



Original Research

# Association of Frailty and Depressive Symptoms With the Establishment of Exercise Habits in Patients Undergoing Outpatient Cardiac Rehabilitation



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## KEYWORDS

Cardiac rehabilitation;  
Depression;  
Exercise;  
Frailty;  
Habits

**Abstract Objective:** To assess whether patients undergoing outpatient cardiac rehabilitation who have frailty and depressive symptoms at discharge are less likely than those without these condition to establish positive exercise habits.

**Design:** A retrospective cohort study that involved the assessment of frailty and depressive symptoms at the end of a 3-month course of cardiac rehabilitation. Frailty was defined as the patient noting 3 or more items using the criteria of Fried et al, while depressive symptoms were delineated by Patient Health Questionnaire-9 (PHQ-9) scores of 10 or greater.

**Setting:** General hospital (1048 beds) with outpatient cardiac rehabilitation in a suburb location in Japan.

**Participants:** 344 individuals underwent outpatient cardiac rehabilitation during the January 1, 2019-June 1, 2022, study period. Of these, 48 individuals were excluded because they did not complete the course and 54 were excluded because they lacked outcome data. Finally, 242 individuals (mean age: 68.2±11.1 years) were analyzed.

**Interventions:** Not applicable.

**Main Outcome Variable:** The establishment of an exercise habit defined as exercising at least 2 days per week and 30 minutes per day.

**Results:** Participants were divided into 4 groups depending upon the presence or absence of frailty and depressive symptoms: non-frail with no reported depressive symptoms (173 subjects), frailty-only (21 subjects), depressive symptoms-only (38 subjects), and frailty and depressive symptoms (10 subjects). Compared with patients who were not depressed and not frail, those with frailty only (odds ratio [OR]: 0.43, 95% confidence interval: 0.21-0.88,  $P=.02$ ) and those

*List of abbreviations:* OR, odds ratio; PHQ-9, Patient Health Questionnaire-9; TPB, Theory of Planned Behavior.

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with frailty and depressive symptoms (OR: 0.21, 95% confidence interval: 0.05-0.82,  $P=.025$ ) had significantly lower ORs for establishing exercise habits. After multivariate adjustment, the OR of establishing an exercise habit was significantly lower in those with only frailty (OR: 0.35, 95% confidence interval: 0.14-0.85,  $P=.005$ ).

**Conclusions:** This study, while limited by the small number of subjects with both frailty and depressive symptoms, indicates that interventions to prevent frailty during hospitalization and cardiac rehabilitation may be essential for cardiovascular disease patients with frailty whether or not associated with depressive symptoms.

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The development of a habit of regular exercise is negatively correlated with mortality.<sup>1</sup> Furthermore, it has been reported that exercise habits improve physical function and coronary risk factors.<sup>2-4</sup> Thus, the establishment of exercise habits is important for the prevention of the onset and recurrence of cardiovascular disease. Outpatient cardiac rehabilitation is important to prevent rehospitalization in patients with cardiovascular disease.<sup>5</sup> However, it was also reported that the compliance rate with exercise therapy is approximately 50% after 1 year.<sup>6</sup> Therefore, it is important to examine factors related to patients establishing exercise habits during outpatient cardiac rehabilitation.

Frailty is a state of vulnerability to stress due to decreased physiological reserve in old age.<sup>7</sup> Frailty is an important endpoint because it is prevalent in patients with cardiovascular disease and is associated with increased disease severity, rehospitalization, and all-cause mortality.<sup>8-10</sup> Frail individuals exercise for less time per week, less frequently, and spend more time sedentary than non-frail individuals.<sup>11,12</sup> A cross-sectional community study reported significantly lower depressive symptoms in the maintenance stage than in the preparation stage in the exercise behavior stage,<sup>13</sup> and depression was associated with a lack of, and less frequent, exercise habits.<sup>14</sup> Thus, it is possible that both psychological and physical factors affect the establishment of exercise habits. However, the association between frailty and depressive symptoms and failure to establish exercise habits in the future is unclear.

This study aimed to investigate the association between pre-discharge depressive symptoms and frailty, either independently or in combination, and the establishment of exercise habits after discharge in outpatient cardiac rehabilitation patients.

## Methods

### Study design

This study was a retrospective cohort study.

### Participants

Subjects admitted to the cardiology or cardiovascular surgery departments of the study hospital, and who started outpatient cardiac rehabilitation after discharge were included in the study. Our outpatient cardiac rehabilitation at our hospital generally consists of 1 session per week, lasting

1 hour, for a duration of 3 months. Upon arrival, patients undergo vital sign measurements and receive a consultation with a cardiologist. Subsequently, they engage in warm-up exercises, followed by 30 minutes of aerobic exercise and 6 resistance training exercises. They conclude with cool-down exercises, a final check of vital signs, and the session ends for the day. After discharge, eligible patients undergo a cardiopulmonary exercise test, while those who are unable to do so receive guidance on engaging in daily activities and exercises at an intensity below the predicted anaerobic threshold based on heart rate and perceived exertion using an actual bicycle ergometer. Based on guidelines,<sup>15</sup> it is recommended to perform exercise at least 3 days a week, with each session lasting at least 30 minutes. Exercise instruction is provided during aerobic exercise sessions and before/after exercise. Patients document the date and amount of exercise in a notebook and bring it to outpatient cardiac rehabilitation. The staff records this information in the electronic medical record system during each visit.

The data used in this study were derived from electronic medical records, which recorded the results of routine clinical practice. We created a manual on assessment methods for physical functioning and conducted practice sessions with all staff members to standardize the skills in the assessment methods. These data were collected prior to the formulation of the research plan, ensuring that the research hypothesis and objectives were blinded. The recorded data from the electronic medical records were also inputted into Excel. The lead author confirmed the consistency between the values in the electronic medical records and Excel, and then proceeded with the selection of the final analysis subjects. This process was standardized and performed by the trained lead author, ensuring appropriate verification and monitoring. Data collection for patient assessments was conducted on a preliminary sample of 30 cases to assess feasibility, including examining the proportion of inclusion and exclusion criteria, as well as the frequency of missing data. Furthermore, a well-defined procedure for chart retrieval was established to ensure smooth and error-free implementation of this study.

This was a minimal risk study as no interventions were performed and the data anonymized according to the Declaration of Helsinki. There were no invasive procedures or interventions in this study. Based on the guidelines of the Ministry of Health, Labor, and Welfare in Japan, the information and informed consent on the research are disclosed on the study hospital homepage and were approved by the Ethics Committee of the study hospital (approval number: 20126, December 15, 2020).

## Outcome measures

### Exercise habit

The establishment of exercise habits was defined as adhering to the recommendations provided to patients and engaging in voluntary physical activity of at least 30 minutes, 2 days per week, outside of the outpatient cardiac rehabilitation program, from hospital admission to discharge and throughout the duration of outpatient cardiac rehabilitation until completion. The criteria were quoted from Japan's Ministry of Health, Labor, and Welfare.<sup>16</sup>

### Measurement of frailty

In this study, the Japanese version of the Cardiovascular Health Study (J-CHS) proposed by Fried et al was used.<sup>7,17</sup> This assessment method is recommended for frailty assessment in Japanese individuals and was employed because of its convenience in evaluating patients more efficiently. The Japanese version of the Cardiovascular Health Study has the following 5 criteria: low grip strength, slow gait speed, exhaustion, weight loss, and low activity.<sup>7,17</sup> Grip strength was measured twice on each side using a Smedley grip strength meter,<sup>a</sup> and the maximum grip strength was recorded. Low grip strength was defined as less than 28 kg and 18 kg for men and women, respectively. Gait speed was measured as usual gait speed. For the gait speed measurement, a 6-m walking path was created and the participants were instructed to walk the 6-m distance from a stationary standing position, and the time was measured at the 4-m distance between 1-m and 5-m points. Gait speed was measured twice and the faster one was evaluated. A gait speed of less than 1.0 m/s was considered a slow gait speed. Exhaustion was defined as a "yes" response to the question, "Do you feel exhausted for no reason?" Weight loss was confirmed if the patient reported a weight loss of 2 kg or more in the past 6 months." Low activity was defined as a negative response to the question, "Do you exercise or play sports regularly?" The subjects were classified into the frailty group if at least 3 items were applicable and the non-frailty group, when 0-2 items were applicable. Frailty were assessed the day before discharge.

### Measurement of depression symptoms

The Patient Health Questionnaire-9 (PHQ-9) is recommended by the American Heart Association as a screening test for depression and is frequently used in cardiology.<sup>18,19</sup> There are 9 questions, each with a score of 0-3, giving a maximum score of 27; the higher the score, the greater the depressive symptoms. The cut-off for having depressive symptoms is 10 points or higher, and cardiac rehabilitation guidelines recommend psychological intervention for those who have such scores.<sup>6,20</sup> The PHQ-9 cut-off used in this study was 10 points or higher. Depressive symptoms were assessed the day before discharge.

### Other measurements

Data on age, sex, body mass index, type of disease, left ventricular ejection fraction, estimated glomerular filtration rate, cognitive function scores from the FIM, number of

hospital days, and presence or absence of exercise habits before admission, were collected. Left ventricular ejection fraction data were collected on admission. Body mass index, estimated glomerular filtration rate, and FIMs were collected at discharge. Disease classification was based on the primary disease of admission and was classified as ischemic heart disease, heart failure, or other.

### Statistical analysis

The subjects were divided into 4 groups according to the presence or absence of frailty and depressive symptoms: non-frailty and no depressive symptoms group, frailty only group, depressive symptoms only group, and frailty and depressive symptoms group. Data are presented as mean  $\pm$  standard deviation, median [25%–75% tiles], or n (%). The chi-square tests were used for comparisons of proportions, the Kruskal-Wallis test for comparisons of medians, and 1-way analysis of variance for comparisons of means, with respective *P* values shown. Multiple comparison tests were performed comparing the non-frailty and no depressive symptoms group to the other groups. Dunn tests were performed for continuous variables and chi-square tests for categorical variables, with Bonferroni correction. Logistic regression analysis was performed with the presence or absence of established exercise habits as the objective variable and the 4 groups of frailty and depressive symptoms as explanatory variables. To address potential sources of bias, age, sex, body mass index, the cognitive function score from the FIM, type of disease (ischemic heart disease, heart failure, or other), and whether outpatient cardiac rehabilitation was conducted, including the period after April 2019 when COVID-19 became prevalent were used as adjustment factors. In the logistic regression analysis, the main effects and interactions of frailty and depressive symptoms were calculated. As a sensitivity analysis, we conducted an analysis excluding age from the adjusted variables in the logistic regression analysis. Furthermore, considering the significant effect of changes in social environment such as movement restrictions due to the COVID-19 pandemic on the establishment of exercise habits, we performed subgroup analyses before and after the COVID-19 outbreak. The authors considered the effect of exercise habits before hospitalization to be significant concerning the outcome of establishing exercise habits. However, in the frailty and depressive symptoms group, there were no individuals with exercise habits before hospitalization, precluding its inclusion as an adjusting factor in the analysis. Instead, we conducted subgroup analyses based on the presence or absence of exercise habits prior to hospitalization. Stata version 17.0 was used as the analysis software.<sup>b</sup> The statistical significance level was set at 5%, and it was assumed that there was a significant difference when  $P < .05$ .

## Results

344 patients began outpatient cardiac rehabilitation during the study period of January 1, 2019, to June 1, 2022. 48 were excluded from analysis because they stopped attending within 1 month of starting the program and 54 were

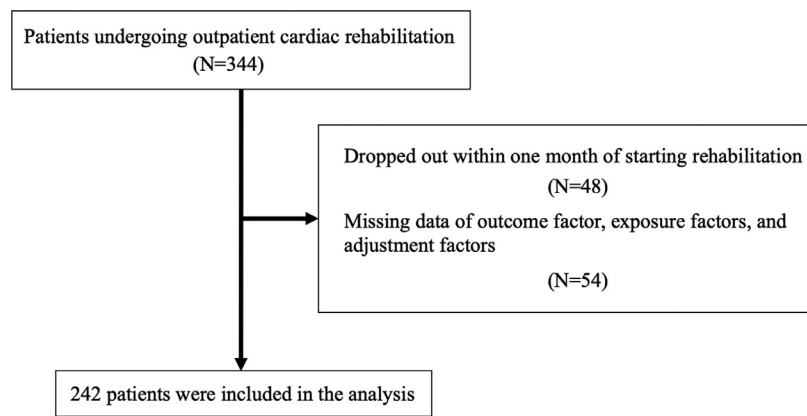


Fig 1 Flow chart for participants.

excluded because of missing outcome data. As a result, 242 were included in the analysis (mean age:  $68.2 \pm 11.1$  years, 174 men/68 women) (fig 1). Among the study participants, 57 (23.4%) had heart failure and 114 (46.7%) ischemic heart disease. Table 1 shows the results of the group comparisons: non-frailty and no depressive symptoms group (173 subjects), frailty-only group (21 subjects), depressive symptoms-only group (38 subjects), and frailty and depressive symptoms group (10 subjects). Significant differences were found in the type of disease, length of hospital stay, and presence or absence of exercise habits before hospitalization ( $P < .01$ ). Multiple comparison tests showed that compared with the non-frailty and no depression symptoms group, the frailty-only group had higher age, lower body mass index, less ischemic heart disease, and longer hospital stay ( $P < .01$ ).

The results of logistic regression analysis on the establishment of exercise habits and their association with 4 groups are presented in table 2. Compared with the non-frailty and no depressive symptoms group, the frailty only group and frailty and depressive symptoms group had significantly lower odds ratios (ORs) for developing exercise habits (OR: 0.43 and OR: 0.21, respectively). After multivariate adjustment, the OR for establishing exercise habits was significantly lower in the frailty-only group (OR: 0.35, 95% confidence interval: 0.14-0.85,  $P = .017$ ). The main effect of frailty on the establishment of exercise habits was significant ( $P = .02$ ), while the main effect of depressive symptoms was not significant ( $P = .73$ ). The interaction between frailty and depressive symptoms regarding the establishment of exercise habits was not significant ( $P = .32$ ). These results remained consistent even after adjusting for confounding factors. In the sensitivity analysis, after excluding age from the adjusting factors in the logistic regression analysis, there was no change in its significance (supplemental table S1; available online only at <http://www.archives-pmr.org/>).

Before the COVID-19 pandemic, there were no individuals with established exercise habits in the frailty and depressive symptoms group. Moreover, the OR for both the frailty-only group and the depressive symptoms-only group were not significantly lower compared with the non-frailty and no depressive symptoms group (supplemental table S2; available online only at <http://www.archives-pmr.org/>). After the COVID-19 pandemic, when comparing with the non-

frailty and no depressive symptoms group, only the frailty-only group showed a significantly lower OR (supplemental table S2; available online only at <http://www.archives-pmr.org/>).

Because of the small number of individuals with exercise habits before hospitalization, which accounted for 56 participants (23%) among the entire cohort, subgroup analysis of the exercise habit before hospitalization group was not feasible (supplemental table S3; available online only at <http://www.archives-pmr.org/>). As a result, the findings and significance of the logistic regression analysis for all study participants remained unchanged.

## Discussion

Patients with frailty undergoing outpatient cardiac rehabilitation had a significantly lower OR for developing exercise habits compared with those who were not frail and had no depressive symptoms at discharge. The depressive symptoms-only group and the frailty and depressive symptoms group which only included 10 subjects did not have a lower OR for the establishment of exercise habits.

A study that followed the community dwelling elderly for 6 years reported that those who exercised regularly or for a longer duration had a lower risk of developing depressive symptoms.<sup>21</sup> Zhong et al reported that high levels of depressive symptoms were associated with high levels of inactivity in a cross-sectional study in the community elderly.<sup>14</sup> On the other hand, studies involving cancer and patients with chronic obstructive pulmonary disease have reported a correlation between high depressive symptoms and poor exercise adherence.<sup>22,23</sup> However, a study focusing on 73 smokers with a history of alcohol dependence found that the attendance rate in exercise sessions for respiratory rehabilitation was similar between the depressed group and the non-depressed group.<sup>24</sup> Consequently, there is no consensus on the effect of depressive symptoms on subsequent exercise adherence. The current research findings, indicating a lack of significant relation between established exercise habits and both the depressive symptoms only group and the frailty and depressive symptoms group (comprising only 10 participants), contribute novelty to the existing literature. Because the current study hypothesis was rejected, it is

**Table 1** Comparison of characteristics of combined frailty and depressive symptoms

	Overall N=242	Non-frailty and No Depressive Symptoms n=173 (71.5)	Frailty Only n=38 (15.7)	Depressive Symptoms Only n=21 (8.7)	Frailty and Depressive Symptoms n=10 (4.1)	P Value
Age, years	68.2±11.1	67.4±10.3	74.7±9.7*	62.6±13.9	68.6±13.5	<.01
Men, %	174 (71.3)	123 (72.1)	27 (71.1)	17 (81.0)	6 (60.0)	.66
Body mass index, kg/m <sup>2</sup>	23.2±3.9	23.6±3.8	21.1±2.8*	24.3±4.1	22.4±5.9	<.01
Disease	114 (46.7)	95 (54.9)	7 (18.4)*	8 (38.1)	4 (40.0)	<.01
Ischemic heart disease, %	57 (23.4)	36 (20.8)	12 (31.6)*	5 (23.8)	3 (30.0)	
Heart failure, %	73 (29.9)	42 (24.3)	19 (50.0)*	8 (38.1)	3 (30.0)	
Other cardiovascular diseases, %	51.9±14.0	52.7±13.7	48.6±148	51.7±12.8	52.1±15.5	.51
LVEF, %	58.3±18.9	58.4±18.2	56.3±20.5	57.5±21.8	60.3±17.9	.82
eGFR at discharge, mL/min/1.73 m <sup>2</sup>	35 [35-35]	35 [35-35]	35 [31-35]	35 [35-35]	35 [30-35]	.25
Cognition function of FIM, score	16 [10-23]	14 [10-21]	24.5 [14-41]*	17 [12-20]	29.5 [13-37]	<.01
Number of hospital days	56 (23.0)	44 (26.0)	7 (18.4)	5 (23.8)	0 (0)	.24
Presence of exercise habit prior to admission, %	102 [53-179]	109 [55-179]	95.5 [36-186]	79 [37-130]	65.5 [34-95]	.16
Outpatient rehabilitation days						

NOTE. Data are presented as mean ± standard deviation, median [25%-75% tiles], or n (%).  
Abbreviation: eGFR, estimated glomerular filtration rate; LVEF, left ventricular ejection fraction.

\* P<.01 compared with non-frailty and no depressive symptoms group.

possible that the cross-sectional association seen in previous studies of lower depressive symptoms in those with exercise habits was represented by the causal relation that exercise improves depressive symptoms.<sup>14</sup> There are several possible reasons why the depressive symptoms-only group or the frailty and depressive symptoms group were not significantly associated with the establishment of exercise habits. The number of patients with depressive symptoms was small. Because of the small sample size, there is a possibility that the statistical power was low, which may have resulted in non-significant findings. Further, the standardized PHQ-9 assessment provides patient education and psychological follow-up for patients with high depressive symptoms. In addition, because of its demonstrated validity as a screening test for depression symptoms and anxiety,<sup>25</sup> some patients with depressive symptoms may have been more motivated to exercise due to anxiety about re-hospitalization. Finally, it is possible that some patients without depressive symptoms were unable to exercise because they were busy or because of a lack of motivation.

Studies have shown that individuals with an exercise habit had significantly higher scores in the timed Up and Go test and 6-minute walk in the community elderly.<sup>26</sup> In addition, non-frailty community-dwelling older people exercised significantly more frequently and for longer per week than frail older people.<sup>11</sup> It was reported that 10 times chair stand-up speeds were improved by walking and strength training for 6 months in 20 community-dwelling elderly.<sup>27</sup> In the present study, it is newly evident that frailty at discharge influenced the establishment of exercise habits. Therefore, the association of the preceding cross-sectional study may be due to the causal effect of low physical function on the failure to establish exercise habits. Frailty may be negatively associated with exercise habit establishment because people find it difficult to walk outdoors or perform strength training. In the theory of behavior change, the Theory of Planned Behavior (TPB), the first step in behavior change is the intention to act.<sup>28</sup> The factors that create this intention are stated as “attitude,” which is a value toward exercise; “subjective norm,” which is the influence of others; and “a sense of behavioral control,” which is the subjective ease of acting. Participation in outpatient cardiac rehabilitation may have retained intention and subjective norms, but the lack of attitude and sense of behavioral control may have influenced the non-establishment of exercise habits. In other words, frailty may induce a fear of falling,<sup>29</sup> a lack of physical confidence, and susceptibility to fatigue. Based on the results of the 4-group comparison, the longer hospital stay in the frailty-only group may also have contributed to this effect. It is also possible that anxiety in the patients’ families may affect subjective norms. The Health Action Process Approach theory indicates that planning is necessary between intention and exercise practice.<sup>30</sup> In addition, “self-efficacy,” which corresponds to the “sense of behavioral control” in TPB, “anticipation of outcome,” which corresponds to the “attitude” in TPB, and risk perception, such as understanding the risks of inactivity, have been shown to influence exercise practice. Therefore, risk perception may also be increased by outpatient cardiac rehabilitation, which supports planning and disease education. However, frail patients have lower self-efficacy and expectancy of outcome,<sup>31</sup> which may have influenced the negative

**Table 2** Association of a combination of frailty and depressive symptoms with the establishment of exercise habits

	n (%)	Those Who Had Exercise Habit n (%)	Non-adjusted Model			Multiple Adjusted Model		
			OR	95% CI	P Value	OR	95% CI	P Value
Non-frailty and no depressive symptoms	173 (71.5)	117 (67.6)	1.00	ref.	ref.	1.00	ref.	ref.
Frailty only	38 (15.7)	18 (47.4)	0.43	0.21-0.88	.02	0.31	0.13-0.71	.005
Depressive symptoms only	21 (8.7)	15 (71.4)	1.20	0.44-3.25	.73	1.40	0.49-4.03	.53
Frailty and depressive symptoms	10 (4.1)	3 (30.0)	0.21	0.05-0.82	.025	0.24	0.05-1.12	.06
Frailty*depressive symptoms					.32			.35

NOTE. Adjustment factor: age, sex, body mass index, disease, score of cognition of FIM, outpatient rehabilitation days, after or before the COVID-19 outbreak.

Abbreviation: 95% CI, 95% confidence interval; ref, reference.

association between frailty and the establishment of exercise habits.

In cardiac rehabilitation, it has been shown that screening for depressive symptoms and psychological interventions for treatment and prevention reduce psychiatric symptoms, improve quality of life, improve treatment adherence, and reduce mortality and the rate of cardiovascular events.<sup>6</sup> Although depressive symptoms were not associated with the establishment of exercise habits, it is necessary to continue to assess depressive symptoms and respond accordingly. Frail patients should be educated to increase self-efficacy by assessing the risk of falling and providing feedback to patients and their families regarding safety and exercise instruction that gradually builds a program starting from simple exercises. For patients with low physical fitness or advanced age before hospitalization, it is important to act quickly to prevent muscle weakness from inactivity and a decline in activities of daily living to prevent frailty.

Because this study was conducted on cardiovascular patients participating in outpatient cardiac rehabilitation, generalizations to other patients and healthy individuals cannot be made. However, this study is necessary to address issues in outpatient cardiac rehabilitation. The effectiveness of outpatient cardiac rehabilitation in preventing rehospitalization has been reported in numerous studies. However, because some cardiac rehabilitation outpatients do not establish an exercise habit, it is important to investigate why to improve the quality of the rehabilitation. This study is novel in this regard. In addition, although there are numerous reports that exercise improves frailty and depressive symptoms, it is important to show the results of this study based on the hypothesis that some frailty and depressive symptoms suppress the establishment of exercise habits. Another strength of this study lies in its investigation of the independent effects of frailty and depressive symptoms, both individually and in combination, by means of their classification.

### Study limitations

This study has several limitations: (1) the data were collected retrospectively. Therefore, the patients' exercise intensity is unknown. In this study, exercise habits were defined in terms of time and frequency, but the amount of exercise also varies depending on the intensity. (2) The

duration from the day of establishing exercise habits to the day of graduating from outpatient cardiac rehabilitation varies among individuals, indicating differences in the duration of exercise continuity. Although the analysis was adjusted for the duration of outpatient cardiac rehabilitation, it is necessary to conduct studies that investigate exercise habits after the completion of outpatient cardiac rehabilitation and define the duration of continuity in the future. (3) The assessment of depressive symptoms was done using a simple questionnaire. (4) The number of cases was small. In particular, the number of cases in the frailty and depressive symptoms group was quite small (10 cases). It is possible that the results were not significant due to the lack of statistical power. (5) Depressive symptoms before hospitalization were not assessed. Therefore, it cannot be determined whether depressive symptoms at the point of discharge from the hospital were associated with the onset of the disease or hospitalization.

### Conclusions

In patients undergoing outpatient cardiac rehabilitation, the rate of establishment of an exercise habit was significantly lower among those with frailty only, compared with those without depression and frailty at discharge. The results of this study suggest that measures to prevent frailty during hospitalization for cardiovascular diseases, and individualized interventions to establish exercise habits may be necessary for cardiovascular disease patients with frailty, even in the absence of depressive symptoms. Further research is warranted to advance the study by increasing the number of cases and evaluating exercise habits at the completion of outpatient cardiac rehabilitation and beyond.

### Suppliers

- Smedley grip strength meter; Takei Kiki Kogyo.
- Stata version 17.0; StataCorp LLC.

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