INTRODUCTION

Heart failure (HF) is a common disease with a high prevalence; moreover, the number of patients with HF is expected to increase in the future.\(^1\)\(^-\)\(^3\) Epidemiological studies in Japan have reported that the number of Japanese patients with HF is estimated to reach 1.3 million by 2030.\(^4\) HF is a disease with a high readmission rate.\(^1\)\(^-\)\(^3\)\(^,\)\(^5\) Because of improvements in the treatment of HF in recent years, the prognosis of patients has improved; however, the readmission rate has increased.\(^1\)\(^-\)\(^3\) According to the Japanese Cardiac Registry of Heart Failure in Cardiology, which is a prospective, multicenter, registered observational study in Japan, the 1-year mortality rate of patients with HF is 7.3%, and the readmission rate within 1 year because of exacerbation of HF is as high as 35%.\(^6\) In patients with HF, decreasing physical function is closely related to readmission.\(^2\)\(^-\)\(^4\)\(^-\)\(^1\)\(^4\) HF exacerbation further reduces physical function, leading to increased readmission risk and health-care costs.\(^1\)\(^-\)\(^3\)\(^,\)\(^7\) Therefore, early detection and prevention of readmission risk due to HF exacerbation are required.

Cardiac rehabilitation (CR) improves the physical function of patients with HF and significantly reduces the risk of readmission.\(^15\)\(^,\)\(^16\) Physical therapists are mainly responsible for exercise therapy, which is the core component of CR, and evaluations of physical function are conducted to plan exercise programs.\(^17\) The 6-Minute Walk Test (6MWT) is a...
typical evaluation of physical function and predicts the prognosis of patients with HF.\textsuperscript{9–14,18–23} Other evaluation methods, such as lower limb strength,\textsuperscript{24,25} balancing ability,\textsuperscript{26} and ability to perform activities of daily living (ADLs),\textsuperscript{27} are also useful for prognostic prediction. However, it is unclear which physical function evaluation method is the most useful for prediction of HF readmission. In the clinical setting, numerous evaluations are conducted for HF patients, and these add a burden on both patients and medical staff. Clarifying which physical function evaluation methods can predict HF readmission may help in reducing this burden. In this study, we aimed to investigate which physical function evaluation method can predict readmission within 1 year because of worsening of HF in patients who were newly diagnosed with HF.

**METHODS**

**Study Design and Subjects**

This single-center retrospective cohort study was conducted on 192 consecutive inpatients who were newly diagnosed with HF. These patients underwent CR at Wakamatsu Hospital of the University of Occupational and Environmental Health from May 2012 to September 2015. Because of the retrospective nature of the study, informed consent was not necessary. We set up an opt-out method that posted the study outline on the website and guaranteed the subjects the opportunity to refuse to participate in the study. In accordance with the Declaration of Helsinki, this study was conducted with approval from the Ethics Committee of the University of Occupational and Environmental Health (no. 280022). HF was diagnosed by a cardiovascular specialist according to the European Cardiology Society HF guidelines.\textsuperscript{28} We excluded 76 patients: 67 were patients who were unable to walk 200 m independently at the time of discharge because of severe HF, musculoskeletal diseases, or neuromuscular diseases; 7 were lost to follow-up after discharge; and 2 were readmitted for other causes. Finally, 116 patients were enrolled in this study. All patients received standard HF treatment and CR on hospital admission and were discharged in a stable state. The end point of this study was HF readmission within 1 year.

**Data Collection**

Clinical characteristics (age, sex, body composition, underlying diseases, comorbidities, cardiac function data, medications, and evaluations of physical function) at the time of discharge and during the clinical course were retrospectively collected from electronic medical records. Patient height was measured in units of 0.1 cm using a height meter, and body weight was measured in units of 0.1 kg using a weighing scale. The body mass index (BMI) was calculated by dividing the body weight (kg) by the square of the height (m) and was reported in kg/m\textsuperscript{2}. Chronic kidney disease (CKD) was defined as an estimated glomerular filtration rate (eGFR) <60 ml/min, according to the Modification of Diet in Renal Disease study equation.\textsuperscript{29} Two-dimensional echocardiographic estimation of the left ventricular ejection fraction (LVEF) was performed using the modified Simpson’s method. The causes of HF, HF with reduced ejection fraction (HFrEF; LVEF <40%), HF with mid-range ejection fraction (HFmrEF; 40%–49%), and HF with preserved ejection fraction (HFpEF; LVEF ≥50%) were diagnosed by cardiologists according to the American College of Cardiology Foundation/American Heart Association Task Force on Practice guidelines.\textsuperscript{30}

**Evaluations of Physical Function**

As evaluations of physical function, the 6MWT, knee extensor strength, grip strength, 30-Second Chair-Stand Test (CS-30), One-Leg Standing Test (OLST), functional reach test, and the Barthel index were evaluated the day before discharge. The evaluations were conducted under electrocardiogram monitoring, and evaluations were stopped if marked dyspnea or leg fatigue occurred. With consideration to patient fatigue, a suitable break was taken between each examination.

The 6MWT was performed to evaluate exercise tolerance. Following the method described in the American Thoracic Society statement,\textsuperscript{31} the longest walking distance for 6 min was measured. The physical therapist was positioned behind the patient (so as not to affect the walking pace) and informed the patient of the remaining time every minute. During the 6MWT, we instructed patients to pause for a rest if necessary.

The knee extension muscle strength was evaluated to determine the lower limb muscle strength. A hand-held dynamometer (μTas MT-1; ANIMA, Tokyo, Japan) was used to measure the knee extension muscle strength. The patient sat on an elevated bed with arms folded and the knee flexed at 90°. The lower end of the dynamometer force pad was set immediately above the ankle joint and was fixed in place with a belt. The knee extension strength was measured twice on the right and left sides under maximum effort. The maximum values were averaged, and the average was divided by the body weight (kgf/kg).

The grip strength was measured to evaluate the upper limb...
muscle strength. A digital grip force meter (TL 110; TOEI LIGHT, Saitama, Japan) was used for grip strength measurement. In the sitting position, the upper limb was adjusted so that the proximal interphalangeal joint of the index finger was at 90°, the elbow flexed at 90°, and the forearm placed in an intermediate position. Grip strengths were measured twice on the left and right sides, and the average value of the respective maximum values was taken as the measured value (kg).

CS-30, which evaluates physical performance, was performed according to the report by Jones et al. 33) The patient sat on a 40-cm-high chair, with the lower limbs shoulder-width apart and the arms folded. The sit-to-stand task was repeated as many times as possible for 30 s, and the number of standing positions was taken as the measured value. If a patient was in the act of standing when 30 s was reached, it was included in the count.

The OLST was performed to evaluate static balance. The patient maintained a one-leg standing position with eyes open and placed both hands beside the waist. The measurement time was up to 60 s and the test was performed twice on the left and right legs. The average of the respective maximum values was taken as the measured value.

The functional reach test, which evaluates dynamic balance, was performed according to the report by Duncan et al. 33) The patient lifted the upper limb to the height of the shoulder in the standing position and let the upper limb reach forward to maintain balance. The reach length was measured twice with the left and right arms, and the average of the respective maximum values was taken as the measured value (cm).

The Barthel index was evaluated to measure the patients’ ability to perform ADLs. The modified Barthel index used at our hospital consisted of 13 items. The score ranges from 0 to 100 points, with a higher score indicating higher ADL performance ability. 34)

Cardiac Rehabilitation

The CR program was conducted once every 60 min at the time of hospital admission and five times a week for all patients. This program is composed of group exercises that are mainly based on resistance training and bicycle ergometry, nutritional guidance, and lifestyle guidance in accordance with the guidelines of the Japan Cardiovascular Society for rehabilitation in patients with cardiovascular disease. 37) After hospital discharge, if the physician considered it necessary or if the patient wished to continue, outpatient CR was performed once or twice a week.

Statistical Analyses

Continuous variables are expressed as the mean ± standard deviation. Categorical variables are expressed as number (percentage). The HF patients were divided into two groups based on whether readmission occurred within 1 year. Baseline characteristics and evaluations of physical function were compared using the Mann-Whitney U test and χ² test.

Logistic regression analysis was used to evaluate whether baseline characteristics and physical function at the time of discharge were related to HF readmission within 1 year. Potential risk factors were initially determined using univariate regression analysis. To determine the independent factors of HF readmission within 1 year, variables with a P-value <0.01 in the univariate analysis were included in the multivariate logistic model with adjustment for age and sex. Prior to multivariate logistic regression analysis, Spearman’s rank correlation test was used to evaluate multicollinearity among the variables.

A receiver operating characteristic (ROC) curve was used to determine the prognostic value and cut-off value of the physical function variables, with HF readmission within 1 year as the state variable. The Youden index was used to calculate appropriate cut-off values.

The factors identified by multivariate analysis and the ROC curve were used to separate patients into two groups according to the cut-off values. A Kaplan-Meier survival curve was used to determine the HF readmission-free rate within 1 year between the two groups. Excluded patients who were unable to walk 200 m independently were also added to the Kaplan-Meier survival curve. The log-rank test was used for comparison among the three groups. All statistical analyses were performed with SPSS version 25 (IBM Corp., Chicago, IL, USA). A P-value <0.05 was considered to be statistically significant.

RESULTS

During the mean follow-up period of 326 ± 92 days, 22 patients (19%) were readmitted for HF. Table 1 shows the clinical characteristics at the time of discharge. The readmission group (n=22) exhibited significantly higher New York Heart Association (NYHA) classes, higher rates of hyperlipidemia, higher levels of blood urea nitrogen (BUN) and serum creatine, and significantly lower CKD rates and eGFR levels than the non-readmission group (n=94). The readmission group had a higher rate of HFrEF. The readmission group also had more patients taking diuretics and fewer patients taking statins. Although no significant differences
Table 1. Clinical characteristics of the patients at initial discharge

|                      | Readmission (n=22) | Non-readmission (n=94) | P Value |
|----------------------|--------------------|------------------------|---------|
| Age (years)          | 74 ± 11            | 72 ± 10                | 0.817   |
| Male sex             | 11 (50)            | 49 (52)                | 0.857   |
| BMI (kg/m²)          | 22.5 ± 3.4         | 22.2 ± 3.7             | 0.788   |
| Hospitalization (days)| 25 ± 7             | 21 ± 8                 | 0.051   |
| NYHA class (I/II/III/IV) | 2 / 8 / 12 / 0     | 21 / 51 / 22 / 0       | 0.006*  |
| Cause of HF, n (%)   |                    |                        |         |
| Ischemic heart disease | 8 (36)             | 55 (59)                | 0.060   |
| Hypertensive heart disease | 0 (0)             | 2 (2)                  | 0.655   |
| Dilated cardiomyopathy | 1 (5)              | 8 (8)                  | 0.461   |
| Valvular heart disease | 6 (27)            | 17 (18)                | 0.243   |
| Others               | 7 (32)             | 12 (13)                | 0.019*  |
| Type of HF           |                    |                        |         |
| HFrEF                | 11 (50)            | 22 (23)                | 0.013*  |
| HFmrEF               | 2 (9)              | 23 (24)                | 0.093   |
| HFpEF                | 9 (41)             | 49 (52)                | 0.343   |
| Medical history      |                    |                        |         |
| Hypertension         | 13 (59)            | 36 (38)                | 0.076   |
| Dyslipidemia         | 19 (86)            | 60 (64)                | 0.041*  |
| Diabetes mellitus    | 15 (68)            | 60 (64)                | 0.701   |
| Chronic kidney disease | 15 (68)           | 84 (89)                | 0.011*  |
| Laboratory data      |                    |                        |         |
| Total protein (g/dL)     | 6.9 ± 0.7          | 6.9 ± 0.6              | 0.924   |
| Serum albumin (g/dL)   | 3.6 ± 0.4          | 3.7 ± 0.5              | 0.319   |
| BUN (mg/dL)           | 27 ± 8             | 21 ± 10                | <0.001* |
| Serum creatine (mg/dL) | 1.21 ± 0.30        | 1.14 ± 0.80            | 0.001*  |
| eGFR (ml/min/1.73 m²)  | 41.78 ± 14.61      | 54.85 ± 20.73          | 0.002*  |
| Hemoglobin (g/dL)     | 11.2 ± 1.8         | 11.9 ± 1.7             | 0.059   |
| Serum sodium (mEq/L)  | 138.8 ± 3.1        | 139.8 ± 2.4            | 0.087   |
| LVEF (%)              | 41.2 ± 16.6        | 45.6 ± 12.4            | 0.247   |
| Medications           |                    |                        |         |
| ACEI/ARB              | 19 (86)            | 83 (88)                | 0.802   |
| β-Blockers            | 19 (86)            | 74 (79)                | 0.418   |
| Diuretics             | 21 (95)            | 51 (54)                | <0.001* |
| Statins               | 9 (41)             | 68 (57)                | 0.005*  |
| Outpatient CR         | 8 (36)             | 51 (54)                | 0.131   |
| 6MWTR (m)             | 343.2 ± 116.3      | 426.3 ± 104.8          | 0.001*  |
| Knee extension strength (kgf/kg) | 0.24 ± 0.11     | 0.27 ± 0.11            | 0.404   |
| Grip strength (kg)    | 23.0 ± 8.9         | 25.6 ± 9.5             | 0.231   |
| One-leg standing test (s) | 13.3 ± 17.7     | 23.1 ± 21.0            | 0.046*  |
| 30-Second chair stand test (time) | 12.7 ± 3.5 | 15.4 ± 5.7             | 0.032*  |
| Functional reach test (cm) | 31.6 ± 6.8     | 33.3 ± 6.6             | 0.265   |
| Barthel index (points) | 97.1 ± 4.5       | 98.1 ± 4.0             | 0.264   |

Continuous variables are presented as mean ± standard deviation. Categorical variables are presented as numbers (%). ACEI=angiotensin-converting enzyme inhibitor, ARB=angiotensin II receptor blocker. *P <0.05.
were found between the two groups, there was a tendency for the hospitalization duration and hypertension rates to be higher in the readmission group. The readmission group had significantly lower 6MWT distances (343 ± 116 vs 426 ± 105 m, P = 0.001), OLST times (13 ± 18 vs 23 ± 21 s, P = 0.046), and CS-30 results (13 ± 4 vs 15 ± 6 times, P = 0.032) than the non-readmission group. There were no significant difference between the two groups in terms of the knee extension strength, grip strength, functional reach test, and Barthel index.

**Table 2** shows the results of univariate and multivariate logistic regression analyses. The following variables had a P-value < 0.01 in the univariate analysis: NYHA class, BUN, eGFR, diuretic use, statin use, and 6MWT. None of the factors identified by univariate analysis were highly correlated (all < 0.9); therefore, the effect of multicollinearity could be excluded. Even after adjusting for age and sex in the multivariate analysis, NYHA class [odds ratio (OR): 3.157; 95% confidence interval (CI): 1.328–7.504; P = 0.009], BUN (OR: 1.071; 95% CI: 1.020–1.125; P = 0.006), eGFR (OR: 0.961; 95% CI: 0.934–0.989; P = 0.006), diuretic use (OR: 21.324; 95% CI: 2.655–171.245; P = 0.004), statin use (OR: 0.273; 95% CI: 0.103–0.724; P = 0.009), and 6MWT (OR: 0.990; 95% CI: 0.985–0.996; P = 0.001) were independently associated with the risk of readmission within 1 year.

**Table 3** shows the ROC curve data for variables that indicate physical function. The 6MWT showed a better prognostic value [area under the ROC curve (AUC): 0.696; 95% CI: 0.565–0.828; P = 0.004] than the other evaluations of physical function. The cut-off value for 6MWT was 382.5 m (sensitivity, 66.3%; specificity, 68.2%; AUC: 0.696; 95% CI: 0.565–0.828; P = 0.004).

**Figure 1** shows the Kaplan-Meier readmission-free survival curve. Among the 67 patients excluded because they were unable to walk 200 m independently, 28 (42%) were readmitted within 1 year [including 8 who died (12%)], 31 (46%) were not readmitted, and 8 were lost to follow-up after discharge. The 1-year non-readmission rates were 90% for the 6MWT ≥382.5 m group, 68% for the 6MWT <382.5 m group, and 53% for those unable to walk 200 m independently (P < 0.001, log-rank test).

**DISCUSSION**

In this study, we aimed to investigate whether measures of physical function could predict readmission within 1 year as a result of worsening HF in patients who were newly diagnosed with HF. This study demonstrated that physical function, particularly the 6MWT at time of discharge, was a predictor of HF readmission within 1 year. Furthermore, the 6MWT cut-off value for predicting HF readmission within 1 year was 382.5 m. This study suggests that the 6MWT distance at the time of discharge is more useful for predicting HF readmission than other measures of physical function in patients who are newly diagnosed with HF.

After discharge, symptoms such as exercise intolerance and dyspnea remain in many patients with HF. Underlying these symptoms is congestion, and many HF patients with congestion are prescribed diuretics. In this study, a diuretic was given at admission in accordance with the Japanese Circulation Society/Japanese Heart Failure Society 2017 Guidelines for Diagnosis and Treatment of Acute and Chronic Heart Failure. If the heart failure stabilized, the diuretic dose was reduced as much as possible. Previous studies have reported that the persistence of congestion symptoms after discharge is associated with decreased physical function and increased readmission risk in patients with HF. In this study, many patients in the readmission group received diuretics. Even a study that assessed an aggressive mobilization program for hospitalized patients with acute HF in Japan reported diuretic use in 66% of the intervention group and 82% of the control group. These findings were similar to our results. Therefore, the readmission group possibly had more severe HF than the non-readmission group. However, several studies have reported that the 6MWT is a useful measure of exercise tolerance in HF patients with severe congestive symptoms. The 6MWT distance at discharge may allow the quick identification of HF patients at risk of recurrence and thereby allow measures to be put in place to help avoid HF readmission.

The cut-off value of 6MWT for predicting HF readmission within 1 year was 382.5 m. Various 6MWT cut-off values for prognostic prediction have been reported, e.g., <450, <400, <300, <200 m. The definition of progressive (stage D) HF was reported as a 6MWT <300 m. In a systematic review on the usefulness of the 6MWT in congestive HF patients, the prognostic value of the 6MWT was highest at 300–490 m, and the predictive ability decreased at 490 m or higher. Furthermore, the 6MWT is useful for prognostic prediction because it is not affected by age, sex, or body composition. These reports support the finding that the cut-off value of the 6MWT distance at discharge observed in this study is appropriate for predicting HF readmission within 1 year.

The 6MWT is a safe and simple evaluation that can be performed without a large walking space or special equipment.
Furthermore, the 6MWT is a prognostic predictor in patients with HF fitted with a left ventricular assist device \cite{43,44} and those with transcatheter valve implantations \cite{45,46}. Therefore, the 6MWT can be applied widely, not only for the evaluation of physical therapy in CR, but also for prognostic prediction in the clinical setting.

In a multinational large-scale study [Heart Failure: A Controlled Trial Investigating Outcomes of Exercise Training (HF-ACTION)], the 6MWT had a prognostic value almost equal to that of the peak oxygen uptake (VO$_2$) \cite{11}. In our study, 25 (22%) of 116 patients underwent cardiopulmonary exercise testing (CPX) at discharge. Analysis of the association between 6MWT and CPX in these 25 patients using the Spearman’s rank correlation coefficient revealed no significant correlation with peak VO$_2$ ($r=0.383$, $P=0.059$), which is strongly related to prognosis. The small sample size and the fact that 6MWT and CPX were not performed on the same day in our study might have led to results different from those of previous studies. Further studies with a larger number of participants and controlled conditions are needed.

### Table 2. Odds ratios of factors related to hospital readmission by logistic regression analysis

|                        | Univariate model |          | Multivariate model |          |
|------------------------|------------------|----------|--------------------|----------|
|                        | OR               | 95% CI   | P Value            | OR       | 95% CI   | P Value |
| Age                    | 1.020            | 0.973–1.070 | 0.413              |          |          |         |
| Male sex               | 0.918            | 0.363–2.324 | 0.857              |          |          |         |
| BMI                    | 1.018            | 0.896–1.157 | 0.786              |          |          |         |
| Hospitalization duration| 1.055            | 0.998–1.115 | 0.058              |          |          |         |
| NYHA class             | 2.763            | 1.288–5.931 | 0.009*             | 3.157    | 1.328–7.504 | 0.009* |
| Cause of HF            | 0.249            | 0.076–0.821 | 0.022              |          |          |         |
| Type of HF             | 2.722            | 0.987–7.507 | 0.053              |          |          |         |
| Hypertension           | 2.327            | 0.903–5.994 | 0.080              |          |          |         |
| Dyslipidemia           | 3.589            | 0.990–13.015 | 0.052              |          |          |         |
| Diabetes mellitus      | 1.214            | 0.451–3.271 | 0.701              |          |          |         |
| Chronic kidney disease | 0.255            | 0.084–0.775 | 0.016              |          |          |         |
| Total protein          | 1.031            | 0.470–2.261 | 0.939              |          |          |         |
| Serum albumin          | 0.606            | 0.221–1.660 | 0.330              |          |          |         |
| BUN                    | 1.065            | 1.018–1.114 | 0.007*             | 1.071    | 1.020–1.125 | 0.006* |
| Serum creatine         | 1.137            | 0.634–2.037 | 0.667              |          |          |         |
| eGFR                   | 0.968            | 0.966–0.992 | 0.008*             | 0.961    | 0.934–0.989 | 0.006* |
| Hemoglobin             | 0.758            | 0.566–1.015 | 0.063              |          |          |         |
| Serum sodium           | 0.871            | 0.738–1.028 | 0.102              |          |          |         |
| LVEF                   | 0.976            | 0.943–1.010 | 0.162              |          |          |         |
| ACEI/ARB               | 0.839            | 0.213–3.305 | 0.802              |          |          |         |
| β-blockers             | 1.712            | 0.460–6.369 | 0.428              |          |          |         |
| Diuretics              | 17.706           | 2.287–137.086 | 0.006*            | 21.324   | 2.655–171.245 | 0.004* |
| Statins                | 0.265            | 0.101–0.693 | 0.007*             | 0.273    | 0.103–0.724 | 0.009* |
| Outpatient CR          | 0.482            | 0.185–1.257 | 0.135              |          |          |         |
| 6MWT                   | 0.993            | 0.988–0.997 | 0.003*             | 0.990    | 0.985–0.996 | 0.003* |
| Knee extension strength| 0.136            | 0.001–14.266 | 0.401              |          |          |         |
| Grip strength          | 0.967            | 0.916–1.022 | 0.232              |          |          |         |
| One-leg standing test  | 0.972            | 0.945–1.001 | 0.054              |          |          |         |
| 30-second chair stand test | 0.884         | 0.789–0.991 | 0.035              |          |          |         |
| Functional reach test  | 0.962            | 0.898–1.030 | 0.265              |          |          |         |
| Barthel index          | 0.945            | 0.854–1.045 | 0.268              |          |          |         |

Age and sex were included in the multivariate logistic model. *P <0.01.
Recent studies have reported that comorbid sarcopenia and frailty in patients with HF significantly worsen the prognosis.\(^{8,47}\) In this study, the evaluations of walking speed and skeletal muscle mass necessary for diagnosing sarcopenia and frailty were not conducted. Therefore, the rates of sarcopenia and frailty in this study were unknown. Sarcopenia and frailty might be responsible for the lower knee extension strength in both groups than in healthy age-matched controls.\(^{48}\) Yamada et al.\(^{27}\) reported that 6MWT <300 m is the cut-off value for frailty in patients with HF. The cut-off value of this study was higher than that reported by Yamada et al. This result might be explained by the targeting of patients with mild to moderate HF in this study. Investigating whether the 6MWT is useful for predicting readmission in HF patients with sarcopenia and frailty is necessary in the future.

Interestingly, the 1-year non-readmission rate of patients unable to walk 200 m independently was the lowest in this study. According to the latest diagnostic criteria for sarcopenia by the European Working Group on Sarcopenia in Older People 2, severe sarcopenia should be considered when it is difficult for patients to complete the 400-m test or it takes more than 6 min to complete the test.\(^{49}\) Comorbid sarcopenia and frailty in patients with HF can greatly worsen the prognosis, suggesting that the gait test is important to

| Table 3. Receiver operating characteristic curve data for physical function |
|---------------------------------------------------------------|
| **Cut-off** | **Sensitivity%** | **Specificity%** | **AUC** | **95% CI** | **P Value** |
|------------|----------------|----------------|---------|------------|-------------|
| 6MWT (m)   | 382.5          | 66.3           | 68.2    | 0.696      | 0.565–0.828 | 0.004*      |
| Knee extension strength (kgf/kg) | 0.23          | 58.7           | 59.1    | 0.579      | 0.447–0.711 | 0.251       |
| Grip strength (kg) | 21.5          | 56.5           | 54.5    | 0.593      | 0.459–0.728 | 0.175       |
| One-leg standing test (s) | 7.5           | 64.1           | 63.6    | 0.660      | 0.534–0.786 | 0.020*      |
| 30-Second standing test (times) | 13.5          | 54.3           | 59.1    | 0.645      | 0.523–0.766 | 0.036*      |
| Functional reach test (cm) | 33.0          | 54.3           | 54.5    | 0.593      | 0.459–0.728 | 0.175       |
| Barthel index (points) | 97.5          | 77.2           | 36.4    | 0.569      | 0.431–0.708 | 0.313       |

*P <0.05.

**Fig. 1.** Kaplan-Meier analysis of readmission within 1 year based on walking capacity. 6MWT=6-minute walk test.
identify sarcopenia patients at high risk for HF readmission. This study has several limitations. First, this was a single-center study with a small sample size; moreover, the patients in this study may not reflect the general HF population. In terms of the clinical characteristics of this study cohort, the CKD rate was significantly higher in the non-readmission group, despite renal function being lower in the readmission group. Kidney disease is a poor prognostic factor in patients with HF.50) Because of the small number of readmission events in this study, logistic regression analysis could not adjust for other potential confounders, including CKD. Second, this was a retrospective study, and various types of information were missing, such as data on brain natriuretic peptide (BNP), N-terminal pro-BNP, and physical activity levels. The knee extension strength was corrected using body weight only, but the leg length was not taken into account. Third, this study excluded patients who were unable to perform evaluations of physical function at discharge because of severe HF, musculoskeletal diseases, or neuromuscular diseases. Therefore, the results of this study may be applicable only to patients with mild to moderate HF. Nonetheless, the Kaplan-Meier curve analysis revealed that the non-readmission rate of patients unable to walk 200 m independently was significantly low. This finding suggests that the walk test may be useful for predicting HF readmission regardless of the severity of HF.

**CONCLUSION**

This study demonstrated that physical function, particularly the 6MWT distance at discharge, is a predictor of HF readmission within 1 year. The cut-off value of the 6MWT distance for predicting HF readmission within 1 year was 382.5 m. Furthermore, the 1-year non-readmission rate of patients unable to walk 200 m independently was the lowest in this study. The 6MWT is a safe and simple measurement and can be applied widely for the evaluation of physical therapy and prognostic prediction in clinical settings. The results of this study may help to reduce the burden on patients and medical staff. Further studies with larger samples are needed to confirm the results of this study.

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**CONFLICTS OF INTEREST**

There are no conflicts of interest directly relevant to the content of this article.

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