

Predictors of Frailty among Older Adults: A Cross-Sectional Study

Frailty Predictors among Older Adults

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ABSTRACT

Introduction: Frailty is a common geriatric syndrome characterized by reduced physiological reserve and increased vulnerability to adverse health outcomes, including falls, hospitalization, functional decline, and mortality. Identifying sociodemographic characteristics and health-related behaviors associated with frailty is essential for planning preventive interventions and improving health outcomes in older adults. Therefore, this study aimed to examine the prevalence of frailty among older adults and to determine its association with sociodemographic characteristics, age, and selected health-related behaviors.

Methods: The study included 156 adults aged 65 and older from Vukovar-Srijem County. Data were collected using a sociodemographic questionnaire that included a health-related behavior section. Frailty was assessed using the Edmonton Frailty Scale. Mann-Whitney U test and Kruskal-Wallis test were used to determine differences in frailty scores between

groups, while Spearman's correlation coefficient was used to examine the relationship between age and frailty. Multiple linear regression was used to examine predictors of frailty within the study population.

Results: The median frailty score was 8 (IQR 5–11), indicating mild frailty in the overall sample. Frailty was significantly higher among women, respondents living in rural areas, those with lower education, and those with poorer financial status. Frailty was higher among participants who did not engage in physical activity, did not maintain a proper diet, did not attend regular preventive check-ups, and were not socially active. Age was positively correlated with frailty ($\rho = 0.534$, $P < 0.001$). Multiple linear regression analysis showed that financial status, physical activity, social engagement, and regular preventive check-ups were significant independent predictors of frailty, explaining 55.7% of the variance.

Conclusion: Frailty in older adults is associated with socioeconomic status and health-related behaviors. Interventions aimed at promoting physical activity, preventive care, and social engagement may help reduce frailty and improve health outcomes in older populations.

INTRODUCTION

The aging of the population is one of the most important demographic and public health challenges of modern society. The increase in life expectancy and the increase in the proportion of older people in the population are associated with a higher incidence of chronic diseases, functional limitations, and an increased need for health and social care [1–4]. In this context, special attention is increasingly being focused on the frailty syndrome, which represents one of the key features of vulnerability in old age.

Frailty is most often described as a syndrome of reduced physiological reserves and weakened resistance to stressors, due to which even minor health disorders can lead to a marked deterioration in functional status and other adverse outcomes [4–8]. It is associated with an increased risk of falls, fractures, hospitalization, longer recovery, functional dependence, institutionalization, and mortality [4, 7, 9]. Therefore, early recognition of frailty is important not only in geriatrics but also in everyday clinical and nursing practice, especially in the planning of individualized care and preventive interventions.

Although frailty is closely related to biological aging, its clinical consequences and management extend beyond physiological changes and include adverse health outcomes, increased care needs, and potentially modifiable lifestyle factors [4, 9–11]. Older age is associated with a higher prevalence of frailty [8], while physical inactivity and unfavorable dietary or nutritional factors are associated with poorer physical functioning and health outcomes in older adults [12–19]. This suggests the need to view frailty not solely as a medical problem, but also as an indicator of the broader vulnerability of older adults. Various models and instruments are used to assess frailty, and a widely used tool is the Edmonton Frailty Scale, which allows for a comprehensive assessment of several important areas of functioning in older adults, including cognitive abilities, general health status, functional independence, social support, medication use, nutrition, mood, continence, and functional performance [20]. The advantage of this approach is that it allows for the identification not only of the presence of frailty but also of areas in which targeted interventions are needed.

Although frailty in older age is the subject of a growing number of studies, data on its prevalence and associated factors in the Croatian context are still relatively limited, especially at the level of local and regional communities. There is particularly little research that simultaneously considers sociodemographic characteristics and health-related behaviors, such as physical activity, proper nutrition, preventive examinations, and social activities. This is precisely the research gap that this study seeks to partially fill.

Therefore, this study aimed to examine the prevalence of frailty among older adults in the Vukovar-Srijem County and to determine its association with sociodemographic characteristics, age, and selected health-related behaviors.

METHODS

Study Design

A cross-sectional study was conducted.

Setting and Participants

A total of 156 adults aged 65 years and older from Vukovar-Srijem County participated in the study. The study included older adults living in their own homes as well as nursing home residents.

Data Collection

Participants were recruited from Vinkovci General Hospital and nursing homes. Data were collected between May and June 2024. Completion of the questionnaire took approximately 20 minutes.

Measurements and Instruments

Data were collected using a two-part questionnaire. The sociodemographic questionnaire assessed participants' characteristics and consisted of five items (sex, age, place of residence, educational level, and financial status). Additionally, information on lifestyle habits and health-related behaviors was collected through four items covering physical activity, proper nutrition, preventive check-ups, and partici-

pation in social activities. The Edmonton Frailty Scale was used to assess frailty [20]. Permission to use the instrument was obtained from the University of Alberta [20]. The scale assesses nine domains: cognitive abilities, general health status, functional independence, social support, medication use, nutrition, mood, continence, and functional performance. The scale consists of 11 items. Items 1–5 and 11 are scored from 0 to 2, whereas items 6–10 are scored from 0 to 1. The total score ranges from 0 to 17 points, with 0–5 indicating the absence of frailty, 6–7 vulnerability, 8–9 mild frailty, 10–11 moderate frailty, and 12–17 severe frailty [20].

Statistical Analysis

Descriptive statistics were used to summarize the study variables. Categorical variables were summarized as absolute and relative frequencies, whereas continuous variables were summarized as medians and interquartile ranges (IQRs). Differences in frailty between two groups were examined using the Mann–Whitney U test, and between three or more groups using the Kruskal–Wallis test. The association between age and frailty was assessed using Spearman's rank correlation coefficient. Multiple linear regression analysis was performed to identify independent predictors of frailty. The assumptions of multiple linear regression were assessed before interpretation of the model. The absence of problematic multicollinearity was confirmed by tolerance values ranging from 0.456 to 0.913 and variance inflation factor values ranging from 1.095 to 2.193. The Durbin–Watson statistic was 2.075, indicating no problematic autocorrelation of residuals. The statistical significance level was set at $p < 0.05$. Data were analyzed using IBM SPSS Statistics for Windows, version 25 (IBM Corp., Armonk, NY, USA; 2017), and JASP version 0.17.2.1 (Department of Psychological Methods, University of Amsterdam, Amsterdam, The Netherlands).

Ethical considerations

The study was conducted in compliance with the General Data Protection Regulation (GDPR). Before participation, all participants were informed about the purpose and objectives of the study and pro-

vided written informed consent. Participation was voluntary and anonymous, and participants could withdraw at any time without consequences. The study was approved by the Ethics Committee of General County Hospital Vinkovci (Registration No. 2387/3/2024; April 15, 2024). Institutional permissions for data collection were obtained from Family Home “Grim”, Vinkovci (April 12, 2024), the Home for the Elderly and Disabled Vinkovci (April 22, 2024), Family Home “Sunce”, Vinkovci (March 23, 2024), and the Home for the Elderly and Disabled “Sveti Ante”, Mikanovci (April 22, 2024). All procedures were conducted in accordance with the ethical standards of the institutional research committees and the Declaration of Helsinki.

RESULTS

A total of 156 participants were included in the study. Most participants were female (95; 60.9%), lived in urban areas (107; 69%), and had completed primary school education (79; 50.6%). Nearly half of the participants reported a below-average financial status (76; 48.7%) (Table 1). The median age was 80 years (IQR 73.3–85.0).

Table 1. Demographic characteristics of the participants (N = 156)

Characteristics		n (%)
Sex	Male	61 (39.1)
	Female	95 (60.9)
Place of residence	Urban	107 (68.6)
	Rural	48 (31.0)
Education level	Primary school	79 (50.6)
	Secondary school	60 (38.5)
	College degree	9 (5.8)
	University degree	8 (5.1)
Financial status	Below average	76 (48.7)
	Average	61 (39.1)
	Above average	19 (12.2)

Note: Data on place of residence were missing for one participant.

Regarding health-related behaviors, the largest proportion of participants reported never engaging in physical activity (77; 49.4%), occasionally maintaining a proper diet (70; 44.9%), regularly attending preventive medical check-ups (69; 44.2%), and not participating in social activities (91; 58.3%) (Table 2).

Table 2. Distribution of health-related behaviors among participants (N = 156)

Variable	Category	n (%)
Physical activity during life	Daily	27 (17.3)
	Occasionally	52 (33.3)
	Never	77 (49.4)
Proper diet during life	Always	22 (14.1)
	Occasionally	70 (44.9)
	Never	64 (41.0)
Regular preventive medical check-ups	Yes	69 (44.2)
	No	31 (19.9)
	Sometimes	56 (35.9)
Participation in social activities	Yes	24 (15.4)
	No	91 (58.3)
	Sometimes	41 (26.3)

Note: Percentages were calculated based on the total sample of 156 participants.

The median total score on the Edmonton Frailty Scale was 8 points (IQR 5–11), indicating mild frailty according to the Edmonton Frailty Scale classification. No frailty was observed in 26.3% of participants, whereas 21.8% had severe frailty. The remaining participants were classified as vulnerable or as having mild or moderate frailty (Table 3).

Table 3. Frailty score and frailty categories among participants (N = 156)

Variable	Category	Median (IQR)
Frailty score		8 (5–11)
		n (%)
Frailty category	No frailty	41 (26.3)
	Vulnerable	29 (18.6)
	Mild frailty	23 (14.7)
	Moderate frailty	29 (18.6)
	Severe frailty	34 (21.8)

Note: Frailty categories were determined according to the Edmonton Frailty Scale classification.

Frailty differed significantly according to sex ($P = 0.025$), place of residence ($P = 0.001$), educational level ($P < 0.001$), and financial status ($P < 0.001$). Higher frailty scores were observed among women, participants living in rural areas, those with lower educational attainment, and those reporting below-average financial status. Post hoc Dunn–Bonferroni analysis confirmed significant differences for educational level and financial status (Table 4).

Table 4. Frailty according to demographic variables (N = 156)

Variable		Frailty Median (IQR)	U/H (df)	P-value
Sex	Male	7 (4–10)	2281.0	0.025*
	Female	9 (6–11.5)		
Place of residence (n=155)	Urban	8 (4–10)	1706.0	0.001*
	Rural	10 (7–13)		
Education level	Primary school	10 (8–12)	49.248 (3)	<0.001†
	Secondary school	7 (4–9)		
	College degree	3 (3–5)		
	University degree	2 (2–3.3)		
Financial status	Below average	10 (8–12)	42.581 (2)	<0.001†
	Average	7 (4–10)		
	Above average	2 (2–5)		

Note: U – Mann–Whitney U test statistic; H – Kruskal–Wallis test statistic; df – degrees of freedom; *Mann–Whitney U test; †Kruskal–Wallis test. Data on place of residence were missing for one participant.

Spearman correlation analysis showed a statistically significant positive association between age and frailty ($\rho = 0.534$, $P < 0.001$), indicating that frailty increased with age. Frailty differed significantly according to physical activity during life ($P < 0.001$), proper diet during life ($P < 0.001$), regular preventive medical check-ups ($P < 0.001$), and participation in social activities ($P < 0.001$). Higher frailty scores were observed among participants who never engaged in physical activity, did not maintain a proper diet, did not attend regular preventive medical check-ups, and did not participate in social activities (Table 5).

Table 5. Frailty according to health-related behaviors and social participation (N = 156)

Variable		Frailty	H (df)	P-value
		Median (IQR)		
Physical activity during life	Daily	3 (2–8.5)	37.086 (2)	<0.001
	Occasionally	7 (4.75–9)		
	Never	10 (7–12)		
Proper diet during life	Always	4 (2–8.5)	24.098 (2)	<0.001
	Occasionally	8 (5–10)		
	Never	10 (7–12.3)		
Regular preventive medical check-ups	Yes	6 (3–8)	52.086 (2)	<0.001
	No	11 (10–13)		
	Sometimes	10 (7.75–12)		
Participation in social activities	Yes	3.5 (2–6)	51.598 (2)	<0.001
	No	10 (7–12)		
	Sometimes	7 (4–9)		

Note: H – Kruskal–Wallis test statistic; df – degrees of freedom.

Multiple linear regression analysis was performed to identify independent predictors of frailty. The overall regression model was statistically significant, $F(9, 145) = 22.482$, $P < 0.001$, and explained 55.7% of the variance in frailty according to the adjusted coefficient of determination (adjusted $R^2 = 0.557$; $R^2 = 0.583$). Financial status ($B = -0.853$, $\beta = -0.155$, 95% CI -1.670 to -0.035 , $P = 0.041$), physical activity ($B = 0.841$, $\beta = 0.166$, 95% CI 0.124 – 1.559 , $P = 0.022$), participation in social activities ($B = 0.944$, $\beta = 0.183$, 95% CI 0.218 – 1.669 , $P = 0.011$), and regular preventive medical check-ups ($B = 1.250$, $\beta = 0.250$, 95% CI 0.613 – 1.887 , $P < 0.001$) were statistically significant independent predictors of frailty. Age did not reach statistical significance in the multivariable model ($B = 0.040$, $\beta = 0.112$, $P = 0.054$), while sex, educational level, place of residence, and proper diet were also not statistically significant. Higher frailty scores were independently associated with poorer financial status, lower physical activity, lower participation in social activities, and less frequent attendance at preventive medical check-ups (Table 6).

Table 6. Multiple linear regression analysis of predictors of frailty

Predictor	B	β	t	P-value	95% CI Lower	95% CI Upper
Constant	-1,405		-0.578	0.564	-6.206	3.396
Sex	0,265	0.034	0.565	0.573	-0.663	1.194
Age	0,040	0.112	1.942	0.054	-0.001	0.080
Education level	-0,615	-0.131	-1.643	0.103	-1.355	0.125
Place of residence	0,820	0.100	1.774	0.078	-0.094	1.733
Financial status	-0,853	-0.155	-2.062	0.041	-1.670	-0.035
Physical activity	0,841	0.166	2.317	0.022	0.124	1.559
Social activity	0,944	0.183	2.571	0.011	0.218	1.669
Preventive medical check-ups	1,250	0.250	3.877	<0.001	0.613	1.887
Proper diet	0,398	0.073	1.118	0.266	-0.306	1.101

Note: B – unstandardized regression coefficient; SE – standard error; β – standardized regression coefficient; t – test statistic; P – statistical significance; CI – confidence interval. Model statistics: $F(9, 145) = 22.482$, $P < 0.001$; $R^2 = 0.583$; adjusted $R^2 = 0.557$. The analysis included 155 participants.

DISCUSSION

This study aimed to describe the distribution of frailty in the study sample and to examine its associations with sociodemographic characteristics, age, and selected health-related behaviors. The results emphasize the importance of social integration, physical activity, socioeconomic status, and preventive health examinations in the development of frailty.

The data suggest that frailty in older age is not an unavoidable byproduct of aging, but a state significantly influenced by modifiable risk factors. Overall, these results indicate that the frailty syndrome is a complex condition arising from the interaction of biological, psychological, social, and functional factors, rather than solely a consequence of biological aging. Previous research has shown that frailty is associated with increased sensitivity to stressors and a higher probability of adverse outcomes, including falls, hospitalizations, functional impairment, institutionalization, and mortality, which is why this understanding of frailty is particularly important in the field of geriatrics and nursing [7, 21, 22].

Early recognition of frailty is crucial for planning and implementing effective preventive strategies. The median score of 8 points indicates mild frailty according to the Edmonton Frailty Scale classification.

The categorical distribution further suggests that frailty extends beyond a small subgroup of the most vulnerable individuals and affects a substantial proportion of the older population.

The findings therefore support the importance of early screening in older age, especially in primary health care and nursing, where timely identification of vulnerable individuals can facilitate the planning of interventions aimed at preserving functional capacity and independence. These results are consistent with evidence showing that the prevalence of frailty varies according to the population and assessment method and that a substantial proportion of older adults are affected [8].

Bivariate analyses showed that frailty was more pronounced in women, participants living in rural areas, participants with lower education and poorer financial status. The higher frailty observed among women is consistent with systematic evidence showing a higher prevalence of frailty among women than men [23]. Multimorbidity and functional limitations, which are common in older adults, may further contribute to the burden of frailty [24]. In addition, the health consequences of widowhood and the possible lack of daily support may be more pronounced in old age, especially if accompanied by social vulnerability and loneliness [25]. Lower levels of education may be associated with lower health literacy, which can make it more difficult for older adults to access, understand, and use health information [26].

Living in rural areas may be associated with poorer access to health services, preventive programs, and organized social activities, which may increase the health and social vulnerability of older adults [27, 28]. Poorer financial status may increase vulnerability to frailty because lower socioeconomic position is consistently associated with a higher prevalence and incidence of frailty [29, 30].

Findings related to health-related behaviors are particularly important. Frailty was higher among participants who did not engage in physical activity, did not maintain a proper diet, did not attend regular preventive medical check-ups, and did not participate in social activities. This pattern suggests that frailty in older age is not only a reflection of age and disease, but also of the long-term effects of lifestyle and level of social inclusion. Physical inactivity can contribute to decreased muscle strength, poorer mobility, and faster functional decline, while poor nutrition can further worsen general health, nutritional status, and resilience. At the same time, the lack of regular preventive examinations may mean less early recognition of health problems and a lower possibility of timely treatment or control of chronic diseases. Not engaging in social activities may be associated with social isolation, lower levels of daily functioning, and weaker psychological resilience, all of which may contribute to greater frailty. Such findings are consistent with literature associating physical activity and adequate nutrition with better health and functional outcomes and social isolation with poorer health outcomes among older adults [10, 12–15, 28].

The positive association between age and frailty was an expected finding and supports the basic theoretical understanding of frailty as a syndrome that develops more frequently with advancing age. With increasing age, there is a gradual decrease in physiological reserves, accumulation of chronic diseases, and a higher risk of functional limitations, which increases the likelihood of developing frailty [6, 8]. However, it is important to note that age did not remain a statistically significant independent predictor in multiple linear regression, although it was on the verge of significance. Such a finding suggests the possibility that part of the influence of age on frailty acts indirectly, through financial status and health-related behaviors.

The most important finding of this study emerged from the multivariate analysis, in which financial status, physical activity, regular preventive examinations and social activities were identified as significant independent predictors of frailty. This means that socioeconomic status and health-related behaviors had the strongest independent association with frailty after controlling for other included variables. At the same time, gender, education, place of residence and diet did not remain statistically significant independent predictors, suggesting that their association with frailty can be at least partially explained by other included variables. The data suggest that frailty in older age is not an unavoidable byproduct of aging, but a state significantly influenced by modifiable risk factors. This distinction is critical for developing interventions that prioritize physical activity, preventive examinations, and social inclusion to mitigate risk levels.

Practical implications

The results of this study may have applications in nursing, primary health care, and public health. Continuous monitoring of older adults should become routine, while special attention should be paid to older people who face financial instability or social isolation. Programs that promote healthy lifestyles and improve access to preventive care are essential for delaying functional decline and maintaining independence. In this way, nurses could be an important link in the early identification of individuals at risk, by providing the necessary education and motivation for changes in health behavior, while connecting patients with available social and medical support.

Study limitations

The results of this study should be interpreted taking into account its limitations. The study was conducted on a relatively small sample of participants from one county, which limits the generalizability of the findings. In addition, it is a cross-sectional study, so it is not possible to conclude cause-and-effect relationships, only about associations between the observed variables. In addition, part of the data is based on self-assessment by participants, which opens up the possibility of response bias. Neverthe-

less, the study provides a valuable contribution to understanding factors associated with frailty in the older population and can serve as a useful basis for future research and the development of preventive programs.

CONCLUSION

Frailty in older adults was associated with socioeconomic status and health-related behaviors, particularly physical activity, regular preventive medical check-ups, and social participation. Although bivariate analyses showed that frailty was positively associated with age and was more pronounced among vulnerable groups of participants, multiple linear regression identified socioeconomic and behavioral factors as the strongest independent predictors of frailty. These findings suggest that frailty is influenced not only by aging but also by modifiable lifestyle and social factors. Physical activity, regular preventive medical check-ups, and social participation may represent relevant targets for future preventive interventions aimed at preserving functional capacity among older adults.

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Author Contributions

Conceptualization, A.B. and Š.M.; Methodology, A.B. and Š.M.; Software, M.M., M.V.; Validation, A.B. and Š.M.; Formal Analysis, M.M., M.V.; Investigation, A.B. and Š.M.; Resources, A.B. and Š.M.; Data Curation, M.M.; Writing – Original Draft Preparation, A.B., M.M. and Š.M.; Writing – Review & Editing, A.B., M.M. and Š.M.; Visualization, A.B., M.M. and Š.M.; Supervision, Š.M.; Project Administration, A.B.

Declaration of Conflicting Interest

The authors declare no conflict of interest.

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