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RESEARCH ARTICLE

FRAILTY LEVELS AND PREDISPOSING FACTORS AMONG OLDER ADULTS WITH CORONARY ARTERY DISEASE: A CROSS-SECTIONAL STUDY

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ABSTRACT

Purpose: This study aimed to evaluate the prevalence of frailty and identify predisposing factors among older adults with coronary artery disease (CAD).
Methods: This descriptive cross-sectional study was conducted with 107 patients aged ≥65 years, who were assessed using an introductory information questionnaire and the Edmonton Frail Scale (EFS). Data were analyzed using descriptive statistics, independent t-tests, one-way ANOVA with Bonferroni post-hoc tests, and multiple linear regression analyses.
Results: The prevalence of frailty (mild, moderately, and severely) was 44.0%, and "apparently vulnerable" frailty was 15,9%. Participants aged ≥75 years had higher mean EFS scores compared to those aged 65–74 years (β=0.677, p<0.001). Participants using >5 medications had higher EFS scores compared to those using ≤3 medications (β=0.566, p=0.009). Female participants exhibited higher frailty scores compared to males (β=-0.590, p=0.003).
Conclusion: The overall frailty prevalence was 44.0% (mild, moderate, severe) among older adults with CAD. Age, polypharmacy, and female gender were independently associated with frailty. These findings highlight the importance of routine frailty assessment in older adults with CAD to ensure holistic care planning and targeted interventions.

Keywords: Coronary artery disease, frailty, frail elderly, nursing, older adults

INTRODUCTION

Globally, there were 761 million persons aged 65 years or over in the world in 2021. This number is expected to double by 2050, reaching 1.5 billion people. If the world's older population continues to grow at this rate, one in six people (16.0%) will be over 65 by 2050 (1). Incidence of chronic diseases increases with age (2). Coronary artery disease (CAD) is a circulatory system disorder. It is one of the cardiovascular diseases that causes the highest mortality and morbidity (3). One of the major risk factors for CAD is older age. As we age, our tissues and organs undergo changes, and our body resistance decreases, making us more susceptible to chronic diseases. Moreover, older adults face more problems due to a weakened immune system and difficulty in adaptation (4). These problems also impair organic functioning vulnerable settings (5). Frailty has been defined as one of the geriatric

syndromes characterized by the loss of biological reserves, failure of physiological mechanisms, and vulnerability to various adverse outcomes (6). Frailty is influenced by multiple factors, including physiological (e.g., age, gender, BMI, comorbidities, muscle strength, polypharmacy), psychological (e.g., depression, cognitive function, anxiety), socioeconomic (e.g., education, income, social support), and lifestyle-related factors (e.g., living alone, smoking, alcohol use, physical activity, diet, and daily living activities) (7,8). Frailty disrupts body homeostasis. Furthermore, the decline in the organ system causes to reduction in overall functional reserve, limiting one's capacity to reply to acute stressors (9,10). The most widely recognized approaches for assessing frailty in the literature include the Fried frailty phenotype, which is based on five phenotypic criteria (unintentional weight loss, self-reported exhaustion, reduced muscle strength, slowness, and low physical activity), the Frailty Index, and the Frailty Scale (6,11). According to a meta-analysis, the incidence of frailty was found to be 48.9% (12). In addition, the concept of pre-frailty represents an intermediate stage between non-frailty and frailty, indicating a moderate-risk condition with a relatively higher likelihood of progressing to frailty over time (12). These frailty-related problems lead to increased levels of dependency, hospitalizations, and health problems (13). Incidence rate of frailty as 43.4 new cases per 1000 person-years was estimated in older adults, and prefrailty as 150.6 new cases per 1000 person-years (14). Patients at risk of cardiovascular diseases are at greater risk of developing frailty (15,16). Frailty commonly coexists with cardiovascular diseases (CVD), such as coronary artery disease (17). In a systematic review and meta-analysis identified that the prevalence of frailty ranged in elderly patients with CAD from 12.5 to 27.8% (18). Fifteen percent of patients with ACS and ≥70 years old referred for coronary angiography are frail (19). Frail older adults have lower functional capacity and less physiological reserve, putting them at risk for heart failure, acute myocardial infarction (MI), or cardiac surgery, which increases stress levels and mortality rates (20). Frailty was associated with short-term mortality, increased in-hospital mortality, as well as long-term mortality in patients undergoing percutaneous coronary intervention (18). Research suggests an association between CAD and frailty. If we assess CAD frailty, we can conduct a geriatric assessment for older adults at risk of mortality and hospitalization and needing long-term care. We can also develop interventions to improve their functional status (18, 21,22). This study aimed to assess frailty levels and examine the factors predisposing older adults with coronary artery disease to frailty.

METHODS

Design and Sampling

This descriptive and cross-sectional study was conducted in the cardiology clinic and outpatient clinic of a public hospital of a state city between January and June 2022. Data were collected using consecutive sampling of all eligible participants over the study period. Cardiology services have a total capacity of 48 beds. The majority of patients in the cardiology service are patients diagnosed with CAD, heart failure, pulmonary artery disease and hypertension. In cardiology polyclinics, patients are examined, blood result evaluations, tests and appropriate treatment planning are carried out. While determining sample size in the research, sample size was estimated using G*Power 3.1.9.7, based on the mean and standard deviation of the fragility variable reported in a previous study (23). A one-sample t-test against a reference value yielded an effect size of 0.3478261. With $\alpha = 0.05$ and power = 0.95, the minimum required sample size was calculated as 91 participants. Of 124 patients screened for eligibility between January and June 2022, 17 patients were excluded (6 declined to participate, 4 were illiterate, and 7 did not speak Turkish). Therefore, the sample consisted of 107 patients who met the following inclusion criteria: (1) being ≥ 65 years, (2) being diagnosed with CAD, (3) having no communication problems (speech, sight, hearing, etc.), (4) being at least literate, and (5) speaking and understanding Turkish. The study was reported according to the STROBE checklist.

Data Collection Tools

Personal Information Form: The form was composed by the researcher after a literature review (23,24). The form consisted of fourteen items (age, gender, income, education, employment status, health coverage, living arrangement, Body Mass Index (BMI), the type of hospital admission (Outpatient clinic: Patients admitted directly from the outpatient clinic at the time of data collection. Emergency: Patients admitted through the hospital emergency department. Referral: Patients transferred from another healthcare facility for further

evaluation or treatment.), number of medications, duration of CAD, tobacco use, and additional chronic diseases).

Edmonton Frail Scale (EFS): Rolfson et al. (2006) (25) developed EFS. Aygör et al. (2013) adapted the scale to Turkish. The scale is scored from 0 to 2.

The total score ranges from 0 to 17 (0-4 = not frail; 5-6 apparently vulnerable, 7-8 mildly frail, 9-10 moderately frail, 11-17 = severely frail). As the score obtained from the scale increases, frailty increases. Cronbach's alpha of 0.75 (26).

Data Collection: Data were collected between January and June 2022.

Ethical Consideration: The study was approved by Gazi University Ethics Commission (Date: 23.11.2021, Number: 18). Permission was obtained from the institution where the research would be conducted. Written informed consent of the participants were obtained. Data collection forms completed by patients were stored in a locked cabinet in a safe place. The data were stored in the computer.

Data Analysis

Data were analyzed using SPSS (v.25.0). The significance level was set at $p<0.05$. Normality was tested with the Kolmogorov-Smirnov and Shapiro-Wilk tests. Independent samples t-test and one-way ANOVA were used for group comparisons, with Bonferroni correction for post-hoc analyses. Effect sizes (Cohen's d for t-test, η^2 for ANOVA) with 95% confidence intervals were reported. Variables found to be significant in univariate analyses were included in the multivariate linear regression model to identify factors associated with frailty (EFS scores). Model fit was evaluated with R^2 and adjusted R^2 values, and multicollinearity was assessed with variance inflation factors (all VIF <2). No missing data were observed; therefore, all analyses used complete cases.

RESULTS

EFS Score According to Baseline Characteristics of Patients

Participants had a mean EFS score of 6.08±4.09. 67.3% of the participants were 65-74 years, 64.5% were male, and 86% were married. 49.5% of participants had primary school degrees, and 93.5% were unemployed. 45.8% of the participants had a negative income (income <expense), 84.1% had health coverage, and 75.7% lived with their spouses. 46.7% of the participants had a BMI of 25-29.9, 57.9% were admitted to the hospital through the emergency department, and 51.4% were diagnosed with CAD <5 years ago. 39.3% of the participants used >5 number of medications, 77.6% had chronic diseases, and 82.2% were non-smokers (Table 1).

Participants >75 years of age had higher mean EFS score than 65-74 years (p=0.000). Female participants had higher mean EFS score than male (p=0.001). Literate participants had higher mean EFS score than primary or middle school degrees (p=0.001). Participants living alone or living with childiren/relative had higher mean EFS score than living with spouse (p=0.033). Who used >5 number of medications or 4-5 number of medications had higher mean EFS score than used ≤3 number of medications (p=0.003). Participants with chronic diseases had higher mean EFS score than without chronic diseases (p=0.015) (Table 1).

EFS Score

Less than half of the participants were non-frail (40.1%), while 15.9% were classified as apparently vulnerable. The overall frailty prevalence was 44.0%, including 11.2% mildly frail, 15.0% moderately frail, and 17.8% severely frail (Table 2). The Cronbach's alpha of the scale was 0.77 in this study.

Predictors of Frailty

To determine how well the explanatory variables (age, polypharmacy, and gender) were related to the outcome variable (EFS scores), multiple linear regression analysis was performed. Age, polypharmacy, and gender were significantly affected with participants' EFS total score (R^2: 0.388, F=6.351, p=0.001). Participants who were >75 years had higher mean EFS score than those aged 65–74 (ß=0.677, p<0.001) (Table 3). Participants who used >5 medications had higher mean EFS score than those who used ≤3 medications (ß=0.566, p=0.009) (Table 3). Female participants had higher mean EFS score than males (ß=-0.590, p=0.003) (Table 3).

DISCUSSION

This study aimed to assess frailty levels in older adults with coronary artery disease and examine factors that increase vulnerability to frailty. Frailty is common in individuals with CAD due to factors such as multiple comorbidities, decreased biological reserve, and loss of functional capacity (27). This study found that 44% of patients were frail (mild, moderate, severe), and predisposing factors affecting

frailty were related to age, gender, and the number of daily medications used. Previous research has shown that the prevalence of acute coronary syndrome population frailty varies widely, ranging from 4.7% to 82.4%, depending on the study setting and assessment tools used (28-31).

Table 1. EFS Score According to Baseline Characteristic of Patients (n=107)

Variables	n	%	EFS X± SS	Test Value	p	Effect size (%95CI)
Overall	107	100	6.08 ± 4.09			
Age (x̄:71.46±5.87)						
65-75	72	67.3	5.04±3.82	-4.045*	0.000	0.834
>75	35	32.7	8.23±3.83			(0.415;1.253)
Gender						
Female	38	35.5	7.89±4.39	3.581*	0.001	-0.721
Male	69	64.5	5.09±3.58			(-1.128;-0.313)
Educational level						
Literate	17	15.9	8.59±4.73[a]	5.184**	0.001***	0,169
Primary School	53	49.5	6.75±3.77[b]			(0,035;0,192)
Middle school	11	10.3	3.45±2.98[b]			a>b
High school	21	19.6	4.24±3.63			
University and higher	5	4.7	4.00±2.65			
Marital Status						
Single	15	14.0	7.93±3.45	1.911*	0.059	-0.533
Married	92	86.0	5.78±4.12			(-1.083;0.018)
Employment Status						
Employed	7	6.5	5,57±2,57	-0.518*	0.733	0.134
Unemployed	100	93.5	6,12±4,18			(-0.633;0.900)
Income						
Income<expense	49	45.8	7,04±3,86	2.998**	0.054	0,105
Income=expense	48	44.9	5,50±4,36			(0,001;0,197)
Income>expense	10	9.3	4,20±2,78			
Health Coverage						
Yes	90	84.1	5,96±4,06	-0.746*	0.457	0.195
No	17	15.9	6,76±4,31			(-0.324;0.714)
Living Arrangement						
With spouse	81	75.7	5,53±4,03[b]	3.511**	0.033**	0,121
With children/relative	16	14.9	7,31±3,84[a]			(0,008;0,216)
Alone	10	9.4	8,60±3,98[a]			a>b
BMI						
≤ 24.9	27	25.3	5.89±4.08	0.372**	0.691	0,014
25-29.9	50	46.7	5.86±3.87			(0,000;0,044)
≥30	30	28.0	6.63±4.53			
The type of hospital admission						
Outpatient clinic	29	27.1	5.48±3.69	0.769**	0.466	0,029
Emergency	62	57.9	6.11±4.12			(0,000;0,081)
Refferal	16	15.0	7.06±4.07			
Duration of CAD						
<5	55	51.4	1.36±0.85	1.972**	0.448	0,072
5-10	13	12.1	5.77±1.09			(0,000;0,152)
≥10	39	36.5	15.0±5.39			
Number of medications						
≤ 3	32	29.9	4.06±3.65[b]	6.231**	0.003***	0,196
4 -5	33	30.8	7.18±4.21[a]			(0,054;0,302)
>5	42	39.3	6.76±3.84[a]			a>b
Tobacco use						
Smokers	19	17.8	5.68±4.20	-0.468*	0.641	0.119
Non-smokers	88	82.2	6.17±4.09			(-0.377;0.615)
Additional chronic diseases						
Yes	83	77.6	6.58±4.03	-2.469*	0.015	-0.580
No	24	22.4	4.26±3.88			(-1.041;-0.119)

*Independent t test **ANOVA ***Bonferroni post-hoc analysis, EFS; Edmonton Frail Scale a,b: Differences between group means (a>b indicates higher mean scores).

Table 2. EFS Score

Frailty level	n	%
Not frailty	43	40.1
Apparently vulnerable	17	15.9
Mild frailty	12	11.2
Moderate frailty	16	15.0
Severe frailty	19	17.8

EFS; Edmonton Frail Scale, SD; Standart deviation

Baseline Characteristics of Patients

Our results showed that participants with lower educational levels (primary or middle school) exhibited higher frailty levels. This finding is consistent with Atakul and Akyar (2019), who reported that older adults with lower education were more likely to be frail (32). Individuals with lower educational levels are generally less likely to adopt healthy lifestyle behaviors and tend to have lower levels of health literacy (33). This may create difficulties in developing appropriate dietary habits, maintaining healthy lifestyle practices, accessing healthcare services, and adhering to medical recommendations. Consequently, older adults with lower educational attainment may exhibit higher levels of frailty due to inadequate health literacy and limited health resources (34). Participants living alone were frailer than those living with their spouses, which is consistent with the literature (32-37). Living alone is considered an objective indicator of social isolation, whereas loneliness is a subjective consequence of the lack of interaction with social networks, community, friends, and family (38). Individuals living alone are regarded as socially vulnerable, and studies have shown that living alone is an important risk factor for various adverse health outcomes such as social isolation, loneliness, and depression (39). This situation may contribute to frailty through health problems associated with lifestyle behaviors or conditions stemming from this lifestyle, including cardiovascular diseases, poor sleep quality, lack of self-care, and cognitive decline (40). Moreover, social frailty that may arise from living alone can lead to the development of physical frailty in older adults (41). A meta-analysis conducted in 2020 found that the risk of frailty increased by 28% among individuals living alone (42). Older adults living with their spouses have advantages in terms of social support, spiritual support, spousal involvement in care processes, and assistance with health-related issues (43).

Frailty Prevalence in Patients with Coronary Artery Disease

The prevalence of frailty (mild, moderately, and severely in our study was 44.0%. Graham et al. (2013) categorized older patients with acute coronary syndrome (ACS) into three groups based on EFS scores (0≤EFS≤3; 4≤EFS≤6; EFS≥7). They found that more than half of the patients had EFS scores greater than 4 (65.5%), indicating that almost seven in ten patients were frail (45).

Table 3. Predictors of Frailty (n=107)

Predictor	Estimate	SE	t	p	β	95% Confidence Interval		VIF
						Lower	Upper	
Intercept	5.301	1.305	4.062	<.001				
Age								1.05
>75 – 65-74	2.771	0.732	3.784	<.001	0.677	0.3221	1.033	
Gender								1.16
Male-Female	-2.416	0.795	-3.037	0.003	-0.590	-0.9764	-0.205	
Educational level								1.08
Primary School–Literate	-0.632	1.018	-0.621	0.536	-0.155	-0.6483	0.339	
Middle School – Literate	-1.953	1.502	-1.300	0.197	-0.477	-12.063	0.252	
High School – Literate	-1.262	1.326	-0.952	0.344	-0.308	-0.9519	0.335	
University and higher – Literate	-2.517	1.868	-1.347	0.181	-0.615	-15.218	0.291	
Living arrangement								1.07
With children – With spouse	1.387	0.989	1.403	0.164	0.339	-0.1407	0.819	
Alone – With spouse	0.751	1.215	0.618	0.538	0.184	-0.4058	0.773	
Number of medications								1.08
4-5 – ≤3	1.614	0.932	1.733	0.086	0.395	-0.0575	0.847	
>5 – ≤3	2.316	0.864	2.680	0.009	0.566	0.1467	0.986	
Chronic disease								1.11
Yes – No	0.810	0.872	0.929	0.355	0.198	-0.2250	0.621	

(R^2:0.388. Adjusted R^2:0.317. AIC:578. BIC:612. DW:1.92)

Ekerstad et al. (2015) reported that almost one in two patients with non-ST-elevation myocardial infarction was frail (48.5%) (15). Lisiak et al. (2016) determined that four in five older adults with ACS were frail (82.4%) (21). Alonso Salinas et al. (2016) found that almost two in five patients with type I myocardial infarction (MI) were frail (35.1%) (29). Kang et al. (2015) found that two in five patients with ACS were frail (43.18%) (30). White et al. (2016) investigated the frailty levels of older patients with ACS (n=4996). They classified 23% and 4.7% of the patients as pre-frail and frail, respectively (31). They reported similar rates of frailty among older patients with ACS. Previous studies have shown that frailty is common among older adults with CAD and that this population is at high risk for frailty With aging, functional decline in organ systems, a decrease in biological reserves, and the presence of comorbid diseases facilitate the development of frailty in CAD patients (27–31). In addition, differences in frailty prevalence may arise not only from measurement methods but also from the characteristics of the study population (e.g., community-based vs. hospital-based, age and gender distribution, education level), comorbidities (the presence of additional diseases), health system differences (access, diagnosis, and screening practices), and social determinants (income, living conditions, social support) (45,46).

Predisposing Factors for Frailty

Older participants (>75 years) exhibited higher frailty levels compared to younger participants, which aligns with previous research (36,45,46). We can state that aging and CAD pave the way for frailty because the former causes functional losses and depletion of physiological reserves, while the latter brings disease burden. Female participants were frailer than their male counterparts. This result suggests that gender (female) is associated with frailty. Research also shows that female patients with CAD are frailer than male (47). It is thought that the higher frailty levels of women compared to men are due to biological and social factors. Biologically, the decline in estrogen levels after menopause may accelerate muscle and bone loss and the reduction of functional reserve, which can increase susceptibility to frailty (48). On the other hand, women face gender-based social responsibilities throughout their lives, such as pregnancy, childbirth, and raising children; this may create both physical and psychosocial burdens and increase susceptibility to frailty (49). In addition, social determinants (differences in education and income levels) and gender-based inequalities (limited access to healthcare, caregiving responsibilities, and lack of social support) are considered important factors that increase the risk of frailty in women. Therefore, it is thought that multiple factors play a role in women's greater susceptibility to frailty (47–49).

Participants taking more than five medications exhibited higher frailty levels compared to those taking fewer medications. Research also shows a linear relationship between polypharmacy and frailty (46,50). According to the results of a study conducted in 2024, polypharmacy was found to be associated with frailty and major cardiovascular events. Moreover, the risk estimates for polypharmacy were stronger among prefrail participants compared to non-frail individuals (50).Saum et al. (2017) investigated the effects of frailty and polypharmacy on health outcomes in older adults and reported three findings. First, one in ten non-frail adults with hyperpolypharmacy became frail in three years (9.3%). Second, their morbidity rates increased. Third, there was association between polypharmacy and Frailty (51). Schoufour et al. (2015) conducted a study with a 3-year follow-up and determined that people at high risk of frailty at baseline used more and more medicines during the follow-up period (52). These results suggest direct relationship between polypharmacy and frailty. This is no surprise because patients on multiple medications suffer from drug-drug interactions, tiredness, and stress and have difficulty managing their symptoms and treatment (50-52). Participants with additional chronic diseases were frailer than those without chronic diseases, which is consistent with the literature (18,21-22). People with chronic diseases must undergo more treatment, are hospitalized more often, experience more stress, and suffer numerous adverse consequences, such as mental and financial problems. Chronic diseases cause deficiencies in organs and systems, leading to frailty (53).

This study is the examine frailty prevalence among older adults with CAD in a public hospital setting in Turkey, providing insight into sociodemographic and clinical factors associated with frailty. Our findings contribute to the literature by identifying potential targets for interventions clinican to prevent or mitigate frailty in this population.

Limitations: This study has several limitations. First, it was conducted in a single public hospital, which

may limit the generalizability of the findings. Second, most of the evaluations relied on participants' self-reports, which may have been subject to recall bias or subjective perceptions. In addition, potentially important factors that could influence frailty, such as physical activity levels, social support mechanisms, and nutritional habits, were not comprehensively assessed. Although a consecutive sampling method was used, the exclusion of illiterate and non-Turkish speaking individuals may have caused selection bias, leading to an under- or overestimation of the prevalence of frailty. The severity of acute coronary syndrome was not assessed, which is a limitation of this study. Finally, the study did not involve missing data; thus, all analyses were performed with complete cases. For these reasons, the results should be interpreted with caution.

CONCLUSION

The current study shows that the overall frailty prevalence (mild, moderate, and severe) was 44.0% among older adults with CAD. Patients with higher prevalence of frailty included those >75 years of age, female, literate, living alone, and used >5 number of medications. >75 years of age, female, and used >5 number of medications were found determinants of fragility among older adults with CAD. Nurses should routinely evaluate the older adults with CAD in terms of fragility, and their treatment and care could be addressed with a holistic approach. Nurses should consider variables which effect frailty when meeting older adults with CAD' needs. Also, nurses could provide informative training to the older adults with CAD about symptoms of frailty and ways to prevent it. To determine the effect of frailty on coronary artery disease, comparative research could be conducted in different methodologies.

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