

Health-Related Quality of Life in Patients With Coronary Heart Disease After Residential vs Ambulatory Cardiac Rehabilitation

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Background: The aim of this study was to evaluate the influence of residential (RCR) vs ambulatory (ACR) cardiac rehabilitation (CR) on health-related quality of life (QOL) connected with changes in exercise capacity of patients with coronary heart disease (CHD).

Methods and Results: The 562 patients with CHD were studied: 313 participants in RCR and 249 participants in ACR. The examination was performed at the beginning of CR and after 8 weeks. QOL was assessed using the EuroQuol 5D (EQ-5D) and SF36 questionnaires. Exercise testing was performed with evaluation of workload during the last stage of the test and rate of perceived exertion intensity. In the first examination, patients from both groups did not differ significantly. After 8 weeks, a similar improvement in QOL was observed in both settings of CR according to EQ-5D and SF36 results. Health status was improved by 11.1% in the RCR group and by 10.4% in the ACR group. Last workload's intensity increased significantly by 32.1% in the RCR group and by 38.1% in the ACR group. The rate of perceived exertion intensity did not change despite the bigger workloads during the exercise test.

Conclusions: Comprehensive CR improves health-related QOL and exercise capacity without differences between residential and ambulatory models. (Circ J 2009; 73: 476–483)

Key Words: Cardiac rehabilitation; Exercise capacity; Health-related quality of life

The number of people who survive myocardial infarction or undergo percutaneous coronary intervention (PCI) or coronary artery bypass graft surgery (CABG) is growing. These people require adequate treatment and care not only pharmacologically but also non-pharmacologically: physiotherapeutic, psychological and educational. Comprehensive cardiac rehabilitation (CR) is designed to support patients with coronary heart disease (CHD) in their physical, psychological and emotional recovery after acute coronary events and to help them change lifestyle and risk factors, as well as to make their lives longer and improve their quality.

Most published studies analyzing the effects of CR have revealed a reduction in total mortality by an average of 30% and cardiovascular mortality by an average of 40%^{1–10}

and also reduction in cardiovascular events risk^{1,4,11}

Recently, not only mortality and morbidity but also health-related quality of life (QOL) has become a key goal for patients with CHD. Many published studies have revealed improvements in the health-related QOL of patients with CHD after CR programs, either the residential model or ambulatory CR (ACR)^{12–23}

The aim of this study was to evaluate the impact of different models of CR, residential vs ambulatory, on health-related QOL according to the exercise capacity of patients with CHD.

Methods

This study was designed as a nonrandomized prospective multicenter study in Poland: the National Program of Prevention and Therapy of Cardiovascular Diseases (POLKARD). We studied 562 patients with CHD from 9 centers of CR in Poland. Consecutive patients were referred to 3 ACR and 6 residential CR (RCR) centers no longer than 2 weeks after myocardial infarction or PCI, and no longer than 6 weeks after CABG.

The reason for the choice of ACR or RCR center was not the patient's clinical state or risk profile for cardiovascular events, but which type of CR was available where the patient lived. Therefore, randomization in our study was impossible.

The first group consisted of 313 patients aged 56.1±8.8

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Table 1. Characteristic of Patients With CHD Who Participated in CR (n=562): Gender, Clinical Reason for Participation in CR Program, Pharmacotherapy and Main Risk Factors of CHD

Characteristic of patients	CR (n=562)		P value: ambulatory vs residential
	Residential (%) (n=313)	Ambulatory (%) (n=249)	
Gender			
Female	11.8	22.9	<0.05
Male	88.2	77.1	<0.05
Reason for rehabilitation			
AMI without PCI and/or CABG	8.3	12	NS
AMI with PCI and/or CABG	58.5	59.1	NS
PCI and/or CABG except AMI	33.2	28.9	NS
Medication			
β -blockers	91.4	92.3	NS
ACE inhibitors	74.8	74.4	NS
Acetylsalicylic acid	96.5	97.9	NS
Statins	93.9	94.0	NS
Calcium-channel blockers	8.0	6.4	NS
Coexisting diseases/risk factors			
Hypertension	63.2	67.1	NS
Hypercholesterolemia	31.3	47.0	<0.05
Hypertriglyceridemia	7.0	8.1	NS
Mixed hyperlipidemia	23.3	14.5	<0.05
Depression	4.8	2.6	NS
Diabetes mellitus	14.4	18.8	NS
Obesity	21.4	27.4	NS
Smoking habit			
Smoker	16.6	14.1	NS
Ex-smoker	58.8	62.4	<0.05
Non-smoker	24.6	23.5	NS

CHD, coronary heart disease; CR, cardiac rehabilitation; AMI, acute myocardial infarction; PCI, percutaneous coronary intervention; CABG, coronary artery bypass graft; ACE inhibitors, angiotensin-converting enzyme inhibitors.

years who participated in RCR and the second group of 249 patients aged 57.4 ± 9.1 years participated in ACR.

In both settings, physical training was based on endurance exercise, mainly riding on a stationary bicycle, with a small amount of resistance training. The RCR group had 3–5 sessions per week of 30 min of cycling and 3–5 sessions per week of 30 min of gymnastics. The ACR group had training sessions 3 times a week for 1 h (30 min of cycling and 30 min of general fitness exercises). Maximal intensity of training based on training heart rate (THR) was calculated by Karvonen's formula: $\text{THR} = \text{rest HR} + 0.6\text{--}0.8 (\text{peak HR} - \text{rest HR})$, where the peak HR is the that achieved during submaximal exercise test.²⁴ Education about risk factors (ie, recommendations concerning physical activity, professional help in quitting smoking, sessions with dieticians and also psychological support) was provided to patients of RCR and ACR to help them change aspects of their lifestyle that can decrease their risk of cardiovascular events.

ACR lasted for 8 weeks, RCR lasted for 3 weeks, and then physical training was continued individually at home for the next 5 weeks according to the doctor's recommendations. All patients who attended RCR programs were instructed to continue systematic physical training (stationary cycloergometer, bicycle, jogging, swimming) in the next weeks at least 3 times weekly for 30 min with individually prescribed intensity. Intensity during home training was self-controlled with measurement of pulse and was limited by training HR calculated according to the Karvonen formula based on exercise testing performed at the end of the RCR.

An examination was performed at the beginning of CR (examination I) and after 8 weeks (examination II) in both groups. Data connected with the amount of exercise training performed at home individually were confirmed by taking

an exact medical history and with the 7-day physical activity recall (SDPAR) questionnaire during examination II (after 5 weeks of home training). The SDPAR questionnaire is a self-reporting instrument for assessing physical activity. Patients were asked about the number of hours spent in sleep, moderate, hard, and very hard activities during the preceding week. These data enabled us to calculate daily energy expenditure in kilocalories.²⁵

QOL was assessed using EuroQuol 5D (EQ-5D)^{26–28} and the Short Form (SF36) questionnaires.^{29,30} The EQ-5D questionnaire has 5 dimensions: mobility, self-care, usual activities, pain/discomfort, and anxiety/depression. Each dimension has 3 levels: no problems (no limitations), some problems and severe problems. Furthermore, health status was measured on a visual analog scale (VAS) in which 0 denotes the worst imaginable health state and 100 the best imaginable health state. Permission to use the EQ-5D questionnaire was obtained from the EuroQuol Group. According to the SF36 questionnaire, physical, psychological and social functioning was measured. The SF36 is a widely used, valid, generic health-related QOL questionnaire consisting of 36 items that form 2 components: physical and psychological. The physical aspect of health comprises physical functioning, role-physical, bodily pain, and vitality, and the psychological aspect of health is composed of role-emotional, social functioning, and mental health. Permission to use it was obtained with the License No. R1-020405-21347.

The submaximal modified Bruce multistage protocol exercise test was also performed with evaluation of workload during the last stage of the examination (in METs) and the rate of perceived exertion on the Borg scale.³¹ Exercise tests were limited by HR limit: $\text{HR} = 85\% \times \text{HR max}$ accord-

Table 2. Quality of Life According to EuroQuol 5D and SF36, Chosen Parameters of Cardiovascular Capacity and Exercise Tolerance in the Examined Patients in I Examination

Examined parameters	Mean values of evaluated parameters in I examination		P value: ambulatory vs residential group
	RCR group (n=313)	ACR group (n=249)	
EuroQuol 5D			
Mobility (%)*	74.4	65.0	NS
Self-care (%)*	91.0	87.3	NS
Usual activities (%)*	63.8	54.2	NS
Pain/discomfort (%)*	35.4	25.4	NS
Anxiety/depression (%)*	33.1	27.4	NS
VAS (in points)	65.7±16.4	65.2±16.2	NS
SF36 physical aspect of health (in points)			
Physical functioning	25.1±4.0	23.9±4.3	NS
Role—physical	5.4±1.6	5.2±1.5	NS
Bodily pain	7.5±2.7	7.5±2.7	NS
Vitality	15.3±3.7	14.3±3.8	<0.05
SF36 psychological aspect of health (in points)			
Role—emotional	4.6±1.3	4.7±1.2	NS
Social functioning	6.9±2.1	6.8±2.0	NS
Mental health	21.3±4.7	19.6±5.1	<0.05
Heart rate at rest (beats/min)	63.8±8.9	66.5±12.4	<0.05
Systolic blood pressure at rest (mmHg)	122.6±16.2	123.9±14.6	NS
Diastolic blood pressure at rest (mmHg)	77.3±9.5	78.3±9.3	NS
Workload during the last stage of the exercise test (METs)	7.0±2.4	6.6±2.8	NS

*Percentage of patients who did not report problems.

RCR, residential cardiac rehabilitation; ACR, ambulatory cardiac rehabilitation; VAS, visual analog scale.

ing to age or with symptoms (ie, clinical, ECG and/or blood pressure changes). Patients treated with β -blockers had a decreased HR limit by 10% according to the American Heart Association recommendations³²

Part of the examination also comprised:

- evaluation of coronary artery insufficiency according to the CCS classification and heart failure cardiac insufficiency according to New York Heart Association (NYHA)
- measurement of weight, height and body mass index (BMI: kg/m²)
- echocardiographic examination (2D and Doppler)

patients with left ventricular ejection fraction <35% according to echocardiography were excluded from our study.

Information on coexisting diseases and risk factors of cardiovascular diseases such as hypertension, diabetes, obesity, hyperlipidemia, depression and smoking habit based on previous medical documentation was collected.

Data concerning costs of RCR and ACR from each rehabilitation center were also collected, calculated and presented as costs per intervention per patient. The mean difference in the cost between ACR and RCR are presented as a fraction of the mean cost of ACR.

Statistical Analysis

Results are presented as means \pm standard deviation (SD). To compare the means of measurable variables, the test for 2 independent samples (in case of comparisons of mean values in 2 groups) or the test for dependent samples (in case of comparisons concerning mean values in the same group, at 2 different time points) were used.

Prevalence of chosen parameters in 2 groups was compared by means of 2 fractions from big samples; correlations between the quantitative parameters were determined by the Pearson's correlation coefficient.

To compare the mean values for quantitative variables,

the Student's t-test was used. Differences between groups and changes over time within each group were assessed by repeated measure analysis of variances. Relation between parameters of QOL and exercise capacity was calculated in each group. Differences were considered as significant at $P < 0.05$. The statistical software program used was Statgraphics Centurion.

Results

The characteristics of the examined patients are shown in **Table 1**. Although the majority of patients participating in both models of CR were males, there was a statistically significantly higher percentage of women in the ACR group than in the RCR (12% vs 23%). Patients with CHD were referred to CR after acute myocardial infarction, and/or PCI or after CABG. The majority of patients in both groups were classified as class I or II of the CCS and NYHA classifications. Patients who participated in RCR or ACR were treated with the same groups of drugs: most were taking platelet inhibitors (usually acetylsalicylic acid), statins, β -blockers and angiotensin-converting enzyme inhibitors.

The presence of other diseases or risk factors of CHD was similar in both groups of patients. The difference between groups was observed only in lipoprotein disorders. The patients who participated in ACR more often suffered from hypercholesterolemia, whereas in the RCR group mixed hyperlipidemia was more frequent.

The results of the QOL at the beginning of CR in the examined patients are presented in **Table 2**. In examination I, patients from both groups did not differ significantly in terms of mobility, self-care, usual activities, pain/discomfort and anxiety/depression, measured with EQ-5D. Also, the health status measured on the VAS was similar at 65.7±16.4 points in the RCR group and 65.2±16.2 points in the ACR group (NS). Physical and psychological aspects of health

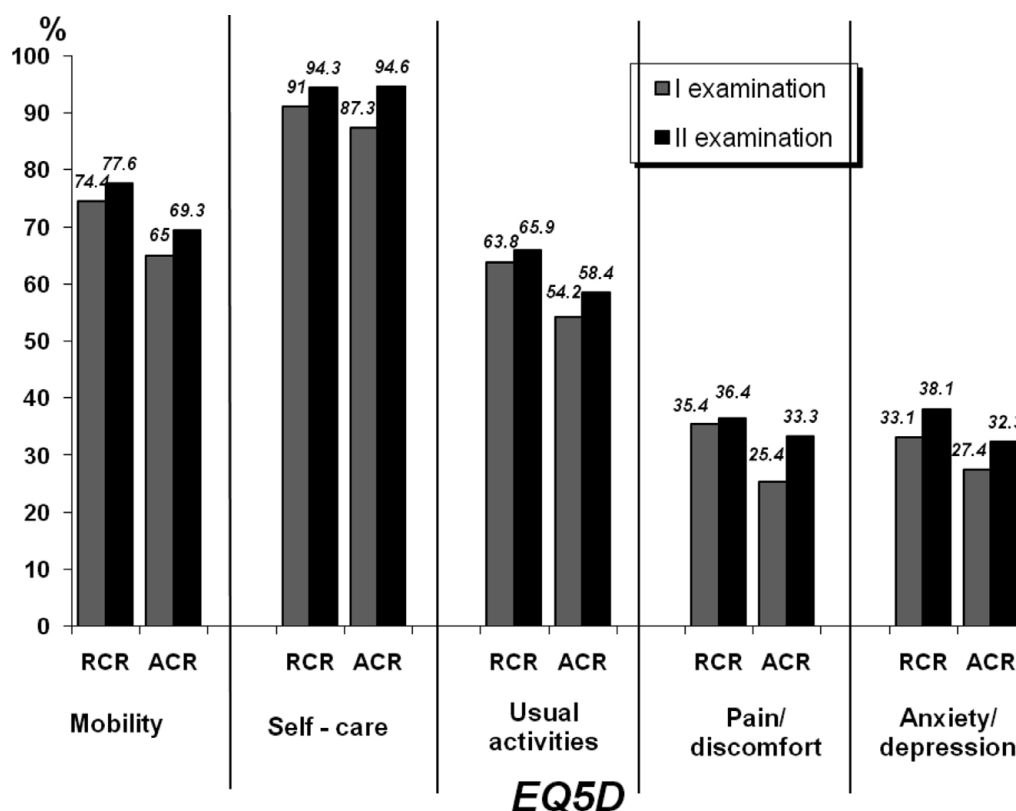


Figure 1. Percentage of patients who reported no problems in the 5 dimensions of the EQ-5D among participants in residential and ambulatory cardiac rehabilitation (RCR/ACR) in examinations I and II. * $P < 0.05$ II vs I examination.

according to SF36 were very similar in the examined groups, too. Only in terms of vitality and mental health were small differences observed to the RCR group's advantage.

At the beginning of CR, chosen parameters of cardiovascular capacity in both groups of patients were similar (Table 2). Only the mean value of HR was lower in the RCR group in comparison with the ACR group. The workload during the last stage of the exercise test and the rate of perceived exertion on the Borg scale was also similar in both groups of patients.

After 8 weeks, an improvement in the QOL according to EQ-5D in the majority of parameters was observed in both settings of CR (Figure 1). Health status (VAS) had improved similarly in both groups, by 11.1% in the RCR group and by 10.4% in the ACR group (NS) (Figure 2).

Improvement in almost all aspects of physical, psychological and social functioning according to SF36 was observed in both groups of patients (Figures 3a, b). The highest improvement was observed in bodily pain, with an increase in the percentage of patients who did not report problems by 29.0% in the RCR group and by 38.2% in the ACR (NS).

After 8 weeks of observation, last workloads increased significantly from 7.0 ± 2.4 to 8.6 ± 2.5 METs by 32.1% in the RCR group and from 6.6 ± 2.8 to 7.9 ± 2.5 METs by 38.1% in the ACR group (Figure 4). Differences between groups were statistically insignificant. The rate of perceived exertion on the Borg scale was unchanged after 8 weeks in both groups of patients, despite the bigger workloads during the exercise test (Figure 5).

Our study also revealed that changes in health-related QOL according to the EQ-5D and SF36 questionnaires were

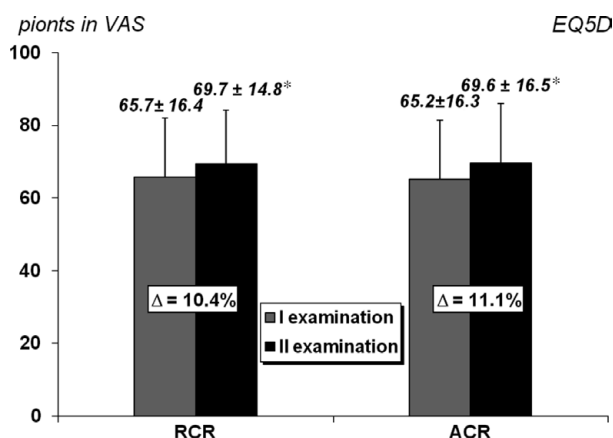


Figure 2. Health status measured on the visual analog scale (VAS) according to the EQ-5D in patients who participated in residential and ambulatory cardiac rehabilitation (RCR/ACR) in examinations I and II. * $P < 0.05$ II vs I examination. Δ Percentage difference between II vs I examination.

not modified by the changes in exercise capacity after CR. For most parameters of health-related QOL, those relations were statistically not significant (R from 0.002 to 0.18, NS).

Cost analysis showed that ACR is cheaper than RCR. Mean costs per intervention per patient of the RCR program in our study were higher by 65% than for the ACR.

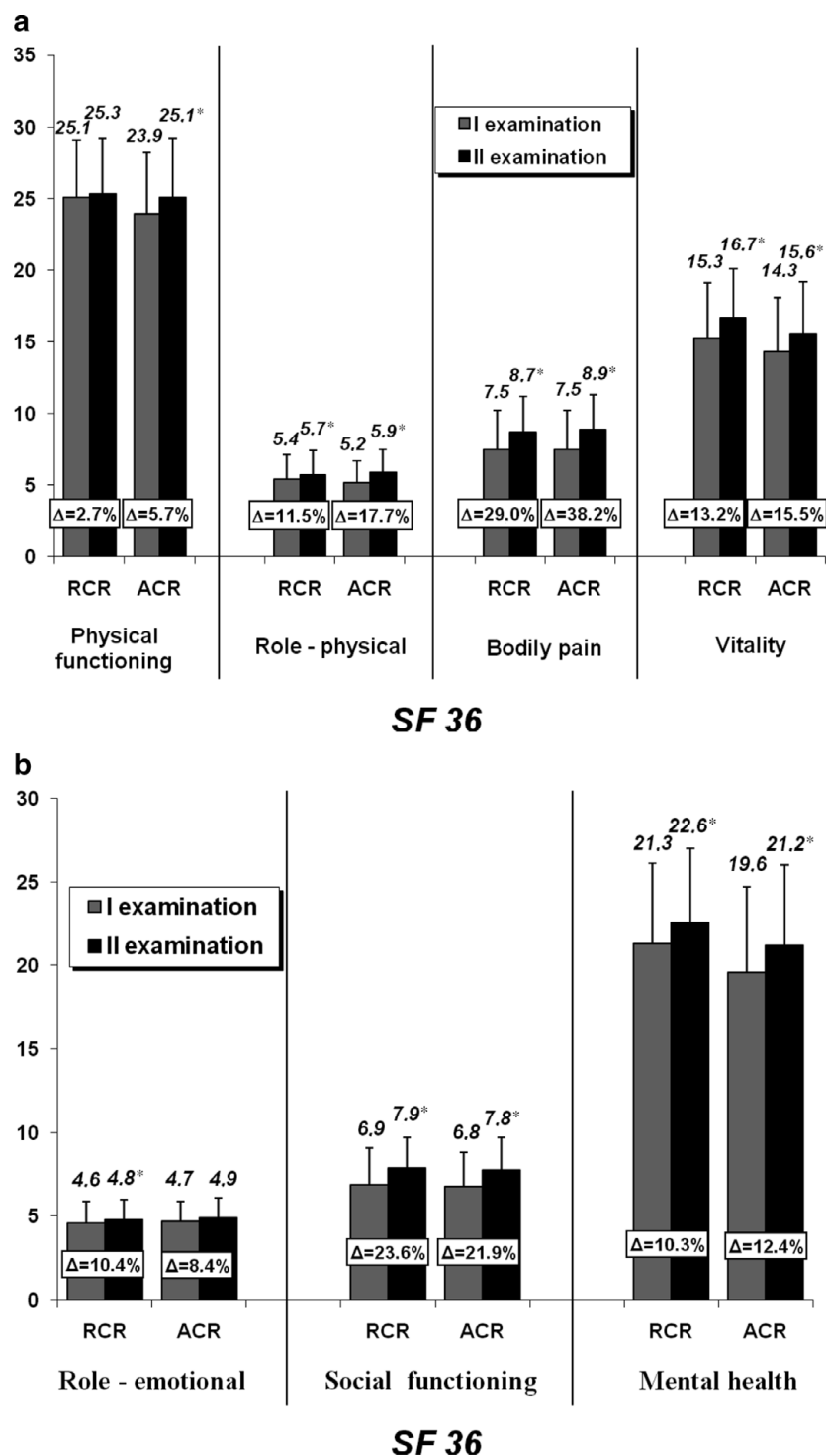


Figure 3. (a) Physical aspect of health according to SF36 in patients who participated in residential and ambulatory cardiac rehabilitation (RCR/ACR) in examinations I and II. * $P < 0.05$ II vs I examination. Δ Percentage difference between II vs I examination. (b) Psychological aspect of health according to SF36 in patients who participated in RCA and ACR in examinations I and II. * $P < 0.05$ II vs I examination. Δ Percentage difference between II vs I examination.

Discussion

There is evidence that patients who undergo comprehensive CR have the major benefit of secondary prevention of CHD. Our study was designed to compare the impact of 2 different models of CR, RCR, which is more expensive, and the cheaper ACR, on health-related QOL. The results of our investigation reveal that in patients with cardiovascular disease who participated in 8 weeks of comprehensive CR, without differences in which model, ambulatory or residential, they undertook, there were statistically significant

improvements in health-related QOL, as well as in ability to exercise. The value of the last workloads during the exercise test increased significantly, while the rate of the perceived exertion on the Borg scale was unchanged during this period.

Previous studies have revealed that programs based only on systematic physical activity improve exercise capacity and the ability to perform physical exercise^{3,5}

Psychological and educational interventions have additional effects and can lead to changes in risk factors, in the patient's life style, and social and psychological function-

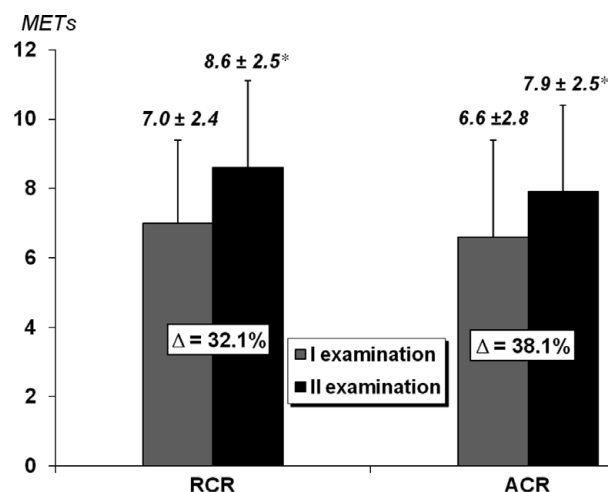


Figure 4. Workload during the last stage of the submaximal exercise test (in METs) in patients who participated in residential and ambulatory cardiac rehabilitation (RCR/ACR) in examinations I and II. * $P < 0.05$ II vs I examination. Δ Percentage difference between II vs I examination.

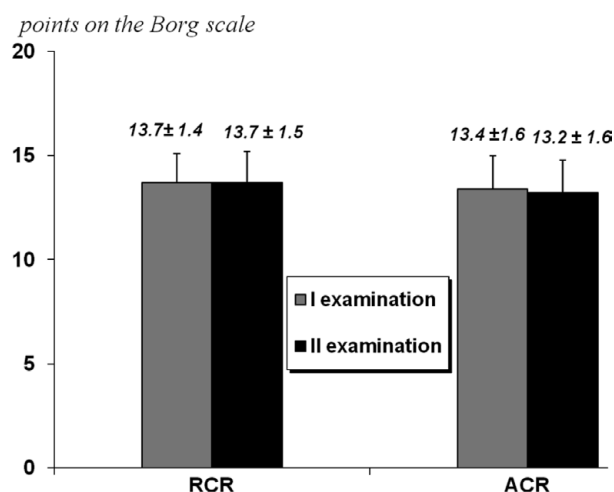


Figure 5. Rate of perceived exertion on the Borg scale in patients who participated in residential and ambulatory cardiac rehabilitation (RCR/ACR) in examinations I and II.

ing^{1,2,7,33–38}

Many published studies have shown an increase in health-related QOL in patients with CHD who undergo CR.^{1,3,5–11,22,39–41} More profound changes have been observed in patients who participate in comprehensive CR programs based on physical activity as well as psychological and educational approaches, compared with patients who have only physical training.^{1,11} However, there are some published studies that indicate that after an uncomplicated revascularization procedure, physical training results in a comparable effect on QOL, compared with a more comprehensive program including an additional psycho-educational intervention program.¹⁷

ACR should be recommended for moderate- and low-risk patients, whereas RCR should be recommended for patients in a more severe clinical state, high-risk patients with, for instance, developed heart failure. Those patients more often develop complications or worsening of their functional state, including cardiac events, during exercise therapy^{42,43} which is why heart failure patients should be supervised much more carefully, needing medical care 24 h/day at the beginning of the CR program at least and is the reason why we excluded patients with left ventricular ejection fraction $< 35\%$. Randomization was not performed in our study because in some regions of our country only one type of CR, ambulatory or residential, is available and so there is no choice for doctors and/or patients.

In our observation the 2 groups of patients examined (ACR and RCR groups) had comparable baseline characteristics. We revealed an improvement in the QOL in the majority of parameters in both settings of CR. Many previously published studies demonstrate an improvement in QOL after CR in patients with cardiovascular diseases, although the results came from different models of CR programs (home-based, hospital-based and ambulatory) and different groups of patients.^{12–23,39–41} An improvement in the exercise capacity of CR patients as a result of physical activity similar to our results was also observed in previous studies.^{3,5,44,45}

We found no correlation between increasing exercise capacity and the improvement in health-related QOL accord-

ing to EQ-5D and SF36. Improvement in health-related QOL observed after 8 weeks of CR depends not only on the improvement in exercise capacity. There are probably many other factors that influence QOL, such as general condition, psychological status, coexisting diseases or the time that has passed since myocardial infarction or coronary intervention. The highest anxiety is observed in the first hours and days after the coronary event and then it decreases with time and good care.

The impact of CR in women might be different than in men, but in our study this evaluation was impossible to perform because there were too few women. The higher percentage of females participating in ACR in comparison with the residential model may be connected with taking part in rehabilitation without disturbing their family life. In our study, women constituted only 16.2% of all participants. In the UK, for example, only approximately 15% of female patients undergo CR, although women constitute 30% of all patients suffering from CHD in that country.^{1,2,46} Many published studies showed that programs of CR in many countries are concentrated on low-risk male patients who have had a myocardial infarction.^{1,47} There is no evidence that other groups of patients, such as women, the elderly or ethnic minorities, would not benefit from CR, so investigations are needed in these groups of patients suffering from cardiovascular diseases.

Our study revealed that the cost of RCR was higher by 65% than for ACR. RCR, which was shorter, lasting only 3 weeks under supervised conditions refunded by the National Health System, was more expensive than the ACR program, which lasted for 8 weeks. Very similar results for the 2 models of CR were achieved with different expenses.

The EQ-5D questionnaire comprises only 5 dimensions and is widely used in cost-effectiveness studies.⁴⁸ The more complex SF36 questionnaire enables evaluation of many more aspects of health-related QOL and is probably more suitable for patients with cardiovascular diseases than the easier, but more general, EQ-5D.

Advantages and Disadvantages of the Study

The advantage of our study is that both groups of patients,

participating in RCRI and ACR, were very similar in aspects of age, health status, pharmacological treatment, risk factors for cardiovascular diseases, comorbidities and QOL, at the beginning of the research. It was a good base for evaluating the impact of the 2 different models of CR.

Unfortunately, we compared 8 weeks of supervised comprehensive intervention in the ACR group with 3 weeks of supervised comprehensive intervention during hospitalization, continued with 5 weeks of home individual training in the RCR group. It would be better if we could compare the same length of supervised intervention, but in our country RCR is recommended only for 3 weeks and cannot be refunded later in the ambulatory setting.

Conclusions

Health-related QOL and exercise capacity improve after 8-week comprehensive CR without differences between the residential and ambulatory models. The improvement of health-related QOL after 8 weeks of CR did not depend on an increase in exercise capacity. The fact that the ambulatory model of CR leads to very similar changes in health-related QOL and exercise capacity as the residential model may be an argument for increasing the number of ambulatory centers in rational health-care politics.

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