported disease of the participants according to frailty levels in all of dimension (N=413)

Self-reported medical conditions	Total	Physical frailty P-value	Psychological frailty P-value	Cognitive frailty P-value	Environmental frailty P-value	Social frailty P-value
Hypertension †	205 (49.6)	0.100	**<0.001**	**<0.001**	0.106	0.241
Diabetes †	120 (29.1)	0.540	0.149	0.391	0.741	0.082
Heart disease †	89 (21.5)	**0.030**	**0.002**	0.451	0.197	0.282
Dyslipidemia †	90 (21.8)	0.060	0.604	0.856	0.187	0.773
Arthrosis/Arthritis †	103 (24.9)	**<0.001**	**0.003**	0.328	0.211	0.719
Thyroid disease †	20 (4.8)	0.608	0.084	0.418	0.746	0.673
Cancer ‡	6 (1.5)	0.143	0.181	0.613	0.741	0.838
kidney disease ††	16 (3.9)	**0.021**	0.360	0.624	0.940	0.678
Parkinson, Stroke ‡	4 (1)	**<0.001**	0.109	0.360	1.000	0.743
Respiratory disease†	42 (10.2)	0.075	**0.002**	0.627	0.349	0.118
Liver disease ††	15 (3.6)	0.822	0.067	0.336	0.939	0.530
Osteoporosis †	38 (9.2)	**<0.001**	0.097	0.141	0.787	0.997
Hearing loss †	112 (27.3)	**0.043**	0.370	**0.029**	0.947	0.305
Poor vision †	204 (49.5)	0.149	0.184	0.059	0.804	0.179
Self-perceived health†						
Poor	66 (16.0)					
Moderate	105 (25.5)	**0.019**	**<0.001**	**0.030**	**0.014**	0.080
Good	241(58.5)					

P-values<0.05 indicated in bold.

† The P-values were calculated based on the Chi-square test; ‡ The P-values were calculated based on Fisher's Exact test; †† The P-values were calculated for the physical domain based on the Chi-square test and for the psychological domain based on the Fisher's Exact test.

The prevalence of "Mild to High" frailty across dimensions was as follows: physical 9.2% (n=16, 95%CI: 6.3-12.3), psychological 13.6% (n=56, 95%CI: 10.2-16.9), cognitive 59.6% (n=246, 95%CI: 54.7-64.4), social 26.4% (n=109,

95%CI: 22-30.5), and environmental 28.3% (n=117, 95%CI: 24.2-32.7). Details of the results for other levels of frailty are shown in Table 3. Overall, 29% of participants (n=120, 95%CI: 24.9-33.4) exhibited degrees of frailty across all dimensions. Figure 1 displays the distribution of frailty within and across domains.

Table 3. Prevalence of frailty based on different dimensions among older adults

Dimensions of frailty	Frailty levels	N	%	(95% CI)
Physical frailty	No to low	216	52.3	47.5-57.1
	Low to mild	159	38.5	33.9-43.1
	Mild to high	16	9.2	6.3-12.3
Psychological frailty	No to low	118	28.6	24.2-33.2
	Low to mild	239	57.9	53.3-62.7
	Mild to high	56	13.6	10.2-16.9
Cognitive frailty	No to low	63	15.3	11.6-19.1
	Low to mild	104	25.2	21.3-29.3
	Mild to high	246	59.6	54.7-64.4
Environmental frailty	No to low	78	18.9	15-22.5
	Low to mild	218	52.8	47.9-57.6
	Mild to high	117	28.3	24.2-32.7
Social frailty	No to low	45	10.9	8-14
	Low to mild	259	62.7	58.1-67.3
	Mild to high	109	26.4	22-30.5

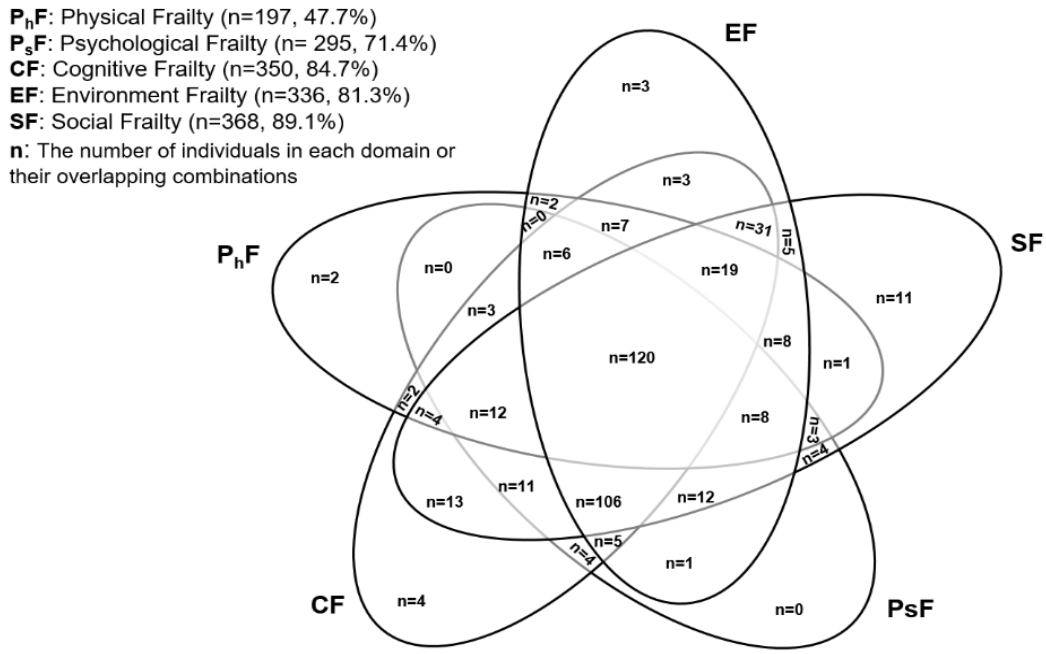

Figure 1. Venn diagram showing the prevalence of frailty in each domain and the degree of overlap between different domains of frailty. In total, only 3 older adults (0.7%) did not have any level of frailty in any of the domains and 120 people (29%) had degrees of frailty in all domains.

Following significant univariate associations, backward stepwise multinomial logistic regression was conducted separately for each frailty dimension assessed by the CFAI-Plus. Individuals were classified into three levels based on their scores: "No to Low", "Low to Mild", and "Mild to High". The "No to Low" level was defined as the reference level in the regression analysis for all dimensions and comparisons.

For the physical frailty, the odds of being in the “Low to Mild” level compared to the “No to Low” level were significantly higher with each additional year of age (OR=1.05, P-value=0.018), dependence in IADL (OR=3.58, P-value<0.001), current smoking (OR=2.51, P-value=0.006), and joint disease (OR=1.88, P-value=0.039), but significantly lower with each additional year of education (OR=0.90, P-value<0.001). Similarly, being older (OR=1.23, P-value<0.001), female (OR=4.46, P-value=0.003), dependent in IADL (OR=4.09, P-value=0.005), a current smoker (OR=3.79, P-value=0.032), and having joint disease (OR=4.27, P-

value=0.003) were associated with significantly higher odds of being in the "Mild to High" level compared to the "No to Low" level. This likelihood decreased significantly with each additional year of education (OR=0.79, P-value<0.001).

For the psychological frailty, the odds of being in the "Low to Mild" level compared to the "No to Low" level were significantly higher for female sex (OR=2.40, P-value=0.002), hypertension (OR=1.76, P-value=0.031), insufficient income (OR=1.82, P-value=0.020), but significantly lower with each unit increase in Mini-Cog scores (OR=0.60, P-value<0.001). The odds of being in the "Mild to High" level compared to the reference level (No to Low level) were significantly higher with each additional year of age (OR=1.14, P-value<0.001), female sex (OR=2.88, P-value=0.011), living alone (OR=4.21, P-value=0.012), poor self-perceived health (OR=4.85, P-value=0.004), and insufficient income (OR=3.70, P-value=0.002).

In the cognitive frailty, with each additional year of age, the odds of being in the "Low to Mild" level compared to the "No to Low" level were significantly higher (OR=1.12, P-value<0.001). Similarly, the odds of being in the "Mild to High" level compared to the "No to Low" level were significantly higher with each additional year of age (OR=1.13, P-value<0.001), dependence in IADL (OR=3.60, P-value=0.025), depression (OR=3.90, P-value=0.006), physical inactivity (OR=2.43, P-value=0.010), and hypertension (OR=2.36, P-value=0.011). However, the odds of being in the "Mild to High" level decreased with each additional year of education (OR=0.89, P-value=0.003).

In the social frailty, the odds of being in the "Low to Mild" level compared to the "No to Low" level were significantly higher for female sex (OR=4.71, P-value=0.001), physical inactivity (OR=2.43, P-value=0.017), insufficient income (OR=2.67, P-value=0.005), and comorbidity (OR=2.13, P-value=0.040). The odds of being in the "Mild to High" level compared to the reference level were significantly higher with each additional year of age (OR=1.08, P-value=0.013), depression (OR=3.90, P-value=0.013), and physical inactivity (OR=2.84, P-value=0.011).

In the environmental frailty, the odds of being in the "Low to Mild" level compared to the "No to Low" level were significantly higher with each additional year of age (OR=1.06, P-value=0.023), rental housing (OR=3.94, P-value=0.033), and each unit increase in BMI (OR=1.10, P-value=0.011). The odds of being in the "Mild to High" level compared to the reference level were significantly higher with insufficient income (OR=3.35, P-value<0.001) and dependence in IADL (OR=3.76, P-value=0.003), but significantly lower with each unit increase in Mini-Cog scores (OR=0.72, P-value=0.015). Detailed results are presented in Table 4.

Table 4. Multinomial logistic regression analysis of factors associated with frailty domains among older adults

Characteristics	Psychological frailty				Social frailty				Environment frailty			
	Low to mild frailty		Mild to high frailty		Low to mild frailty		Mild to high frailty		Low to mild frailty		Mild to high frailty	
	OR (95% CL)	P	OR (95% CL)	P	OR (95% CL)	P	OR (95% CL)	P	OR (95% CL)	P	OR (95% CL)	P
Age (y)	1.02 (0.98-1.07)	0.242	1.14 (1.07-1.22)	**<0.001**	1.00 (0.94-1.06)	0.845	1.08 (1.01-1.15)	**0.013**	1.06 (1.00-1.12)	**0.023**	1.06 (0.99-1.12)	0.053
Gender (Female)	2.40 (1.39-4.13)	**0.002**	2.88 (1.27-6.53)	**0.011**	4.71 (1.84-12.0)	**0.001**	2.23 (0.81-6.16)	0.120	-	-	-	-
IADL (Dependent)	1.09 (0.55-2.18)	0.786	2.37 (0.97-5.78)	0.056	-	-	-	-	1.82 (0.79-4.20)	0.157	3.76 (1.56-9.06)	**0.003**
Hypertension	1.76 (1.05-2.96)	**0.031**	1.82 (0.83-4.00)	0.131	-	-	-	-	-	-	-	-
Live alone	1.79 (0.73-4.39)	0.200	4.21 (1.37-12.8)	**0.012**	-	-	-	-	-	-	-	-
Self-reported health												
Moderate	1.04 (0.47-2.29)	0.909	4.85 (1.67-14.0)	**0.004**	-	-	-	-	-	-	-	-
Severe	1.51 (0.77-2.96)	0.222	4.57 (1.76-11.9)	**0.002**								
Inadequacy income	1.82 (1.09-3.04)	**0.020**	3.70 (1.59-8.58)	**0.002**	2.67 (1.33-5.36)	**0.005**	1.89 (0.87-4.09)	0.103	1.53 (0.87-2.69)	0.137	3.35 (1.71-6.54)	**<0.001**
Mini-Cog score	0.60 (0.48-0.76)	**<0.001**	0.80 (0.58-1.11)	0.196	-	-	-		0.82 (0.65-1.04)	0.111	0.72 (0.55-0.94)	**0.015**
Comorbidity	-	-	-	-	2.13 (1.03-4.38)	**0.040**	1.17 (0.52-2.26)	0.697	-	-	-	-
Children<2	-	-	-	-	1.32 (0.26-6.63)	0.729	5.11(1.01-25.8)	**0.048**	-	-	-	-
Depression	-	-	-	-	1.31 (0.46-3.72)	0.606	3.90 (1.34-11.3)	**0.013**	-	-	-	-
Physical inactivity	-	-	-	-	2.43 (1.17-5.05)	**0.017**	2.84 (1.27-6.36)	**0.011**	-	-	-	-
Housing (Rental)	-	-	-	-	-	-	-	-	3.94 (1.11-13.8)	0.033	3.65 (0.96-13.8)	0.057
BMI (Continuous)	-	-	-	-	-	-	-	-	1.10(1.02-1.19)	0.011	1.08 (0.99-1.18)	0.055
Nagelkerke R2	0.376				0.263				0.191			

Characteristics	Physical frailty				Cognitive frailty			
	Low to mild frailty		Mild to high frailty		Low to mild frailty		Mild to high frailty	
	OR (95% CL)	P	OR (95% CL)	P	OR (95% CL)	P	OR (95% CL)	P
Age (y)	1.05 (1.00-1.10)	**0.018**	1.23 (1.13-1.33)	**<0.001**	1.12 (1.04-1.20)	**<0.001**	1.13 (1.05-1.21)	**<0.001**
Gender (Female)	1.61 (0.96-2.68)	0.066	4.46 (1.65-12.0)	**0.003**	0.87 (0.41-1.83)	0.719	1.75 (0.86-3.53)	0.119
Education (y)	0.90 (0.86-0.95)	**<0.001**	0.79 (0.70-0.89)	**<0.001**	0.97 (0.91-1.05)	0.532	0.89 (0.83-0.96)	**0.003**
IADL (Dependent)	3.58 (1.95-6.58)	**<0.001**	4.09 (1.51-11.0)	**0.005**	1.87 (0.57-6.08)	0.296	3.60 (1.17-11.0)	**0.025**
Current smoker	2.51 (1.29-4.88)	**0.006**	3.79 (1.12-12.8)	**0.032**				
Arthrosis/Arthritis	1.88 (1.03-3.43)	**0.039**	4.27 (1.61-11.3)	**0.003**				
Depression					2.08 (0.75-5.17)	0.155	3.90 (1.49-10.2)	**0.006**
Physical inactivity					1.51 (0.75-3.03)	0.241	2.43 (1.23-4.79)	**0.010**
Hypertension	-	-	-	-	1.33 (0.67-2.63)	0.411	2.36 (1.21-4.57)	**0.011**
Nagelkerke R2	**0.424**				**0.324**			

Note: OR: Odds Ratio; CI: Confidence Interval; IADL: Instrumental Activities of Daily Living; BMI: Body Mass Index

P-values<0.05 indicated in bold; No to low frailty is reference group

Discussion

Due to the limited global studies on multidimensional frailty, especially environmental frailty, this study examined frailty and related factors in five different dimensions in northeastern Iran. Based on previous studies conducted in Iran and other countries, it was found that the prevalence of this syndrome can vary depending on the tools used[4,7,15]. In the study of Vander Elst et al. (2020), the prevalence of multidimensional frailty and pre-frailty was 55.6% and the prevalence of physical frailty was 76.3%[5]. In a review study in 2021, the prevalence of multidimensional frailty and pre-frailty was 26.8% and 36.4%, respectively[36]. However, the results of these studies are not comparable with the present study due to the lack of calculation of total frailty.

The prevalence obtained for high physical frailty in the present study is consistent with the global average prevalence of frailty (9.9%)[7], and the prevalence obtained in China (9.1%)[16], Indonesia (8.1%)[21], Korea (7.9%)[20], and Italy (7.6%)[37]. The prevalence of "Mild to High" physical frailty is consistent with a study in Singapore (48.3%) and Mexico (49%)[15,25]. However, the prevalence of physical frailty and pre-frailty in other studies is different from the present study. Of course, it should not be ignored that the present study was conducted in a country with a low to medium income, which is faced with a large percentage of older adults and has less healthcare facilities than developed countries. The prevalence of psychological frailty was 4 to 35% in a review study[38], 23% in Mexico[25], and 3.5% in Japan[23], which is lower than the present study. The definition of psychological frailty in the above studies as the simultaneous occurrence of physical frailty with a depressive disorder can be the reason for this difference. The CFAI-Plus examines most of the subjective cognitive complaints (SCC) in the cognitive dimension. The prevalence of SCC in older adults varies from 6 to 53%[39]. The prevalence of "Low to Mild" and "Mild to High" cognitive frailty in the study of Dury et al. (2019) was 54% and 24%, which is almost consistent with the present study[13]. Unlike the present study, the prevalence of social frailty was 18% in Japan[14], 20.5% in Korea[19], 18.3% in Singapore[15]. In the winter season, the difficulty in heating the house will be accompanied by the exacerbation of pulmonary and muscular physical diseases[40]. Unsuitable housing for the life of older adults, which has small rooms, many floors and stairs, and unsafe and deprived neighborhood, slippery sidewalks, lack of sports facilities and transportation are associated with increasing frailty. Because they are associated with the risk of falling, reducing health-related behaviors and limiting people's access to health services and resources and social support[41,42]. Older people tend to stay in their home and neighborhood as much as possible. This is largely dependent on whether the conditions of their place of residence are suitable or not[27]. Therefore, it is important to include environmental conditions in the assessment of frailty in older adults. Data on the prevalence of environmental frailty are very limited. In only two studies that were found in this case; The prevalence of "Mild to High" environmental frailty was 17.5% in Belgium and Brussels[13], and 18.2% in China[43]. While in our study, the prevalence of "Mild to High" frailty in environmental dimension is higher. This difference may be due to the use of different tools, cultural and geographical differences, the difference in demographic characteristics, better socioeconomic status, and the necessary arrangements in those countries for aging in place. However, the prevalence of frailty in older people is significant and requires careful planning to find in a timely manner and supportive measures.

Consistent with other studies in regression analysis, this study also found that physical frailty was positively associated with female gender, older age, lower education, and dependence in IADL[21,37]. Higher frailty at older adults is due to physiological changes and reduced function of body systems in old age[1]. Higher frailty in women can be due to a steady decline in performance, followed by an increase in comorbidity and the incidence of disability in them, while men are more likely to experience sudden death[44]. Less education restricts access to health information and, as a result, leads to a lack of appropriate measures to manage or prevent frailty[17,21]. In the present study, as in other studies, smoking intensified physical frailty in regression analysis[24,45]. But such a connection was not found in studies conducted in Indonesia and Korean[20,21]. The reason for the association between smoking and frailty in our study could be the higher percentage of men. In Iranian culture, smoking is not common for women and it is considered ugly. Also, women tend to have a healthy lifestyle more than men. Arthrosis/Arthritis in this study was associated with a higher risk of physical frailty, which is consistent with the results of multivariate analysis in the study Thinuan et al. (2020) [17], and univariate analysis in the study Jung et al. (2020) and Liotta et al. (2017)[20,37]. In the present study, the prevalence of physical frailty in people with osteoporosis and kidney and heart problems was higher, which is consistent with the study of Jung et al. (2020)[20]. The above findings are important for health care providers. Because, with better management and control of the disease, the functional limitations caused by these diseases are reduced.

Psychological frailty in this study, as in previous studies, was associated with older age, lower education, physical inactivity, female gender, poor economic and cognitive status, and illness[15,46,47]. People with poor cognitive function have less physical activity and social contact, and this social isolation leads to depression[18,38]. In studies in Italy and five European countries, living alone was associated with a higher risk of frailty, which is consistent with the results of the present study in the psychological dimension[37,44]. People who live alone may experience more stress and psychological problems due to financial instability and lack of a source of support such as a spouse or loved ones[18]. Similar to the results of this study for the psychological dimension, in a study by Thinuan et al. (2020) poor self-perceived health was associated with higher frailty[17]. People who are dissatisfied with their health may not be diligent in performing health-related activities such as exercise or proper diet, so the likelihood of frailty increases[21]. In the present study, the risk of cognitive frailty increased with age, physical inactivity, dependence in IADL, hypertension, and depressive symptoms. These results are consistent with Rivan et al. (2020) and Ghanbarnia et al. (2024) studies[48,49]. The exacerbation of cognitive frailty with hypertension is consistent with previous studies[50,51]. With high blood pressure, blood flow to different parts of the brain is disrupted and changes are made in the white matter that affects cognitive function. Like the results of the present study for mild psychological frailty, hypertension is also associated with depression[50]. Depression can lead to reduced social support, physical activity, and self-care, all of which can contribute to

physical and cognitive frailty. On the other hand, physical and cognitive frailty can exacerbate depression through the same mechanism[52]. Depression and cognitive impairment play an important role in creating adverse outcomes such as reduced quality of life, reduced physical function, and disability[48].

In this study, as in other studies, female gender, lower income, comorbidity, physical inactivity, and depression increase the risk of social frailty[44,46,47]. Also, the risk of social frailty in people without children or with one child was higher, which is in line with the previous study[53]. In Iran, due to insufficient government support for older adults, the level of family support for older adults is higher than non-family support, and this support is much higher among first-degree family members[28]. On the other hand, traditional Iranian values emphasize having a large family and strong family support and consider having more children as a sign of higher social and economic prestige. Therefore, older adults with fewer children receive less support and care in their old age, which can cause them to feel lonely and social frailty. In the current study, consistent with previous studies[14,25,37,20], The prevalence of frailty in univariate analysis was significantly higher in all dimensions in people with comorbidities.

Studies on factors associated with environmental frailty are limited. In the present study, poor cognitive status and disability were associated with an inappropriate living environment, which is consistent with a previous study[47]. Also, rented housing and insufficient income were associated with environmental frailty. Rented houses may not have adequate sanitary facilities, natural light and proper ventilation. Tenants often cannot make the necessary changes and improvements to their living environment to promote aging in place, and rent costs can put a lot of financial pressure on them. Also, People with low income may live in cheap and rented houses that do not have proper sanitary and physical conditions and have inadequate ventilation and lack of space.

In contrast to previous studies that reported an association between polypharmacy and frailty[17,20], this study consistent with a Brazilian study[18], found no association between polypharmacy and any frailty dimension (physical, psychological, cognitive, social, or environmental). This discrepancy may be explained by the possibility that polypharmacy, often observed in individuals with multiple chronic conditions or severe diseases, facilitates better disease management, potentially mitigating frailty risk in some populations.

Based on studies examining the prevalence and factors associated with frailty, variability in findings arises from multiple factors, including socio-cultural differences, diverse frailty assessment tools, and varying health policies across countries. Underlying factors such as the type and number of chronic conditions, demographic characteristics, and living environments also significantly influence frailty across its dimensions (physical, psychological, cognitive, social, and environmental). Understanding the prevalence and determinants of frailty in these dimensions can inform the design of targeted health interventions and preventive strategies tailored to each dimension. Such knowledge enables health professionals and policymakers to better address the needs of older adults, support aging in place through improved community infrastructure, and allocate resources for health, education, and support programs more effectively. Furthermore, it enhances public awareness of the importance of frailty prevention and management in older age. Examining the prevalence and factors associated with frailty in Iranian older adults contributes to global knowledge in this field and underscores the need for international efforts to address frailty and its prevention.

The strength of this study lies in its comprehensive assessment of frailty across all dimensions (physical, psychosocial, cognitive, social, and environmental) using the CFAI-Plus, with a novel focus on the less-studied Environmental and Cognitive dimensions, addressing a gap in the literature where multidimensional frailty studies are scarce. However, several limitations must be acknowledged. First, the cross-sectional design precludes establishing causality between frailty and associated factors, limiting the ability to determine whether risk factors precede or result from frailty. Second, the study was conducted in a small urban population in Shahroud, which restricts generalizability to rural, culturally diverse, or institutionalized populations. Third, the CFAI-Plus is a self-reported tool assessing frailty dimensions, such as depressive symptoms, social engagement, and difficulties in recalling new information or managing finances. While self-reported tools are standard for capturing subjective experiences in frailty research, they may be subject to recall bias, or social desirability bias for sensitive topics like mental health or social isolation, potentially affecting the accuracy of prevalence estimates. Fourth, the collection of demographic data on chronic conditions (e.g., hypertension, joint disease) relied solely on participants' self-reports without clinical verification, which may introduce inaccuracies if participants misreported their health status. Finally, despite examining various demographic, health-related, and lifestyle variables in the present study, some other confounding factors that were not measured may have influenced the observed associations, indicating the need for further research.

This study, using a multidimensional assessment tool (CFAI-Plus), emphasized the importance of evaluating frailty not as a single unified condition but as a complex phenomenon encompassing physical, psychological, cognitive, social, and environmental domains. By identifying distinct risk profiles for each domain through multinomial regression analysis, the study highlights that frailty should be approached in a domain-specific manner rather than relying on aggregate indices alone. These findings provide valuable insights for health service providers and policymakers, underscoring the need for early detection strategies and tailored interventions that address the specific vulnerabilities in each domain. Such targeted approaches can contribute to more efficient resource allocation, delay the progression of frailty, and ultimately improve the quality of life in older adults.

Ethical Considerations

The study was approved by the Ethics Council of Shahroud University of Medical Sciences, with the code IR.SHMU.REC.1398.163. All participants were informed about the aims and procedures of the study and were assured of the confidentiality and anonymity of their responses. Participation was voluntary, and written informed consent was obtained from all participants prior to data collection.

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Conflict of Interest

None.

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