



# Impact of the COVID-19 pandemic on phase 2 cardiac rehabilitation patients in Japan

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## Abstract

This study aimed to clarify the effects of the interruption of cardiac rehabilitation (CR) and refraining from going outside due to the COVID-19 pandemic on hemodynamic response and rating of perceived exertion (RPE) during exercise including differences by age in phase 2 CR outpatients. Among 76 outpatients participating in consecutive phase 2 CR in both periods from March to April and June to July 2020, which were before and after CR interruption, respectively, at Sanda City Hospital were enrolled. The inclusion criterion was outpatients whose CR was interrupted due to COVID-19. We compared the data of hemodynamic response and RPE during exercise on the last day before interruption and the first day after interruption when aerobic exercise was performed at the same exercise intensity in the <75 years group and ≥75 years group. Fifty-three patients were enrolled in the final analysis. Post-CR interruption, peak heart rate increased significantly ( $p=0.009$ ) in the <75 years group, whereas in the ≥75 years group, weight and body mass index decreased significantly ( $p=0.009$ , 0.011, respectively) and Borg scale scores for both dyspnea and lower extremities fatigue worsened significantly (both,  $p<0.001$ ). CR interruption and refraining from going outside due to the COVID-19 pandemic affected the hemodynamic response, RPE during exercise and body weight in phase 2 CR outpatients. In particular, patients aged ≥75 years appeared to be placed at an increased risk of frailty.

**Keywords** COVID-19 · Phase 2 cardiac rehabilitation patient · Hemodynamic response · Rating of perceived exertion

## Introduction

Coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) may increase mortality in affected patients with cardiovascular disease (CVD) [1]. In addition, because it spreads from person to person via close contact, the delivery of cardiac

rehabilitation (CR) is currently being hampered in many countries due to the COVID-19 pandemic [2, 3].

The Japanese Association of Cardiac Rehabilitation announced guidelines to consider discontinuing phase 2 outpatient CR, particularly group exercise therapy, in endemic areas of COVID-19 in Japan. Outpatient phase 2 CR was actually interrupted in many areas, especially during the April–May state-of-emergency declaration. Furthermore, the government requested citizens to refrain from going outside. It is thus expected that physical activity performed during phase 2 CR has decreased drastically. The problem of decreased physical activity due to COVID-19 is a global concern [4–7]. In fact, the introduction of a quarantine due to COVID-19 had a detrimental effect on the level of habitual physical activity performed by heart failure patients [8]. Reduced physical activity significantly lowers peak oxygen uptake ( $VO_2$ ) [9], which is the gold standard indicator of cardiorespiratory fitness, and its decrease indicates a poor prognosis in patients with CVD [10, 11]. As well, the effects of COVID-19, such as weight gain, also increase the risk of

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heart disease [12]. As a result of staying at home, physical activity and exercise levels drastically decline while dietary habits remain unchanged or fail to offset this inactivity, thus producing a positive energy balance [13]. In fact, it was observed in northern Italy that obese outpatients gained significant weight 1 month after the beginning of the lockdown period there [14]. However, as it has also been reported that prolonged sedentary bouts were associated with worse frailty in CVD patients, it is possible that CVD patients may lose weight [15].

Thus, there is concern that interruption of CR or refraining from going outside may adversely affect the physical and cardiopulmonary function of outpatients participating in phase 2 CR. However, what effect it would have on hemodynamic response during exercise is unknown. It is important to clarify the effects of the interruption of phase 2 CR and refraining from going outside on patients and to predict their condition at the resumption of CR and use this knowledge for exercise therapy and patient education. Above all, it is also useful as a measure against a recurrence of the pandemic.

Therefore, in this study, we hypothesized that the physical function of phase 2 CR patients would decline due to the pandemic of COVID-19. However, the change in these functions might differ depending on age and should be considered separately in patients < 75 years old and those  $\geq$  75 years old [16]. Hence, the aim of this study was to clarify the effects of the COVID-19 pandemic on hemodynamic response, rating of perceived exertion (RPE) during exercise and body weight including differences by age in outpatients in whom phase 2 CR was interrupted due to the pandemic.

## Methods

### Study design and patients

This was a retrospective, single-center, observational study. Seventy-six outpatients who participated in consecutive phase 2 CR in the two periods from March to April and June to July 2020, which were before and after interruption, respectively, of CR at Sanda City Hospital were enrolled. The inclusion criterion was outpatients whose CR was interrupted due to COVID-19, and the exclusion criteria were patients with a change in exercise intensity and medications or who experienced cardiovascular events during the period of interruption. We compared the data obtained on the last day before interruption of CR with that obtained on the first day after resumption of CR when aerobic exercise was performed at the same exercise intensity. Patients' characteristics and clinical parameters including age, sex, body mass index, left

ventricular ejection fraction, medical history, medications, CR interruption period, exercise intensity and parameters of usual aerobic exercise in CR were obtained from the electronic medical records by two physical therapists. A nurse questioned each of the patients to determine if they had decreased their level of exercise during the interruption of CR. The present study complied with the Declaration of Helsinki with respect to investigation in humans and was approved by the Ethics Committee of Sanda City Hospital (approval no. 2020006). Written informed consent was obtained from each patient.

### CR exercise program

Aerobic exercise was performed based on the Guidelines for Rehabilitation in Patients with Cardiovascular Disease (JCS 2012) [17]. Exercise intensity is prescribed according to exercise at anaerobic threshold level, 40–60% of the peak  $\dot{V}O_2$ , 40–60% of maximum heart rate (HR) or a Borg scale score of 12–13 or resting HR + 30 bpm (resting HR + 20 bpm for patients receiving  $\beta$ -blockers). Some patients underwent high-intensity interval training at 85% peak HR. Aerobic exercise was performed on a cycle ergometer or uphill treadmill, and the exercise time was 20 min. All patients exercised while wearing a surgical or cloth mask.

### Hemodynamic assessment during CR

The variables chosen for monitoring were HR and systolic blood pressure (SBP) as indicators of hemodynamic response. We measured the resting (Rest) and peak (Peak) HRs. For SBP, we measured the resting (Rest) SBP and the immediate post-exercise (Post) SBP. HR (Rest) was measured from lead II of a 3-lead electrocardiogram recorded using the limb lead method during exercise. All SBPs were measured with the patient in the sitting position. These measurements were obtained by one physical therapist and two nurses.

### Rating of perceived exertion (RPE) assessment during CR

The RPEs for dyspnea and lower extremity fatigue were assessed using the Borg scale score [18] 10 min after the start of exercise and just before cooldown. The Borg scale score has been suggested to be a valid tool for monitoring and prescribing exercise intensity independent of sex, age, exercise modality, physical activity level and coronary artery disease status [19]. The same assessment panel was used for all patients to ensure minimal interindividual variability.

## Statistical analysis

Continuous variables are expressed as medians and interquartile ranges, categorical variables are expressed as percentages (numbers). Continuous variables were compared using the Mann–Whitney  $U$  test and categorical data were compared using the  $\chi^2$  test or the Fisher exact test, as appropriate. The Wilcoxon rank sum test was used to compare pre- and post-CR interruption. A  $p$  value of  $<0.05$  was considered to indicate statistical significance. All statistical analyses were performed with EZR (Saitama Medical Center, Jichi Medical University, Saitama, Japan), which is a graphical user interface for R (The R Foundation for Statistical Computing, Vienna, Austria). More precisely, it is a modified version of R commander designed to add statistical functions frequently used in biostatistics.

## Results

Seventy-six outpatients participated in phase 2 CR in the two periods from March to April and June to July 2020. Of them, 62 patients with interruption of CR were enrolled, with the exception of 14 patients who continued CR in individual 1:1 CR sessions. Patients with a change in exercise intensity ( $n=6$ ) or medications ( $n=2$ ) and patients admitted to hospital due to heart failure ( $n=1$ ) were excluded. Thus, 53 patients were included in the final analysis (Fig. 1). Table 1 presents their clinical characteristics. There were no significant differences between the patients in the  $<75$  years group and the  $\geq 75$  years group in sex, left ventricular ejection fraction, medical history, medications, CR interruption period, decreased exercise during CR interruption and exercise intensity at CR. Body weight, hemodynamics and RPE pre- and post-CR interruption can be compared in Table 2. Among the hemodynamic variables

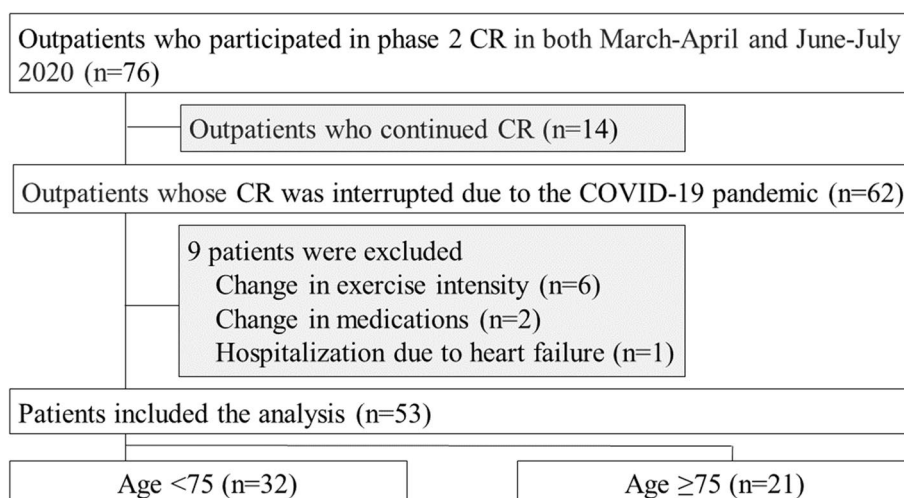
measured post-CR interruption, HR (Peak) showed significant increases ( $p=0.001$ ) in all patients. The peak Borg scale scores for both dyspnea and lower extremity fatigue also showed significant increases ( $p=0.001$ ,  $0.003$ , respectively). Following post-CR interruption, the  $<75$  years group experienced a significant increase in HR (Peak) ( $p=0.009$ ), whereas the  $\geq 75$  years group experienced significant decreases in weight ( $p=0.009$ ) and BMI ( $p=0.011$ ) and worsening of the Borg scale scores for both dyspnea and lower extremities fatigue (both,  $p<0.001$ ).

## Discussion

Interruption of CR and refraining from going outside due to the COVID-19 pandemic affected the hemodynamic response, rating of perceived exertion during exercise and body weight in outpatients who were participating in phase 2 CR. Further, the impact of these findings was different between the group aged  $<75$  and that  $\geq 75$  years of age. The results in all patients showed that post-CR interruption, HR increased and Borg scale score worsened when assessed at the same intensity of exercise as that performed pre-CR interruption. However, age-specific examinations revealed that the findings in the outpatients under 75 years old and those over 75 years old were completely different.

Only HR (Peak) changed in the group under 75 years of age, whereas weight loss and worsening of RPE were observed in the group over 75 years old. The most likely cause of these changes are the decreases in exercise and physical activity. There have been reports of decreased physical activity due to the COVID-19 pandemic [5–7, 20]; and in the present study as well, 86.8% of patients responded that the amount of exercise they performed was reduced. A decrease in physical activity has various adverse effects. Cessation of regular exercise rapidly abolished all training

**Fig. 1** Patient flow through the study. CR: cardiac rehabilitation; COVID-19: Coronavirus disease 2019



**Table 1** Clinical characteristics of the patients

	All patients, <i>n</i> = 53	Age < 75 years, <i>n</i> = 32	Age ≥ 75 years, <i>n</i> = 21	$\chi^2$ value	<i>p</i> value
Age (years)	73 (67–76)	68 (61–72)	76 (76–80)		<0.001
Male, <i>n</i> (%)	41 (77.4)	23 (71.9)	18 (85.7)		0.323
LVEF (%)	58.6 (46.9–65.6)	58.9 (48.6–65.6)	56.1 (45.2–65.5)		0.547
Medical history					
Previous MI, <i>n</i> (%)	24 (45.3)	16 (50.0)	8 (38.1)	0.324	0.596
Angina pectoris, <i>n</i> (%)	13 (24.5)	6 (18.8)	7 (33.3)	0.775	0.379
CHF, <i>n</i> (%)	23 (43.4)	15 (46.9)	8 (38.1)	0.121	0.728
Hypertension, <i>n</i> (%)	35 (66.0)	23 (71.9)	12 (57.1)	0.658	0.417
Diabetes mellitus, <i>n</i> (%)	27 (50.9)	18 (56.2)	9 (42.9)	0.453	0.501
Medications					
Beta blocker, <i>n</i> (%)	42 (79.3)	28 (87.5)	14 (66.7)		0.090
ACE-I/ARB, <i>n</i> (%)	36 (67.3)	25 (78.1)	11 (52.4)	2.766	0.101
CCB, <i>n</i> (%)	20 (37.7)	13 (40.6)	7 (33.3)	0.060	0.806
Diuretic, <i>n</i> (%)	22 (41.5)	14 (43.8)	8 (38.1)	0.015	0.902
Period of CR interruption (days)	77 (63–92)	70 (59.6–98)	84 (70.0–91)		0.334
Decreased exercise during CR interruption, <i>n</i> (%)	46 (86.8)	27 (84.4)	19 (90.5)		0.690
Exercise intensity (watts) <sup>a</sup>	50 (40–60)	50 (40–60)	50 (40–60)		0.869

Values shown are *n* (%), medians (interquartile ranges)

ACE-I angiotensin-converting enzyme inhibitor, ARB angiotensin II receptor blocker, CCB calcium channel blocker, CHF congestive heart failure, CR cardiac rehabilitation, LVEF left ventricular ejection fraction, MI myocardial infarction

<sup>a</sup>Only cycle ergometer (*n* = 49)

**Table 2** Patients' body weight, hemodynamics and RPE pre- and post-CR interruption

	All patients, <i>n</i> = 53			Age < 75 years, <i>n</i> = 32			Age ≥ 75 years, <i>n</i> = 21		
	Pre-interruption	Post-interruption	<i>p</i> value	Pre-interruption	Post-interruption	<i>p</i> value	Pre-interruption	Post-interruption	<i>p</i> value
Body weight (kg)	65.1 (58.6–71.4)	65.3 (57.9–71.5)	0.359	67.2 (59.8–74.0)	66.6 (59.2–73.3)	0.254	61.7 (57.4–69.4)	60.4 (56.0–67.9)	0.009
BMI (kg/m <sup>2</sup> )	23.4 (22.1–25.5)	23.4 (21.6–25.4)	0.239	23.7 (21.6–26.4)	23.8 (22.5–26.4)	0.367	23.3 (22.1–24.9)	22.9 (22.2–24.4)	0.011
Rest HR (bpm)	64 (61–71)	67 (60–76)	0.114	64 (58.8–70.3)	65.5 (58.8–75.3)	0.143	64 (62.0–72.0)	71.0 (60.0–77.0)	0.324
Peak HR (bpm)	101 (91–109)	104 (92–112)	0.001	101.5 (90.8–109.3)	104.5 (90–112)	0.009	100.0 (92.0–108.0)	103.0 (95–110)	0.052
Rest SBP (mmHg)	130 (116–140)	126 (113–143)	0.690	131 (121.5–140)	124.5 (112.5–143)	0.281	128 (115.0–137)	131.0 (115.0–147)	0.538
Post-exercise SBP (mmHg)	127 (110–139)	125 (114–142)	0.495	121.5 (105.8–145.0)	124.5 (112.8–142)	0.104	128.0 (112.0–145.0)	126.0 (116.0–137)	0.554
Peak Borg scale: dyspnea	12 (12–13)	12.5 (12–13)	0.001	12 (12.0–13)	12 (12.0–13)	0.260	12 (11.5–12)	13 (12.5–13)	<0.001
Peak Borg scale: lower extremities	12 (12–13)	12.5 (12–13)	0.003	12 (12–13)	12.5 (12.0–13)	0.440	12 (12–12)	13.0 (12.5–13)	<0.001

CR cardiac rehabilitation; BMI body mass index; HR heart rate; RPE rating of perceived exertion; SBP systolic blood pressure. Values shown are medians (interquartile ranges)

adaptations for cardiorespiratory fitness and cardiometabolic health within one month after cessation [21]. Even if exercise is not completely interrupted, reductions of more than one- to two-thirds in training frequency and/or duration reduce exercise capacity. Furthermore, despite maintaining training frequency and the duration of exercise, a decrease of one- to two-thirds in exercise training intensity reduces both  $\text{VO}_{2\text{max}}$  and submaximal endurance time [22]. There are several reports of an increase in HR occurring at the same exercise intensity after exercise interruption in subjects <75 years of age. Increases in HR that occur with tapering, reduced training and complete cessation of training may reflexively arise to counteract the reduction in ventricular filling and maximal stroke volume that occurs when the volume of blood decreases [22, 23]. However, there was no significant increase in HR (Peak) in our  $\geq 75$  years group. In this regard, the decline in  $\beta$ -receptor density with age may be due to a slowing heart rate response at moderate exercise intensity with low catecholamine levels [24].

In contrast, the  $\geq 75$  years group experienced weight loss and deterioration of the Borg scale score at the same exercise intensity, suggesting concern that these are indications of an increased risk of frailty. Weight loss is a typical characteristic of frailty [25], and one of the causes of weight loss is a decrease in skeletal muscle mass [26]. Physical inactivity and a sedentary life lead to specific alterations in the skeletal muscle that contribute to insulin resistance, impairment of oxidative function and rapid hypotrophy [27]. These changes in the muscle pathophysiology usually take place after a couple of weeks, but they can also occur more quickly in older people [27]. The changes in the Borg scale score in the  $\geq 75$  years group was greater than the value reported as the minimally clinically important difference in both dyspnea and lower extremity fatigue [28]. The worsening of the Borg Scale score for lower extremity fatigue may reflect this decrease in skeletal muscle mass and may also indicate a decrease in skeletal muscle metabolism [29]. Furthermore, as the Borg scale score is useful as a marker of impending decline in mobility-intact older adults [30], and its decrease is a serious issue with regard to the prognosis of patients with cardiac disease. The  $\geq 75$  years group had performed independent activities of daily living and was able to exercise at 50 W, the same level as that in the <75 years group. The percentage of the outpatients who reported that their physical activity decreased was also not significantly different from that of the <75 years group. Nonetheless, the factors leading to this result were the functional reserve capacity of the heart and skeletal muscle decline with age [31]. Several studies have proved that the losses in strength and function due to detraining are higher in the elderly than in younger people [27, 32].

Currently, a system to provide phase 2 CR during the COVID-19 pandemic is under consideration [2, 3]. The

present study suggested that more careful intervention is needed with a focus on the decline of physical function, especially in patients aged 75 years and older.

## Study limitations

Several limitations of this study need to be acknowledged. First, this was a single-center, retrospective study comprising a very small number of patients. Second, detailed physical activity and exercise during CR interruption were not investigated. As we were not able to actually measure skeletal muscle mass and  $\text{VO}_2$ , quantitative evaluation will be required in a future study. Third, Table 1 shows that the 77.4% of patients were men and the authors found no difference between men and women in the present study. However, it is well known that women were less likely to perform physical activity and that sarcopenia strongly affected postmenopausal women [33]. Thus, gender-related differences, it needs to do more research work in the future trial. Finally, the parameters obtained from usual exercise therapy (HR and SBP) may reduce the overall quality of the present assessment. However, in the current situation where exercise tests in hospitals are difficult to perform due to the COVID-19 pandemic, these parameters measured during usual exercise may be useful as the easiest and safest indicators that can be obtained.

## Conclusion

Interruption of CR and refraining from going outside due to the COVID-19 pandemic affected the hemodynamic response, rating of perceived exertion during exercise and body weight in outpatients participating in phase 2 CR. The effect was particularly large on patients aged 75 and over and appeared to place these patients at an increased risk of frailty.

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## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

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