

REHABILITATION OF WOMEN WITH A HISTORY OF MYOCARDIAL INFARCT

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Abstract

Objective: To assess the effectiveness of cardiac rehabilitation on physical capacity and heart function in post-myocardial infarction women and to compare it to the results of rehabilitation in a group of post-infarction men.

Methods: The study included 27 women aged between 43 and 75 years (mean age 62 ± 8.51 years) and 34 men between 46 and 74 years of age (mean age 63 ± 8.4 years) who suffered a myocardial infarction, were treated in a hospital, and afterwards participated in cardiac rehabilitation. The following tests were performed prior to and after 24 one-hour sessions of physical training: assessment of the ejection fraction, treadmill MET levels test for the evaluation of effort tolerance, estimation of perceived exertion using the Borg scale, level of heart failure in NYHA classification, intensity of stenocardial pain in CCS, and BMI. The obtained results were compared and analysed using statistical methods.

Results: MET-measured physical capacity increased significantly from 4.30 ± 2.61 to 6.36 ± 2.21 ($P < .001$) in women and from 5.85 ± 2.60 to 8.38 ± 2.57 ($P < .001$) in men. Ejection fraction also increased from $59.69\% \pm 9.07$ to $61.91\% \pm 10.41$ ($P < .05$) in women, and from $54.12\% \pm 10.44$ to $56.09\% \pm 9.64$ ($P < .05$) in men. In both groups, deterioration of heart failure or intensification of stenocardial pain was not observed. In women, the level of perceived exertion scored in the Borg scale decreased from 14.11 ± 1.09 to 13.7 ± 1.14 ($P < .05$). In contrast, no significant changes in the level of perceived exertion were documented in men.

Conclusions: Following cardiac rehabilitation, increased physical capacity and improved left ventricle systolic function was observed in both men and women.

Key words: women, myocardial infarction, cardiac rehabilitation

Introduction

For men and women, ischemic heart disease (IHD) is the most frequent cardiovascular disorder [1,2], and constitutes the cause of approximately 20% of deaths in United States and Europe [3]. The prevalence of IHD increases with age, for women it has risen from 0.1-1% in 45- to 54-year-olds to 10-15% in 65- to 74-year-olds [4]. Increased incidence in women is associated with menopause and the resultant lack of the protective effect of oestrogens. This period is associated with the development of arterial hypertension, lipid metabolic disorders, and diabetes, as well as with reduced physical activity, all representing risk factors of IHD. Moreover, emotional disorders, depressive states, and diminished memory and concentration affect both the course of the disease and its treatment [5].

Despite the dynamic development of diagnostic and therapeutic methods, and the implementation of IHD prevention programs, women participate markedly less often in cardiac rehabilitation than men, although their IHD-specific morbidity risk is higher, [6-8]. It is estimated that 55% of women in Europe will die as a result of cardiovascular disorders; the corresponding fraction for men is 43% [5]. The objective of this study was to analyse the effects of training performed in the course of cardiac rehabilitation program on the overall physical capacity and heart function in women with a history of myocardial infarction.

Methods

The study included a group of 27 women aged 62 ± 8.51 years (ranging from 43 to 75 years of age) and the reference group of 34 men aged 63 ± 8.4 years (ranging from 46 to 74 years of age). All the participants were treated due to myocardial infarct at the cardiology ward and subsequently qualified to the rehabilitation program on outpatient basis. The characteristics of studied groups are summarized in Table 1.

The patients were examined prior to the outpatient cardiac rehabilitation 7-10 days after myocardial infarct. Physical capacity expressed in MET and the level of perceived exertion at peak exercise expressed in the Borg scale were determined during an exercise test. Moreover, the ejection fraction (EF) was determined echocardiographically, the degree of cardiac failure and the severity of coronary symptoms were classified using NYHA and CCS scale, respectively, and body mass index (BMI) was calculated. The level of physical capacity expressed by MET was determined with Quinton Q55 treadmill using modified Bruce protocol. The echocardiographic examination was conducted with Vivid FIDE device. After hospital discharge, the patients were qualified to the outpatient program of cardiac rehabilitation. The average length of the period between myocardial infarct and the beginning of rehabilitation was 16.82 ± 6.34 days.

Table 1. *Characteristics of women and men from studied group*

	In-farct	Treat-ment	Location					Infarct	Ar-terial hy-per-tension	Hy-per-cho-leste-rol-e-mia	Dia-betes	NYHA					CCS					BMI			To-bacco smo-king							
	transmural	non-transmural	conservative	anterior	inferior	lateral	notspecified	mixed	first	consecutive	yes	no	yes	no	yes	no	class I	class II	class III	class IV	no data	class I	class II	class III	class IV	no data	normal (18.5 – 24.9)	overweight (≥25)	obesity (>30)	smokers	non-smokers	
Women (n = 27)	10	17	17	10	3	2	5		24	3	24	3	20	7	5	22	14	10	1	0	2	18	7	0	0	2	3	7	17	7	20	
Men (n = 34)	15	19	21	13	7	14	7	2	4	20	14	22	12	17	17	10	24	23	5	1	0	5	21	5	2	0	6	8	20	6	10	24

The rehabilitation included 24 training sessions consisting of three 60-minute sessions per week. Each session started with general fitness exercises in various positions, representing a 10-15 minute warm-up. Subsequently, aerobic endurance training was performed with dumb-bells (2-4 kg) and medicine balls (2 kg and 3 kg), rowing ergometer, and stepper, as well as interval training on cycle ergometer. The duration of this main phase of training was 25-35 minutes approximately. The relaxation phase (10-15 min) comprised of Schultz's autogenic training. The sessions were characterized by progressive exercise intensity adjusted individually to participants' abilities. Additionally, resistance training was used in case effortlessly performing 15 repetition of 30-50% 1RM (one repetition maximum), with perceived exertion below 14 units in Borg scale. All patients completed the rehabilitation program.

Statistical Analysis

All baseline tests were repeated at the end of the rehabilitation program. The values of pre- and post-training parameters were compared on statistical analysis. The analysis was conducted using STATISTICA package and the results were presented as arithmetic means and standard deviations. The significance of differences in normally distributed variables was veri-

fied with the Student's *t*-test for dependent variables. The results were presented as figures and tables.

Results

Prior to the rehabilitation, the level of physical capacity corresponding to MET ≥ 7 , qualifying the patients to the low-risk group of cardiovascular episodes [9], was documented in 7 women and 16 men, as compared to 15 women and 28 men at the end of the training program. The improvement in physical capacity expressed in MET is summarized in Table 2.

The training-related improvement in MET was documented in 20 women (74.1%) and 27 men (79.4%). No changes of this parameter were observed in 5 women (18.5%) and 7 men (20.6%), and a decrease was shown in two female patients (7.4%).

Prior to the rehabilitation, the peak of MET in women was 4.30 ± 2.61 , as compared to 6.36 ± 2.21 post-rehabilitation level; this difference proved significant on statistical analysis ($P < .001$). Men were characterized by higher mean values of MET: 5.85 ± 2.60 and 8.38 ± 2.57 pre- and post-rehabilitation, respectively. This difference also proved to be statistically significant ($P < .001$; Fig. 1).

The ejection fraction equal to 50% or higher, qualifying to the low-risk group of cardiac episodes

Table 2. *Distribution of physical capacity levels (MET) and ejection fraction (EF) prior to and after rehabilitation*

	Women n=27		Men n=34	
	Prior to rehabilitation	After rehabilitation	Prior to rehabilitation	After rehabilitation
MET ≥ 7	7	15	16	28
MET < 7	20	12	18	6
EF $\geq 50\%$	23	23	24	27
EF $< 50\%$	4	4	10	7

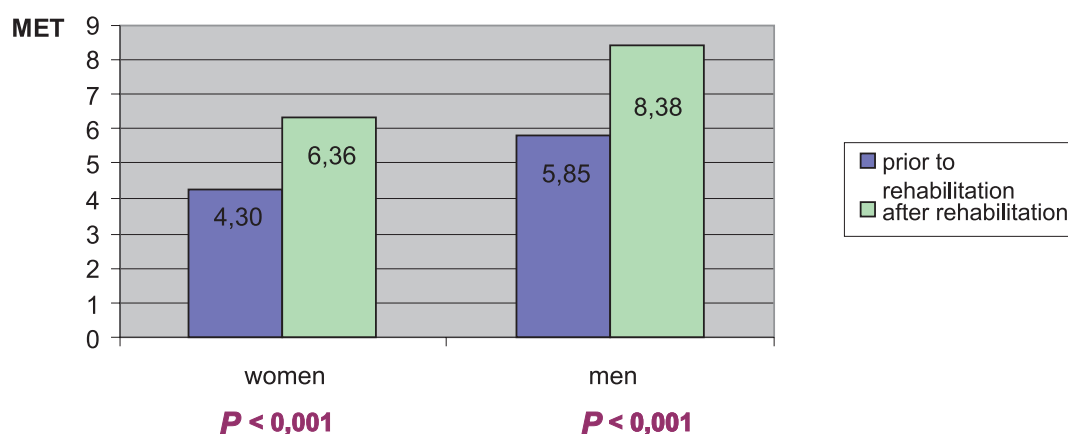


Fig. 1. Peak metabolic equivalents (MET) in women and men prior to and after rehabilitation

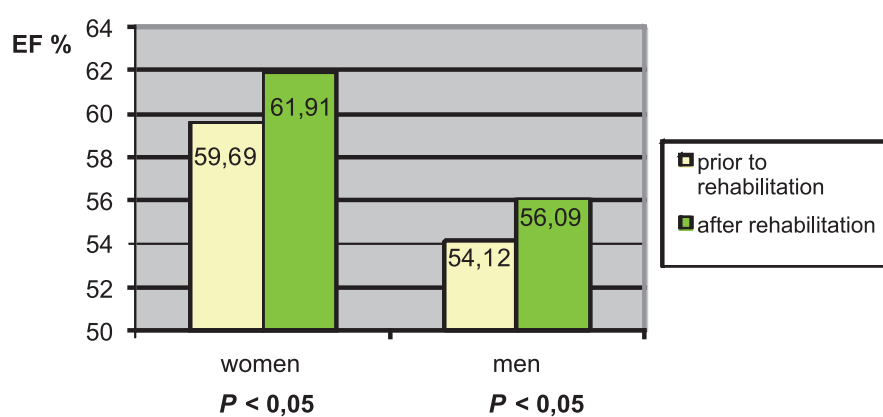


Fig. 2. Mean level of ejection fraction (EF) in women and men prior to and after rehabilitation

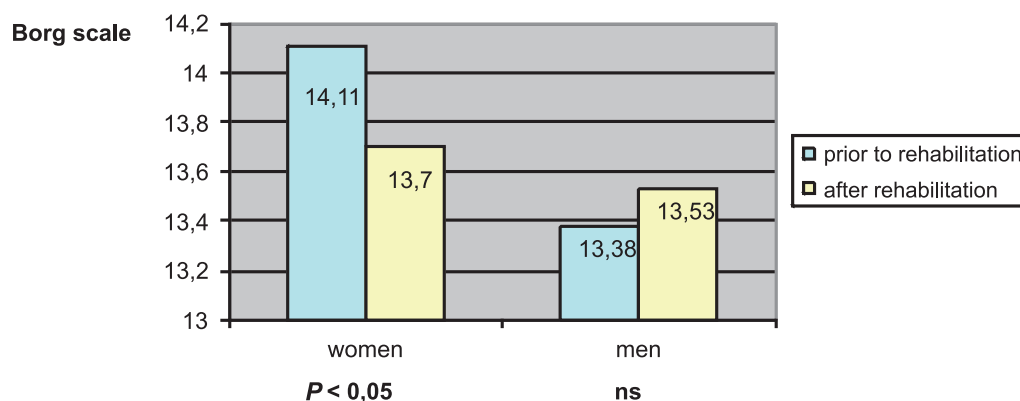


Fig. 3. Mean level perceived exertion experienced during exercise test performed prior to and after rehabilitation

[9], was documented in 23 women and 24 men prior to the rehabilitation, and in 23 women and 27 men following the completion of the program (Table 2).

In the case of women, the lowest values of EF were found to be 40% prior to the training and 37% after the program; the highest values of this parameter were 76% and 80% prior to and after the training, respectively. In men, the lowest and the highest pre-training values of EF were 30% and 69%, respectively; post-training values ranged between 33% and 75%. An increase in ejection fraction was documented in 16 women (59.3%); no changes in this parameter were

observed in four female patients (14.8%), and seven women (25.9%) showed post-training reduction. EF increased in response to rehabilitation program in the case of 18 men (52.9%), while no changes or reduction of this parameter were observed in 5 (14.7%) and 11 male patients (32.4%), respectively. Both women and men were characterized by significant rehabilitation-related improvement in EF: from $59.69\% \pm 9.07$ to $61.91\% \pm 10.41$ in women ($P < .05$), and from $54.12\% \pm 10.44$ to $56.09\% \pm 9.64$ in men ($P < .05$; Fig. 2).

Women showed a significant reduction in the Borg rating of perceived exertion during post-training exer-

cise test: from 14.11 ± 1.09 prior to the rehabilitation to 13.7 ± 1.14 post-rehabilitation ($P < .05$). Similar rehabilitation-related changes were not documented in male patients (Fig. 3).

Before rehabilitation comparing the results female to male patients (Table 3) it was found lower physical efficiency ($P < .05$), higher level of perceived exertion ($P < .01$) and higher ejection fraction ($P < .05$) in women. After rehabilitation the physical efficiency was improved in both groups however the difference between groups was more significant ($P < .01$). The level of perceived exertion was equaled in both groups (ns) due to reducing in women (Fig.3). Ejection fraction in women after rehabilitation was significantly higher ($P < .05$) although it was increased in both groups.

Statistical analysis revealed that a lower level of perceived exertion during the second exercise test was reported by one-third of all women ($n=9$), who were characterized by significantly poorer physical capacity, lower ejection fraction, and lower BMI after the rehabilitation program. This data suggests that despite a similar rehabilitation-related increase in MET, only a fraction of women showed a lower level of perceived exertion during the second exercise test. Probably, the reduction in ejection fraction observed in nine women occurred despite post-rehabilitation MET increase and

resulted from the fact that two of them had a history of two myocardial infarcts. Additionally, a lower level of perceived exertion correlated with a significant rehabilitation-related reduction of BMI only in this subgroup of women. In males, lower level of perceived exertion was documented solely in nine patients, who were characterized by higher MET during the second exercise test. The relationship between the level of perceived exertion and the changes in capacity, ejection fraction, and BMI is summarized in Table 4.

The results of the second (post-rehabilitation) exercise test showed that more women reached the target heart rate (12 vs. 8); also, less women were forced to discontinue the exercise test due to fatigue (12 vs. 16).

No significant rehabilitation-related changes in the degree of cardiac insufficiency symptoms expressed in NYHA scale and the grade of ischemic symptoms expressed in CCS scale were documented both in women and men.

Discussion

Physical exercise plays a vital role in the primary and secondary prevention of cardiovascular disorders. According to a number of authors, women may derive more benefit from cardiologic rehabilitation as compared to men due to their lower baseline capac-

Table 3. *Peak metabolic equivalents (MET) and level of perceived exertion (Borg) experienced during peak exercise, and ejection fraction (EF) in women and men prior to and after rehabilitation*

		Women (n=27)	Men (n=34)	P
Prior to rehabilitation	MET	4.30 ± 2.61	5.85 ± 2.60	*
	Borg	14.11 ± 1.09	13.38 ± 1.01	**
	EF	59.69 ± 9.07	54.12 ± 10.44	*
After rehabilitation	MET	6.36 ± 2.21	8.38 ± 2.57	**
	Borg	13.70 ± 1.14	13.53 ± 1.19	ns
	EF	61.91 ± 10.41	56.09 ± 9.64	*

ns – non-significant

* $P < 0.05$

** $P < 0.01$

Table 4. *Perceived exertion (Borg) in relation to other parameters studied in women and men*

parameter	Borg scale	Women (n=27)			Men (n=34)		
		nc /↑ level n = 18	↓ level n = 9	P	nc /↑ level n = 25	↓ level n = 9	P
Δ BMI		0.08 ± 1.23	-0.45 ± 1.1	ns	0.26 ± 1.18	0.16 ± 0.79	ns
Δ MET		2.09 ± 1.97	2.0 ± 1.66	ns	2.4 ± 2.0	2.88 ± 1.97	ns
Δ EF		2.33 ± 6.12	0.11 ± 5.67	ns	2.48 ± 4.71	0.44 ± 6.54	ns
BMI II		31.71 ± 3.77	27.39 ± 1.93	*	26.42 ± 2.87	28.78 ± 4.4	ns
MET II		7.17 ± 2.32	5.78 ± 2.0	*	7.80 ± 2.56	10.0 ± 1.87	*
EF II		63.72 ± 10.07	55.12 ± 10.24	*	55.2 ± 10.6	58.56 ± 6.1	ns

nc – no change

ns – non-significant

* $P < 0.05$

ity [8,10,11]. Women with heart failure demonstrate similar patterns of improvement during cardiac rehabilitation compared with men and, in fact, show greater improvements in fitness and longer term exercise levels [12].

The Iowa Women Health study revealed that the mortality rate due to cardiovascular causes is twice as low in the most physically active women as compared to those that are least physically active; this phenomenon occurred irrespectively of the diet [13,14].

Blair et al. observed a strong inverse relationship between the degree of physical capacity and all-cause mortality for women and men. The strong inverse correlation between IHD-specific mortality and physical capacity was observed even after adjusting the results for cigarette smoking, arterial hypertension, elevated cholesterol and glucose, high BMI, and familial predisposition to IHD [15].

Oldridge and O'Connor revealed that the 3-year mortality rate of myocardial infarct patients participating in cardiac rehabilitation program is lower by 25% as compared to the controls [16,17].

The meta-analysis by Berlin et al. documented that the most active and most efficient individuals are characterized by two times lower IHD-specific mortality risk [18].

Recent reports show that higher baseline fitness predicted lower mortality. The novel finding was that improvement in fitness during a cardiac rehabilitation program and improvements that persisted at 1 year were also associated with decreased mortality, most strongly in patients who start with low fitness. At 1 year, each MET increase in cardiorespiratory fitness was associated with a 25% point reduction in overall mortality [19].

Similar conclusions were formulated by O'Callaghan et al., who studied a group of 37 women and 227 men with a history of myocardial infarct and aortal-coronary bypass and observed a positive effect of physical exercise manifested as improved physical capacity [20].

Exercise capacity was significantly improved among women completing different cardiac rehabilitation programs (gender-specific "tailored" program compared with a traditional cardiac rehabilitation). Modifiable factors positively associated with post-training capacity included reduced waist circumference and improved physical functioning [21].

Similar study performed by Cannistra et al. in a group of 174 men and 51 women delivered measurable improvement in both genders. After completing the rehabilitation program, exercise duration increased by 31% and 21% in women and men, respectively; also, MET values improved by 30% and 16%, respectively [22].

Ades et al. conducted analogous study in a group of older patients (at least 62 years of age). During

the 12-week period, the group of 226 patients with IHD participated in multidisciplinary training with a frequency of three times per week. The peak oxygen uptake was increased by 17% and 19% for women and men, respectively. We would like to emphasize that women were qualified to the cardiac rehabilitation programs less frequently than men, although the baseline clinical status of patients was similar for both genders [8,23].

Also, our study revealed a positive effect of rehabilitation on physical capacity and ejection fraction of women and men after myocardial infarct; additionally, the reduction of post-exercise self-reported perceived exertion was observed in female patients.

The improved ejection fraction is the expected training-related benefit. This was confirmed in the study by Specchia et al. who analysed the relationship between physical training, ejection fraction, and the prognosis of IHD in patients with a history of one myocardial infarct. Multivariate analysis revealed low ejection fraction as the only independent prognostic factor of future coronary episodes. EF below 40% was associated with 8.63-fold higher risk of another training-related coronary episode in physically inactive individuals as compared to the trained subjects. In contrast, the risk was similar for both groups if ejection fraction was above 40% [23,24].

In our study the significant improvement of ejection fraction was found in both groups, however before and after training significant lower EF was observed in male patients. It can be suggested that lower EF in men was due to recurrent myocardial infarction in 41% participants while in women it was only in 11%.

It is particularly desirable to refer post-myocardial infarct women to specialist cardiac rehabilitation due to their markedly lower participation rate in post-infarct rehabilitation programs [23,25] as well as the necessity of increasing one's physical activity as a component of secondary prevention. Women participate in the specialist rehabilitation less frequently because they do not perceive IHD as a real threat to life and consider the activities of daily living to constitute a sufficient amount of physical activity. Consequently, motivating female patients to increased physical activity by explaining the benefits of such attitude with regards to the overall physical capacity and improved cardiovascular function becomes vitally important within the framework of cardiologic management.

Conclusions

The participation of post-myocardial infarct women in cardiac rehabilitation program has a positive impact on their physical capacity and lower feeling the load of effort.

Systematic physical training included in the cardiac rehabilitation program significantly improves ejection fraction in women.

The positive impact of physical activity on the overall capacity and cardiac function, show that cardiac rehabilitation should be routinely prescribed alongside pharmacological agents and surgical treatment, particularly in the case of women.

Declaration of interest

The author reports no conflicts of interest.

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