

Home-based exercise is associated with improved cardiac functional performance in patients after acute myocardial infarction

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Abstract

Objective: To evaluate the effects of home-based exercise and physical activity on cardiac functional performance in patients after acute myocardial infarction (MI) during the coronavirus disease 2019 (COVID-19) pandemic.

Methods: This retrospective study enrolled patients that received treatment of acute ST-segment elevation MI between and were followed-up 6 months later. The patients were divided into physically active and inactive groups based on their levels of home exercise after hospital discharge.

Results: A total of 78 patients were enrolled in the study: 32 were physically active and 46 were physically inactive. The baseline characteristics were comparable between the two groups. At the 6-month visit, left ventricular ejection fraction and six-minute walking test (6MWT) were significantly improved while the proportion of patients with a New York Heart Association (NYHA) functional III classification was decreased in the active patients, whereas these parameters were not significantly changed in the inactive patients. In addition, the 6MWT was greater while the proportion of patients with an NYHA III classification was lower in the active group than the inactive group at the 6-month visit.

Conclusion: Maintaining physical activity at home was associated with improved cardiac functional performance in patients after acute MI during the COVID-19 pandemic.

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Introduction

Medical treatment of acute myocardial infarction (MI) has been substantially improved over the last two decades. In addition to pharmacological interventions, exercise training is a well-established adjuvant treatment to achieve improved long-term outcomes in patients with acute MI.¹ Accumulating evidence shows that exercise training after acute MI can significantly improve exercise capacity, the quality of life and survival rates with a reduced incidence of non-fatal re-infarction.¹ Moreover, early exercise training right after hospital discharge has been proven safe and feasible in patients with acute MI.²

In many countries, exercise training has been incorporated into cardiovascular rehabilitation programmes as an important component. For example, the American College of Cardiology (ACC)/American Heart Association (AHA) guidelines for the management of patients with acute MI recommend that the post-infarction patients should engage in a minimum of 20 minutes of exercise at the level of brisk walking at least three times a week.^{3,4} In China, cardiac rehabilitation programmes and facilities are not widely available, especially in less developed areas. Patient education and exercise suggestions are routinely provided to patients with acute MI before discharge. Fast walking and square dancing are the most popular types of outdoor exercise among middle-aged Chinese men and women, respectively. Square dancing, also known as plaza

dancing, is an exercise routine performed to music in squares, plazas or neighbourhood parks. Either fast walking or square dancing meets the intensity of exercise recommended by the ACC/AHA guidelines.

Outdoor exercise routines were unfortunately interrupted by the coronavirus disease 2019 (COVID-19) pandemic, during which cardiac rehabilitation was solely dependent on home-based exercise. Many patients were not well prepared to adapt to home-based exercise. This study aimed to retrospectively investigate the effects of home-based exercise during the COVID-19 pandemic on cardiac functional performance in patients with acute MI.

Patients and methods**Study population**

This retrospective study enrolled consecutive patients that received treatment of acute ST-segment elevation MI in the Department of Health Care, Xinjiang Military General Hospital, Urumchi, Xinjiang, China between September 2019 and December 2019 and were followed-up at 6 months between March 2020 and June 2020. The patients were diagnosed with acute ST-segment elevation MI according to guidelines^{3,5,6} and were treated with primary or rescue percutaneous coronary intervention (PCI) or thrombolysis.

The protocol of this study was approved by the Ethics Committee and Institutional Review Board of the Xinjiang Military

General Hospital (no. 83111-47). All participants provided written informed consent.

Baseline characteristics

Baseline characteristics including age, sex, body mass index (BMI), and a history of smoking, hypertension, diabetes mellitus and dyslipidaemia, were collected from a record review. Information regarding the location (anteroseptal, inferior, or lateral) of the MI and the treatment strategies (primary PCI, rescue PCI or thrombolysis) were also collected.

Follow-up at 6 months

Patients with acute MI were routinely followed-up in the Department of Health Care at 6 months after hospital discharge. During the follow-up visit, information regarding home-based physical exercise, including frequency, duration and types of exercise, during the COVID-19 pandemic when outdoor fitness was interrupted, was reported by the patients. Fast walk was defined as walking at 100 to 129 steps per min. The patients who engaged in equal to or more than 20 min of exercise at least three times a week were considered as physically active,⁴ while the patients who engaged in less exercise were considered as physically inactive.

Assessment of cardiac functional performance

On the day before hospital discharge and at the 6-month follow-up visit, cardiac functional performance of the patients was evaluated by assessing the New York Heart Association (NYHA) functional classifications, six-minute walking test (6MWT) and left ventricular ejection fraction (EF). The NYHA functional classifications were assessed by a cardiologist (L.M.). The standard 6MWT was performed on a measured

indoor track.⁷ Two-dimensional echocardiography was used to determine left ventricular EF by the planimetric method using a Philips iE33 xMATRIX ultrasound system (Philips Medical Systems, Andover, MA, USA).

Statistical analyses

All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 21.0 (IBM Corp., Armonk, NY, USA). The distribution of continuous variables was analysed using the Kolmogorov–Smirnov test of normality. Normally distributed continuous data are presented as mean \pm SD and compared between the two groups using Student's *t*-test. Continuous data that were not normally distributed are presented as median and interquartile range (IQR; presented as the difference between Q3 and Q1) and compared between the two groups using Mann–Whitney *U*-test. Categorical data are presented as *n* of patients (%) and were compared using Fisher's exact test. A *P*-value < 0.05 was considered statistically significant.

Results

The present study included 78 patients that received PCI or thrombolytic treatment for acute ST-segment elevation MI and completed a 6-month post-discharge follow-up visit. The patients were divided into physically active and inactive groups based on their self-reported physical exercise during the COVID-19 pandemic. The active group consisted of 32 patients that engaged in a minimum of 20 min of exercise at least three times a week, while the inactive group consisted of 46 patients that did less exercise. The baseline characteristics including age, sex, BMI, and history of smoking, hypertension, diabetes mellitus and dyslipidaemia were similar between the active and inactive

groups (Table 1). The locations of acute MI and the therapeutic strategies were also comparable between the two groups. Most of the patients in both groups (37 of 46 [80.4%] in the inactive group versus 29 of 32 [90.6%] in the active group) received primary PCI treatment.

The patients in the active group engaged in a median (IQR) of 30.0 (25.0) min of exercise per day on a median (IQR) of 4.0 (1.8) days per week, while the patients in the inactive group only exercised for a median (IQR) of 0 (11.3) min on a median (IQR) of 0 (2.0) days in a week ($P < 0.01$ for both comparisons) (Table 2). The majority of the patients in both groups chose fast walking and dancing as their home-based exercise during the COVID-19 pandemic.

Table 1. Demographic and clinical characteristics of patients ($n = 78$) enrolled in a study to investigate the effects of home-based exercise and physical activity on cardiac functional performance after acute myocardial infarction (AMI) during the COVID-19 global pandemic stratified according to levels of physical activity.

	Inactive group $n = 46$	Active group $n = 32$
Age, years	57.6 ± 8.5	59.3 ± 7.2
Male	28 (60.9)	18 (56.3)
Smoking	17 (37.0)	7 (21.9)
BMI, kg/m ²	25.7 ± 4.0	24.8 ± 3.1
Hypertension	29 (63.0)	20 (62.5)
Diabetes mellitus	15 (32.6)	9 (28.1)
Dyslipidaemia	18 (39.1)	11 (34.4)
Anteroseptal AMI	30 (65.2)	19 (59.4)
Inferior AMI	15 (32.6)	13 (40.6)
Lateral AMI	1 (2.2)	0 (0.0)
Primary PCI	37 (80.4)	29 (90.6)
Rescue PCI	8 (17.4)	3 (9.4)
Thrombolysis	1 (2.2)	0 (0.0)

Data presented as mean ± SD or n of patients (%). No significant between-group differences ($P \geq 0.05$); continuous data were compared using Student's t -test and categorical data were compared using Fisher's exact test. BMI, body mass index; PCI, percutaneous coronary intervention.

The pre-discharge cardiovascular functional performance in terms of left ventricular EF, 6MWT and NYHA functional classifications was comparable in patients between the active and inactive groups (Table 3). At the 6-month post-discharge visit, the mean ± SD EF was slightly but significantly improved in patients in the active group ($48.7 \pm 7.1\%$ versus $44.7 \pm 6.8\%$, $P < 0.05$), while the mean ± SD EF in the patients in the inactive group was not significantly improved ($45.8 \pm 7.1\%$ versus $43.9 \pm 7.6\%$). However, there was no significant difference in EF between the two groups at the 6-month visit. Similarly, 6MWT was significantly improved in the active group (561.3 ± 77.6 m versus 497.4 ± 76.4 m, $P < 0.01$), but was not improved in the inactive group (526.6 ± 61.4 m versus 498.8 ± 81.6 m). In addition, 6MWT at the 6-month visit was significantly greater in the active group than that in the inactive group ($P = 0.03$). The increases in EF and 6MWT were greater in the active group than the inactive group ($P < 0.05$ for both comparisons). There were significant differences between the two groups at both time-points and between the pre-discharge evaluation and the post-discharge visit in terms of the number and proportion of patients classified as NYHA I and NYHA II. The patients classified as NYHA III in the active group, but not in the inactive group, were less at the 6-month visit than before discharge ($P < 0.05$). The active group had significantly less patients classified as NYHA III than the inactive group at the 6-month visit ($P = 0.03$).

Discussion

This current retrospective study found that active engagement in home-based exercise during the COVID-19 pandemic when outdoor exercise was interrupted was associated with improved cardiac functional performance in patients with acute MI.

Table 2. Comparison of the physical exercise characteristics in patients ($n=78$) enrolled in a study to investigate the effects of home-based exercise and physical activity on cardiac functional performance after acute myocardial infarction during the COVID-19 global pandemic stratified according to levels of physical activity.

	Inactive group $n=46$	Active group $n=32$	Statistical analysis ^a
Frequency, days/week	0.0 (2.0)	4.0 (1.8)	$P < 0.01$
Duration, minutes/day	0.0 (11.3)	30.0 (25.0)	$P < 0.01$
Type of exercise	22	32	
Fast walking	13 (59.1)	19 (59.4)	NS
Dancing	10 (45.5)	12 (37.5)	NS
Yoga	0 (0.0)	3 (9.4)	NS
Tai Chi	1 (4.5)	2 (6.3)	NS

Data presented as median (interquartile range presented as the difference between Q3 and Q1) or n of patients (%).

^aContinuous data that were not normally distributed are presented as median (interquartile range) and were compared using Mann–Whitney U -test and categorical data were compared using Fisher's exact test; NS, no significant between-group difference ($P \geq 0.05$).

Table 3. Cardiovascular and functional performance in patients ($n=78$) enrolled in a study to investigate the effects of home-based exercise and physical activity on cardiac functional performance after acute myocardial infarction during the COVID-19 global pandemic stratified according to levels of physical activity.

	Inactive group $n=46$	Active group $n=32$	Statistical analysis ^a
EF, %			
Baseline	43.9 ± 7.6	44.7 ± 6.8	NS
Follow-up	45.8 ± 7.1	$48.7 \pm 7.1^*$	NS
Changes	2.0 (5.5)	2.5 (4.0)	$P = 0.04$
6MWT, min			
Baseline	498.8 ± 81.6	497.4 ± 76.4	NS
Follow-up	526.6 ± 61.4	$561.3 \pm 77.6^{**}$	$P = 0.03$
Changes	32.5 (104.0)	47.0 (75.0)	$P = 0.02$
NYHA I			
Baseline	6 (13.0)	4 (12.5)	NS
Follow-up	6 (13.0)	8 (25.0)	NS
NYHA II			
Baseline	25 (54.3)	19 (59.4)	NS
Follow-up	28 (60.9)	22 (68.8)	NS
NYHA III			
Baseline	15 (32.6)	9 (28.1)	NS
Follow-up	12 (26.1)	2 (6.3)*	$P = 0.03$

Data presented as mean \pm SD, n of patients (%) or median (interquartile range presented as the difference between Q3 and Q1).

^a P -values are between-group comparisons for baseline, follow-up or the changes. Continuous data were compared using Student's t -test; continuous data that were not normally distributed are presented as median (interquartile range) and were compared using Mann–Whitney U -test; and categorical data were compared using Fisher's exact test; NS, no significant difference ($P \geq 0.05$).

* $P < 0.05$, ** $P < 0.01$ versus baseline within the same group.

EF, ejection fraction; 6MWT, six-minute walk test; NYHA, New York Heart Association classification.

The COVID-19 pandemic has caused significant morbidity and mortality worldwide.⁸ It not only directly leads to illnesses and deaths, but also indirectly causes harmful effects on cardiovascular health of patients via changing their daily life and routines.⁸ The present study is an example that investigated one of the side-effects of the COVID-19 pandemic on patients with coronary artery disease.

The benefits of a physically active lifestyle for cardiovascular health have been well documented.⁹⁻¹¹ Atherosclerotic coronary artery disease is a lifelong process, which progresses from fatty streaks and flow-limiting vascular stenosis to total occlusion of epicardial coronary arteries that clinically manifest as myocardial ischaemia and/or infarction.¹² Most cardiovascular disease-related morbidities and mortalities are attributed to modifiable behaviours such as physical inactivity.¹² Exercise as a critical component of lifestyle modifications is important for both primary and secondary prevention of coronary artery disease.^{13,14} The ACC/AHA guidelines recommend that all patients that have recovered from acute ST-segment elevation MI should be engaged in cardiac rehabilitation or secondary prevention programmes when they are available.^{3,4,15} It has been reported that exercises of greater intensity lead to a better improvement in functional capacity and the quality of life in patients after MI.¹⁶⁻¹⁸ In China, cardiac rehabilitation programmes are only available in 24% of large medical centres according to a previous study¹⁹ and are lacking in underdeveloped areas. Most Chinese patients live in apartments instead of houses and get used to outdoor exercise such as fast walking for men and square dancing for women in their neighbourhood or community. The community-based exercise has been proven to improve the quality of life and cardiac function in patients after MI and PCI procedure.^{20,21}

Unfortunately, community-based outdoor exercise was interrupted by either the stay-home order or by the fear of being outside during the COVID-19 pandemic. Outdoor exercise was entirely shut down roughly from January 2020 to March 2020 in China. There are many obvious barriers to home-based exercise, including lack of resources, equipment or enough space in their apartments. Therefore, the patients after acute MI were unprecedentedly challenged to adhere to home-based exercises during the COVID-19 pandemic, especially from January 2020 to March 2020. The present study demonstrated that adherence to home-based exercises and maintaining physical activity were associated with improved cardiac functional performance in terms of increases in left ventricular EF and 6MWT and a decrease in the NYHA III functional classification. To the best of our knowledge, there is a lack of reports about the side-effects of being physically inactive during the COVID-19 pandemic on cardiovascular health in patients after acute MI.

The present study had several limitations. First, the retrospective study design was a limitation, but it was impossible to perform a prospective study to identify the cardiovascular impact of this unpredictable pandemic. Secondly, the present study was a single-centre analysis with a relatively small number of patients, so it may have less external validity. Thirdly, the levels of physical activity were self-reported by the patients, which could lead to potential reporting bias. In addition, the intensity of the home-based exercises was not quantified. Also, the present study did not compare the levels and type of physical activity between the two groups before the COVID-19 pandemic. Comparison of physical activity during the non-COVID-19 pandemic period could provide useful information regarding the impact of the pandemic on daily exercise routine of the patients.

Despite these limitations, the present study demonstrated for the first time one of the side-effects of the COVID-19 pandemic on cardiovascular health in patients after acute MI, which the physicians should pay close attention to.

In conclusion, engaging in home-based exercises and maintaining physical activity were associated with improved cardiac functional performance in patients after acute MI during the COVID-19 pandemic.


Declaration of conflicting interest

The authors declare that there are no conflicts of interest.

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