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ORIGINAL ARTICLE

The impact of cardiac rehabilitation for older adults with heart failure who underwent invasive cardiac treatment eligible for long-term care needs certification: A retrospective cohort study

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Abstract

Background: This study aimed to assess the usefulness of cardiac rehabilitation (CR) for older adults with heart failure (HF) who need nursing care and investigate the effect of CR on cognitive function (CF) and basic activities of daily living (BADL).

Methods: This was a retrospective cohort study. The study included older adults with HF eligible for long-term care insurance in fiscal year 2014 (FY2014) as the baseline and followed them up until March 2018. Patients were divided into two groups, CR (+) and CR (−), and the changes in their CF and BADL scores over time for 3 years were investigated.

Results: Of the 765 patients included in the study, 36.5% performed CR. BADL scores in the CR (+) and CR (−) groups (mean (SE)) were 5.81 (0.26) vs. 5.87 (0.20) in FY2014, 5.6 (0.28) vs. 5.92 (0.21) in FY2015, 5.72 (0.31) vs. 6.15 (0.22) in FY2016, and 5.64 (0.33) vs. 6.40 (0.25) in FY2017, respectively. BADL scores worsened over time in the CR (−) group but had a trend to inhibit decline in the CR (+) group, and a significant difference was observed between both groups ($p = 0.04$). Multivariate analysis showed a significant difference in CR as a factor suppressing ADL decline after 1 year (adjusted odds ratios: 0.54, 95% confidence intervals: 0.36–0.82; $p = 0.004$). However, no significant difference in the CF scores was observed.

Conclusion: CR for older adults with HF eligible for long-term care needs certification does not affect CF and may suppress ADL decline.

KEYWORDS
activities of daily living, cardiac rehabilitation, database study, heart failure, long-term care insurance

1 | INTRODUCTION

Japan has the highest proportion of people aged 65 years or older globally, and the number of patients with heart failure (HF) in Japan is increasing over time with aging.[1] The number of invasive cardiac treatments such as emergency percutaneous coronary intervention (PCI), coronary artery bypass grafting (CABG), and valve surgery is also increasing with aging, and almost all types of heart diseases after invasive cardiac treatment may lead to HF.[2,3] Many patients with HF are older adults, and their activities of daily living (ADL) tend to decrease due to age-related degenerative and disuse changes and cognitive decline.[2–4]

The medical care system in Japan is the universal health insurance system that guarantees all citizens public medical insurance, and the long-term care insurance system is one of the self-reliance support systems for older adults.[5] With the increase in the number of older adults with HF, the number of those eligible for long-term care insurance is expected to increase. Therefore, it is necessary to provide comprehensive and efficient care by combining medical care with long-term care to deal with the HF pandemic, which is a challenge in a super-aging society.

Cardiac rehabilitation (CR) for patients with HF proved to be useful not only for facilitating early ambulation and hospital discharge and preventing rehospitalization but also for managing HF diseases and improving exercise tolerability and quality of life (QOL).[6] Early intervention with rehabilitation is useful for older adults, prevents frailty, and significantly improves physical functioning.[7,8] CR encourages early ambulation and may prevent adverse effects such as physical and cognitive decline caused by overstaying in bed. However, there are few reports of the usefulness of CR for older adults with HF aged 75 years or older, especially for those who require assistance with ADL such as household chores or physical ADL, to receive long-term care needs certification. To our knowledge, no previous research has investigated systematically, analyzed, and reported the effect of CR in older adults with HF eligible for long-term care needs certification. Therefore, this study aimed to investigate trends in functional prognosis after CR in older adults with HF eligible for long-term care needs certification and the impact of CR on cognitive function (CF) and ADL.

2 | METHODS

2.1 | Study design and data source

This was a retrospective cohort study from a combined medical and nursing claims database. Yokohama City is a municipality with the largest population in Japan after the special district of Tokyo. It has the largest population aged over 65 in Japan.[9] Therefore, the healthcare database of Yokohama City (Yokohama Original Medical Database (YoMDB)) was used to assess the usefulness of CR for older adults with HF eligible for long-term care needs certification. YoMDB is a large medical claims database that includes residents of Yokohama City with the following three insurance types: National Health Insurance, Medical Care System for Older Senior Treatment, and Public Assistance. This database, built by Yokohama City, was approved by the Information Disclosure and Personal Information Protection Review Board based on the Yokohama City Ordinance. It can be used only by administrative officers from departments overseeing medical care. This database includes 68.3% of Yokohama City residents aged 65–69 years, 84.1% of residents aged 70–74 years, 99.7% of residents aged 75–79 years, and 98.6% of residents aged >80 years. Hence, it has strong characteristics for older adults and is an especially reliable database for those aged >75 years.[10] Complications were identified according to the International Classification of Diseases, 10th Revision (ICD-10), whereas medical practices were identified based on Health Insurance Claims Data.

2.2 | Study participants

Patients who were diagnosed with HF (ICD-10 codes I50.0, I50.1, I50.9, I11.0, I13.0, and I13.2) based on YoMDB's medical claims between April 2014 and March 2015 (the fiscal year 2014 (FY2014), baseline period) and underwent invasive cardiac treatment, such as PCI, CABG, and valve surgery, during the baseline period were evaluated (Appendix A). Of these patients, those certified for long-term care needs in the baseline period were included in this analysis (Figure 1). Complications were determined based on the claims data before or during FY2014 and medical practices such as invasive cardiac treatment and intensive care unit/high care unit/coronary care unit (ICU/HCU/CCU) management were extracted based on the claims data during FY2014. Patients who underwent CR in the month of the invasive cardiac treatment or the following month during the baseline period were selected as the CR-conducted group (CR (+) group). To establish the CR (−) group comprising participants without a series of claims related to CR during the follow-up period, we excluded those who had made such claims from FY2015 to FY2017, except for FY2014, from the CR (−) group. CF and basic ability to perform basic activities of daily living (BADL) items were obtained and evaluated. Since YoMDB does not include information on the Barthel index, we selected 12 items, including transfer, moving, dietary intake, urination, defecation, oral cleanliness, body washing (bathing), face washing, hairdressing, wearing a jacket, wearing pants, and clipping nails, evaluated in "Assistance" in the long-term care certification information as BADL.[11] CF and BADL were scored based on the following definitions. The scores in the baseline period were compared with 1 year later (April 2015–March 2016, FY2015), 2 years later (April 2016–March 2017, FY2016), and 3 years later (April 2017–March 2018, FY2017), respectively. The long-term changes in each score of CF and BADL from FY2014 to FY2017 were compared between the CR (+) and CR (−) groups to verify the usefulness of CR. Data, including "Not described items related to CF and BADL in the long-term care certification information during the follow-up period," "Death by the previous year," and "No certification of long-term care needs," were handled as missing values and excluded from the analysis.

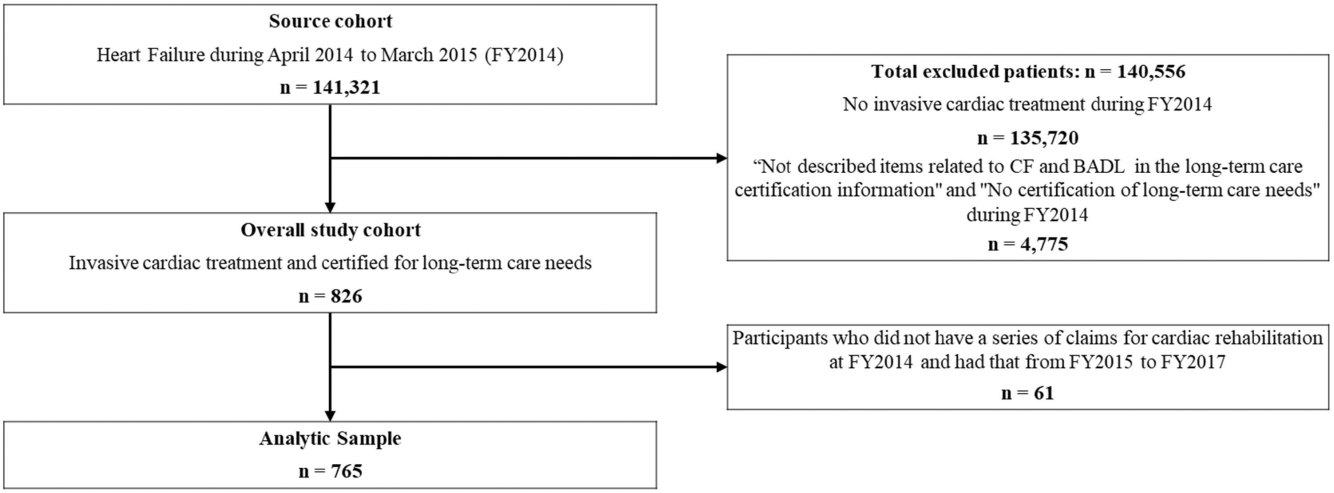

FIGURE 1 Study participants.

2.3 | Definition of CF and BADL scores

One of the tools used for measuring cognitive function is the Cognitive Performance Scale (CPS), with studies confirming a moderate correlation between the mentioned scale and the MMSE.[12] Regarding three items of CF related to CPS on the certification survey[13] in the long-term care needs, that is, "short-term memory," "cognitive ability," and "communication ability," short-term memory was scored with 0 points (no problem)/1 point (with the problem), cognitive ability with 0 points (independence)/1 point (with the problem), and communication ability with 0 points (able to communicate)/1 point (with the problem). The total CF score ranged from 0 points to 3 points, and 3 was considered the worst score. Regarding the BADL, the 12 items were evaluated and scored by classifying them into "not assisted" without caregiver's assistance (0 points) and "assisted" with some assistance (1 point). The total BADL score ranged from 0 points to 12 points, and 12 was considered the worst score. For each item, if the score was decreased or unchanged by 1 point or more compared to the FY2014 score, it was handled as "improvement," and if the score was increased by 1 point or more, it was handled as "deterioration."

2.4 | Statistical analysis

Demographic data, medical history, and questionnaire scores were summarized using descriptive statistics. The CF and BADL score data were not normally distributed, so nonparametric statistical analysis was performed. To assess the effectiveness of CR, we analyzed changes in CF and BADL scores over time at baseline and after 1, 2, and 3 years. Differences in the CF and BADL scores between the baseline and each FY were analyzed using the Friedman test, a nonparametric alternative to the repeated measures analysis of variance, with a p-value of ≤0.05 considered significant. Logistic regression models were used to assess the association between potential risk factors for functional decline and the likelihood of the CF and BADL scores decline in follow-ups. During multivariable analyses, to control for the effect of confounder effects, adjusted odds ratios (aORs) and 95% confidence intervals (CIs) were adjusted for age, gender, stroke history, diabetes mellitus, ICU/HCU/CCU management, and each baseline scores. Candidate variables to be included in the logistic model were selected based on biological and clinical plausibility as a risk factor for functional decline. To evaluate differences in outcomes between the baseline and each FY, respectively, and to identify factors independently associated with the risk of the CF and BADL scores changes, a multivariable logistic model was then computed, including necessary variables associated with the outcome, and a parsimonious predictive model was obtained. All the analyses were performed using R software version 4.2.0 (R Core Team, 2019).

3 | RESULTS

Of the patients with a diagnosis of HF in the medical claims for FY2014 and undergoing invasive cardiac treatment, 765 received a long-term care needs certification. The patients were followed up until FY2017. Baseline characteristics are shown in Table 1. Of the 765 patients, 401 were men (52.4%), and 364 were women (47.6%). The mean age was 79.9 years, with 150 patients (19.6%) aged ≤74 years, 416 patients (54.4%) aged 75–84 years, and 199 patients (26.0%) aged ≥85 years; 279 patients (36.5%) underwent CR. Major complications were hypertension in 744 patients (97.3%), dyslipidemia in 469 patients (61.3%), diabetes mellitus in 388 patients (50.7%), and atrial fibrillation in 259 patients (33.9%). The most common invasive cardiac treatment was PCI in 545 patients (71.2%). The CR implementation rates were 25.3% (38/150 patients) in patients aged ≤74 years, 40.4% (168/416 patients) in patients aged 75–84 years, 36.7% (73/199 patients) in patients aged ≥85 years, 30.7% (123/401 patients) in men, and 42.9% (156/364 patients) in women. In addition, regarding complications and invasive cardiac treatment, 32.4% (140/432 patients) had acute coronary syndrome (ACS), 22.8% (124/545 patients) had PCI, 77.6% (52/67 patients) had aortic surgery, 70.7% (87/123 patients) had valve surgery, and

TABLE 1 Characteristics of the study participants.

	Total sample *n* (%)	CR implementation		*p*-value
		Yes (%)	No (%)	
Total number of participants	765	279 (36.5)	486 (63.5)	
Age (mean)	79.9			
≤74 years	150 (19.6)	38 (13.6)	112 (23.1)	0.005
75–84 years	416 (54.4)	168 (60.2)	248 (51.0)	
≥85 years	199 (26.0)	73 (26.2)	126 (25.9)	
Sex				
Men	401 (52.4)	123 (44.1)	278 (57.2)	<0.001
Women	364 (47.6)	156 (55.9)	208 (42.8)	
Complications				
Acute coronary syndrome	432 (56.5)	140 (50.2)	292 (60.1)	0.008
Acute aortic dissection	105 (13.7)	67 (24.0)	38 (7.8)	<0.001
Stroke	232 (30.3)	77 (27.6)	155 (22.6)	0.59
Pneumonia	171 (22.4)	63 (22.6)	108 (22.2)	0.91
Malignant tumor	162 (21.2)	54 (19.4)	108 (22.2)	0.35
Diabetes mellitus	388 (50.7)	141 (50.5)	247 (50.8)	0.94
Atrial fibrillation	259 (33.9)	111 (39.8)	148 (30.5)	0.009
Hypertension	744 (97.3)	273 (97.9)	471 (96.9)	0.45
Dementia	129 (16.9)	40 (14.3)	89 (18.3)	0.158
Chronic kidney disease	182 (23.8)	68 (24.4)	114 (23.5)	0.77
Dyslipidemia	469 (61.3)	176 (63.1)	293 (60.3)	0.45
Invasive cardiac treatment				
CABG	71 (9.3)	43 (15.4)	28 (5.8)	<0.001
IABP	80 (10.5)	44 (15.8)	36 (7.4)	<0.001
Aortic surgery	67 (8.8)	52 (18.6)	15 (3.1)	<0.001
Valve surgery	123 (16.1)	87 (31.2)	36 (7.4)	<0.001
PCI	545 (71.2)	124 (44.4)	421 (86.6)	<0.001
ICU/HCU/CCU management				
Yes	478 (62.5)	227 (81.4)	251 (51.7)	<0.001
CF score (mean, SE)	1.11 (0.05)	1.09 (0.08)	1.12 (0.06)	0.85
BADL score (mean, SE)	5.84 (0.16)	5.81 (0.26)	5.87 (0.20)	0.85

Abbreviations: BADL, basic activities of daily living; CABG, coronary artery bypass grafting; CF, cognitive function; CR, cardiac rehabilitation; IABP, intra-aortic balloon pump; ICU/HCU/CCU, intensive care unit/high care unit/coronary care unit; PCI, percutaneous coronary intervention; SE, standard error.

60.6% (43/71 patients) had CABG. The CF rate for postoperative ICU/HCU/CCU management was 47.5% (227/478 patients). No difference in the CR rates depending on the degree of caregiving in CF and BADL was observed.

In baselines, CF scores were (mean [standard error {SE}]) 1.11 (0.05) and BADL scores for 12 items were 5.84 (0.16). CF and BADL scores in the CR (+) and CR (−) groups were 1.09 (0.08) and 1.12 (0.06) for CF and 5.81 (0.26), and 5.87 (0.20) for BADL, respectively. Changes in the mean scores for CF and BADL at baseline (FY2014) and after 1 year (FY2015), 2 years (FY2016), and 3 years (FY2017) are shown in Figure 2A,B. The number of dropouts in each year for the CR (+) and CR (−) groups was 60 and 87 in FY2015, 39 and 52 in FY2016, and 23 and 52 in FY2017, respectively, and excluded from the analysis. The reason for dropping out was missing data, including "Not described items related to CF and BADL in the long-term care certification information during the follow-up period," "Death by the previous year," and others. CF scores in the CR (+) and CR (−) groups were 1.2 (0.09) vs. 1.27 (0.06) in FY2015, 1.34 (0.10) vs. 1.38 (0.07) in FY2016, and 1.34 (0.11) vs. 1.53 (0.08) in FY2017, respectively. BADL scores in the CR (+) and CR (−) groups were 5.6 (0.28) vs. 5.92 (0.21) in FY2015, 5.72 (0.31) vs. 6.15 (0.22) in FY2016, and 5.64 (0.33) vs. 6.4 (0.25) in FY2017, respectively. The CF scores worsened over time in both groups. However, no significant difference was observed. As for the BADL score, worsening was over time in the CR (−) group but had a trend to inhibit the decline in the CR (+)

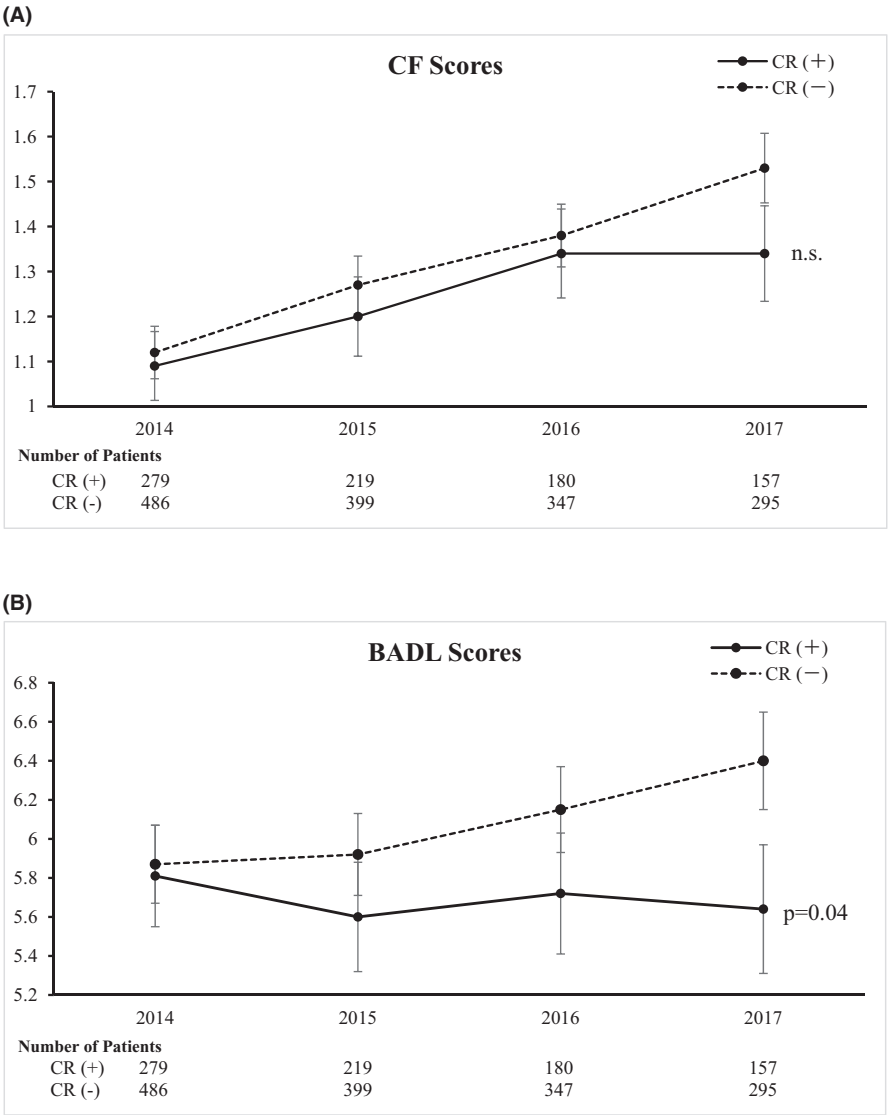

FIGURE 2 (A) Changes in the mean cognitive function (CF) scores in the cardiac rehabilitation (CR) (+) and CR (−) groups at baseline (FY2014) and after 1 year (FY2015), 2 years (FY2016), and 3 years (FY2017). The higher score is worse. (B) Changes in the mean basic activities of daily living (BADL) scores in the cardiac rehabilitation (CR) (+) and CR (−) groups at baseline (FY2014) and after 1 year (FY2015), 2 years (FY2016), and 3 years (FY2017). The higher score is worse.

group. A significant difference in yearly changes in BADL scores was observed between the CR (+) and CR (−) groups ($p = 0.04$). Continuous CR implementation among the CR (+) group in each year was 37/219 (16.9%) in FY2015, 12/180 (6.7%) in FY2016, and 8/157 (5.1%) in FY2017, respectively.

The ORs and 95% CIs from logistic regressions that adjust for the patient and setting characteristics described above are shown in Table 2. There was a significant difference in CR in comparison with baseline and 1 year later as a factor suppressing ADL decline (aOR: 0.54, 95% CI: 0.36–0.82, p = 0.004) but not in comparison with 2 and 3 years later. However, for the CF score, there was no significant difference in CR in comparison with any other period.

4 | DISCUSSION

To the best of our knowledge, this is the first study to investigate trends in the use of CR in older adults with HF who received long-term care needs certification by analyzing a highly exhaustive real-world database in Japan. Although they received long-term care needs certification, CR implementation rates among them showed a trend similar to the implementation rates for whole patients with HF in Japan. The results of following CF and BADL scores longitudinally showed a trend to maintain BADL scores in the CR (+) group, which was statistically significant. However, CF scores declined over time regardless of the presence or absence of CR implementation, and no significant difference was observed between the two groups.

The study results revealed that the participation rates showed the same tendency as in a previous study in Japan, which reported that the participation rates of CR for hospitalized patients with HF were approximately 33%.[14] However, the participation rates of CR for patients with ACS showed a lower tendency than those in a previous study in Japan.[15] The participation rates of CR after PCI have been increasing each year; that is, 52% of patients with ACS who underwent the primary PCI performed CR during hospitalization, and 15% of the stable coronary artery disease patients who underwent the primary PCI performed CR during hospitalization in Japan.[15] Implementation of CR for patients with ACS may improve

TABLE 2 Association between cardiac rehabilitation and cognitive function and basic activities of daily living.

	FY2014 vs. FY2015				FY2014 vs. FY2016				FY2014 vs. FY2017			
	Univariable		Multivariable		Univariable		Multivariable		Univariable		Multivariable	
	OR (95% CI)	*p*-value	aOR (95% CI)	*p*-value	OR (95% CI)	*p*-value	aOR (95% CI)	*p*-value	OR (95% CI)	*p*-value	aOR (95% CI)	*p*-value
CF scores												
Age (per 1 year)	1.04 (1.00–1.07)	0.040	1.06 (1.02–1.11)	0.001	1.03 (1.00–1.06)	0.096	1.05 (1.02–1.09)	0.003	1.02 (0.99–1.05)	0.124	1.05 (1.01–1.09)	0.008
Sex (Men)	1.23 (0.80–1.90)	0.34	1.31 (0.82–2.08)	0.25	1.05 (0.71–1.55)	0.82	1.12 (0.73–1.72)	0.61	1.11 (0.74–1.66)	0.61	1.17 (0.75–1.81)	0.49
CR	1.07 (0.68–1.70)	0.76	1.12 (0.68–1.86)	0.65	1.04 (0.69–1.58)	0.85	1.07 (0.67–1.73)	0.77	0.83 (0.54–1.27)	0.40	0.78 (0.48–1.27)	0.32
Stroke	1.18 (0.75–1.88)	0.47	1.29 (0.80–2.08)	0.31	0.81 (0.53–1.24)	0.33	0.83 (0.53–1.31)	0.42	0.81 (0.53–1.25)	0.34	0.86 (0.54–1.36)	0.52
DM	0.94 (0.61–1.45)	0.78	1.01 (0.64–1.60)	0.97	1.01 (0.68–1.49)	0.98	1.16 (0.76–1.78)	0.50	0.77 (0.51–1.15)	0.20	0.88 (0.57–1.36)	0.56
ICU/HCU/CCU management	0.76 (0.49–1.17)	0.21	0.73 (0.45–1.19)	0.21	0.81 (0.54–1.20)	0.29	0.74 (0.47–1.17)	0.20	0.93 (0.62–1.40)	0.73	0.95 (0.60–1.52)	0.84
Baseline CF score	0.55 (0.44–0.69)	<0.001	0.51 (0.40–0.65)	<0.001	0.52 (0.42–0.64)	<0.001	0.48 (0.39–0.60)	<0.001	0.53 (0.44–0.65)	<0.001	0.50 (0.41–0.62)	<0.001
BADL scores												
Age (per 1 year)	1.02 (0.99–1.05)	0.129	1.03 (1.01–1.06)	0.021	0.94 (0.91–0.97)	<0.001	0.95 (0.92–0.98)	0.001	1.02 (0.99–1.06)	0.21	1.03 (0.99–1.07)	0.20
Sex (Men)	1.41 (0.98–2.02)	0.063	1.33 (0.89–1.99)	0.161	2.17 (1.40–3.37)	<0.001	1.95 (1.24–3.09)	0.004	1.00 (0.59–1.70)	1.00	0.99 (0.57–1.73)	0.97
CR	0.54 (0.38–0.78)	0.001	0.54 (0.36–0.82)	0.004	0.86 (0.54–1.36)	0.51	0.97 (0.59–1.61)	0.91	0.91 (0.53–1.59)	0.75	0.91 (0.50–1.67)	0.76
Stroke	0.84 (0.57–1.23)	0.36	0.90 (0.60–1.37)	0.63	0.86 (0.55–1.37)	0.54	0.80 (0.50–1.30)	0.37	1.02 (0.58–1.79)	0.96	1.05 (0.59–1.85)	0.88
DM	0.87 (0.61–1.24)	0.45	0.93 (0.63–1.39)	0.73	1.67 (1.08–2.57)	0.022	1.43 (0.91–2.26)	0.120	0.95 (0.56–1.61)	0.84	1.03 (0.59–1.80)	0.91
ICU/HCU/CCU management	0.53 (0.36–0.77)	0.001	0.72 (0.47–1.11)	0.132	1.18 (0.76–1.83)	0.47	1.26 (0.78–2.06)	0.35	0.80 (0.46–1.40)	0.44	0.88 (0.48–1.60)	0.67
Baseline BADL score	0.84 (0.80–0.88)	<0.001	0.83 (0.79–0.87)	<0.001	1.01 (0.96–1.06)	0.85	1.01 (0.96–1.06)	0.72	0.95 (0.89–1.01)	0.12	0.95 (0.89–1.01)	0.13

Abbreviations: aOR, adjusted odds ratio; BADL, basic activities of daily living; CF, cognitive function; CI, confidence interval; CR, cardiac rehabilitation; DM, diabetes mellitus; ICU/HCU/CCU, intensive care unit/high care unit/coronary care unit; OR, odds ratio.

exercise tolerability and QOL and reduce recurrence, coronary risk factors, cardiovascular death, and mortality; thus, it is recommended as Class I by various guidelines.[16–18] In addition, acute phase CR in invasive cardiac treatment proved to be effective in various aspects such as postoperative physical function, exercise tolerability, QOL, ICU length of stay, rehospitalization rate, and medical costs.[19]

The number of CR implementations and registered instructors of CR in Japan is increasing yearly,[20] but the implementation rates of CR are not so high compared with those in other countries,[21] and the overall CR implementation rates in this study were not very high either. This may be due to several factors that hinder CR implementation, such as shortage of manpower, equipment, social awareness, and economic incentives for CR.[22] Although there was not enough evidence previously about such patients complicated by frailty and sarcopenia, evidence related to the prognostic improvement of CR in frailty and HF with preserved ejection fraction has gradually been provided.[8] Because many older adults with HF and long-term care needs may have a high rate of comorbid frailty, sarcopenia, and cognitive impairment, insufficient evidence of the effectiveness of CR for such patients at that time may be a factor in the low-CR implementation rates in this study. However, our findings showed a statistically significant suppressing ADL decline over time in the CR (+) group compared with the CR (−) group. Even older adults with HF eligible for long-term care needs certification should not hesitate to actively participate in CR. Implementing CR in the month invasive cardiac treatment was conducted or the following month may suppress the long-term decline in ADLs. ADL decline is known as a key factor in defining the prognosis of patients with HF,[23] so it may be important to conduct CR in older adults with HF as well, from the perspective of improving the prognosis as one of the measures for HF pandemic in a super-aging society. Conversely, the presence or absence of CR implementation did not affect CF. However, a previous study reported that continuous exercise therapy is effective in suppressing CF decline.[24] It is important to detect cognitive decline early in older adults with HF and prevent adverse effects. This may affect medication and lifestyle management and suppress disease progression and recurrence. It is necessary to consider the impact of continuous CR on CF in future studies.

Furthermore, it is desirable to start a comprehensive CR program for patients with HF in a stable phase, continue outpatient CR, and continue disease management after hospital discharge.[25] However, continuous CR for outpatients in this study was rarely performed, similar to that in a study in Japan.[14] Although implementing continuous CR on an outpatient basis is important, the main problem is insufficient referrals for outpatient CR in the first place. Therefore, there is a demand for the construction of two-way cooperation between acute and convalescent hospitals that use efficient medical resources based on a community-based integrated care system. Moreover, promoting the maintenance phase CR and considering the use of CR provided in convalescent wards are necessary.[26] Cardiac telerehabilitation (CTR) can increase the low-CR implementation rates in Japan. In fact, Japan has sufficient potential to benefit from CTR given its developed infrastructure for telemedicine.[27] To ensure the effective use of CTR, there is a need to improve digital technology, accumulate evidence, and expand the insurance system, as well as enhance the collaboration within good multidisciplinary teams for CTR, including cardiologists, paramedics, and general physicians. According to the results, because the CR was associated with suppressing BADL score decline only after 1 year, long-term ADL improvement may require not only continuous CR but also an exercise routine supported by a primary care doctor. Further discussion is needed to determine whether the suppression of ADL decline and prognostic improvement effects can be obtained by increasing the CR implementation rates and establishing a medical system that enables continuous CR for outpatients. Additionally, it is important to perform CR effectively to have an implementation system for CR at each medical facility, family support, patient motivation, and so on. However, in this study, we have not been able to sufficiently verify their influence, so this possibility will be the subject of further studies.

4.1 | Limitations

Although the results showed the importance of CR for older adults with HF eligible for long-term care needs certification in an aging society, this study has some limitations. First, YoMDB has the advantage of covering data on medical and long-term care needs certification for the entire older population in Yokohama City. However, because this study uses only claim data and there is no data about cardiac function, such as echocardiography data or laboratory data, HF severity cannot be evaluated. Moreover, the detailed program of CR is not evaluated and there may be variability regarding the validation of CR quality, CR continuity, and educational intervention in each facility. Second, because the characteristics and prognosis of each invasive cardiac treatment and cardiac disease related to the etiology of heart failure are different, further analysis based on basic cardiac information, such as arrhythmia, cardiomyopathy, and valvular disease, is needed to obtain more reliable results. Third, because our study focused on the impacts of rehabilitation after invasive cardiac treatment, a large number of patients were excluded from the analysis, thus the risk of selection bias. Furthermore, as the data of some patients who did not show any changes in CF and BADL have been excluded from the analytic sample, the study results could have led to an overestimation. Fourth, to improve the accuracy and value of the study results, we should have separately analyzed the CR for inpatient and outpatient settings. Fifth, frailty and sarcopenia were not identified, and the Mini-Mental State Examination and Barthel index, which are known as universal indices for evaluating CF and ADL, were also missing in the YoMDB. The BADL score is limited to the 12 items evaluated based on long-term care certification information. Therefore, it is difficult to state that the entire ADL is evaluated. Finally, other unadjusted or unmeasured confounding factors, such as the level of care need, the details of

CR, nutritional status, locomotor training, and various rehabilitation measures using long-term care insurance services, might have affected the outcomes.

5 | CONCLUSIONS

CR for older adults with HF eligible for long-term care needs certification does not affect CF and may contribute to the suppression of ADL decline in the short term.

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CONFLICT OF INTEREST STATEMENT

The authors declare no Conflict of Interests for this article. Masaru Asai is employed by Pfizer Japan, Inc. However, Pfizer Japan Inc. did not fund and had no involvement in conducting this study. Dr. Yuji Nishizaki is an associate editor of the *Journal of General and Family Medicine*.

DATA AVAILABILITY STATEMENT

This large medical invoice database can be accessed only by administrative officers from departments in charge of medical care.

ETHICS STATEMENT

This study protocol was approved by the Research Ethics Review Committee of Juntendo University (approval number: 2019204) and the Institutional Ethics Committee of Yokohama City University School of Medicine (B180700010). This study was conducted in compliance with the provisions of the Declaration of Helsinki (as revised in Brazil 2013).

PATIENT CONSENT STATEMENT

This study used an opt-out system at the official website of Yokohama City instead of obtaining informed consent. The Information Disclosure and Personal Information Protection Review Board, based on the Yokohama City Ordinance, waived informed consent.

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REFERENCES

1. Cardiovascular Disease Medical Treatment Survey Report. JROAD (The Japanese Registry of All cardiac and vascular Diseases). 2021 [Cited 10 July 2023]. Available from: https://www.j-circ.or.jp/jittai_chosa/media/jittai_chosa2020web_1.pdf
2. Tsutsui H, Tsuchihashi-Makaya M, Kinugawa S, Goto D, Takeshita A, JCARE-CARD Investigators. Clinical characteristics and outcome of hospitalized patients with heart failure in Japan. Circ J. 2006;70:1617–23.
3. Shiba N, Watanabe J, Shinozaki T, Koseki Y, Sakuma M, Kagaya Y, et al. Analysis of chronic heart failure registry in the Tohoku district: third-year follow-up. Circ J. 2004;68:427–34.
4. Ide T, Kaku H, Matsushima S, Tohyama T, Enzan N, Funakoshi K, et al. Clinical characteristics and outcomes of hospitalized patients with heart failure from the large-scale Japanese registry of acute decompensated heart failure (JROADHF). Circ J. 2021;85:1438–50.
5. Ministry of Health, Labour and Welfare. Outline of Long-Term Care Insurance System.
6. Long L, Mordi IR, Bridges C, Sagar VA, Davies EJ, Coats AJ, et al. Exercise-based cardiac rehabilitation for adults with heart failure. Cochrane Database Syst Rev. 2019;1:CD003331.
7. Kitzman DW, Whellan DJ, Duncan P, Pastva AM, Mentz RJ, Reeves GR, et al. Physical rehabilitation for older patients hospitalized for heart failure. N Engl J Med. 2021;385:203–16.
8. Kamiya K, Sato Y, Takahashi T, Tsuchihashi-Makaya M, Kotooka N, Ikegame T, et al. Multidisciplinary cardiac rehabilitation and long-term prognosis in patients with heart failure. Circ Heart Fail. 2020;13:e006798.
9. Ministry of Health, Labour and Welfare, [Cited 10 July 2023]. Available from: https://www.kaigokensaku.mhlw.go.jp/chiiki-houkatsu/kibobetsu.html
10. Suzuki Y, Dohmae S, Ohyama K, Nishino H, Fujii H, Shuri J. Demand for home medical care will continue to increase in the next decades: an analysis from the Yokohama original medical database (YoMDB). Geriatr Gerontol Int. 2018;18:1578–9.
11. Ministry of Health, Labour and Welfare. Certified Investigator Textbook. 2009. Revised Edition, [Cited 10 July 2023]. Available from: https://www.mhlw.go.jp/content/000819416.pdf
12. Büla CJ, Wietlisbach V. Use of the cognitive performance scale (CPS) to detect cognitive impairment in the acute care setting: concurrent and predictive validity. Brain Res Bull. 2009;80:173–8.
13. Ministry of Health, Labour and Welfare. Family doctor's report, [Cited 10 July 2023]. Available from: https://www.mhlw.go.jp/content/12301000/000331631.pdf
14. Kamiya K, Yamamoto T, Tsuchihashi-Makaya M, Ikegame T, Takahashi T, Sato Y, et al. Nationwide survey of multidisciplinary care and cardiac rehabilitation for patients with heart failure in Japan – an analysis of the AMED-CHF study. Circ J. 2019;83:1546–52.
15. Kanaoka K, Soeda T, Terasaki S, Nishioka Y, Myojin T, Kubo S, et al. Current status and effect of outpatient cardiac rehabilitation after percutaneous coronary intervention in Japan. Circ Rep. 2021;3:122–30.
16. Amsterdam EA, Wenger NK, Brindis RG, Casey DE, Ganiats TG, Holmes DR, et al. 2014 AHA/ACC guideline for the management of patients with non-ST-elevation acute coronary syndromes: a report of the American College of Cardiology/American Heart Association task force on practice guidelines. J Am Coll Cardiol. 2014;64:e139–228.
17. Ibanez B, James S, Agewall S, Antunes MJ, Bucciarelli-Ducci C, Bueno H, et al. 2017 ESC guidelines for the management of acute myocardial infarction in patients presenting with ST-segment elevation: the task force for the management of acute myocardial infarction in patients presenting with ST-segment elevation of the European Society of Cardiology (ESC). Eur Heart J. 2018;39:119–77.
18. Kimura K, Kimura T, Ishihara M, Nakagawa Y, Nakao K, Miyauchi K, et al. JCS 2018 guideline on diagnosis and treatment of acute coronary syndrome. Circ J. 2019;83:1085–196.
19. Hillis LD, Smith PK, Anderson JL, Bittl JA, Bridges CR, Byrne JG, et al. 2011 ACCF/AHA guideline for coronary artery bypass graft surgery. A report of the American College of Cardiology Foundation/American Heart Association task force on practice guidelines.

Developed in collaboration with the American Association for Thoracic Surgery, Society of Cardiovascular Anesthesiologists, and Society of Thoracic Surgeons. J Am Coll Cardiol. 2011;58:e123–210.
20. The Japanese Association of Cardiac Rehabilitation (JACR). Association Summary in Japanese. [Cited 10 July 2023]. Available from: https://www.jacr.jp/about/summary/
21. Goto Y. Current state of cardiac rehabilitation in Japan. Prog Cardiovasc Dis. 2014;56:557–62.
22. Goto Y. Current status and future perspective of cardiac rehabilitation in Japan. J Jpn Coron Assoc. 2015;21:58–66.
23. Tohyama T, Ide T, Ikeda M, Kaku H, Enzan N, Matsushima S, et al. Machine learning-based model for predicting 1 year mortality of hospitalized patients with heart failure. ESC Heart Fail. 2021;8:4077–85.
24. Erickson KI, Voss MW, Prakash RS, Basak C, Szabo A, Chaddock L, et al. Exercise training increases size of hippocampus and improves memory. Proc Natl Acad Sci U S A. 2011;108:3017–22.
25. Tsutsui H, Isobe M, Ito H, Okumura K, Ono M, Kitakaze M, et al. JCS 2017/JHFS 2017 guideline on diagnosis and treatment of acute and chronic heart failure – digest version. Circ J. 2019;83:2084–184.
26. Makita S, Yasu T, Akashi JY, Adachi H, Izawa H, Ishihara S, et al. JCS/JACR 2021 guideline on rehabilitation in patients with cardiovascular disease. Circ J. 2023;87:155–235.
27. Kaihara T, Scherrenberg M, Falter M, Frederix I, Itoh H, Makita S, et al. Cardiac telerehabilitation — a solution for cardiovascular Care in Japan. Circ Rep. 2021;3:733–6.

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APPENDIX A

PROCEDURE CODES FOR INVASIVE CARDIAC TREATMENT.

Invasive cardiac treatment	Procedure codes
Aortic surgery (e.g., thoracic endovascular aortic repair, aortic aneurysm surgery)	K560-00, K560-02, K561-00
Coronary artery bypass grafting	K552-00, K552-02, K937-00
Intra-aortic balloon pump	K600-00
Percutaneous cardiopulmonary support	K601-00, K602-00
Percutaneous coronary intervention	K546-00, K547-00, K548-00, K549-00, K550-00, K550-02
Pulmonary artery surgery	K570-00, K570-02
Surgical ventricular restoration	K553-02
Valve surgery (e.g., transcatheter aortic valve implantation, tricuspid surgery, percutaneous mitral valve repair)	K554-00, K555-00, K555-02, K556-02, K557-02, K557-03, K559-02, K560-00, K569-00